

ELECTRONIC DESIGN

Meeting the Reliability Challenge, a Special Report . . . p 33



MICROWAVES...p 177

ELECTRONIC DESIGN - ONE DAY SERVICE USE BEFORE NOVEMBER 8th, 1961

Name _____ Title _____

Company _____

Company Address _____ City _____ Zone _____ State _____

10 20 30 40	50 60 70 80 90	100 110 120 130 140	150 160 170 180 190	200 210 220 230 240	250 260 270 280 290
1 11 21 31 41	51 61 71 81 91	101 111 121 131 141	151 161 171 181 191	201 211 221 231 241	251 261 271 281 291
2 12 22 32 42	52 62 72 82 92	102 112 122 132 142	152 162 172 182 192	202 212 222 232 242	252 262 272 282 292
3 13 23 33 43	53 63 73 83 93	103 113 123 133 143	153 163 173 183 193	203 213 223 233 243	253 263 273 283 293
4 14 24 34 44	54 64 74 84 94	104 114 124 134 144	154 164 174 184 194	204 214 224 234 244	254 264 274 284 294
5 15 25 35 45	55 65 75 85 95	105 115 125 135 145	155 165 175 185 195	205 215 225 235 245	255 265 275 285 295
6 16 26 36 46	56 66 76 86 96	106 116 126 136 146	156 166 176 186 196	206 216 226 236 246	256 266 276 286 296
7 17 27 37 47	57 67 77 87 97	107 117 127 137 147	157 167 177 187 197	207 217 227 237 247	257 267 277 287 297
8 18 28 38 48	58 68 78 88 98	108 118 128 138 148	158 168 178 188 198	208 218 228 238 248	258 268 278 288 298
9 19 29 39 49	59 69 79 89 99	109 119 129 139 149	159 169 179 189 199	209 219 229 239 249	259 269 279 289 299
300 310 320 330 340	350 360 370 380 390	400 410 420 430 440	450 460 470 480 490	500 510 520 530 540	550 560 570 580 590
301 311 321 331 341	351 361 371 381 391	401 411 421 431 441	451 461 471 481 491	501 511 521 531 541	551 561 571 581 591
302 312 322 332 342	352 362 372 382 392	402 412 422 432 442	452 462 472 482 492	502 512 522 532 542	552 562 572 582 592
303 313 323 333 343	353 363 373 383 393	403 413 423 433 443	453 463 473 483 493	503 513 523 533 543	553 563 573 583 593
304 314 324 334 344	354 364 374 384 394	404 414 424 434 444	454 464 474 484 494	504 514 524 534 544	554 564 574 584 594
305 315 325 335 345	355 365 375 385 395	405 415 425 435 445	455 465 475 485 495	505 515 525 535 545	555 565 575 585 595
306 316 326 336 346	356 366 376 386 396	406 416 426 436 446	456 466 476 486 496	506 516 526 536 546	556 566 576 586 596
307 317 327 337 347	357 367 377 387 397	407 417 427 437 447	457 467 477 487 497	507 517 527 537 547	557 567 577 587 597
308 318 328 338 348	358 368 378 388 398	408 418 428 438 448	458 468 478 488 498	508 518 528 538 548	558 568 578 588 598
309 319 329 339 349	359 369 379 389 399	409 419 429 439 449	459 469 479 489 499	509 519 529 539 549	559 569 579 589 599
600 610 620 630 640	650 660 670 680 690	700 710 720 730 740	750 760 770 780 790	For employment brochures give home address	870 880 890
601 611 621 631 641	651 661 671 681 691	701 711 721 731 741	751 761 771 781 791		871 881 891
602 612 622 632 642	652 662 672 682 692	702 712 722 732 742	752 762 772 782 792		872 882 892
603 613 623 633 643	653 663 673 683 693	703 713 723 733 743	753 763 773 783 793		873 883 893
604 614 624 634 644	654 664 674 684 694	704 714 724 734 744	754 764 774 784 794		874 884 894
605 615 625 635 645	655 665 675 685 695	705 715 725 735 745	755 765 775 785 795		875 885 895
606 616 626 636 646	656 666 676 686 696	706 716 726 736 746	756 766 776 786 796		876 886 896
607 617 627 637 647	657 667 677 687 697	707 717 727 737 747	757 767 777 787 797		877 887 897
608 618 628 638 648	658 668 678 688 698	708 718 728 738 748	758 768 778 788 798		878 888 898
609 619 629 639 649	659 669 679 689 699	709 719 729 739 749	759 769 779 789 799		879 889 899

If 25 or more items circled
please describe reasons:

For Change of Address:

Old Company Name _____

Old Company Address _____

City _____

Zone _____

State _____

I Do Design Work

I Supervise Design Work

I Do No Design Work

ELECTRONIC DESIGN - ONE DAY SERVICE USE BEFORE NOVEMBER 8th, 1961

Name _____ Title _____

Company _____

Company Address _____ City _____ Zone _____ State _____

10 20 30 40	50 60 70 80 90	100 110 120 130 140	150 160 170 180 190	200 210 220 230 240	250 260 270 280 290
1 11 21 31 41	51 61 71 81 91	101 111 121 131 141	151 161 171 181 191	201 211 221 231 241	251 261 271 281 291
2 12 22 32 42	52 62 72 82 92	102 112 122 132 142	152 162 172 182 192	202 212 222 232 242	252 262 272 282 292
3 13 23 33 43	53 63 73 83 93	103 113 123 133 143	153 163 173 183 193	203 213 223 233 243	253 263 273 283 293
4 14 24 34 44	54 64 74 84 94	104 114 124 134 144	154 164 174 184 194	204 214 224 234 244	254 264 274 284 294
5 15 25 35 45	55 65 75 85 95	105 115 125 135 145	155 165 175 185 195	205 215 225 235 245	255 265 275 285 295
6 16 26 36 46	56 66 76 86 96	106 116 126 136 146	156 166 176 186 196	206 216 226 236 246	256 266 276 286 296
7 17 27 37 47	57 67 77 87 97	107 117 127 137 147	157 167 177 187 197	207 217 227 237 247	257 267 277 287 297
8 18 28 38 48	58 68 78 88 98	108 118 128 138 148	158 168 178 188 198	208 218 228 238 248	258 268 278 288 298
9 19 29 39 49	59 69 79 89 99	109 119 129 139 149	159 169 179 189 199	209 219 229 239 249	259 269 279 289 299
300 310 320 330 340	350 360 370 380 390	400 410 420 430 440	450 460 470 480 490	500 510 520 530 540	550 560 570 580 590
301 311 321 331 341	351 361 371 381 391	401 411 421 431 441	451 461 471 481 491	501 511 521 531 541	551 561 571 581 591
302 312 322 332 342	352 362 372 382 392	402 412 422 432 442	452 462 472 482 492	502 512 522 532 542	552 562 572 582 592
303 313 323 333 343	353 363 373 383 393	403 413 423 433 443	453 463 473 483 493	503 513 523 533 543	553 563 573 583 593
304 314 324 334 344	354 364 374 384 394	404 414 424 434 444	454 464 474 484 494	504 514 524 534 544	554 564 574 584 594
305 315 325 335 345	355 365 375 385 395	405 415 425 435 445	455 465 475 485 495	505 515 525 535 545	555 565 575 585 595
306 316 326 336 346	356 366 376 386 396	406 416 426 436 446	456 466 476 486 496	506 516 526 536 546	556 566 576 586 596
307 317 327 337 347	357 367 377 387 397	407 417 427 437 447	457 467 477 487 497	507 517 527 537 547	557 567 577 587 597
308 318 328 338 348	358 368 378 388 398	408 418 428 438 448	458 468 478 488 498	508 518 528 538 548	558 568 578 588 598
309 319 329 339 349	359 369 379 389 399	409 419 429 439 449	459 469 479 489 499	509 519 529 539 549	559 569 579 589 599
600 610 620 630 640	650 660 670 680 690	700 710 720 730 740	750 760 770 780 790	For employment brochures give home address	870 880 890
601 611 621 631 641	651 661 671 681 691	701 711 721 731 741	751 761 771 781 791		871 881 891
602 612 622 632 642	652 662 672 682 692	702 712 722 732 742	752 762 772 782 792		872 882 892
603 613 623 633 643	653 663 673 683 693	703 713 723 733 743	753 763 773 783 793		873 883 893
604 614 624 634 644	654 664 674 684 694	704 714 724 734 744	754 764 774 784 794		874 884 894
605 615 625 635 645	655 665 675 685 695	705 715 725 735 745	755 765 775 785 795		875 885 895
606 616 626 636 646	656 666 676 686 696	706 716 726 736 746	756 766 776 786 796		876 886 896
607 617 627 637 647	657 667 677 687 697	707 717 727 737 747	757 767 777 787 797		877 887 897
608 618 628 638 648	658 668 678 688 698	708 718 728 738 748	758 768 778 788 798		878 888 898
609 619 629 639 649	659 669 679 689 699	709 719 729 739 749	759 769 779 789 799		879 889 899

If 25 or more items circled
please describe reasons:

For Change of Address:

Old Company Name _____

Old Company Address _____

City _____

Zone _____

State _____

I Do Design Work

I Supervise Design Work

I Do No Design Work

VIA
AIR
MAIL

FIRST CLASS
Permit No. 725
New York, N. Y.

B U S I N E S S R E P L Y M A I L

No Postage Stamp Necessary If Mailed In U. S.

POSTAGE WILL BE PAID BY

ELECTRONIC DESIGN

ONE DAY READERS INQUIRY SERVICE

850 Third Avenue
New York 22, New York

VIA
AIR
MAIL

FIRST CLASS
Permit No. 725
New York, N. Y.

B U S I N E S S R E P L Y M A I L

No Postage Stamp Necessary If Mailed In U. S.

POSTAGE WILL BE PAID BY

ELECTRONIC DESIGN

ONE DAY READERS INQUIRY SERVICE

850 Third Avenue
New York 22, New York

Radars in the Sun

Combining business with pleasure is especially satisfying when the business is itself a pleasure. Earlier this month, *ED* editor Alan Corneretto enjoyed such a situation during a business-vacation trip to Puerto Rico. One scheduled stop—the Advanced Research Project Agency's ionospheric research facility at Arecibo—turned out to be the highlight of the Puerto Rican trip.

As his article on p 8 of this issue indicates, the scope of this radar is overwhelming. Deep in semitropical wilds, swarms of workers are building a reflecting dish 1,000 ft in diameter. The dish sits in a much larger bowl, over which three towers rise about 300 ft from adjacent hills. The sight of this installation taking form in near-jungle is impressive. So is the concept of a radar this size, which originated with Dr. W. E. Gordon of Cornell University.

Dr. Gordon foresaw the usefulness of a radar antenna in which beam mobility would be traded advantageously for resolution. Unlike similar research instruments, the dish near Arecibo will not move; this makes its huge size possible. However, the radar's feed will be mobile enough to provide a conical, though narrow-angle, beam of useful dimensions. Use of a natural depression in Puerto Rico's limestone hills is adding to the savings made possible by the fixed design of the dish.

Although strikes, unusual rainfall, and drainage difficulties have delayed the project, Cornell engineers are confident that the huge radar, able to transmit 2.5-megawatt pulses, will be completed and will make major contributions to knowledge of the ionosphere. In passive operation, as a radio telescope, the dish and its ultra-low-noise receiver are expected to be useful in a variety of radio-astronomy experiments.



Surveying part of the Arecibo radar installation are, from the left, Dr. W. E. Gordon of Cornell University, originator of the project; L. M. Lalonde, project engineer; and Alan Corneretto *ELECTRONIC DESIGN* news editor.

CIRCLE 2 ON READER-SERVICE CARD ▶

RAYTHEON FILTER ARRAYS



More Rugged...Weigh Less Take Less Space...More Precise

Wherever you have an application involving multiple narrow-band filter channels, you'll find Raytheon Magnetostriction Filters will meet your most exacting requirements. They are ideal for *Shock, Vibration, and Test Equipment, Spectrum Analyzers, Underwater Sound Analysis Equipment, Telemetry Equipment, Oscillators and Wireless Paging Systems.*

Features of the Raytheon Magnetostriction Bandpass Filter Arrays include:

Unlimited combinations can be arrayed at accurately spaced frequency intervals—At 50 kc., center frequency can be adjusted within 0.3 cps.

More economical for arrays in 45 kc to 300 kc range—Priced from \$12 to \$35 per filter.

Arrays are smaller and lighter—A bank of ten filters can be mounted on a 1¼" x 3" panel—total assembly

weighs only ten ounces.

Higher Q and higher frequencies than toroidal coils—Q from 2,000 to 15,000. Resonant frequencies from 45 to 300 kc.

Wide dynamic range—40 to 55 db.

Stable over wide temperature extremes—Over range from -60°C to +80°C, maximum resonant frequency variation is only 8 ppm/°C.

Ideal impedances for transistor circuits—Single filter input and output standard from 15 to 2,000 ohms.

For additional data on Raytheon Magnetostriction Filters please write to: Raytheon, Industrial Components Division, 55 Chapel Street, Newton 58, Mass.

Stock Filters with Fixed Center Frequency Available from Local Franchised Raytheon Distributors.

RAYTHEON COMPANY

INDUSTRIAL COMPONENTS DIVISION

RAYTHEON

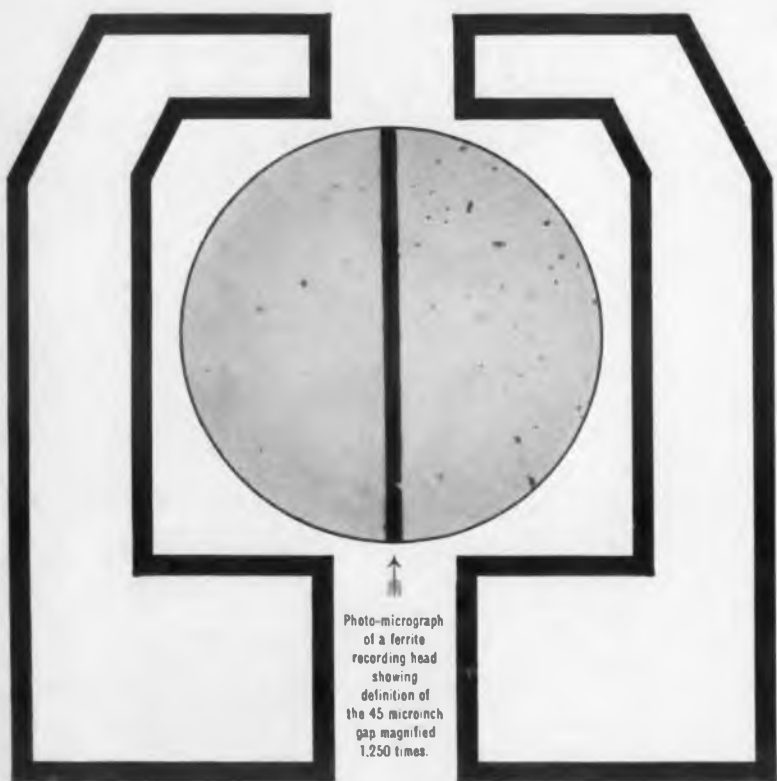


Photo-micrograph
of a ferrite
recording head
showing
definition of
the 45 microinch
gap magnified
1,250 times.

NEW FERROXCUBE RECORDING HEADS OUTPERFORM ALL OTHERS

Ever bent upon improving ferrites, Ferroxcube research and development engineers have just come forward with new and significant material developments that establish a new high in recording head performance. Initial permeability measures upward to 5000. Higher density enables improved machining and finishing characteristics that make for better gap definition and reduction of gap length. Beyond this, there are the highly important advantages of simplicity of construction, consistency of performance, lower power losses, more constant permeability as a function of frequency, and lower cost. To learn more, write today for your copy of "Basic Characteristics of Ferroxcube Recording Head Materials, Bulletin No. TD-9"

FOREMOST
IN THE
FIELD OF
FERRITE

FERROXCUBE

CORPORATION OF AMERICA
SAUGERTIES, NEW YORK



CIRCLE 3 ON READER-SERVICE CARD

CONTENTS

September 27, 1961
Vol. 9 Number 20

ELECTRONIC DESIGN News	4
Transducers Needed to Spur Process Control	4
Stretch's Utilization In Business Explained	6
Design of Project Defender Probe on Schedule	8
Electron Beams Form PN Junctions	12
Atlas Computer Uses New Logic Approach	16
Washington Report	20
Recessed Wafers Support Circuits	26
Reliability Is a Function of Attitude	31
Editorial Comment	
<hr/>	
Meeting the Reliability Challenge—An ELECTRONIC DESIGN Special Report	33
The section includes a summary of the status of the Darnell Report, the basic concepts of reliability testing and its applications to the TACAN program and a list of military specifications relating to reliability. Also included are practical articles discussing the organization and responsibilities of a reliability group and the technique of variation research, a tool to force defects to reveal themselves	
The Darnell Report—Its Contents and Present Status	34
The background, contents and present status of the Parts Specifications Management for Reliability, PSMR-1	
Reliability Testing and Its Application to the TACAN-AGREE	36
The fundamentals of reliability testing are described and the results of the TACAN-AGREE reliability program outlined—Dr. A. L. Floyd	
Reliability Analysis of a Long Established System—The Hammer and Nail	50
Ridiculous reliability figures can be obtained when erroneous assumptions form the foundation of a rigorous analysis—C. O. Holmquist	
The Reliability Group: Its Organization and Responsibilities	52
The particular duties and obligations of a reliability staff are outlined with the intent to provide high-quality products at high yield—Dr. R. W. Hull	
Variation Research—The Science of Forcing Defects to Reveal Themselves	60
A useful technique for rapidly locating defects in products and processes with two case histories illustrating the application—D. Shainin	
Military Standards and Specifications on Reliability	66
A handy list of documents covering reliability tests and standards	
<hr/>	
Evaluating Data for Low-Noise Transistor Circuit Design	70
Presents and evaluates typical measurements for a low-noise transistor input circuit—W. A. Rheinfelder	
Product Features	74
Newly available products of exceptional interest to design engineers	
Low Hysteresis G-Sensor Features High Output	74
Hysteresis of this accelerometer is rated at 0.25 per cent; its output is from 0 to 5 v	
Building-Block Circuit Boards	76
Quality printed-circuit mounting board and accessories can save engineering time and costs in circuit breadboarding and fabrication of electronic equipment	

Electronic Design

Hayden Publishing Company, Inc.
850 Third Ave., New York 22, N. Y.

New Products	78	
Introducing this issue's new products are a transistor-waveform measuring system, an acoustic serial memory, a tape transport device for controlling take-up real speed, a high-speed analog-digital converter, and a subminiature slip-ring cartridge. Also featured, all new products on display at the National Electronics Conference, Oct. 9-11		
New Products Directory	80	
All the products presented in this issue are indexed with reference to page and Reader-Service number		
ELECTRONIC DESIGN Engineering Data	175	
Transistor Load Impedance and Dissipation Nomogram—A. J. Eisenberg .. 175		
MicroWaves	177	
A practical package for the microwave designer is contained in this section of MicroWaves. The round-up on parametric frequency multipliers focuses on a new field for profitable conquest. Those enmeshed in hardware design may find inspiration and assistance in the article on strip-line technique and the nomogram on design of coaxial cavity filters		
Systems Applications Due for Parametric Frequency Multipliers ..	179	
A considerable new market is emerging for these solid-state microwave generators. Small size, low power drain and stability contribute to the increasing design interest in these devices		
When to Use Strip Transmission Line	182	
Economy and versatility of design can be achieved with strip-line components. The various lines available and typical microwave applications are pointed out—J. Taub		
Cavity Nomogram Speeds Design of Symmetrical Band-Pass Filters	188	
Time-consuming calculations are avoided in this handy aid to the microwave designer—P. Ravenhill, H. Smith		
Ideas for Design	210	
Transformer-Coupled "Tree" Checks Binary Word Parity		210
Fast Pulse Train Synched to Slow Input Trigger		210
Balanced Xformer Windings Can Be Single-Ended or Push-Pull		212
Compensating Voltage Reduces Zener Diode Variations		213
Ideas-for-Design Entry Blank		211
New Literature	202	
Books	208	
Letters	214	
Careers	216	
Your Career	216	
Advertisers' Index	222	



ELECTRONIC DESIGN is published biweekly by Hayden Publishing Company, Inc., 850 Third Avenue, New York 22, N. Y. T. Richard Gascoigne, Chairman of the Board; James S. Mulholland, Jr., President; Edmund C. Grainger, Jr., Secretary. Printed at Poole Bros., Inc., Chicago, Ill. Controlled circulation postage paid at Chicago, Ill., and at New York, N. Y. Copyright © 1961, Hayden Publishing Company, Inc., 38,851 copies this issue.

**NOW —
CHOPPER-STABILIZED
PERFORMANCE
FROM
A
DC
AMPLIFIER
MEASURING
3
CUBIC
INCHES**



ACTUAL SIZE

Here is a wideband, differential DC amplifier that meets the performance and reliability requirements of missile-in-flight applications. It features encapsulated modular design... extremely high common mode rejection... and chopper stabilization for elimination of stability problems. Occupying only 3.15 cubic inches and weighing only 5 ounces, the PM Model 4001 is specifically designed to drive subcarrier oscillators from low-level transducers in missileborne telemetry systems. In every respect, here is big amplifier performance in a pocket-size package. Contact PM Electronics for complete information on the 4001, or air-borne DC and AC amplifiers in packaging configurations to meet your specific needs.

Brief Specifications on PM 4001

INPUT IMPEDANCE 30,000 ohms, differential
COMMON MODE REJECTION 100 db at DC, 80 db at 400 cps
GAIN Up to 500
OUTPUT LEVEL ± 5 volts into 100K ohms
LINEARITY $\pm 0.3\%$
FREQUENCY RESPONSE ± 0.1 db DC to 500 cps. ± 1 db from DC to 5 KC
GAIN STABILITY $\pm 0.25\%$ for 24 hours
DC DRIFT Less than 1 μ volt/ $^{\circ}$ C



ELECTRONICS, INC.

5221 University Ave., San Diego, Calif., JU 3-3166

LOOK TO PM FOR AMPLIFIERS—a complete line of high precision models to answer your specific problems...for DC, AC, ground and missileborne applications.

CIRCLE 4 ON READER-SERVICE CARD

Transducers Needed to Spur Process Control

Visitors at ISA Show Hail Advantages of Electronic Approach, But Industry Must Still Rely on Hydraulic, Pneumatic Systems

Thomas E. Mount
West Coast Editor

ON-STREAM analysis for process control is still hampered by a lack of suitable transducers, judging from comments at the Instrument Society of America show in Los Angeles, Sept. 11-15.

Electronic closed-loop systems appear to show great promise, but only in a few instances are they available to the process industries.

John E. Witherspoon of Rocketdyne, the conference program coordinator, said most current process-control systems use hydraulic or pneumatic techniques, even when automatic sampling of the process is available.

The fast response, ease of operation, and reduced accessory equipment, such as compressors, make all-electronic systems desirable, industry spokesmen said. In many processes, however, transducers suitable for automatic control have been lacking. The quantitative analysis of a batch of chemicals in process often is a tricky, lengthy busi-

ness, frequently susceptible only to indirect techniques, it was agreed.

As an example of an all-electronic closed-loop system, Consolidated Electroynamics Corp., Pasadena, Calif., showed its Model 26-212 high-speed process chromatograph. Designed for chemical processing—such as petroleum refining, food processing, nuclear reactor control, and drug manufacturing—the system performs continuous quantitative analyses and controls the composition of the chemicals being manufactured.

Chromatographic techniques comprise the sampling of the process stream, stratification of its components according to their boiling points, and quantitative detection of these components. The last is done with a detector, such as a thermal conductivity cell, electrical conductivity detector, or flame ionization.

David Fraade, director of marketing for Consolidated Electroynamics, said also suitable to closed-loop control techniques are:

Mass spectrography, automatic titration,

moisture detection, trace oxygen analysis, trace sulfur detection, refractometry (for fractional distillation processes), viscosity (where vibration-pattern changes in a vibrating reed are detected), and ultra-violet and infrared detection (for measuring the absorption characteristics of chemicals).

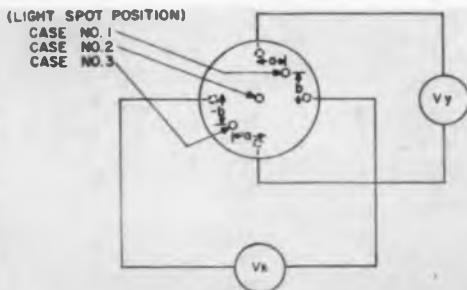
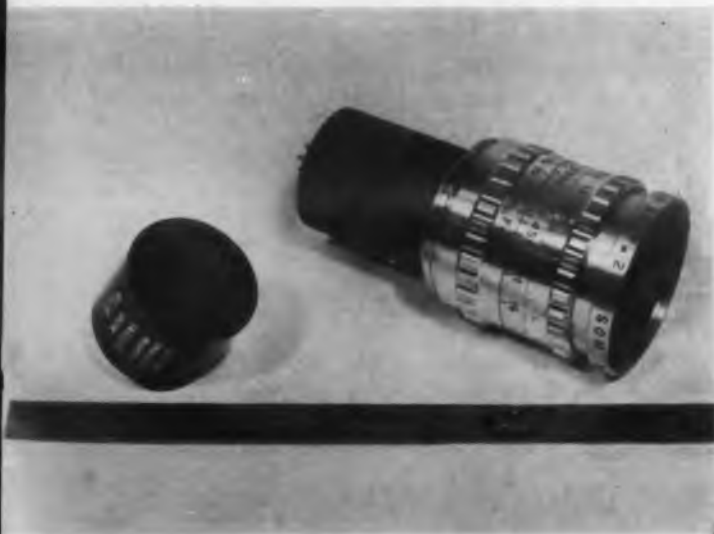
Three manufacturers offer increasingly sophisticated photoelectric transducers this year. Micro Systems, Inc., Pasadena, Calif., showed a line of radiation-tracking transducers designed to detect the position of visible-to-near-infrared radiation simultaneously in two axes. Giannini Controls Corp., Pasadena, Calif., demonstrated a photoelectric potentiometer, dubbed Photopot by the company.

A newly formed company, Data Sensors, Inc., Gardena, Calif., offered a photoelectric accelerometer with low (0.5 per cent) non-linearity and 0.5 per cent hysteresis. The accelerometer uses two phototransistors, a microminiature tungsten light source, and a cantilever pendulum acting as a shutter. As the transducer is accelerated, the cantilever end is displaced, changing the amount of light intercepted by the phototransistors.

Micro Systems' radiation-tracking transducer comprises a circular silicon solar cell with four opposed contacts on the periphery to delineate the x and y axes. A spot of light focused on the center of the cell causes a lateral flow of current from the center to the circumference.

Applications for the device are said to be in space-communications system alignment, missile-launch alignment, solar and lunar reference sensors for satellite orientation, gyro pickoff, and automatic high-speed auto-collimation.

The Giannini photoelectric potentiometer uses a light beam as a wiper arm. The light beam causes semiconductor material, which bridges a gap between a conductor and a resistance element, to become conductive.



Two versions of Micro Systems' radiation tracking transducer, with and without lens system, are shown at left. The principle of operation of the device is illustrated above. With the light spot in the positions shown for three possible cases the following signals would be generated: Case No. 1: $V_x = a$; $V_y = b$. Case No. 2: $V_x = 0$; $V_y = 0$. Case No. 3: $V_x = -a$; $V_y = -b$.

As the light travels the length of the semiconductor-filled slit, the potentiometer's output changes. Because of the lack of friction, long life is expected for the device.

Remote Instrumentation In Oceanography Described

A marine sciences technical session at the show covered oceanographic-measurement theory and problems of remote instrumentation and telemetry. Leon D. Carver, president of Hiac Corp., Claremont, Calif., described the application to the measurement of turbidity of a system for the automatic counting and sizing of particular matter in fluids. The technique originally was developed for detecting and measuring contaminants in oil.

A tiny light beam passes through a small stream of sample fluid. Each time the beam is interrupted by a particle the signal is changed and the particle is counted. Particles as small as five microns can be counted.

Turbidity indirectly is a measure of ocean turbulence and mixing. The system also is useful, Mr. Carver said, for biological science. Organisms of a given size can be "seen" multiplying or diffusing through the water.

The oceanographic tower off Mission Beach, San Diego, was described by William Armstrong of Naval Electronics Laboratory. In addition to the standard recording instrumentation and meteorological equipment, the tower measures internal, below-surface waves. This is done by measuring the level of thermoclines with a thermistor sensor at the end of a line. As the wave passes, the thermocline rises; the extent of its rise is a measure of the size of the wave.

To measure ocean-wave forces on offshore structures, Dr. Thomas Russell of California Research Corp. used eight force dynamometers, a wave gage (a vertical resistance wire), recording instruments, and programing units.

Thomas Ward of Telemetering Corp. of America described what is said to be the first practical application of pcm/fm/fm telemetry to oceanography.

The initial system designed for the Air-Sea Environmental Interaction Research program, headed by A & M College of Texas, contained three pcm-fm subchannels, each supporting the transmission of the 2,000 bit per sec output from a field data-processing unit. The transmitter operates in the 132-144-mc band with a half-watt power output. ■ ■

NOW!
standards lab
precision...
with military
reliability!



Rugged new KINTEL programmable
Digital Voltmeter designed to MIL-E-4158A
...measures AC and DC from 0.001
to 999.9 volts with an accuracy of
0.01% \pm 1 digit DC, 0.1% AC



USED IN MAJOR MISSILE PROGRAMS. Extensively tested and proved in the field in missile checkout systems, the Model 412 Digital Voltmeter is designed to meet the stringent environmental requirements of MIL-E-4158A for operational ground support equipment. These units have established an unprecedented record of reliability and accuracy in daily service for ICBM testing.

DESIGNED FOR AUTOMATIC SYSTEMS. All major control functions can be remotely programmed...the readout unit remotely mounted in as little as 3½" of rack space. Two isolated input channels are provided, with AC and DC measurement mode and automatic or manual ranging independent for each channel. Digital recorder drive capability is built in.

THE ONLY DIFFERENTIAL DIGITAL VOLTMETER. Completely isolated, guarded inputs eliminate ground loop problems, reject common-mode hum and noise, allow stable, accurate AC or DC measurement at differing ground potentials—regardless of whether printer or other output equipment is grounded or floating.

TEST MISSILES OR TRANSISTORS. If you can't afford down time at the wrong time, if you must have continuous, reliable operation even under adverse environmental conditions, if you need automatic system capability, high accuracy, versatility, then this new KINTEL Digital Voltmeter meets your requirements. Write for technical literature or demonstration. Representatives in all major cities.

BRIEF TECHNICAL SPECIFICATIONS

DC RANGE:
 \pm 0.001 to \pm 999.9 volts in 3 automatic or manual ranges, automatic polarity.

AC RANGE:
0.001 to 999.9 volts, in 3 automatic or manual ranges, 60 to 1000 cps.

ACCURACY:
0.1% of FS for AC, 0.01% \pm 1 digit of reading for DC.

INPUT IMPEDANCE:
10 megohms for DC, 1 megohm and 200 μ f for AC.

COMMON MODE REJECTION:
86 db minimum for 60 cps common-mode signals.

OPERATIONAL FEATURES:
All controls remotely programmable, built-in digital recorder drive, two isolated input channels with range control and AC or DC mode independent for each channel.

5725 Kearny Villa Road,
San Diego 11, California
Phone: BRowing 7-6700

KINTEL
A DIVISION OF
COHU
ELECTRONICS, INC.

CIRCLE 5 ON READER-SERVICE CARD

NOW! A REMARKABLE, NEW
0-40 volt @ 500 ma
DC POWER SUPPLY
BY PERKIN
THE ONLY POWER SUPPLY AVAILABLE
COMBINING THESE 20 FEATURES:



Model TVCR040-05

0-40 volts @ 0-500 ma

1. Voltage Regulation: $\pm .01\%$ or ± 2 mv
2. Current Regulation: $\pm .02\%$ or $\pm 50\mu$ amp
3. Remote Voltage Programming: Full-range 0-40 v
 Factory calibrated @ 100 ohms/volt $\pm .25\%$
4. Remote Current Programming: Full range 15-500 ma
 Factory calibrated @ 1 mho/ampere $\pm 1\%$
5. Voltage Limiting: Continuously adjustable 0-42 v
6. Current Limiting: Continuously adjustable 0-600 ma
7. Remote Voltage Sensing 8. Parallel Operation 9. Series Operation
10. Vernier Voltage Adjust: 5 mv resolution
11. Vernier Current Adjust: 50μ amp resolution
12. Transient-Free 13. Short-Circuit Proof
14. Extremely Fast Response: 25 μ sec
15. Low Ripple: 500 μ volts (voltage regulation mode)
 50 μ amps (current regulation mode)
16. Convection Cooling 17. Portable 18. Regulation Mode Switch
19. Master-Slave Operation 20. Excellent Long-Term Stability

Additional Specs ■ AC Input: 105-125 v, 1 ϕ , 47-420 cps, 0.5 A
 ■ Max. Ambient Temp.: 45°C ■ Meters: Dual Scale 0-50 V.DC, 0-600 ma
 ■ Dimensions: 5 1/4" H, 8" W, 9" D—adapter to mount two in 19" rack
 ■ Weight: 15 lbs. (approx.) ■ Finish: Gray per MIL-E-15090B

AND ALL FOR JUST \$198 f. o. b. El Segundo

PERKIN

Representatives in principal cities.

ELECTRONICS CORPORATION

345 Kansas Street, El Segundo, California □ Spring 2-2171



CIRCLE 6 ON READER-SERVICE CARD

PERKIN SALES REPRESENTATIVES

ALBUQUERQUE, N. M.
Brooks-Feeger Assoc.
5510 Domingo Rd., N.E.
AM 8-1724

ANGOLA, IND.
Law Instrument Co.
Box 95
217 & 8101-R

ATLANTA 5, GA.
E. G. Holmes & Assoc.
4969 Roswell Rd., N.E.
BL 5-6660

BALTIMORE, MD.
Gawler-Knoop Co.
807 E. Seminary Ave.
Townson 4, Md.
EN 9-3151

CHICAGO 23, ILL.
Saffro & Assoc.
5209 N. Kimball Ave.
JU 8-0905

CLEVELAND, OHIO
Gaine Engineering
29503 Bruce Drive
Willowick (Cleveland), Ohio
Whitney 3-3731

DALLAS 20, TEXAS
Wallace Assoc.
P. O. Box 13203
FL 7-7080

DENVER, COLO.
Brooks-Feeger Assoc.
3041 S. Broadway
Englewood, Colo.
SU 1-7375

DES MOINES, IOWA
Design & Sales Eng. Co.
2702 41st Pl.
BL 5-4584

DETROIT 34, MICH.
Gaine Engineering
E. 1474 Outer Drive
Detroit 34, Michigan
Forest 6-5353

GREENSBORO, N. C.
E. G. Holmes & Assoc.
440 W. Market St.
Suite B-1
BR 2-0855

INDIANAPOLIS, IND.
Law Instrument Co.
P. O. Box 27062
ST 7-0009

KANSAS CITY 8, MO.
Design & Sales Eng. Co.
2600 Grand Ave
GR 1-1640

LAWRENCE, MASS.
Richard D. Frink Assoc
46 Amesbury St.
MU 3-3252

LOS ANGELES, CALIF.
Instruments for
Measurements
3455 Cahuenga Blvd.,
Suite F
Hollywood, Calif.
HO 9-7294

MINNEAPOLIS, MINN.
Northport Eng., Inc.
1729 Selby Ave.
St. Paul 4, Minn.
MI 6-2621

**NEW YORK CITY AND
NORTHERN NEW JERSEY**
Gawler-Knoop Co.
178 Eagle Rock Ave.
Roseland, N. J.
N. Y. Tele. DI 4-2997
Roseland Tele. CA 6-4545

ORLANDO, FLA.
E. G. Holmes & Assoc.
1220 Edgewater Dr.
CH 1-2128

PHILADELPHIA, PA.
Gawler-Knoop Co.
835 Glenside Ave.
Wyncote, Pa.
Phila. Tele. WA 7-1820
Wyncote Tele. TU 4-8805

PHOENIX, ARIZ.
Brooks-Feeger Assoc.
34-A E. First St.
Scottsdale, Ariz.
WH 6-2111

SALT LAKE CITY, UTAH
Brooks-Feeger Assoc.
253 Rio Grande,
Rm. No. 5
EL 9-2427

SAN DIEGO 4, CALIF.
Instruments for
Measurements
2420 University Ave.
JU 3-1972

SAN FRANCISCO, CALIF.
Cerruti & Assoc.
P. O. Box 509
116 Cypress St.
Redwood City, Calif.
EM 9-3354

SEATTLE, WASH.
Testco
Boeing Field - Rm. 108
PA 3-9000

ST. LOUIS 5, MO.
Design & Sales Eng. Co.
7603 Forsyth Blvd.,
Rm. 304-06
PA 1-6403

SYRACUSE, N. Y.
D-B Assoc.
P. O. Box 284
DeWitt (Syracuse), N. Y.
GI 6-0220

**WASHINGTON, D. C. &
MARYLAND**
Gawler-Knoop Co.
8732 Flower Ave.
Silver Spring, Md.
JU 5-7550

WICHITA, KAN.
Design & Sales Eng. Co.
400 N. Emporia
Wichita, Kan.

CANADA
Electromechanical
Products
Markham Rd.
Agincourt, Ont., Canada
AX 3-7011

AUSTRALIA
Geo. H. Sample & Son
(Electronics) Pty. Ltd.
Sample House
17-19 Anthony St.
Melbourne C.I. Australia
FJ 4138

BELGIUM
Belram Electronics
43 Ch. De Charleroi
Brussels, Belgium
38.12.40

ISRAEL
Electronics Ltd.
48 W. 48th St.
New York 36, N. Y.
CO 5-8323

EASTRONICS LTD.
P. O. Box 2554
Tel Aviv, Israel
66890

NEW ZEALAND
Geo. H. Sample & Son
(Electronics) (N. Z.) Ltd.
Box 3250
431 Mount Albert Rd.
Mount Roskill, S. I.
Auckland, New Zealand
89-4 39

FRANCE
Megex
105, Quai Branly
Paris 15, France
Sog. 36-93

SPAIN
ATAIO Ingenieros
A. Aguilera No. 8
Madrid, Spain
23 27 42

SWEDEN
Erik Ferner AB
Box 56
Bromma, Sweden
87 01 40

NEWS

Stretch's Utilization In Business Explained

CEIR Hopes to Use Computer Profitably on Small Problems

EXPECTED usefulness of the IBM 7030 Stretch computer for business data processing was described at the 16th National Meeting of the Association for Computing Machinery in Los Angeles, Sept. 5-8.

William V. Crowley of the Corp. for Economic & Industrial Research, Inc. (CEIR) gave an optimistic appraisal of the potential of the Stretch machine for simultaneous processing of many business problems. CEIR plans to install two of the machines at its computing centers despite failure of the computer to achieve original design objectives.

Stretch was designed by International Business Machines Corp. for complex problems demanding large arithmetic capacity, such as the hydrodynamics problems involved in nuclear work. The first machine was built for the Atomic Energy Commission at Los Alamos, N. M. Mr. Crowley told his audience that the machines can be used profitably for hundreds of smaller problems simultaneously. Small companies will rent processing time on them from the CEIR center for research, design, and planning.

Mr. Crowley asserted that a Stretch system will perform 800 times the operations that could be performed by an IBM 650—for less than 30 times the cost of the 650, or about \$1,700 per hour. This comparison was based on arithmetic speeds alone.

"The economics of Stretch-type computers can be demonstrated as much more advantageous than several large-scale computers operating side by side," Mr. Crowley said, adding: "Many of the problems of the future will not be solvable on anything but computers of Stretch-like capacity."

Mr. Crowley asserted that the technical and theoretical communications problems formerly associated with centralized computing operations have been virtually solved.

He went on: "Computer program know-how and computer system management skill now exist to make this type of operation feasible and successful. Very few organi-

CIRCLE 7 ON READER-SERVICE CARD

zations will have enough of these computer-requiring problems at any one time to justify the buying or leasing of such a large machine for the organization's use only."

The audience took a "wait-and-see" attitude toward Mr. Crowley's estimate.

Stretch was to be delivered to Los Alamos in June, 1960. Due to difficulty—primarily with the half-microsecond memory, which has been discarded in favor of a 2.18- μ sec memory—the delivery was delayed until December, and finally to April, 1961. IBM reportedly reduced the price of Stretch from \$13 million to \$8 million.

Only 10 Stretches are to be built—those that were on order last March—an industry source said. IBM declined to comment on this report.

According to Bengt Carlson, director of computer operations at Los Alamos, Stretch was placed in operation in the middle of May, and has done well since. The system is slower than had been anticipated three years ago, Mr. Carlson said. Depending on programing, Stretch may be 25 per cent or more slower than specifications called for, he estimated. In other types of problems it works just as fast as was anticipated, Mr. Carlson said.

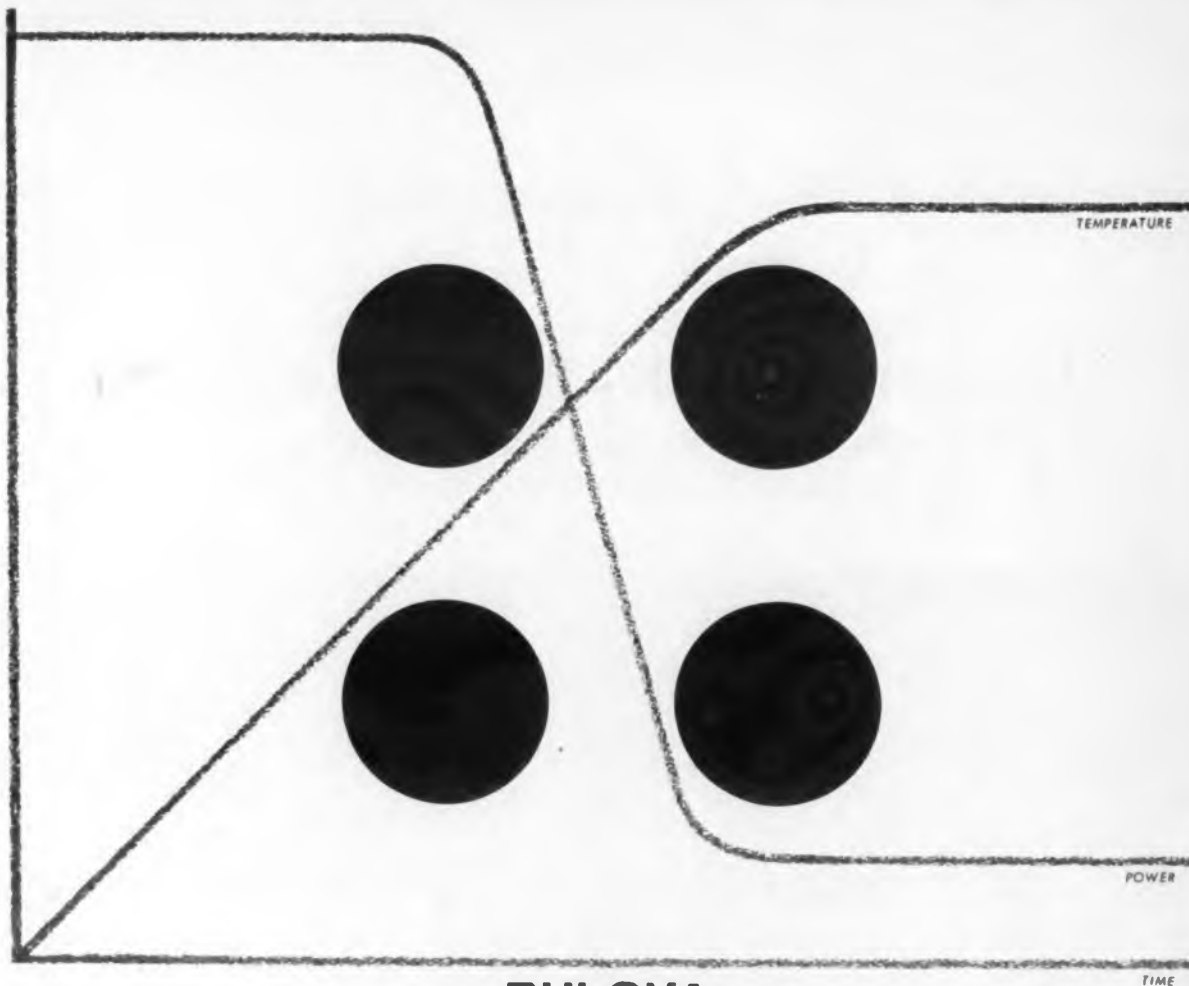
Stretch has a high degree of precision. Word length is the equivalent of 14-1/2 decimal digits.

"Through-put" for Stretch is said to be relatively limited. Programing, Mr. Crowley said, will solve this difficulty. ■ ■

Counter Totals Patterns



Latest version of numa-rite pattern counter developed at the University of Illinois uses a 20-by-20 matrix of photocells as its retina. Threshold-logic circuitry senses n-ness and drives indicator tubes to show count of separate patterns that prevent overhead light from reaching photocells. Response is instantaneous for any combination of a convenient number of patterns.



BULOVA PROPORTIONAL SILICON TRANSISTOR CONTROLLED OVEN



Where ever temperature variations affect the "percentage" of heat required to maintain efficient operation, the new Bulova proportional control oven eliminates temperature cycling, RF interference noise, surges of oven power, and the drift of temperature differential due to aging. The oven temperature can be set to an accuracy of $\pm .5^{\circ}\text{C}$ and has a range of $+40^{\circ}\text{C}$ to $+125^{\circ}\text{C}$.

The stepless control of the Bulova proportional system is accomplished by two highly stable Bulova developments: (1) a temperature sensitive bridge, and (2) a transistorized amplifier supplying

power proportional to the output of the bridge. Thus any unbalance created by resistance changes is amplified and conveyed to the heater . . . which receives only enough power to take care of heat loss with a $.01^{\circ}\text{C}$ stability or better. DC proportional control is employed to eliminate any interference of oven control circuitry with the internal circuitry.

If you'd like more information on how the Bulova proportional control oven can extend the life of your units to equal that of the solid state components used, write Department 1771, Bulova Electronics, Woodside 77, New York.

CIRCLE 8 ON READER-SERVICE CARD

Design of Project Defender Radar Probe on Schedule

*Giant Facility in Puerto Rico to Aid Ionospheric Study;
Snags in Building 1,000-ft Dish Delay Opening to Spring*

Alan Corneretto
News Editor

BY EARLY next spring, the huge 430-mc radar being built near Arecibo, Puerto Rico, for the Advanced Research Projects Agency of the Defense Department should be collecting data on electron density in the ionosphere.

This is an estimate made in Arecibo earlier this month by scientists of Cornell University's Center for Radiophysics and Space Research, the prime contractor to the Air Force Cambridge Research Laboratory for design and construction of the radar system.

The installation is part of Project Defender, designed to minimize danger from missile attack.

Difficulties in transforming a Puerto Rican valley into a 1,000-ft-diam, mesh-lined dish have postponed operation from July of this year to 1962, but design of the electronic equipment is proceeding according to plan, Cornell scientists report.

Although the 1/6-deg beam transmitted by the radar will be able to cover the sky only within 20 degrees of zenith, the facility is expected to be useful for experiments involving the major planets, the moon, and some space vehicles. This is in addition to its primary tasks of measuring the variation of electron density with height, the fluctuations of electron density at fixed heights, and electron temperatures and magnetic-field strengths at various heights.

Aperture Surface Tolerance Poses Challenge of Design

The fixed spherical reflector of the radar will be fed by a line feed supported above it on a rotating azimuth truss. The feed

will be capable of all types of polarization and will fully illuminate the aperture, which is to have a radius of curvature of 870 ft and a surface tolerance of $+0.1$ ft. Achieving this tolerance is expected to be one of the main structural-design problems connected with the project.

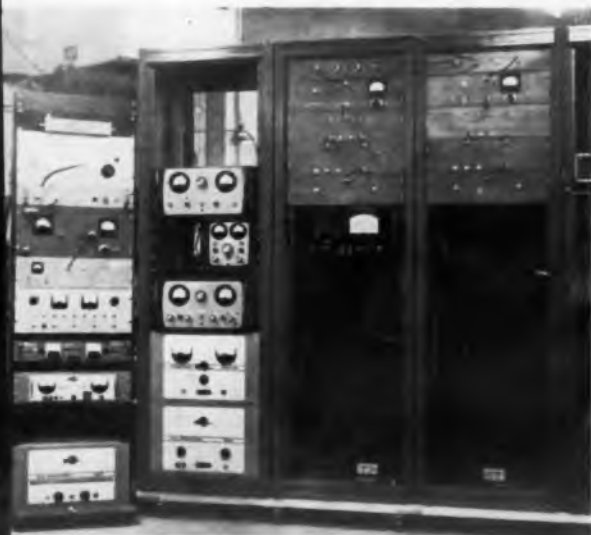
Design goals for the transmitter include: a peak power output of 2.5 megawatts at 430 mc, and an average power of 150 kw, with pulse-to-pulse stability of 0.2 db. Cw power is expected to be 100 kw. Frequency stability of the primary 1-mc oscillator source is designed to be 2.5 parts in 10^9 over periods from 1 sec to 1 hr. Frequency deviation of the rf output from the source frequency is expected to be less than 3 cps. Pulse lengths of 2 to 10,000 μ sec are to be available with a repetition rate of 1 to 1,000 pps.

A low-noise receiver, using an electron-beam-type parametric amplifier in its front end will have two channels (one for reserve) and a noise figure of less than 2 db. The receiver front end will be about 1,400 ft from the main 30-mc if amplifier. Gain stability of the equipment is expected to be 0.2 db. Because system accuracy will be important during operation, a single 1-mc stable oscillator will control the receiver local oscillators, transmitter, and clocks.

The feed is being designed to yield a gain of not less than 60 db in the secondary pattern, with sidelobes more than 17 db below the main lobe, and polarization crosstalk below 30 db. Bandwidth will be at least 1 mc. Though the feed, which will hang from tower-supported cables about 430 ft above the reflector surface, will weigh less than 5 tons, the entire feed-supporting structure will weigh about 450 tons. The feed



Spherical surface over which a metal mesh will be laid has diameter of 1,000 ft and is several hundred feet deep. Cable-supporting tower rises 250 ft above hill overlooking reflector dish. Tower is one of three to support line feed hanging from a network of cables.



Receiver for ionospheric radar probe has parametric amplifier front end, left, which helps hold noise figure for the equipment to about 2 db.

is being designed to operate in 30-mph winds and to survive 140-mph hurricanes.

Range-Gate Integration System Stumps Designers

Signals received by the system will be processed by a data-recording and processing subsystem which includes range-gate integrating circuitry for recording electron density versus height, and a spectrum analyzer for determining electron temperature versus height. The Cornell scientists report that design of the range-gate integration system is a problem they have not yet solved.

The receiver feeds a system of 100 gates, which are controlled to be open in sequence for periods varying from 2 μ sec to 10 mil-licsec to receive pulses reflected from various sections of the ionosphere. Signal levels of the returning pulses vary over a large dynamic range, from about 10 mv at noise level to 10 v. The problem of designing a single type of gate to handle both the low-strength, ultra-short pulses, and the strong-

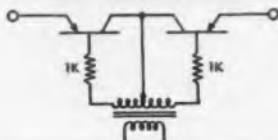
NEW PHILCO SILICON CHOPPERS

With SPAT* Matched-Pair Uniformity
Bring High Fidelity To Low Level Switching!

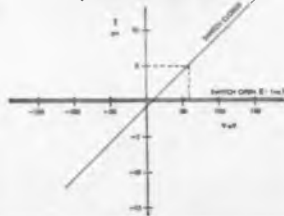
T2363 CHARACTERISTICS

Emitter Voltage, BV_{ECC}	-30 volts
Collector Cutoff Current $I_{CC}(V_{CB} = -10V)$	0.001 μ A max.
Emitter Collector Current $I_{EC}(V_{CB} = -10V)$	0.001 μ A max.
Offset Voltage $V_{CC}(I_B = -200 \mu A, I_C = 0)$	1.5 mv max.
Offset Voltage V_{CC} (T2357 Matched Pair, $I_B = -1mA$ at all temperatures from 25° to 85° C)	50 μ V max.

TYPICAL CHOPPER CIRCUIT



T2353: I-V CHARACTERISTIC (in above circuit)



Philco SPAT® Choppers are immediately available in quantities 1-999 from your Philco Industrial Semiconductor Distributor.

For low level switching applications, Philco now makes available *Silicon Precision Alloy Transistor Choppers—produced on industry's only fully-automatic chopper production line—to assure the uniformity so important to matched pairs.

Only Philco Choppers offer you all these advantages—made possible by the SPAT® process:

- Low offset current—1 nanoampere maximum;
- Low offset voltage—50 μ v maximum (for the matched pair);
- Guaranteed match over a temperature range—25° to 85° C;
- Guaranteed maximum offset voltage for a wide range of base current values;
- High gain-bandwidth product;
- Meet all requirements of MIL-S-19500B.

To assure ultra-high fidelity in multiplex systems for telemetry, multi-channel communications, analog computers, and other low level data handling applications, be sure to specify Philco SPAT® Choppers. For complete data, write Dept. ED92761.

CIRCLE 9 ON READER-SERVICE CARD

PHILCO
Famous for Quality the World Over
LANSDALE DIVISION, LANSDALE, PA.



KEY's molded resistors maintain precise stability ... regardless of environment!

Key's new Series of Epoxy Molded Precision Carbon and Metal Film Resistors maintain precise stability—even withstands thermal "plunge" shock test from -60°F to $+365^{\circ}\text{F}$ —without change in characteristics.

Key's new molding process permits the utilization of a larger core size for a given wattage, yet retains environmental characteristics far exceeding any other resistor encapsulation method. Larger cores mean increased film surface area, resulting in improved reliability and stability through more efficient heat dissipation.

Typical of the characteristics of Key's coating material is its relative water absorption as shown:

MATERIAL	CONDITIONS: A. S. T. M. D570—40T
Key coating	.04%
Epoxy, molded, mineral filled	.10%
Diethyl Phthalate, glass filled	.12%
Diallyl Phthalate, mineral filled	.20%

Here is a resistor which gives predictable performance under all environmental conditions. *Precise and positive* in characteristics, the new Key Series of Epoxy Molded Precision Film Resistors are the finest obtainable for any application— aerospace, industrial or commercial—at economical cost.

METAL FILM				
KEY TYPE	WATTS 125°C	VOLTS	NOMINAL SIZE DIAMETER	LENGTH
KM2	0.1	100	.095	.235
KM5	0.125	200	.120	.300
KM60	0.125	250	.155	.413
KM65	0.250	300	.217	.568
KM70	0.50	350	.261	.706
KM75	1.0	500	.396	1.045

CARBON FILM				
KEY TYPE	WATTS 125°C	VOLTS	NOMINAL SIZE DIAMETER	LENGTH
E2	0.1	100	.110	.230
E5	0.125	200	.133	.295
E10	0.250	300	.133	.420
E20	0.50	500	.195	.600
E25	1.0	1000	.333	.955



KEY RESISTOR CORPORATION

321 West Redondo Beach Boulevard Gardena, California - TWA CPT 8007

NEWS

Project Defender ...

(continued from p 9)

er, longer pulses is delaying completion of the range-gating portion of data-processing system.

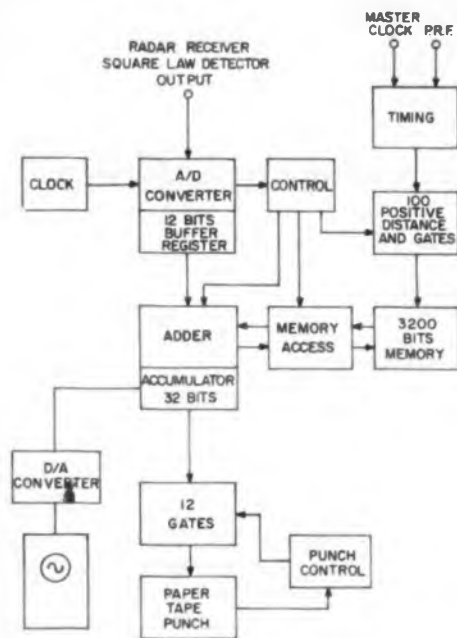
Transistor gates so far designed by the Cornell scientists introduced errors in the form of spikes in the gated output signals. Diode gates turned out to be nonlinear at low signal levels. A four-transistor gate required two pairs of matched diodes and a balanced drive-signal system. These introduced critical adjustment problems and the likelihood of errors in the output signals. No single circuit so far has operated satisfactorily over more than about 60 per cent of the range desired, the scientists said.

Digital Technique, Dual Range-Gate Sets Weighed

Under consideration as a solution is the expensive approach of building two sets of range gates, and a somewhat novel digital technique. Dr. T. E. Talpey, and M. A. Feyjaó, participating in receiver and data-processing design on the project, have proposed that an analog-to-digital converter digitize the output of the receiver for storage in a very fast memory as an increment to a number stored there as a result of previous pulses. Because the range slots are to be spaced as close as $2 \mu\text{sec}$, the entire sequence of digitizing, reading out of the



Data-processing section of system has punch-control circuitry, top; digital clock showing Nixie tubes; an analog-to-digital converter, shown open; and a logarithmic amplifier to compress the 30-db dynamic range of incoming signals so they can be handled by an analog-to-digital converter.



Digital range-gate system in rough-idea form is being proposed by Cornell engineers at Arecibo. System would take signals from radar receiver after they were reflected from ionosphere and digitize them for integration in a fast memory. There would be 100 slots spaced $2 \mu\text{sec}$ apart. The system would permit integration of a million pulses.

memory, adding, and inserting back into the memory, would have to occur in less than $2 \mu\text{sec}$.

Whether analog range gating or the proposed digital method is used, the subsystem will be, in effect, a special-purpose computer. Eventually, the project engineers report, a general-purpose computer probably will be provided for data processing at the facility.

If the Arecibo facility were equipped with suitable peripheral equipment it could be used for a variety of radio-astronomy experiments, as well as its primary tasks.

Dr. W. E. Gordon of Cornell, the project director, said the facility could be used to study the spectrum and polarization of solar bursts between 10 and 20 mc, measure the spectrum and polarization of bursts from Jupiter from 15 to 25 mc, make two-wave length comparison of radio sources, make interferometric observations, and partially track deep space probes.

A possibly important application would be the detection of hydromagnetic disturbances and shock waves, such as those caused by passage of a missile or by explosions in space. ■ ■

OLD-TIMERS AT A MODERN ART

19 years represents an extraordinary backlog of experience in the remarkable art of solid-state electronics. And it was in 1942 that the first commercial

SYLVANIA SILICON DIODES

were produced — the famous 1N21. Production, then, was tedious and costly. Today, highly automated Sylvania production lines duplicate diode types in *mass, exactly, quickly, economically.*

Equally important, the industry's most modern production facilities provide diodes of superior reliability. For example, every Sylvania Silicon Diode is subjected to severe leak-detection Zyglo tests to assure exceptional quality glass-to-metal seals. They're cycled from -65°C to $+175^{\circ}\text{C}$ to test the rugged, all-glass miniature package. Finally, every Sylvania Silicon Diode must "prove itself" under the critical examination of fully automated test equipment.

Specify from the industry's widest line of Silicon Junction Diodes—Specify Sylvania

1N456/A	1N463/A	1N488/A
1N457/A	1N464/A	1N625
1N457 JAN	1N482/A/B	1N626
1N458/A	1N483/A/B	1N627
1N458 JAN	1N484/A/B	1N628
1N459/A	1N485/A/B	1N629
1N459 JAN	1N486/A/B	1N643A
1N461/A	1N487/A	1N659
1N462/A		

Call your Sylvania Sales Engineer or Sylvania Franchised Semiconductor Distributor for a complete list of types. For tech data, write Semiconductor Division, Sylvania Electric Products Inc., Dept. 189, 1100 Main St., Buffalo 9, New York.



SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS



CIRCLE 11 ON READER-SERVICE CARD

WHEREVER YOU ARE
YOU GET THE

BEST FAST

from
your
**SEALLECTRO
DISTRIBUTOR**

TEFLON TERMINALS

The terminal that revolutionized the industry, showing the way to faster, better, more dependable terminations compatible with the most critical requirements, is just as close as your local Sealectro distributor. He carries a wide choice of terminals, feedthroughs, test jacks, probes, stand-offs and countless other Press-Fit components.



**SUB-MINIATURE
R.F. CONNECTORS**

Your Sealectro distributor has them in stock—the superior sub-miniature r.f. connector, precisely made to assure optimum electrical and mechanical performance. Now available in Snap-On and Screw-On types in either Clamp-On cable connecting or the time-saving, cost-cutting new Crimp-On type.

SEALLECTOBOARD PROTO-KIT

Brand-new, and better too! Complete programming systems that eliminate patch cords. Provide component interpositioning by merely pushing in a pin. The Sealectroboard concept is currently being used in many of the most critical electronic systems. Get a Proto-Kit from your Sealectro distributor today—it has 1001 uses!



* Write for catalogs and listings of distributors...

Sealectro CORPORATION
139 HOYT STREET • MAMARONECK, N. Y.
British Branch: Surrey, England

CIRCLE 12 ON READER-SERVICE CARD

NEWS

Electron Beams Form PN Junctions

*Automation Based on Programed Video Signals
May Eliminate Masking and Etching Processes*

Robert Haavind
Chief News Editor

AUTOMATED production of semiconductor devices and microcircuitry with electron beams controlled by video signals appears feasible with techniques now under development. Control of the beams by programed video signals might eliminate masking and etching methods now used to make semiconductor devices.

Diodes that are said to have excellent electrical characteristics have been produced in a vacuum chamber at CBS Laboratories, Stamford, Conn., by alloying aluminum onto n-type silicon with an electron beam. Researchers hope that by refining the technique they can also make useful diffused junctions.

Aside from the possibility of automated production, the electron-beam method should have the following advantages:

- Cleaner junctions because of low impurity concentrations in a vacuum chamber and the surface cleaning effect of the beam.
- Faster production—diode microjunctions have been formed in 30 seconds.
- Finer control of junction location and area, if feedback devices are developed.
- Other vacuum techniques, such as thin-film deposition or electron-beam welding and micromachining, could be used in conjunction with the CBS technique.

Feedback System For Beam Positioning Needed to Achieve Automation

One of the important steps needed for automation of the electron-beam method is development of a feedback system for controlling beam position on a substrate. In present work, beam position is controlled visually by the color difference between areas under and surrounding the beam. This suggests an optical feedback system. Since optimum beam energies and substrate temperatures have not yet been determined, however, it is possible that the color difference will not be great enough for this approach.

As a further test of the electron-beam



Electron-beam equipment for junction formation, developed by CBS Laboratories, operates mostly in the range below 15-kv beam potentials. Beams down to 1/2 mil at 100- μ a beam current can be produced by the machine. Further studies are needed to optimize beam energy, substrate temperature, and other factors to make feasible automatic production of devices by this technique.

method, CBS researchers plan to produce a more complex structure, similar to a planar transistor. Before techniques can be optimized, however, much further data—such as best beam energies, impurity materials, and substrate temperatures—must be determined. The studies have been conducted under a year-long \$55,000 contract from the Army Signal Corps. The contract recently was renewed for another year at \$50,000.

The electron beams used in the CBS approach are operated mostly in the range below 15 kv. Other research organizations have been exploring the uses of electron beams for microcircuitry with beams of higher potential. For example, the Zeiss machine, licensed by Hamilton Standard Div. of United Aircraft Corp., operates in the range over about 25 kv. This range is suitable for welding contacts or micromachining, according to Alexander P. Ramsa, physicist with CBS Laboratories. However, lower energies are necessary for forming junctions.

Vacuum Chambers Likely In Manufacturing Devices

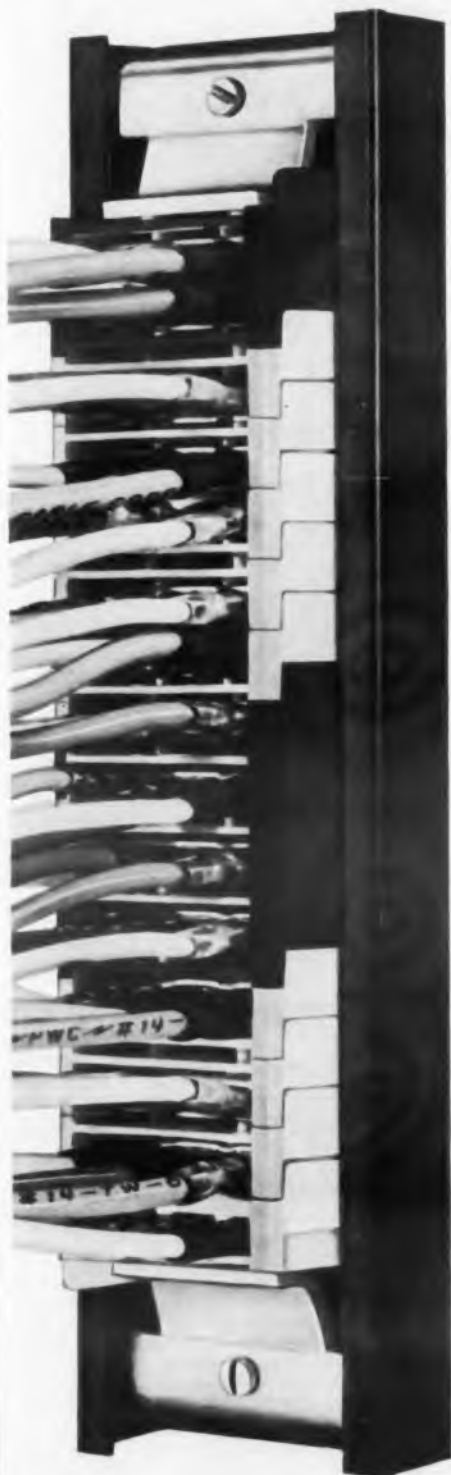
Manufacturing equipment based on electron-beam techniques probably would consist of vacuum chambers with guns of varying energy ranges directed at the processing area. Automatically controlled micro-manipulators and timing and sensing devices also would have to be developed.

One area that needs further study, Mr. Ramsa said, is the choice of doping materials for use in electron beam-formed junctions. Aluminum was chosen for the CBS experiments because of its low vapor pressure.

Other desirable dopants, such as antimony or bismuth, have higher vapor pressures and might be distilled out of the processing chamber by the vacuum system. These materials might be usable if they are combined with other elements, such as tin, to form binary alloys.

Another possibility, which may be explored later, is the use of ion beams to perform doping. The doping material would be used to form the ion beam directed at a semiconductor substrate. Ion guns suitable for such experiments are in development at CBS Laboratories, although they are presently being used for other projects.

Dr. Reinhart W. H. Engelmann has been working with Mr. Ramsa on the electron-beam processes. Dr. Harold Jacobs of the Signal Corps Laboratories and Mr. Ramsa hold two basic patents on the formation of semiconductor junctions by beam techniques. ■ ■



**HIGH-DENSITY
WITHOUT TOOLS!**

**HIGH-DENSITY
WITHOUT TOOLS!**

**HIGH-DENSITY
WITHOUT TOOLS!**

**HIGH-DENSITY
WITHOUT TOOLS!**

THE ONE-TRACK MIND OF TERMI-BLOCK*

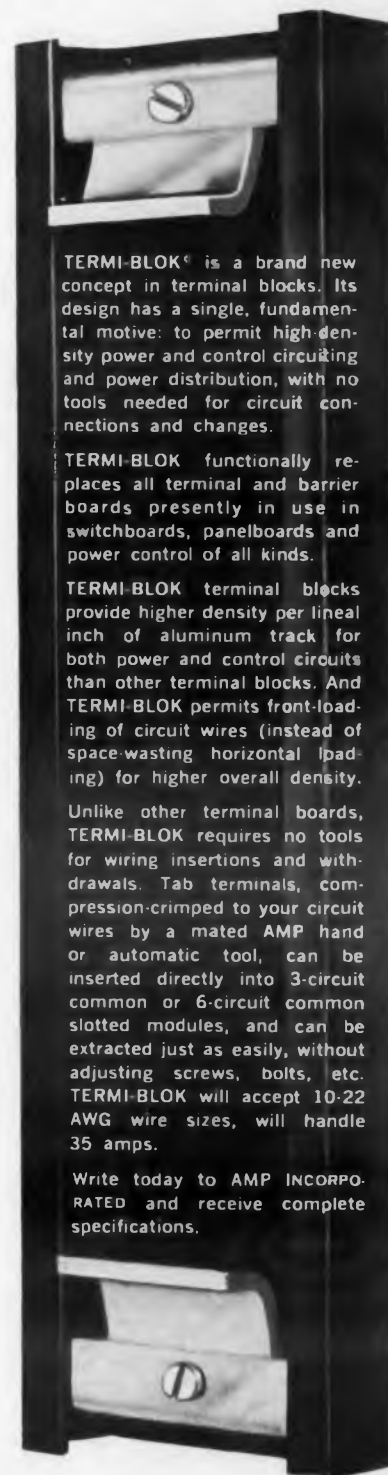
**HIGH-DENSITY
WITHOUT TOOLS!**

**HIGH-DENSITY
WITHOUT TOOLS!**

**HIGH-DENSITY
WITHOUT TOOLS!**

**HIGH-DENSITY
WITHOUT TOOLS!**

* Trademark



TERMI-BLOCK® is a brand new concept in terminal blocks. Its design has a single, fundamental motive: to permit high-density power and control circuiting and power distribution, with no tools needed for circuit connections and changes.

TERMI-BLOCK functionally replaces all terminal and barrier boards presently in use in switchboards, panelboards and power control of all kinds.

TERMI-BLOCK terminal blocks provide higher density per lineal inch of aluminum track for both power and control circuits than other terminal blocks. And TERMI-BLOCK permits front-loading of circuit wires (instead of space-wasting horizontal loading) for higher overall density.

Unlike other terminal boards, TERMI-BLOCK requires no tools for wiring insertions and withdrawals. Tab terminals, compression-crimped to your circuit wires by a mated AMP hand or automatic tool, can be inserted directly into 3-circuit common or 6-circuit common slotted modules, and can be extracted just as easily, without adjusting screws, bolts, etc. TERMI-BLOCK will accept 10-22 AWG wire sizes, will handle 35 amps.

Write today to AMP INCORPORATED and receive complete specifications.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

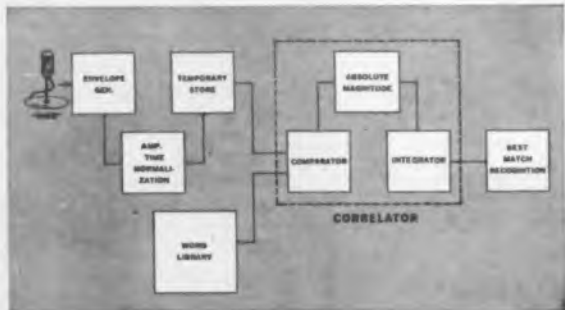
CIRCLE 13 ON READER-SERVICE CARD

BULOVA ANALOGUE TECHNIQUES APPLIED TO PATTERN RECOGNITION

Bulova teams of unusually creative electronic scientists and engineers play an ever increasing role in the state of the art advances in analogue techniques. Consider the nature and application of these Bulova techniques as they relate to spoken word recognition.

Advances in digital techniques used in pattern recognition have tended to obscure the prior art of analogue pattern recognition. Work with the analogue approach was successfully applied to the matching of maps and similar data as early as 1950. However, since that initial success, no major new application to these principles has developed.

At the present time, pattern recognition has taken on a much broader area of application than previously and is now applied to such things as automatic readers, spoken word recognition and photographic interpretation. Bulova Research & Development Laboratories is extending this analogue approach to these modern requirements; the first effort is being devoted to spoken word recognition.



Spoken word recognition can serve two functions: (1) it can be used for coding to conserve transmission bandwidth or (2) as automatic vocal control. Although both are concerned with analysis, the major difference between these applications is that only the bandwidth reduction problem involves synthesis.

One of the analogue approaches to word recognition assumes the use of a standard word library in the form of waveforms. The comparison of a waveform derived from a spoken word and the library word results in recognition. The concept, as shown in the diagram, utilizes waveform duration and amplitude normalization, a form of cross correlation and criterion of best match. Experimental equipment, consisting basically of closed loop tape recorders and necessary electronic analogue computing equipment, has been set up for evaluation of this analogue technique. The first tests as performed on speech waveforms, compared envelopes. The comparison was based on obtaining the



absolute magnitude of the difference between the spoken word waveform and the library waveform. The minimum of the integral of this difference establishes the choice. In other words, the criteria is a best match based on

$$\int_0^T |f(t) - g(t)|^2 dt$$

where $f(t)$ represents the envelope of the spoken word
 $g(t)$ represents the envelope of the library word

As shown in the block diagram, the envelope is placed in temporary storage after amplitude and duration normalization. Repetition of the input envelope results in the generation, out of the correlator, of the series

$$\sum_j |f(t) - g_j(t)|^2 dt$$

The value of j which produces the minimum term as j is varied indicates the best match and thus produces the word-identification.

Tests of this system have been performed in our laboratory with encouraging results. The attached figures are recordings of the correlator output as a function of correlation time for the two words "nine" and "five". Each pulse amplitude is proportional to the magnitude of the difference integral and it can be seen that a significantly better match is obtained for "nine" vs "nine" as compared to "nine" vs "five".



STANDARD "NINE" VS S. R. "NINE" STANDARD "NINE" VS B. F. "FIVE" STANDARD "NINE" VS B. F. "NINE"

The reliability of any speech recognition technique depends on the degree of independence of the identifying parameter on the information property of speech. It is the intent to apply the analogue matching technique to various envelope characteristics of speech to test the efficiency of this approach relative to this criterion. Envelopes can be developed which are proportional to amplitude, frequency, zero crossings and their derivatives. Experimental evaluation of these envelopes will lead to a simple, real-time, spoken word recognizer.

Bulova developments in the fields of electronics and analogue techniques offer significant advances in the state of the art to meet the growing needs of both industry and the Military.

ENGINEERS: If you are interested in enhancing the state-of-the-art, in applying advanced theory, and developing your inherent capabilities under enlightened management in a professional atmosphere, write Dr. R. Hersey, Personnel Manager. All qualified applicants considered regardless of race, creed, color or national origin.

BULOVA RESEARCH & DEVELOPMENT LABORATORIES
a division of BULOVA WATCH COMPANY, INC.
62-10 WOODSIDE AVENUE • WOODSIDE 77, NEW YORK

CIRCLE 14 ON READER-SERVICE CARD

NEWS

Minuteman May Chart New Reliability Techniques

Many of the novel techniques used to produce the electronics portion of the Minuteman intercontinental missile may find their way into standard use in electronic design. Two in particular—worst-case circuit design and reliability improvement through failure analysis and corrective action—may have important effects in the electronics industry. The impact of these techniques was analyzed by Dr. W. J. West, reliability director at Autonetics Div., North American Aviation, Inc., Downey, Calif. Autonetics is the Air Force's prime contractor for most of the missile's airborne electronics equipment.

Dr. West reported at the fall meeting of the Electronic Industries Association, in New York City, Sept. 11-15, that Autonetics is adopting worst-case design based on Monte Carlo analytical techniques throughout the company's design centers.

The methods used by Autonetics are based on extreme derating, wide component tolerances and use of cooling. The company's circuit designers have a budget of reliability, which their circuits may not exceed, but within which reliability may be distributed as desired.

Parts Suppliers Subject To Close Quality Control

According to Dr. West, one of the keys to achieving component reliability is the detailed failure analysis and the effective corrective action to improve a parts supplier's production techniques. This often involves retraining of production workers.

In order to take effective corrective action, however, the prime contractor must examine the procedures used by the supplier inside the supplier's plant. Though some companies may resist this, permitting inspection goes a long way toward assuring reliable parts, Dr. West said. He believes that corrective action, combined with the many other inspection, documentation, and analysis techniques, could enable a company new to the Minuteman program to manufacture parts different from those in the program but at least as reliable. This would take about a year, he said.

For a special report on reliability see p 33 of this issue of ELECTRONIC DESIGN.

Ford Widens Industry Stake With Acquisition of Philco

Acquisition of Philco Corp. by Ford Motor Co. combines two organizations with important roles in space electronics as well as moving the auto-maker into other branches of the industry.

Ford's Aeronutronics Div., Newport Beach, Calif., among other space assignments, is developing the capsule to be landed on the moon from the Ranger spacecraft. This work is being done under a Jet Propulsion Laboratory contract.

Philco's Western Development Laboratories, Mountain View, Calif., is associate prime contractor for electronics in the Midas satellite program, and also is known to be working on the Samos surveillance-satellite system.

Philco's other activities in the semiconductor, computer, radio and television, and appliance fields now give Ford a heavy stake in the industry as a whole.

CBS Sells Plant, Quits Transistor Production

Columbia Broadcasting System, Inc. has sold the last manufacturing facility of its CBS Electronics division.

The company has announced the tentative sale to Raytheon Co. of its recently opened transistor and diode plant at Lowell, Mass. The plant operated only about six months. Earlier this year Columbia closed its operations at Danvers and Newburyport, Mass., and at Windham, Me.

CBS Electronics Laboratories Div., Stamford Conn., will continue operating, the company says.

GE Enters Signal-Diode Competition With PEP

PEP—Planar, Epitaxial, Passivated silicon diodes for high-speed computer use and general-purpose applications represent General Electric's entry into the \$100 million diode business.

GE's SD-150 features a minimum conductance of 50 ma at 1 v with a typical conductance of 100 ma and less than 2 nsec recovery time. Typical capacitance is less than 1 pf with 2 pf considered maximum.

The SD-150 is enclosed in a conventional subminiature glass package and a microminiature version, MSD-150, also is available.



HIGH-POWER DRY LOADS for X-band—air-cooled LXH7 above and water-cooled LXH1 at right. See table below for specifications.

Raytheon introduces compact dry loads for high power at UHF, S and X bands

New design techniques offer high-power load capabilities in compact lightweight units

Utilizing new design techniques, these Raytheon high-power loads are designed to meet a wide variety of system and laboratory requirements at minimum costs. The new dry loads offer reliability and compactness at high power levels previously only associated with water loads.

The models listed at right are available from stock. In addition, with new standardized designs Raytheon can give fast delivery of units matching custom needs. Write today for details on this or other Raytheon developments in microwave devices. Special Microwave Devices Operation, Raytheon Company, Waltham Industrial Park, Waltham 54, Massachusetts.

TYPICAL SPECIFICATIONS — HIGH POWER LOADS

Band	UHF	S	S	X	X	X	X
Model No.	LXH1	LSH1	L _C SH1	LXH1	LXH7	LXH11	LXH12
Freq. (kMc)	.325-.475	2.6-3.1	2.9-3.1	7.0-10.0	7.0-10.0	9.0-12.4	7.0-10.0
Av. Power	60 kW	25 kW	500 W	5 kW	600 W	5 kW	5 kW
Max. VSWR	1.10/1	1.10/1	1.10/1	1.10/1	1.10/1	1.10/1	1.10/1
Waveguide	WR 1800	RG75/U	RG96/U	RG51/U	RG51/U	RG52/U	RG51/U
Flange	Alum CPR-1800	UG584/U	UG45/U	UG51/U	UG51/U	UG39/U	UG51/U
Cooling	Liquid	Liquid	Liquid	Liquid	Air	Liquid	Liquid
Length	90	36	8 $\frac{3}{8}$	9	6 $\frac{3}{8}$	9 $\frac{3}{8}$	7 $\frac{11}{16}$
Width	14	5 $\frac{11}{16}$	1"	1 $\frac{3}{8}$	3 $\frac{3}{8}$	1 $\frac{3}{8}$	1 $\frac{3}{8}$
Height	24 $\frac{1}{2}$	5 $\frac{3}{8}$	2 $\frac{1}{8}$	1 $\frac{11}{16}$	2 $\frac{1}{8}$	1 $\frac{11}{16}$	1 $\frac{3}{8}$
Approx. Wt. (lbs.)	200	35	1.5	4.05	1	5	4

RAYTHEON

RAYTHEON COMPANY

SPECIAL MICROWAVE DEVICES OPERATION
CIRCLE 15 ON READER-SERVICE CARD



EVERYTHING'S SPECIAL



about these Elastic Stop® nuts...



...except their availability and ultimate cost to you.

Elastic Stop nuts come in hundreds of shapes and sizes. We have illustrated just a few to show you it is possible to choose a nut shape that will make your assembly job easier and faster.

How can you always be sure you have the real thing? Easy! The unique, instantly identifiable red nylon locking insert is your clue to an Elastic Stop nut's special brand of shakeproof, shockproof locking performance. Once you see "the ring of reliability" you know that *this* locknut is going to stay put . . . on any bolted connection . . . for as long as you want it to stay! It will not come off until it's wrenched off, and then it can be reused fifty or more times.

If your product's performance depends on tight bolted con-


nections or precise adjustments, Elastic Stop nuts are the best, lowest priced, reliability insurance you can buy. And in figuring "true costs" the final figure should never be based on initial price alone. Value analysis has repeatedly demonstrated that product breakdowns or serious field service problems attributable to fastener failure easily cost more than the modest price of an Elastic Stop nut. The *ultimate cost* of stop nut quality and performance can make them today's "best buy."

ESNA's 30-year background in design and production of self-locking nuts assures you the most complete line in the business. For complete flexibility to meet your size, shape or volume requirements call on ESNA.



ELASTIC STOP NUT CORPORATION OF AMERICA

2330 Vauxhall Road, Union, New Jersey, Dept. 564-957

for the ring  of reliability

CIRCLE 16 ON READER-SERVICE CARD

NEWS

Atlas Computer Uses New Logic Approach

Ferranti System Has Fast Fixed Store of Wire Mesh, Ferrite Rods

THE Atlas asynchronous computer—designed to run several programs concurrently while appearing as a single-program system to its simultaneous users—is described as the world's most powerful by its producers, Ferranti, Ltd., Hollinwood, England.

The computer is said to execute nearly one million commands per second, to have an access time of 0.3 μ sec to its fast fixed store, and to be able to add 48-bit, 40-digit numbers in about 1 μ sec each. It is said to cost between \$8 million and \$10 million.

Atlas was designed jointly by Ferranti and Manchester University, where installation of the first commercial system is nearing completion. Another Atlas has been ordered by the National Institute for Research in Nuclear Science at Harwell, England.

Ferranti reports that the Atlas computer depends primarily on logical design rather than novel hardware for its performance. The most significant electronic innovation in the system, Ferranti says, is a fast fixed store consisting of woven wire mesh into which ferrite rods are inserted to represent digits. This memory has an access time of 0.3 μ sec and contains 8,192 48-bit words in the standard size. The fast fixed store can be increased to store a theoretical maximum of more than 262,000 words, the company says. It holds frequently required commands.

The fast store is one of four large memories having different access times. The several stores appear as one memory to the user because of the computer's logical organization, which permits transfer of information between different levels of storage by system routines implemented by appropriate hardware.

**'Extra Codes' Usable
With Basic Information**

Atlas is operated by a relatively simple command code of the single-address type, supported by "extra codes" which provide entry to built-in subroutines. The "extra codes" may be mixed with basic instructions without complications, Ferranti says, and



Ferrite-rod, wire-mesh memory of experimental version of Atlas computer contains fixed instructions and computes on basis of information supplied by slower memories in system. Its access time is said to be 0.3 μ sec. An Atlas designer, Dr. R. L. Grimsdale, Manchester University, adjusts a ferrite rod in wire matrix.

without endangering other programs being run simultaneously. The "extra-code" subroutines are stored in the ferrite-rod fast memory.

The Atlas includes a "fast-carry adder" to ensure that the speed of addition is not hampered by carryover propagating from one digit to the next, the company says.

Another feature of the system's logical design is the method used to transfer information between the various stores as required. Built-in subroutines, commanded by the "extra codes," shift required information automatically according to a "page-address" system. In this system, numbers are identified by being in a particular shock, called a page, rather than by addresses signifying physical positions in the stores. The pages have no fixed location; they are moved from one location to another, according to which is needed in the high-speed store for current computing.

The computer is transistorized. Standard data-processing languages such as Fortran and Algol may be used with Atlas, the company says. ■ ■

Why engineers
are specifying **VK** Capacitors
for CK Capacitor requirements...

VITRAMON, INC. SUPPLIES
PROOF
OF PERFORMANCE

with every shipment



The "proof of performance" for all CK Capacitors ("VK" Capacitors purchased against MIL-C-11015/18 or /19) is enclosed with your order! Automatically and voluntarily, "Vitramon" supplies copies of Acceptance Testing Data — with every shipment.

And test results are impressive! Where absolute conformance to military specifications is essential, CK Capacitors adhere closely to requirements. In critical areas where specifications may be surpassed, CK Capacitors offer reliability "above and beyond." Here's how they measure up:

DISSIPATION FACTOR	
MIL. REQUIREMENT	ACTUAL PERFORMANCE
2.5% for all values	1.5% for values thru 680 mmf. 2.5% for values 820 thru 10,000 mmf.

TEMPERATURE COEFFICIENT	
MIL. REQUIREMENT	ACTUAL PERFORMANCE
+30% -56% for all values	$\pm 10\%$ for values thru 680 mmf. $\pm 15\%$ for values 820 thru 10,000 mmf.

CK Capacitors are checked 100% for dissipation factor and capacitance, and to insure that the parts stay within tolerance, only 2/3 of the available capacitance band is used. Parts are checked for Insulation Resistance after being subjected to a seal test consisting of exposure in live steam for 21½ hours under 15 p.s.i. Parts are also gauged 100% for physical dimensions.

Insist on "proof of performance"
for the CK Capacitors you use
... specify "VK" micro-miniature
ceramic capacitors.

© VITRAMON, INC., 1961

CIRCLE 17 ON READER-SERVICE CARD

VK Micro-miniature
**CERAMIC
CAPACITORS**

Conforms with MIL-C-11015/18/19



VK 30
case size:
0.3" square
lead spacing:
0.2"



VK 20
case size:
0.2" square
lead spacing:
0.2"

- 10-10,000 mmf
- -55° C to 150° C
- 200 VDC rating



automatic FREQUENCY RESPONSE

Signatures

for reliable
sonic design studies,
quality control,
precise calibration,
transmission loss,
polar response



Model 3304 Automatic Frequency Response Recorder

Automatic high speed calibration and frequency response recording...performed in far less time than is possible with other techniques...and, with the dependability, repeatability and precision of a Bruel & Kjaer System.

VERSATILE . . . complete, integrated response recording systems covering 2-2,000 c/s; 20-20,000 c/s; 200-200,000 c/s. One writing table for strip or polar recording.

FAST . . . AUTOMATIC PROGRAMING or remote control minimizes operator attention. Response recording can be made in 15 seconds.

FLAT . . . CONSTANT LEVEL testing signal, an exclusive B & K feature, is obtained by servo regulation of the output.

AUTOMATIC . . . continuous frequency scanning or single chart operation and reset.

FULL . . . 4-INCH CHART with frequency preprinted scale. Recorder features clean and reliable multi-colored inking with disposable cartridges.

Write for Complete Information • NOW!

B & K INSTRUMENTS, INC.
Please send me . . .
 Response Recorder Brochure
 Short Form Catalog
NAME _____
COMPANY _____
ADDRESS _____



B & K INSTRUMENTS, INC.
Bruel & Kjaer Precision Instruments

3030 WEST 106th STREET • CLEVELAND 11, OHIO • Clearwater 1-8430

CIRCLE 18 ON READER-SERVICE CARD

NEWS

Army Tests New Computer For Use In Combat Areas

A new member of the Army's FIELDATA family of combat-area data processors is undergoing evaluation tests at Fort Monmouth, N. J., Signal Research and Development Laboratory.

Called the Informer, the general-purpose computer will aid intelligence, logistics and personnel operations. It was built by International Business Machines Corp.

Informer is housed in a 2-1/2-ton truck and can be driven over broken terrain in all weather.

The computer's central processing unit, main memory, and power supply take no more space than a five-drawer filing cabinet. Informer requires no air-conditioning. The central processor is said to operate from -25 F to ± 125 F and in up to 97 per cent humidity. The unit's solid-state components can withstand up to 7.5 g, IBM says.

Computer and Tape Operate X-Ray Diffraction System

By programming a computer to operate a special X-ray diffractometer, researchers at Bell Telephone Laboratories hope to obtain more than 17,000 crystallographic readings a day. An experienced X-ray crystallographer can obtain manually only about 3,000 readings a day, according to Bell.

In Bell's system, called Pexrad (Programmed Electronic X-ray Automatic Diffractometer), such information as crystal lattice constants, wavelength of the X-ray beam and instrumental constants are fed to a computer on punched cards, along with a compiling program. The computer generates a magnetic tape, from which a punched paper tape is made. This tape controls the motors that rotate the crystal and receiving scintillation counter of the diffractometer and permits an X-ray beam of proper wavelength to irradiate the crystal for sufficient time.

The intensity of the beam diffracted by the crystal is measured and recorded on punched tape. The crystal is automatically rotated to the next position and the process is repeated. The punched tape from the sys-



Almost completely automatic X-ray diffractometer is operated by punched tape, of the type held here by Dr. S. C. Abrahams, who developed the new system at Bell Telephone Laboratories, Murray Hill, N. J.

tem is converted to a magnetic tape and fed back into the computer, which integrates the intensities, corrects for various factors, and prints out correct data.

Franklin Institute Opens Science Research Service

A Science Information Service has been organized by The Franklin Institute in Philadelphia. The service will aid industry and scientific institutions on R&D projects, primarily by providing extensive literature searches.

The service will offer searches in any area of mathematics, engineering, physics, chemistry and industrial processing. The service will handle bibliographic compilations, annotated bibliographies, abstracts of articles, current-literature monitoring and translations.

Poll Shows Increased Reliance on Standards

Increasing reliance on standards and standardization programs is indicated in a poll of 67 companies by the American Standards Association.

All responding companies said their standards activities had helped lower costs. The 15 companies giving specific data reported savings of up to 20 per cent of gross income.

Two-thirds of the firms said standardization is being extended, and many indicated wide use of company standards committees.

Linde *Materials & Coatings* News

LINDE COMPANY, DIVISION OF UNION CARBIDE CORPORATION

Polish semiconductors scratch-free with 99.98% pure alumina powders

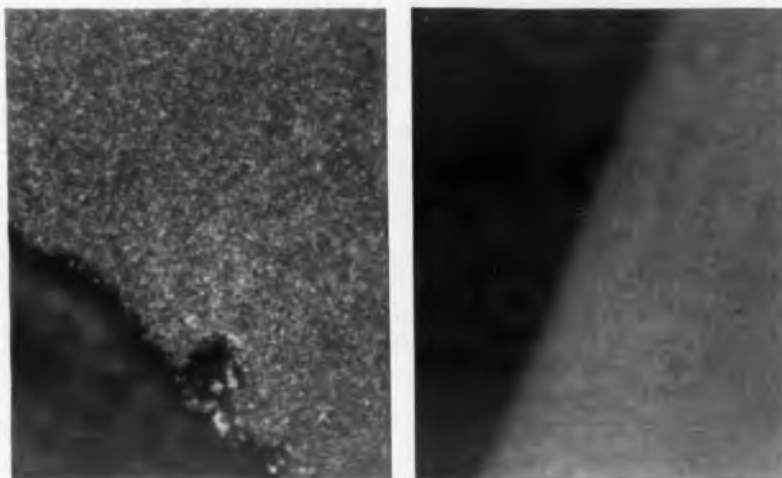


Photo at left: A typical as lapped silicon wafer, showing edge chip, prior to finishing. (Magnified 42X). Right: Complete polishing with LINDE alumina abrasives leaves edge of silicon and wafer scratch-free. (Magnified 144X).

The surfaces of the semiconducting wafers used in the new high-speed mesa switching transistors and planar diodes must have a superior surface finish, flatness, and parallelism—prior to final etching and diffusion. This effect is now being achieved in full production with high-purity alumina abrasives produced by LINDE.

Three particle sizes

Three basic particle size ranges of aluminum oxide powders suitable for polishing silicon and germanium wafers are available for this application, as well as many others. The difference in size and hardness, as listed below, give these 99.98% pure powders their individual properties.

	TYPE 0.3A	TYPE 0.05B	TYPE 1.0C
Formula	Al ₂ O ₃ (Alpha)	Al ₂ O ₃ (Gamma)	Al ₂ O ₃ (Alpha)
Crystal System	Hex.	Cubic	Hex.
Hardness, MOHS'	9	8	9
Size, Microns	0.3	0.05	1.0

Type 1.0C is used to remove stock from surfaces that are rougher than 6 micro-inches rms; Type 0.3A for preliminary polishing, and Type 0.05B for final polishing of the wafers.

In the initial stages of junction transistor or diode production, the powders can be used for preparing metallographic cross-sections of the assemblies according to standard methods on a horizontal polishing wheel. For semiconductors, LINDE has developed several adaptations of standard techniques.

Extremely uniform

LINDE Types A, B, and C alumina powders are chemically prepared and have an extremely uniform ultimate particle size which obviates any further levigation before use. By simple reference to a specific lot number, succeeding production lots can be ordered with abrasive properties tailored to an individual application.

For data on semiconductor and other critical polishing, check the coupon.

Flame-Plated tungsten carbide coatings precision-finished

Tungsten carbide coatings, applied with the LINDE Flame-Plating process, are being used successfully on hundreds of precision parts because the coatings are well suited for finishing down to 1 microinch rms.

Most frequently used precision grinding equipment is diamond wheels, resulting in lowest overall cost on ordinary cylindrical and flat work. On many contour grinding jobs, special grades of silicon carbide wheels will do the job, eliminating the high cost and lack of precision associated with shaped diamond wheels. Diamond-abrasive lapping techniques give high finishes.

Get complete data on Flame-Plating precision parts—send the coupon.

Plasma-Plate process applies thin dielectric coatings

Next time you need a low-cost, thin dielectric coating for cathode cups, consult Linde Company. LINDE's Plasma-Plate process has economically put alumina insulation coatings on molybdenum cups, and has even built structures on mandrels—for example, the grid cage shown below. This inert gas process can apply refractory metals melting up to 7100°C., also metal carbides, borides, and oxides, to a variety of base metals. Discuss your requirements with us. For further information, check and send the coupon.



Tungsten grid cage—intricate structure built up on mandrel using the Plasma-Plate process.

CHECK—CLIP COUPON—ATTACH TO BUSINESS LETTERHEAD

Linde Company, Dept. ED-94
270 Park Avenue
New York 17, N. Y.

UNION
CARBIDE

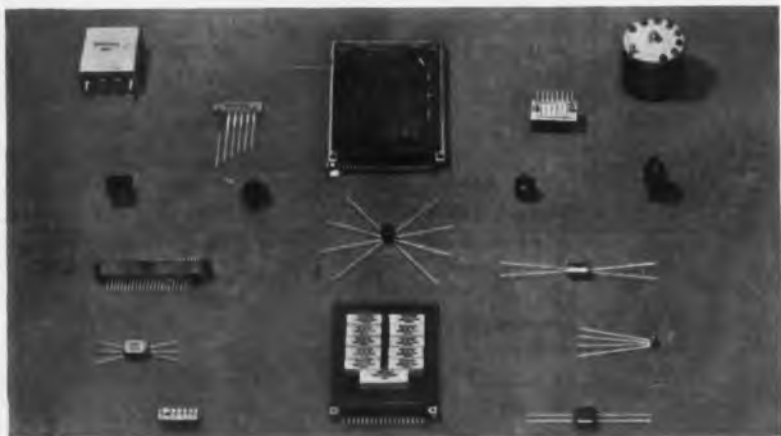
Please send details on the items checked:

- LINDE Alumina Abrasive Powders
 LINDE Finishing of Flame-Plated Parts
 LINDE Plasma-Plated Dielectric Coatings

LINDE
COMPANY

"Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation

CIRCLE 19 ON READER-SERVICE CARD



CUSTOM PACKAGING IS NO NOVELTY AT SPRAGUE'S SPECIAL PRODUCTS DIVISION

★ Sprague Electric Company's *SPECIAL PRODUCTS DIVISION* was founded originally to meet the electronic industry's needs for reliable packaged assemblies and subassemblies.

★ Sprague has developed and produced packages with countless variations in electrical characteristics and mechanical configurations, in all shapes and sizes, with and without semi-conductors, as wiring boards, in encapsulated cases, in cast blocks, in hermetically-sealed packages.

★ In Sprague packaged assemblies, internal components are connected by soldering, welding, wire-wrapping, or printed wiring techniques.

★ Sprague versatility offers several basic types of construction, including molded cellular, high-density "cordwood", and molded multiple-circuit construction, permitting densities in excess of 200,000 standard components per cu. ft.

★ For application engineering assistance without obligation, write or call the Special Products Division, Sprague Electric Company, 347 Union Street, North Adams, Massachusetts.

SPRAGUE COMPONENTS

PACKAGED COMPONENT ASSEMBLIES
FUNCTIONAL DIGITAL CIRCUITS
MAGNETIC COMPONENTS
PULSE TRANSFORMERS
CERAMIC-BASE PRINTED NETWORKS
HIGH TEMPERATURE MAGNET WIRE

CAPACITORS
RESISTORS
TRANSISTORS
INTERFERENCE FILTERS
PIEZOELECTRIC CERAMICS
PULSE-FORMING NETWORKS

SPRAGUE

THE MARK OF RELIABILITY



CIRCLE 20 ON READER-SERVICE CARD

WASHINGTON REPORT



Albert Warren
Washington Editor

ELECTRONIC HIGHWAY DETOURED

Fully automatic highways are not just ahead for American motorists, despite the demonstrated feasibility of electronic controls of automobile speed, spacing, and stops. This was the consensus even of visionaries among experts at the World Traffic Engineering Conference in Washington.

For one thing, O. K. Norman of the U. S. Bureau of Public Roads said, it would cost \$75,000,000 to build a 100-mile stretch of electronic highway with roadside installations and devices attached to cars. For another, he pointed out that all but 5 per cent of trips on American roads run less than 15 miles. Mr. Norman said that such a distance does not justify expensive gadgetry to keep traffic safely in line at 100 mph.

The Bureau of Roads has been playing with the electronic-highway idea, but Mr. Norman reported that it might be five years before any experimental start is made. "It is unlikely that the great monetary investments needed will be forthcoming for a long time to come," he told the conference, at which 31 countries were represented.

Speakers at the meeting agreed, however, that other applications of electronics—such as television controls and computer estimates of vehicular flow—are not only efficient but also can be money-saving. Summing up a series of papers on electronic traffic devices used or planned in the U. S., Great Britain, France, Germany, and India, Baltimore's traffic commissioner, Henry A. Barnes, said: "This type of equipment is no longer considered a gadget." Barnes reported that in his own city electronics had yielded such an increase in street capacity to handle traffic that some new construction projects had been postponed for at least ten years.

AIA CAMPAIGNS FOR ARMS-SPECIFICATIONS REVOLUTION

The Aerospace Industries Association wants to eliminate "obsolete" military material and design specifications which, it asserts, retard technology. Spokesmen for leading electronics, aircraft, and propulsion contractors have been caucusing in Washington preparatory to dispatching an AIA modernization mission to the Pentagon. Their plan is to carry the campaign to Defense Secretary Robert S. McNamara through Assistant Secretary Thomas D. Morris. They hope a joint AIA-Pentagon task force will be mobilized to attack chronic specification and paperwork problems.

Immediate AIA objectives: (1) Selection of specific weapon projects for intense review. (2) Stake-outs of areas to determine where costs can be reduced and lead times shortened. (3) Scrapping of outmoded contract documents. (4) Consolidation of service speci-

fications for the same equipment. (5) Elimination of "obsolete" requirements that hamper design, thus limiting progress in techniques.

Ultimately, the AIA seeks a revolution in Pentagon policy so that performance specifications will replace detailed initial material and design blueprints as main contract criteria.

The AIA complains that the paperwork-bound rigidity of the present Pentagon system not only gives contractors headaches but also inhibits inventors. A common case in point: if a manufacturer is so bold as to make a change from specifications, it isn't enough for him to prove that his improvement will work. He must also justify why he didn't follow the obsoleted specifications in the first place.

RADIO EXPLORES AGE-OLD MYSTERY OF BIRD FLIGHT

Electronics finally may solve a question that has gone unanswered through science's centuries: How do birds navigate with such astonishing precision? The answer could be that they are equipped with physiological devices that react, radar-and-compass-like, to changes in the electromagnetic flux.

Science's latest—and possibly promising—exploration into the mystery of bird flight has been undertaken by the Office of Naval Research, using new radio apparatus developed by Philadelphia's American Electronic Laboratories. Already a 20-mile trip by a homing pigeon to its loft in Philadelphia has been recorded on an elaborate chart providing precise directional data for triangulation-plotting of the bird's exact flight pattern. Researchers of ONR's Biological Orientation Program hope that from this start they can work up a sophisticated system of sensory devices to monitor birds' reactions to magnetic and other environmental changes.

The electronic tool in the initial experiment is a radio unit, weighing less than an ounce, which is strapped to the pigeon. Powered by three mercury-button cells, it has a transistorized oscillator and amplifier with a 1-mw output. Trailing from the package and below the pigeon in flight is a 40-in. half-wave dipole antenna whose first eight inches are stiffened with a fiberglass rod to guard against wing interference. Two specially designed receiving stations, including direction-finding, high-gain Yagi antennas on rotating pedestals, pick up the pigeon's flight signals.

Many explanations of bird navigation and the homing instinct have been advanced. None has been proven. Other hypotheses in addition to the electromagnetic-response theory: (1) Birds somehow react to the Coriolis-effect phenomenon attributed to the earth's rotation. (2) They just observe landmarks and guide themselves accordingly. (3) They chart their courses by taking readings on the sun and moon.

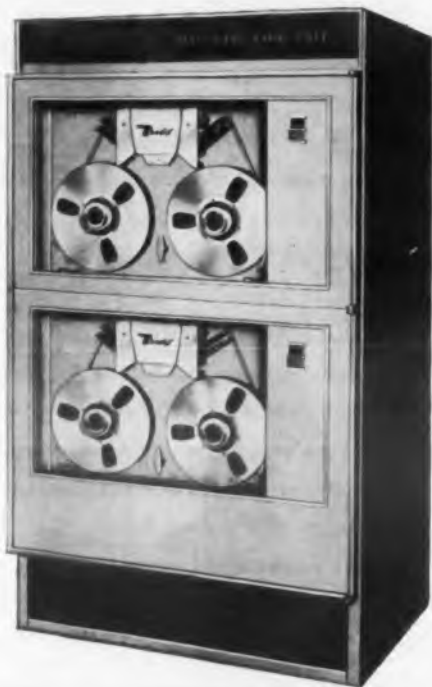
TELEVISION IMAGES IN THE DARK

A new image-intensifier orthicon tube developed by the Radio Corp. of America for the Army Corps of Engineers gives field commanders clear pictures of operations at night—without exposing troops to lights. Demonstrated to newsmen at the Association of the United States Army meeting in Washington, the RCA tube amplifies dim skyglow 100,000 times, bringing otherwise-invisible troops and objects to television screens. In an earlier test at Fort Story, Va., night amphibious landings were observed with clarity far back from the shoreline.

at BENDIX



they chose **POTTER**
High Density for the G-20
Computer.



the **POTTER** High Density System

as used with the Bendix G-20 Computer results in a highly reliable computer system that sets new standards for ease of use, power and efficiency.

The Potter 906 II is the heart of the High Density Recording System. This solid-state Digital Magnetic Tape Transport provides the G-20 with recording so reliable that in 40 hours of continuous recording less than a second of re-read time is required to recover drop-outs due to transient error. With this same type of equipment data-transfer rates of 360,000 alpha-numeric characters per second at packing-densities to 1500 bits per inch are possible with transient errors fewer than 1 in 10^8 .

To learn how the Potter High Density technique can be applied to your data handling problem . . . write today for your copy of "THE TOPIC IS HIGH DENSITY".

POTTER



INSTRUMENT CO., INC.

PLAINVIEW, NEW YORK

CIRCLE 21 ON READER-SERVICE CARD

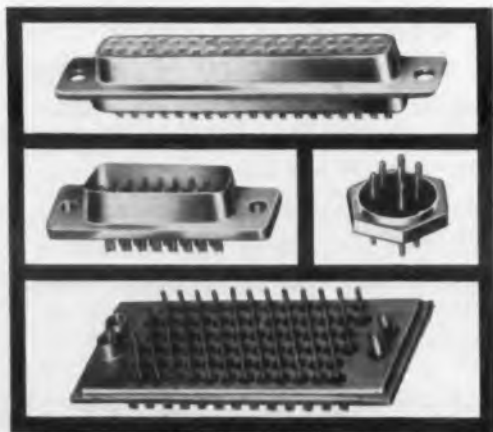
*adding to its already
extensive line,*

BURNDY

Announces:

Escon hermetically sealed connectors

By adding the creative engineering inherent in ESCON glass and ceramic hermetically-sealed connectors to its expanding line, Burndy moves to the fore as a major supplier of this vital component. This complete line of hermetically-sealed miniature, subminiature and micro-miniature connectors will answer the precise requirements in missile, aircraft, computer and other electronic systems. This addition gives Burndy the broadest line of connectors in the industry. It is with understandable pride that we welcome the respected name of ESCON to the BURNDY family of dependable connectors.



Burndy/Escon—an affiliate of

BURNDY

NORWALK, CONNECT.

CIRCLE 22 ON READER-SERVICE CARD

NEWS

TV Comparator Permits 300-Fold Magnification



Close-up of television-comparator monitor shows full-screen view of postage stamp, printed-circuit disk, and pin head. Magnification is about 10 to 1.

Magnification of up to 300 times is possible with a novel television comparator that permits examination and precise measurement of tiny solid objects.

The closed-circuit TV system enables an operator to inspect components such as transistors, resistors, diodes, microminiature wafers, watch parts, and subassemblies. The unit also can be used to examine live biological specimens and standard laboratory slides.

Using a single aircraft-type control stick, the operator can position the image on the screen and change its magnification through the entire range without loss of focus.

The TV comparator, made by GPL Division of General Precision, Inc., is being shown with a companion device—a microfilm televisor.

The company says the microfilm readout device permits a greater range of magnification than ever before, even at great distances.

Time-Sharing System Studied for FAA Use

A proposed air-traffic-control communication subsystem that would permit voice and data time-sharing on one channel is under study by the Federal Aviation Agency.

Known as ACCESS (Aircraft Communications Electronic Signaling Service), the con-

cept was developed jointly by Motorola, Inc. and General Precision, Inc. It has the two-fold objective of drastically curtailing the volume of voice communications between pilots and ground controllers and of better organizing essential voice communications.

A simple encoder-decoder unit represents a basic module, to which input and output equipment may be added, depending upon the desired degree of participation in digital communications.

Motorola is responsible for the design of the so-called MADE (Minimum Airborne Digital Equipment) box. This encoder-decoder unit, weighing 6 lb, is to cost about \$1,361. It could be used with a low-speed printer, costing about \$300.

The ACCESS system, using phase-shift keying modulation, will handle digital information within the audio bandwidth available in existing vhf, uhf and hf equipment. A data rate of up to 1,200 bits per sec is reported feasible.

Flight Tester Delivered



This pressure generator, said to be the first operational unit of its type, has been delivered to Republic Aviation Corp. for air-data-computer testing of its F-105 fighter. The unit, designated Master Air Data Computer Automated Tested (MADCAT) was built by U.S. Science Corp., a subsidiary of United Industrial Corp. The portable ground-support equipment converts electrical analogs to precise pressure outputs. It can be used to simulate flight conditions of air speed, altitude, air temperature, and angle of attack.

ELECTRONIC DESIGN • September 27, 1961



TINY...

Latest space-maker for size-conscious designers of transistorized commercial and entertainment equipment is the new Sprague Type 157P Molded-case Filmite® "E" Capacitor, which combines unusual compactness with exceptional performance characteristics.



TAN...

Distinctive *tan* coloring identifies the Type 157P Capacitor and serves as your warranty of outstanding shock-and-humidity resistance. The tough molded armor also protects against possible damage during soldering operations, or changes in capacitance from mechanical pressure where wrapped capacitors are clamped or cast in assemblies.



TERRIFIC!

Standard operating temperature range is -40 C to $+85\text{ C}$. And with voltage derating, this outstanding capacitor may be operated to $+105\text{ C}$! Its high insulation resistance (due to the polyester film dielectric and molded housing) is another characteristic which qualifies the 157P Capacitor for critical coupling applications.



For complete technical data on Type 157P Filmite "E" Capacitors, write for Engineering Bulletin 2065 to Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Mass.

SPRAGUE COMPONENTS

CAPACITORS
RESISTORS
MAGNETIC COMPONENTS
TRANSISTORS

INTERFERENCE FILTERS
PULSE TRANSFORMERS
PIEZOELECTRIC CERAMICS
PULSE-FORMING NETWORKS

HIGH TEMPERATURE MAGNET WIRE
CERAMIC-BASE PRINTED NETWORKS
PACKAGED COMPONENT ASSEMBLIES
FUNCTIONAL DIGITAL CIRCUITS

SPRAGUE
THE MARK OF RELIABILITY

Sprague and  are registered trademarks of the Sprague Electric Co.

CIRCLE 23 ON READER-SERVICE CARD



How to find laminations when you need them fast!

High permeability lamination stock list goes out to purchasing agents and engineers semimonthly

A stock list, mailed every other week, pinpoints the quantities and sizes of our high permeability laminations that are immediately available from stock. It's sent to purchasing agents and interested engineers throughout the country. To get *your* regular copy, just address a request to Magnetics Inc., Department ED-94, Butler, Pa.

What makes the stock list important? Depleted inventories or stepped-up production means that when laminations are needed, they're needed fast—and in perfect condition. Magnetics Inc. stock list shows what types are available for immediate shipment. In addition, the stock list contains information on the new higher permeability "E" grade laminations. What's more, stocks listed reinforce those maintained at regional outlets on the east and west coast (all connected by teletype to assure fast delivery). What makes Magnetics Inc. high permeability lamina-

tions special is the fact that they are the heart of high performance audio transformers, chokes and countless other fast response magnetic devices. They're burr-free, precision-sized and flat (thanks in part to a standardized 9" long carton that keeps the laminations undistorted during shipment and stocking). For more information, write to Magnetics Inc., Dept. ED-94, Butler, Pa.

Magnetics Inc. also publishes a bi-weekly stock list on tape wound cores and permalloy powder cores. It's available to you along with the laminations stock list. Ask for it.

MAGNETICS inc.

CIRCLE 24 ON READER-SERVICE CARD

NEWS

Diamonds, Borazon Made Semiconductive in Lab

Semiconducting diamonds of the p-type, and both p- and n-type borazon (cubic form of boron nitride with hardness equal to diamonds and similar structure) have been produced in the laboratory.

If practical applications are achieved, these materials promise high reliability in extreme environments.

Both materials were made semiconductive by the addition of controlled amounts of impurities by researchers at General Electric Co.'s Research Laboratory, Schenectady, N. Y.

Since both p- and n-type semiconductors will be needed for devices, work is continuing on the development of n-type diamond. The diamonds are made semiconducting by adding impurities, such as boron, beryllium or aluminum, at high temperatures and pressures to a mixture of graphite and a catalyst used by GE to make diamonds.

Either p- or n-type borazon can be grown onto a seed crystal of the opposite type, forming pn junctions. Beryllium is used to produce p-type borazon, and several materials, such as sulfur, silicon, many organic compounds, and potassium cyanide, can be used to get n-type.

The method for producing semiconducting diamonds was developed by Dr. Robert H. Wentorf, Jr., of the GE Research Laboratory, and Harold P. Bovenkerk, of the GE Metallurgical Products Dept.

Dr. Wentorf, who developed the original process for making borazon, also developed semiconducting borazon.

Accuracy Is Our Policy . . .

In the news story "Thin-Film Hall Device Is Nearing Production," which appeared in the Aug. 2, issue, p 6, the open-circuit output sensitivity was incorrectly called the Hall coefficient. The sensitivity is the Hall constant, divided by the film thickness. Further, the article implied that conventional units require more input power. Actually, thin film units require higher power inputs, but at the same time give higher output voltages for the same input current and magnetic field strength.


Get valuable information on advanced measuring techniques



APPLICATION NOTES

yours without charge, without obligation




Hewlett-Packard Application Notes, covering a wide variety of subjects, include both theoretical and "how to do it" information. They are composed of information derived from the experience of  engineers both in general areas of measurement and in solving specific measurement problems. Many interested readers have found Application Notes useful in the past. You may find them helpful, too.

Check this partial list of titles:

- # 2 Frequency Measurement of Low-Level Signals, up to and above 12.4 GC
- # 6 Homodyne Generator Detection System, to measure attenuation, rf leakage, antenna patterns, etc.
- # 15 Distortion and Intermodulation
- # 36 Sampling Oscillography
- # 42 Applications of 416A Ratio Meter, reflectometer techniques
- # 43 Continuous Monitoring of Radar Noise Figures
- # 44 Use and Usefulness of the 185A 1,000 MC Oscilloscope (44A, Synchronizing the 185A; 44B, Pulse Analysis; 44C, Component Switching Speed Characteristics Measurement)
- # 48 Applications of the 218A Pulse and Delay Generator
- # 50 How to Make VLF Frequency Comparison Measurements with Standard Laboratory Equipment
- # 52 Frequency and Time Standards

Other Application Notes cover such subjects as measuring FM signals, measuring rf pulse carrier frequency, microwave spectrum synthesis, waves on transmission lines, square wave and pulse testing, measurement of cable characteristics, instruments for transducer applications. The Application Notes Index gives a complete listing.

Fill in and mail the attached post card for Application Notes of interest to you, or for a complete list of titles.

See the reverse
side of this
page for other
helpful 
publications

BUSINESS REPLY MAIL
No postage stamp necessary if mailed in U. S.

—Postage Will Be Paid By—

Hewlett-Packard Company
Department K
1501 Page Mill Road
Palo Alto, California

First Class
Permit No. 201
Palo Alto, Calif.



Engineers in electronics
and allied fields are invited
to join the roster of
regular readers of the

hp JOURNAL

published throughout
the year, presenting
factual reports on new
measurement techniques,
new instrumentation.



TYPICAL SUBJECTS

- Improved sweep frequency techniques for broad band microwave testing
- Square wave and pulse testing of linear systems
- Effect of μ -circuit non-linearity on the amplitude stability of RC oscillators
- A new frequency counter plug-in unit for direct frequency measurement to 510 MC
- Two versatile new power supplies for high power semiconductor work
- An improved method for measuring losses in short waveguide lengths

YOURS WITHOUT CHARGE *Just check box in white area on card below and mail.*

Please send these APPLICATION NOTES:

#2, #6, #15, #36, #42, #43, #44A, #44B,

#44C, #48, #50, #52, Complete Index

Put me on the mailing list for the **hp** JOURNAL

Inform my **hp** representative that I would like to receive the new 1961 **hp** general catalog.

Name _____ Title _____

Company _____ Bldg. or Mail Sta. _____

Address _____



Now available! The new 1961 **hp** catalog giving complete information on the more than 400 precision electronic instruments manufactured by Hewlett-Packard. Just contact your nearest **hp** representative for your copy — or check the appropriate box on the postcard.

Firm to Share Use Of Optical Scanner

An arrangement has been made between Minneapolis-Honeywell and Farrington Manufacturing Co. of Needham Heights, Mass., for use of Farrington optical scanning-reading equipment on Honeywell electronic-data-processing systems.

Honeywell, under the arrangement, will incorporate Farrington optical scanners as a customer option in its EDP systems to provide an automatic on-line input for the Honeywell 800 and 400 systems.

Farrington electronic reading machines scan ordinary business documents and instantaneously translate the numeric or alpha-numeric information into business machine language for output on punched cards, punched paper tape, or magnetic tape.

Three basic series of optical scanners produced by Farrington are:

- Document Reader Series—Scanner reads numeric or alpha-numeric on card or paper stock.

- Page Reader Series—Scanner reads whole pages of numeric or alpha-numeric data.

- Self-Punching Series—Scanner reads numeric information on unpunched tabulating cards and punches the information back into the same card.

GE Gets Flowmeter Calibrator



Two flowmeter calibration stands, capable of measuring up to 150,000 and 15,000 lb per hr, respectively, have been installed in General Electric Co.'s new flowmeter laboratory, West Lynn, Mass. Repeatability accuracy of both is 0.1 per cent. Temperatures up to 365 F and down to -72 F can be duplicated to test fluids. The new facility will test GE's industrial and aircraft true-mass flowmeters.

POWER FROM NICAD

NICKEL CADMIUM RECHARGEABLE BATTERIES

FOR AIRCRAFT ■ MISSILES ■ CONSUMER PRODUCTS ■ ELECTRONICS ■ COMMUNICATIONS

3 TYPES HERMETICALLY SEALED CELLS



BUTTON 20-500 mAh

CYLINDRICAL 100 mAh-4.0 Ah

RECTANGULAR 1.5-2.3 Ah

2 TYPES VENTED CELLS



SINTERED PLATE 500 mAh-240 Ah (Miniaturized and Large Industrial Types)

POCKET PLATE 10 Ah-2048 Ah

NICAD Batteries, in miniaturized Sealed and Vented Cells, are constantly in demand where there is a vital need for highly reliable and durable power sources. Suitable for the most stringent military requirements, these versatile cells are also adaptable to a wide variety of critical commercial, consumer and industrial applications.

Rechargeable, miniaturized, lightweight, NICAD Sealed Cells require no maintenance and operate in any position. High current discharge capabilities and extended shelf life make these cells ideal for battery-powered equipment that must operate instantly and efficiently.

NICAD sintered plate Vented Cells are designed to give exceptionally long life under cycle and float service. They can be stored in any state of charge for long periods without attention or fear of deterioration. They will operate in any position on discharge.

Pocket plate types are ideally suited for standby power and control, signal and alarm systems, emergency lighting, stationary engine cranking, cycling service, switchgear tripping and closing, locomotive starting. They seldom require maintenance, have an exceptionally long life and will maintain sustained voltage at heavy discharge rates. There's no sulphation, no corrosive fumes.

For further information on both Vented and Hermetically Sealed Cells, additional usage and application, write . . .



NICAD BATTERY DIVISION GOULD-NATIONAL BATTERIES, INC.

E-1404 1st National Bank Bldg.
St. Paul 1, Minnesota

[NICAD] is a trademark of Gould-National Batteries, Inc.

CIRCLE 28 ON READER-SERVICE CARD



CONSUMER PRODUCTS

Cordless Appliances
Dictating, Recording Equipment
Shavers
Radios
Hearing Aids
Electronic Medical Aids



ELECTRONICS

Instruments
Receivers/Transmitters
Computers
Telemetering
Portable Communications Equipment



MISSILES AND ROCKETS

Control
Guidance
Telemetering



AIRCRAFT

Engine Starting
Emergency Lighting
Controls and Alarms
Rescue Gear



COMMUNICATIONS

Telephone
Telemetering
Microwave

TYPICAL USES



POWER PLANTS

Switchgear Operation
Supervisory Control
Emergency Lighting and Power
Microwave



RAILROADS

Switchgear Operation
Microwave
Engine Starting
Lanterns



INDUSTRIAL

Switchgear Operation
Emergency Lighting
Engine Starting
Flashlights and Lanterns
Cordless Power Tools



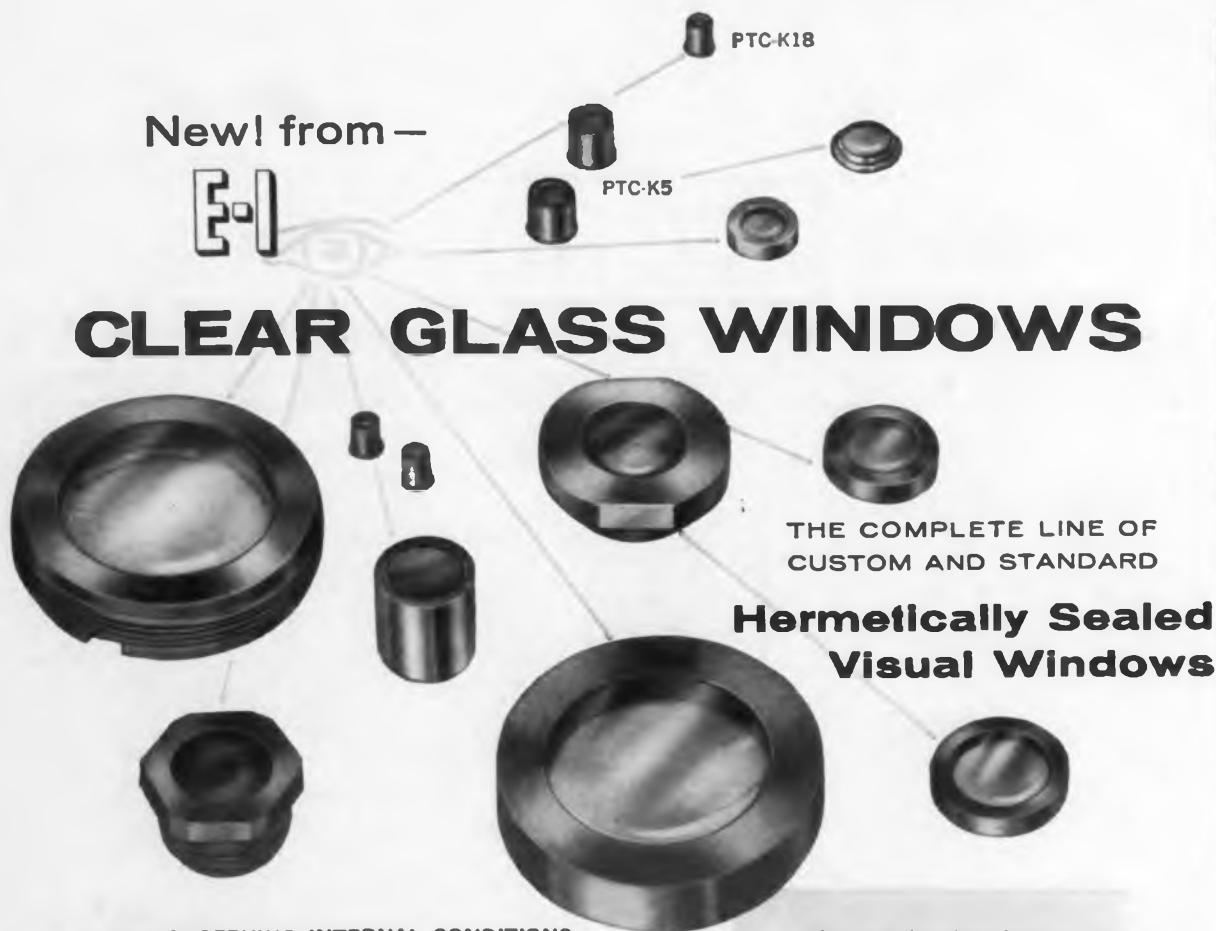
MARINE

Engine Starting
Radio and Alarms
Life Boats

New! from —

E-I

CLEAR GLASS WINDOWS



THE COMPLETE LINE OF
CUSTOM AND STANDARD

Hermetically Sealed Visual Windows

— FOR OBSERVING INTERNAL CONDITIONS IN HERMETICALLY SEALED ELECTRONIC, ELECTRICAL AND MECHANICAL EQUIPMENT

E-I clear glass windows are manufactured to the same high quality standards that have made **ELECTRICAL INDUSTRIES** the industry-preferred name in glass-to-metal seals. E-I sealed windows are available in both kovar and compression types. Compression sealed windows are extremely rugged... meet the test of the most gruelling "space age" environments! For complete information and recommendations on specific applications, just call or write today; detailed data will be supplied to you promptly on request, without obligation.

ELECTRICAL INDUSTRIES

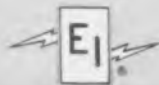
MURRAY HILL, NEW JERSEY

A Division of Philips Electronics & Pharmaceutical
Industries Corporation

Patented in Canada, No. 523,390; in United Kingdom,
No. 734,583; licensed in U. S. under No. 2561520

For All Applications

INDICATOR LIGHT OBSERVANCE
METER READING
FLOW AND FLUID LEVEL
PRESSURE INDICATION
GAS-MOISTURE CONTROL VALVES
TRANSISTOR PHOTO CAPS
PHOTO SENSITIVE DEVICES
REFRIGERATION EQUIPMENT
AIR CONDITIONERS
ENVIRONMENTAL CHAMBERS
SPECIAL LABORATORY UNITS, ETC.



SPECIFICATIONS FOR STANDARD CLEAR GLASS, SEALED WINDOWS

	MATCHED SEALS (KOVAR)	COMPRESSION SEALS (STEEL)
THICKNESS	.040" to 200"	.090" to 500"
GLASS O.D.	150" to 300"	From 150" up

Mechanical strength up to 10,000 P.S.I. depending on design and application; various finishes available, as well as special shapes and sizes.

NEWS

Recessed Wafers Support Circuits

*System Adaptable to Molecular
And Conventional Techniques*

A "MIDDLE-OF-THE-ROAD" approach to microminiaturization, which uses presently available micromin components, yet is adaptable to deposited circuits and molecular electronic techniques, has been developed by Thompson Ramo Wooldridge, Inc., Canoga Park, Calif.

The recently announced system employs Fotoceram wafers on which the designer can mount conventional micromin circuit elements or which can be imprinted with molecular circuits. The wafers are arranged in stacks by means pressure connectors.

Components lie in cavities preformed into the board and are joined with coplanar leads running along the surface of the board. The connectors are integral with the board and can be mounted on all four sides and in any component area. Boards may be connected in any plane. An entire system can be built up from such wafers without interconnecting wires.

Improved Cooling, High Density Packing Claimed

Each wafer stack is said to embody built-in natural convection channels for improved cooling. Maximum power dissipation for circuits using this technique is cited as 3.5 kw per cu ft. Packing density of 250,000 elements per cu foot is claimed for complete subassemblies, with higher densities attainable on individual wafers.

Other advantages reported for the tech-



Typical function board configuration possible with Thompson Ramo Wooldridge micromin technique. Note recesses in wafers to accept components. The wafers can be connected along any edge and in any plane, according to the company.



One-piece connector used in Thompson Ramo Woolridge micromin system is shown with microtransistor. Pencil point provides scale.

nique include high environmental tolerance and maintainability. Company spokesmen note that the arrangement of wafers and connectors permits more test points than do conventional printed circuits. Each subsystem can be tested individually before installation and defective wafers can be replaced with a simple tool.

Thompson Ramo officials state that the new technique is ready for production. The cost is said to be about one and a half times that of conventional techniques (assuming equal component costs). ■ ■

Coating Process Permits Controlled Use of Metals

Experimental work in coating various substrates has led to a technique for coating conductive or light-transmissive thin films on plastic or glass substrates.

The technique, developed by Halex, Inc., of El Segundo, Calif., involves deposition of substrates with high-abrasive and corrosion-resistant characteristics to produce both controlled light transmission and conductivity on one surface. The process can be applied both to continuous rolls and discrete sections, according to Halex.

Previously, only relatively soft or low-melting substances could be used in coating mylar or glass substrates; now it is possible through a high-vacuum process to deposit metals such as platinum tantalum, niobium and nichrome in a manner that minimizes the effects of fractional distillation, the company said. As a result, Halex reports that it is able to deposit these thin films on substrates of a wide variety of geometries with an end product of controlled electric conductivity and light-transmissiveness on the same piece of substrate material.

SEE US AT NEA
BOOTH NO. 2



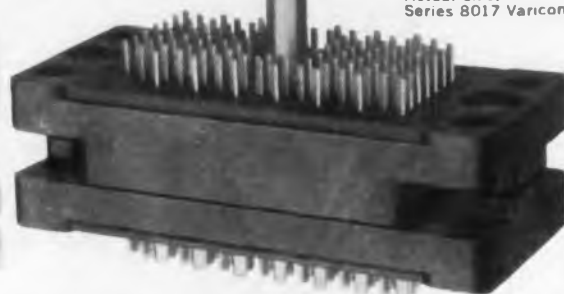
Actual Size,
Series 8017 Varicon

WHY, TOO, DID

TELEREGISTER

SELECT

ELCO VARICONS?



Because only the most reliable, versatile connectors were acceptable for the "Instamatic" data processor TELEREGISTER designed and produced for UNITED AIR LINES. This staggeringly sophisticated complex, exceeded only by the government's DEW Line, interconnects UNITED'S Denver control center with some 3,000 agents in 68 cities via 12,000 miles of communications circuits; transmits information in a split second; eventually will handle 180,000 seat reservations a day. And in the heart of this processor, ELCO VARICON Connectors, Series 8017.

So find out how VARICONS, with their unique fork-like contacts and infinite applicability, can solve your design, production, reliability and budgetary problems, too. Request Bulletin 8017 and VARICON Catalog.

IF IT'S NEW ...
IF IT'S NEWS
IT'S FROM ...



ELCO CORPORATION: M Street below Erie, Philadelphia 24, Pa., CU 9-5500

ELCO Pacific: 2200 Centinela, West Los Angeles 64, Cal., GRanite 8-0671
International ELCO A. S., Lindealle 42, Copenhagen, Vanlose, Denmark
ELCO Australasia, Bradbury House, 55 York Street, Sydney, Australia

CIRCLE 30 ON READER-SERVICE CARD

50% SMALLER!



OR MORE POWER IN THE SAME SPACE!

G-E miniature Vac-u-Sel[®] Selenium Rectifier advantages include:

- + New thin cell construction (.010" in thickness) + Voltage ratings up to 31,500 PRV (50% greater than ordinary units) + New phenolic housing (approximately twice the dielectric strength of glass melamine housings) + Operation at ambient temperatures up to 130°C with no derating! + New Automatic Continuous Evaporation (ACE) manufacturing process (greater uniformity from cell to cell, stack to stack) + 15% price reduction + Current range 1.5 to 25 ma.

General Electric's new line of thin cell, high voltage, cartridge type half wave selenium rectifiers features the *smallest cartridge size on the market today for a given voltage rating*. You can specify one rectifier rated as high as 31,500 volts . . . for as little as 19¢ per KV! And, of course, the lower the voltage rating, the smaller the cartridge will be. The units shown are actual size.

Your G-E Semiconductor District Sales Man-

ager will give you complete information to satisfy your requirements for ion generators, radar power supplies, or other low current, high voltage applications. Or write to Rectifier Components Department, Section 23133, General Electric Company, Auburn, New York. In Canada: Canadian General Electric, 189 Dufferin St., Toronto, Ont. Export: International General Electric, 150 E. 42nd St., New York 17, N. Y.

FOR FAST DELIVERY OF SELENIUM, GERMANIUM AND SILICON RECTIFIERS AT FACTORY-LOW PRICES, CALL YOUR G-E SEMICONDUCTOR DISTRIBUTOR

GENERAL ELECTRIC

CIRCLE 31 ON READER-SERVICE CARD

NEWS

Encoder Readied for Weather Duty



A photoelectric encoder mated to a standard Kollsman Altimeter Setting Indicator, left, is shown with digital readout test equipment, right. The equipment, designed by Kollsman Instrument Corp., Elmhurst, N. Y., for a nuclear weather station will transmit barometric-pressure data in digital form twice in a 17-sec period at 3-hr intervals. The station, developed for the Atomic Energy Commission by Martin Co., is scheduled for shipment shortly to northern Canada. (See ED, Aug. 2, p 34).

Carburization Cuts Electron Emissions

A process that suppresses emission from portions of cathode surfaces and auxiliary electrodes has been developed by Philip Metalonics of Mount Vernon, N. Y.

The company says the patented technique, which consists of surface carburization, is useful in generating electron beams of special shapes and in preventing electron emission from cathode supports and auxiliary electrodes close to the cathode. Normally, it is difficult to achieve these objectives because most metals become activated by cathode evaporation and migration products.

Emission from barium-activated dispenser cathodes is reduced by one to three orders of magnitude in the normal operating range of 900 to 1,200 C, the company says. The effect can be achieved at still lower temperatures when cathode evaporation rate is low, for instance in the case of auxiliary electrodes used in conjunction with oxide-coated cathodes.

According to the company, the technique also has been used successfully for generating hollow beams, of disk-shaped grids, accelerating anodes, beam focusing and guard electrodes.

Cathodes having beam focusing or guard electrodes now can be produced as a single structure. The method is reported to be effective in eliminating emission from molybdenum end hats in magnetron cathodes.

Solar Generator Designed To Power Irrigation Pump

A solar-thermoelectric generator designed to power a water pump may find economical application in arid underdeveloped lands.

Westinghouse Electric Corp., in cooperation with the Solar Energy Laboratory of the University of Wisconsin, has built and tested a 50-w power plant.

The company now is developing a 200-w unit. This power plant, it is reported, could pump enough water from a depth of 20 ft to irrigate about four acres of land at the rate of 24 in. of water a year.

Westinghouse says a 200-w plant also could supply the personal needs of 1,200 persons on the basis of 5 gal of water per person a day.

To provide the stated amounts of water, the company says the generator would have to work 10 hr a day for 250 days a year, allowing for about a third of the year for inclement weather.

The generator, weighing just over 16 lb, has a peak operating $T_H = 593$ C and $T_C = 65.5$ C.

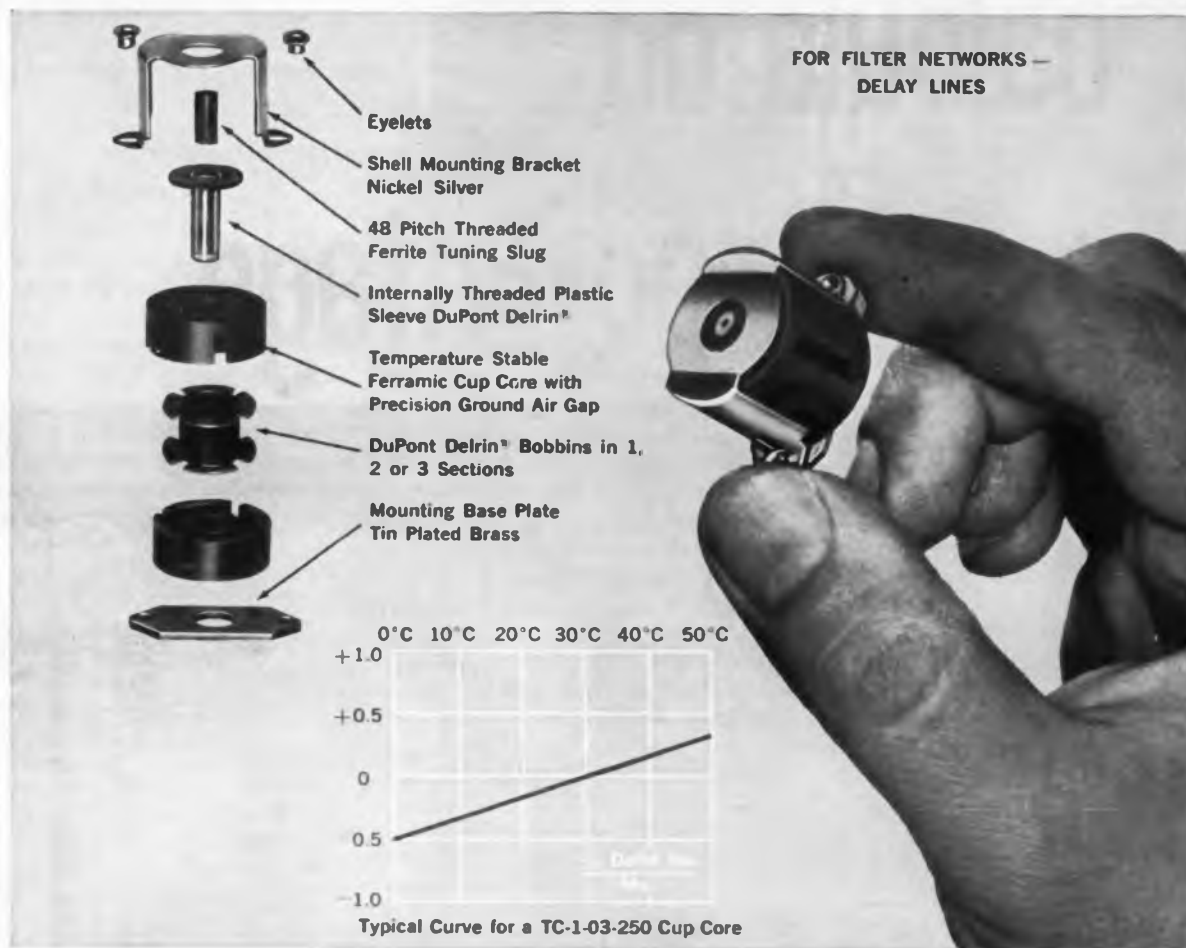
Kurt Katz, senior engineer at the Westinghouse new-products laboratories, described the thermoelectric generator last month at the United Nations Conference on New Sources of Energy in Rome.

Tracker for Astronaut



This quad-helix steerable array antenna, being checked by G. R. White, Project Mercury manager for Bendix Corp. of Los Angeles, will aim itself automatically as the manned Mercury space craft comes within range, then receive telemetered signals from space. A global network of 18 National Aeronautics and Space Administration stations, employing such antennas, will receive some 90 channels of telemetered data, maintain two-way communications, and transmit ground-controlled backup of the craft's control functions.

From General Ceramics Division of
INDIANA GENERAL CORPORATION



FERRAMIC® Cup Core Assemblies with Unmatched Stability 0° C to 50° C (International Series)

FEATURES THAT PAY OFF IN PERFORMANCE AND COST

- Seven sizes from stock .599" to 1.425" O.D.
- Frequencies — 1KC to 1MC
- "Q" values to 750
- Standard Gapped Inductance Values 40 to 1000 MH/1000 turns
- Extreme temperature stability
- Trimmer for minimum of 12% adjustment
- Complete assembly available

Now, a complete line of in-stock cup core assemblies designed for electronic coil applications requiring inductance and permeability having exacting temperature stability and linearity.

The high "Q" factor exhibited by these temperature compensated cup cores is engineered to meet the most rigid coil design requirements.

TC permeability stable units combine optimum operating performance in the smallest possible space providing complete design flexibility at low cost.

For exact recommendations and fast off-the-shelf deliveries, write, wire or phone today — ask for Bulletin 28-M9.



GENERAL CERAMICS

Phone VAlley 6-5100 • Direct Distance Dialing Code 201

KEASBEY, NEW JERSEY, U. S. A.

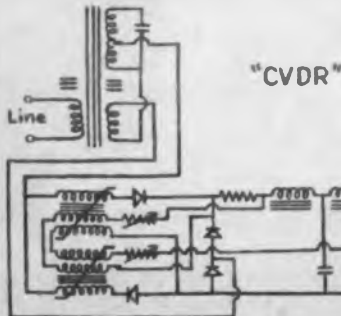
TECHNICAL CERAMICS, FERRITES AND MEMORY PRODUCTS
CIRCLE 32 ON READER-SERVICE CARD

calculated advantage

For all your a-c and d-c power supply requirements or special engineering, contact your nearest SOLA representative:

New SOLA "CVDR" d-c supply simplifies missile-age circuit design, reduces costs.

It's a natural for computers, communications equipment, and similarly sophisticated electronic gear. Made for today's stringent operating parameters. Ends costly dependence on over-engineered d-c power sources.



CVDR provides both line and load regulation without tubes or transistors. Line regulation $\pm 1\%$, for $\pm 15\%$ line voltage changes; 1% load regulation from zero to full load; 1% peak to peak ripple. Fits 19" relay racks, and measures only $3\frac{1}{2}$ " high. Custom configurations and power ratings available on special order.

Line voltage stabilization is by means of the Sola "CV" self-regulating transformer. Load voltage stabilization is accomplished by the series "IX" voltage drop in the saturable reactor (see schematic). This voltage drop is controlled by the load current itself.

CVDR is ready right now, off-the-shelf, in units rated 6-volts, 10-amps . . . and 12, 18 or 24 volts, 5-amps. For outstanding reliability in a-c and d-c power supplies tailored to every application, see your SOLA representative . . . or write to address below.

SOLA ELECTRIC CO., 1717 Buase Road, Elk Grove Village, Ill. MEmpstead 9-2800
IN CANADA, Sole-Basic Products Ltd., 377 Evans Ave., Toronto 18, Ontario

SOLA



Division of Basic Products Corporation

CALIFORNIA, San Francisco: Sola Electric Co., Three W. 37 Ave., San Mateo, Flreside 1-6538
• Los Angeles: Sola Electric Co., 2907 West Vernon Avenue, AXminster 2-0166

COLORADO, Denver: Slaybaugh & Thompson 100 W. 13th Avenue, AComa 2-5826

FLORIDA, Winter Park: James Millar Assoc., P. O. Box 1603; Midway 7-7407

GEORGIA, Atlanta: James Millar Assoc., 1036 Peachtree Street N. E., TRinity 6-0919

INDIANA, Indianapolis: R. O. Whitesell & Assoc., 6620 E. Washington Street; Fleetwood 9-5374

IOWA, Des Moines: McDowell Redingshafer Sales Co., 3615 Olive St.; JEFFerson 3-3277

KENTUCKY, Louisville: R. O. Whitesell & Assoc., 400 N. 38 Street; SPring 6-2024

MASSACHUSETTS, Newton: Sola Electric Co., 272 Centre Street; Blgelow 4-3354

MICHIGAN, Detroit: R. C. Merchant & Co., Inc., 18411 W. McNichols Rd.; KENwood 5-6000

MINNESOTA, Minneapolis: Helmann Co., 1711 Hawthorne Avenue; FEderal 2-5457

MISSOURI, Kansas City: McDowell-Redingshafer Sales Co., 1103 E. Armour; WEstport 1-5622

• St. Louis: McDowell-Redingshafer Sales Co., 3615 Olive Street; JEFFerson 3-3277

NEW JERSEY, Little Ferry: Sola Electric Co., 84 Industrial Avenue; HUBbard 9-1060

NEW YORK, Buffalo: R. W. Mitscher Co., 487 Ellicott Square Building; TL 4-2517

NORTH CAROLINA, Charlotte: Ranson, Wallace & Co., 116 1/2 E. 4th St.; EDison 4-4244

OHIO, Cleveland: Sola Electric Co., 14235 Detroit Avenue; LAKewood 1-8038

PENNSYLVANIA, Philadelphia: Sola Electric Co. (Philadelphia answering service — WAInut 2-5340); or 210 North 6 Street, Camden 2, N. J.; EMerson 5-7744

• Pittsburgh: R. G. Sidnell & Co., 675 Princeton Blvd.; CHurhill 2-1476

TEXAS, Dallas: Robert E. Nesbitt Co., 1925 Cedar Springs; RIVERSide 7-4145

WASHINGTON, Seattle: Northwestern Agencies, Inc., 4130 First Ave. So.; MAIne 3-8882

WASHINGTON, D. C.: Sola Electric Co., contact 8719 Colesville Rd., Silver Spring, Md.; JUNiper 5-0331

CIRCLE 33 ON READER-SERVICE CARD

CIRCLE 767 ON READER-SERVICE CARD
ELECTRONIC DESIGN • September 27, 1961

EDITORIAL

Reliability Is a Function of Attitude

Reliability has been the single most-talked-about subject in the electronics industry for 10 years. It holds an all-time top record. Yet, unreliability is still the chief fault of equipment being produced. Why all the talk and so little action?

The most common answer is, "we don't put our money where our mouth is." When it gets down to greater reliability or greater costs, the latter, as a limiting factor, comes first.

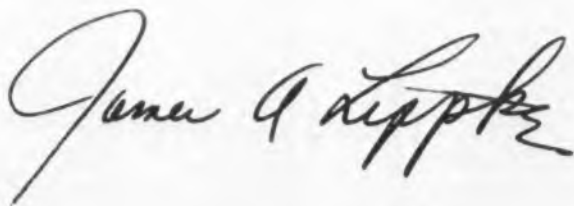
Those who have achieved high reliability know that spending money is not the whole answer. Whether you achieve reliability or not depends on "do you really mean it." Regardless of whether your product is Minuteman or a TV set, to get reliability you have to want it. Reliability, if it is to be achieved, must become almost a personal religion. Like a virtue, it can be talked about endlessly but a state of virtue only comes by living it. Reliability has to be uppermost in one's set of values if it is to become meaningful.

North American Aviation, Inc., learned on the Minuteman Program that you can't readily get followers of the new religion by conversion—not unless these persons could be totally "reborn" again, to draw an analogy from Christian theology.

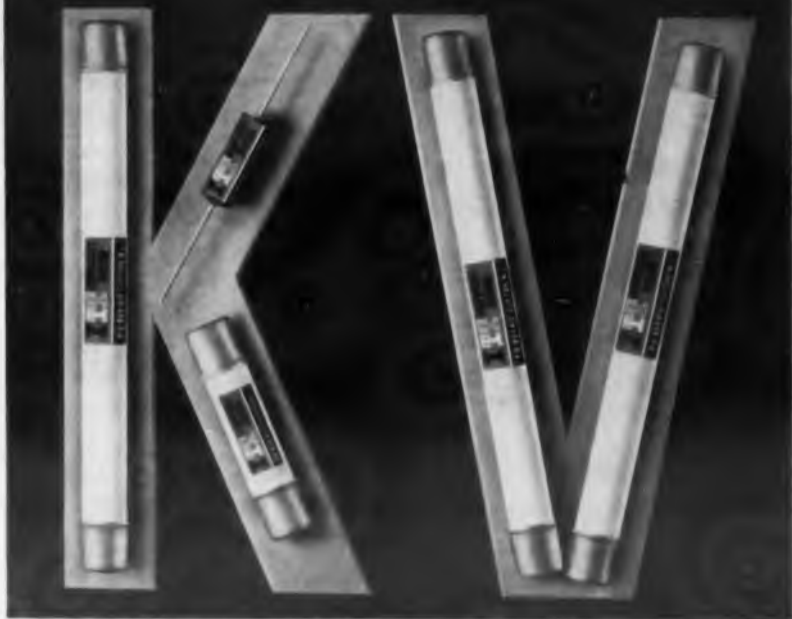
New plants, new assemblers, new foremen, new outlooks, have proved vital. Assemblers and foremen with ingrained habits often can't acquire the new perspective that is needed. In many instances, "assembly lines" must be broken up into a series of single stations where multiple operations are performed and then thoroughly checked by tests. The procedure often calls for a new plant layout. To achieve reliability, each person involved must know what he is doing in every detail and he must be able to link his actions—such as dropping a component on the floor—with final system reliability.

Fortunately deliberate, costly individual steps in achieving reliability can result in lower final costs. A higher reliability transistor often costs an equipment producer less because he has fewer rejects during final test. A high-quality TV set can produce greater profit for a manufacturer because customers will pay more for a service-free set.

But regardless of cost involved, reliability, or simply, quality, is achieved only when reliability or quality is considered the most important factor.



UP TO 16



RUGGED ITT HIGH-VOLTAGE SILICON CARTRIDGE RECTIFIERS

This ITT high-voltage line represents the latest advances of the state of the art. Constructed from selected p-n junction diodes assembled in series within an insulated cartridge, each silicon rectifier is completely vibration-safe and moisture resistant. Available with axial leads, or with ferrule terminals which permit mounting into standard 30-ampere fuse clips. In high-voltage, high-current, high-temperature applications, these ITT rectifiers satisfy the most stringent military and industrial requirements.

Write for information on the complete line of ITT high-voltage silicon cartridge rectifiers. Application assistance is available for your specific requirements.



SEMICONDUCTOR DEPARTMENT ■ COMPONENTS DIVISION

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION, CLIFTON, NEW JERSEY

CIRCLE 34 ON READER-SERVICE CARD

CARTRIDGE TYPE

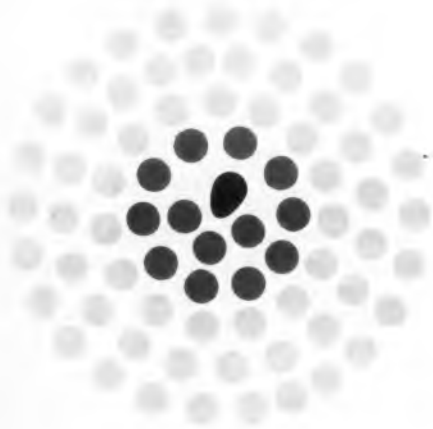
Absolute Max. Rtg. Res.-Ind. Load at 75°C Ambient		
EIA TYPE	PEAK INVERSE VOLTAGE (VOLTS)	MAX. RECTIFIED DC OUTPUT CURRENT (ma)
1N1134	1500	100
1N1136	1800	85
1N1138	2400	60
1N1140	3600	65
1N1142	4800	50
1N1143A	6000	65
1N1145	7200	60
1N1147	12000	45
1N1149	16000	45

Operating Temp. Range: -55°C to +150°C Ambient
NOTE: Permissible current at 25°C is 115% of the value at 75°C. Derate linearly from 75°C to zero current at 150°C.

AXIAL LEAD TYPE

MAXIMUM RATINGS		
EIA TYPE NUMBER	PEAK INVERSE VOLTAGE (VOLTS)	MAX. AVERAGE RECT. CURRENT * (ma) @ 25°C
1N1730	1000	200
1N1731	1500	200
1N1732	2000	200
1N1733	3000	150
1N1734	5000	100
1N2382	4000	150
1N2383	6000	100
1N2384	8000	70
1N2385	10000	70

* Resistive or Inductive Load
Continuous DC Voltage Same as PIV
Max. Surge Current (8ms) at 100°C: 2.5 Amperes
Operating Temp. Range: -55°C to +150°C Ambient



Performance characteristics demanded in today's and tomorrow's military weapons and space programs can only be achieved by complexity. Yet complexity for performance gains is certain to be accompanied by a loss in operating time due to component failures and assembly defects due to the sheer number of parts and manufacturing steps involved.

To illustrate the reliability problems facing designers of complex electronic systems, consider the almost unbelievable demands placed on the individual component. From preliminary estimates conducted on a satellite electronic system, no less than 95 per cent certainty of three years mean-time-between-failure (MTBF) is acceptable. Based on the use of 10,000 components in such a system (a conservative estimate), a failure rate of 0.0002 per million hours is required of each part; another way to express this is a MTBF of 508,000,000 hours for each component! As another example, the electronic control and guidance system for the Minuteman missile has an initial objective of 7,000 hours MTBF; this has been likened to running 30,000 TV sets for a year without a single failure. Several orders of magnitude improvement in systems MTBF must be achieved over present-day equipment performances.

The efforts of the Department of Defense in establishing the Ad Hoc Study Group on Parts Specifications Management are outlined in "Parts Specifications Management—The PSMR-1 Report," p 34. In addition, the activity of government and industry groups to implement the recommendations is discussed.

The theory and objectives of reliability testing are detailed in "Reliability Testing and its Applications to the TACAN-AGREE Program," authored by Dr. A. L. Floyd of Hoffman, see p 38. Dr. Floyd, as Director of Reliability, was responsible for achieving the

meeting the reliability challenge—

Howard Bierman
Technical Editor

An ELECTRONIC DESIGN Special Report

following reliability gains in the first test of AGREE-reliability demands: 700 per cent increase in equipment reliability, 10 times improvement in performance and, for added measure, 30 per cent decrease in unit price. The task is detailed in his article.

What functions should a reliability group perform? How can bickering and time-consuming arguments between the reliability group and engineering, production and control be kept to a minimum? Dr. R. W. Hull, V.P. and Director of Reliability for General Instruments, outlines the duties and responsibilities of the reliability group and also spells out management's role in backing up the group. The organization details are covered in "The Reliability Group: Its Duties and Responsibilities," p 54.

Industrial consultant Dorian Shainin, V.P. and Director of Reliability of Rath and Strong, Inc., details the technique of "Variation Research," p 60 a tool for improving process and product quality. By means of well-planned statistical experiments, defects can be forced to expose themselves.

A list of "Military Standards and Specifications on Reliability" is included on p 66 to provide a working guide to the design engineer engaged in defense contracts.

Finally, to illustrate how absurd reliability prediction techniques can be, Carl O. Holmquist, Capt., U.S.N., provides a magnificent account of the probabilities and statistics encountered with a hammer-nail combination. See how close you can come to predicting the "Over-all Reliability of a Long Established System — The Hammer and Nail," p 52.



Parts Specifications Management for Reliability—

The PSMR-1 Report: Its Contents and Present Status

“Parts Specifications Management for Reliability (PSMR-1)”, more commonly termed the “Darnell Report,” created considerable interest when released in the summer of 1960. The background leading to the report preparation, its contents and the efforts of industry and government to put its recommendations in effect are described.

HIGHLY reliable components offer an excellent start for the manufacture of a complex electronic system. Recognizing the needs for adequate parts specifications without frustrating delays and for their dissemination to design and logistics groups as rapidly as possible, the Department of Defense sponsored the Ad Hoc Study on Electronic Parts Specifications Management for Reliability. The study group's recommendations were distributed in July, 1960 and created considerable comment among parts manufacturers and their customers. Among the top questions receiving attention was, “How will the recommendations be implemented?”

Before attempting to answer this question, the background and contents of the study report will be outlined.

Background Leading to the Study Program

In the AGREE report of June 1957, Task Group 5 recommended a complete review of the parts specification program. The Ad Hoc Study on Parts Specifications Management for Reliability was established in July, 1958 and the first meeting was held in October, 1958 with Mr. Paul S. Darnell of the Bell Telephone Laboratories and Consultant to Office, Secretary of Defense, serving as chairman. The study group consisted of a balanced team of military and industry members experienced in parts, electron tubes, semiconductors, equipment and systems design. The

joint military-industry representation was deliberately planned to insure consideration of both the manufacturer and customer. The study was concerned only with electronic components; mechanical parts were not included.

The following areas were covered in the study:

1. Specification of reliability of parts in terms of failure rate as a function of time. Test procedures and means to determine compliance with the level specified.
2. Survey of methods used to prepare and coordinate parts specifications.
3. Review of Qualification Approval testing requirements and procedures.
4. Evaluate the adequacy of test requirements with respect to reliability demands and quality control procedures.
5. Establish a program for the exchange of technical characteristics and test data on components.
6. Establish means to develop and disseminate design guides and parts application data (including failure rate data) as a function of circuit application severity level and environment.

What the Darnell Report Is

Report PSMR-1 (Parts Specifications Management for Reliability) contains the recommendations of the Ad Hoc Study Group and was distributed to government agencies and industry in July, 1960. (The PSMR-1 is often called the Darnell Report since Mr. P. S.

Darnell headed the study group.) Volume I, intended primarily for management, relates the recommendations offered by the five task groups engaged in the effort. Volume II, for use by specification writers, covers the concepts and objectives of failure-rate requirements, procedures for incorporating reliability assurance provisions into parts specifications and means of preparing design and procurement documentation for military parts; also included are three prototype specifications (for paper dielectric capacitors, relays and electron tubes.)

The principal recommendations contained in the PSMR-1 include:

1. Establish a high-level government-industry advisory group on management of electronic parts specifications to plan and direct an effective program on a continuous basis.
2. Shift ASEA (Armed Services Electro-Standards Agency) to the Office of the Assistant Secretary of Defense (S & L); this would provide at office, Secretary of Defense level, centrally directed support of the electronic parts specification program.
3. Change the format for specifications to embrace reliability levels, life test plans and environmental limits. Also modify Qualified Approval procedures, acceptance inspection sampling plans and request certified test data be included with shipped individual lots. Finally, procedures are outlined to limit the total time required for specification preparation and printing to 26 weeks maximum; presently, it is possible for similar work to take a year and a half before completion.

What the Darnell Report Is Not

Despite the intensive efforts of all involved in the study, it is obvious that many problems are still to be solved. Therefore, it is of

equal importance to recognize the limitations of the PSMR-1.

1. The PSMR-1 *is not* the last word in parts specifications management. It is a solid foundation upon which a more complete and encompassing program can be built.

2. The prototype specifications contained in Volume II are intended to familiarize the specification writer with the principles established. Items in the prototype guides may require revision to make use of the latest available techniques.

3. The PSMR-1 *is not* a reliability document but rather a recommendation on procedures related to how to specify reliability—high or low level—and procedures to keep the specifications on a timely basis.

4. Last, and obvious, the PSMR-1 *is not* the solution to the parts reliability problem. The specification effort must, of necessity, be supported by a strong program of research and development in the parts area and the capability of industry to produce units to high reliability levels.

How is the Government Implementing the Darnell Report?

The Ad Hoc Study provided recommendations of prime importance for achieving high reliability. High reliability is needed for our military missiles, to safely transport an astronaut into space, to keep our defense communication nets in constant operation and maintain the alertness of our radar warning systems. The recent activity of the DOD, Navy, Army and Air Force to incorporate the Darnell Report recommendations is quite encouraging.

Navy, Bureau of Ships: ARINC Research Corp. is under contract to provide improved semi-conductor specifications, including reliability and life-test sampling procedures, based on analysis of data collected from semiconductor manufacturers, equipment manufacturers and government laboratories. Modes of failure and their distribution, failure prediction techniques, and the most efficient sampling plan to attain high consumer confidence at low testing costs are of prime interest. In addition, ARINC is carefully scrutinizing data involving the application of semi-conductor devices.

The Bureau of Ships has adopted the PSMR-1 prototype format for the preparation of tube specifications. Taking the lead for the DOD, the Bureau of Ships has initiated the revision of capacitor specification in accordance with PSMR-1 recommendations and other specifications to be reworked include

those for connectors, relays, resistors and transformers. In addition, the recently released MIL-STD-242 (Navy) "Electronic Equipment Parts—Selected Standards" includes application curves with failure rates plotted for certain parts categories.

Army Signal Corps: The Signal Corps, acting for the DOD and with the cooperation of Battelle Memorial Institute, has revised MIL-R-10509B (except for small lot provisions) to the PSMR-1 principles.

Air Force: The Air Force Systems Command has issued instruction that all AF-generated specs follow the PSMR-1 concept. Gentile Air Force Base is including failure-rate requirements and sampling plans in new tube purchase specifications. The Air Force has also indicated that data accumulated from the Minuteman reliability program will be entered on PSMR-1 format specifications when available.

DOD: Following the release of the Darnell Report, a planning group was set up to resolve problem areas and schedule the necessary implementation. The group consisted of representatives of the office, Director of Defense, Research and Engineering, office, Assistant Secretary of Defense, Installation and Logistics and the military departments. The status of progress resulting from a series of weekly meetings is as follows:

1. The Dept. of Defense has initiated the revision, on a priority basis, of selected specifications for items for which reliability requirements are urgently needed. All new specifications developed by the DOD will contain reliability requirements as recommended in the report. One of the basic objectives of the program to revise or develop new specifications is the establishment of specifications binding upon all military departments and the reduction of single-service specifications.

2. The recommendations contained in the report pertaining to the organization for the management of specifications have been given extensive consideration and an organization structure to achieve the objectives is now under consideration.

3. Qualification approval procedures in the M-205 Manual are being revised in accordance to PSMR-1 suggestions. Products will be qualified to specific failure-rate levels and remain on the Qualified Products List (QPL) only on the basis of continuing to meet the stated life test requirements; the passing failure-rate level will be posted along with the product on the QPL. Also, clearance has been obtained to permit distribution of

EIA, AIA, IRE, PGRQC and the ASQC are jointly sponsoring a symposium on "Specifying Reliability in Semiconductor Device Specifications," Oct. 25 and 26. The conference will be held at the Dept. of Interior Auditorium, 18 and C Sts., N.W., Washington, D.C. Mr. Paul Darnell will moderate a panel discussion on "What Price Reliability?"

The Minuteman ICBM program, with an initial objective of a 7,000-hour MTBF for its guidance and control system, represents an enormous reliability challenge. With the component reliability program entering its second year of study, considerable information relating to parts reliability has been collected. ELECTRONIC DESIGN will soon report the results stemming from the Autonetics division of North American Aviation, Inc. and the 11 component manufacturers involved.

QPL's to parts users and manufacturers rather than solely to parts users.

4. Changes in the M-200 Series Manuals (DOD standardization manual) to the PSMR-1 recommendations have been drafted and are in the process of tri-service coordination.

5. A MIL-STD document has been prepared to extend contractual requirements for technical data and documentation on parts not fully identified under military standards and specifications. The document is undergoing tri-service coordination while, at the same time, comments are being solicited from industry.

6. A detailed study of existing reliability assurance plans for small lots is under way to develop an effective solution to a difficult problem. The effort is being coordinated with various JEDEC groups of EIA.

7. A guide manual for specification writers is being completed and will be circulated among industry groups.

In addition, a program is being developed to educate and train inspectors on the concepts of sampling plans and procedures. A draft of a tri-service specification for a single elapsed-time indicator standard has been

ELECTRONIC DESIGN wishes to thank Mr. E. J. Nucci, Coordinator for Reliability, Office of Electronics, Office, Director of Defense (R&E) and Mr. George Ritter, Office of Assistant Secretary of Defense (I&L) for their assistance in furnishing material for the above article.

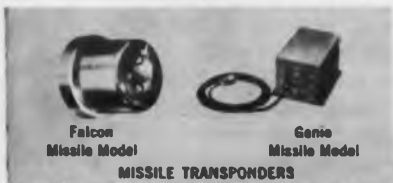


PARAMI

TO SCORE "WILLIAM TELL 1961" WEAPONS MEET

Once again, the Parami Miss Distance Indicator system will score the William Tell Weapons meet at Tyndall AFB. No other off-the-shelf system covers the effective ranges of all the missiles—no other system scores with the accuracy of Parami.

When the Air Defense teams fire Falcons, Sidewinders, and Genies at the Firebee drones, Parami transponders in the missiles and targets will be talking to each other and the ground station will be eavesdropping with pen and paper in hand, recording the score of each firing for the meet referees within seconds.



Falcon
Missile Model Genie
Missile Model
MISSILE TRANSPONDERS



TARGET TRANSPONDER



GROUND STATION RECORDER RACK



Electronics

THE RALPH M. PARSONS COMPANY

ELECTRONICS DIVISION

151 South De Lacey Avenue, Pasadena, California

LOS ANGELES
LONDON
NEW YORK
PARIS
WASHINGTON

OFFICES IN
OTHER
PRINCIPAL CITIES
THROUGHOUT
THE WORLD

WORLD WIDE SERVICES: APPRAISALS AND ECONOMIC STUDIES • ARCHITECT-ENGINEERING • CONSTRUCTION • ELECTRONIC SYSTEMS AND COMPONENTS • MINING AND METALLURGICAL ENGINEERING • PERSONNEL TRAINING • PETROLEUM-CHEMICAL ENGINEERING • PETROLEUM PRODUCTION SYSTEMS • PLANT OPERATION • POWER PLANT ENGINEERING • WATER DEVELOPMENT AND SYSTEMS

CIRCLE 36 ON READER-SERVICE CARD



finished and is awaiting approval. Finally, it is planned that a time limit of 12 weeks maximum will be set for the preparation or revision of a specification, excluding printing time.

Industry's Efforts in Implementing the Darnell Report

Industry groups, such as the Electronics Industries Association (EIA) and the Aerospace Industries Association (AIA), after close examination of the PSMR-1, endorsed and supported the recommendations contained. Private companies engaged in complex system deliveries had already been involved in specifications management and had been following procedures similar to those outlined in the PSMR-1. Industry's progress in implementing the PSMR-1 can be summarized as follows:

EIA: The Military Products and Parts divisions have provided helpful comments on possible problem areas to be resolved. JEDEC Tube and Semiconductor groups JT-5 and JT-11 are considering the adoption of the Ad Hoc Study Prototype Specification format and contents. The JT-11 group is working closely with the military and industry on improved sampling plans; also in progress are steps to include LTPD (Lot Tolerance Per Cent Defective) figures in new specifications to provide greater customer confidence. These, and other JEDEC efforts, are expected to result in device quality as well as improved specifications.

The EIA M5.2 Reliability Group is collecting parts failure rate data to include in a design-guidance handbook. All companies involved in equipment and component manufacturing have been asked to contribute their data to assist the project. Plans are for the Government to print the handbook and to of-

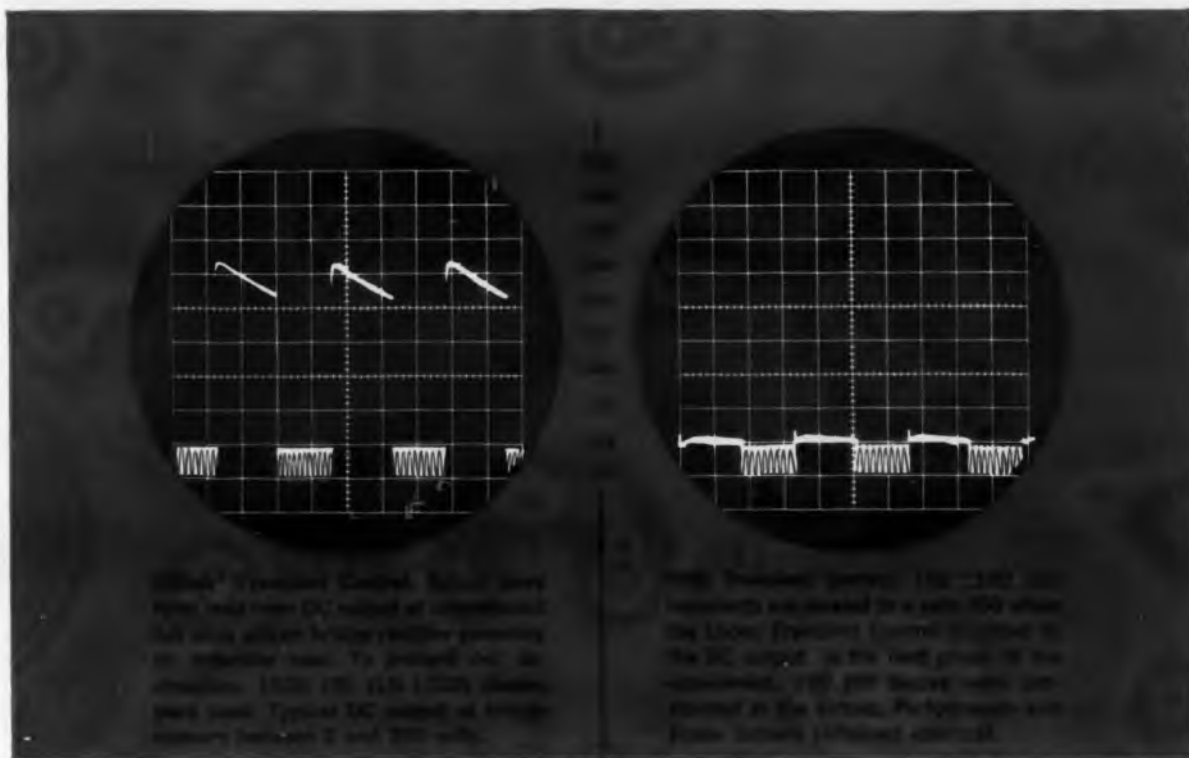
reliability

fer it at the cost of printing to all interested parties.

AIA: The Aerospace Industries Association's Electronic Equipment Technical Committee (EETC) has approved the principles of the PSMR-1 and is in strong support of the recommendation to establish a central group at DOD level to integrate the reliability activity.

Private Companies: Many of the complex systems contractors, including Lockheed, GE Missile and Space Div., Bell Labs, Westinghouse and Hoffman, are already using techniques of PSMR-1 and some have developed specifications similar to the PSMR-1 prototypes; efforts are underway to conduct an exchange of PSMR-1 prepared specs rather than duplicate efforts by several companies on the same spec. Many component manufacturers are engaged in the preparation of specifications for their parts in accordance with the PSMR-1 prototypes. Another trend to the Darnell Report recommendations is the growing number of "certified reliability" ads and brochures offering customers full test data with delivered lots as proof of compliance to stated specifications.

Despite the slow, but steady, progress in the implementation of the PSMR-1, many pitfalls lie ahead. Companies must be prepared to invest in new or improved facilities for testing, manufacturing processes may require extensive revisions to meet stated requirements and a well-planned education and training program for all levels of personnel must be initiated. However, for want of an "easier" way, the concept of high-reliability components to produce a high-reliability system must be strictly adhered to. The benefits to be gained are obvious—the penalty likewise does not require elaboration. ■ ■



New low-cost Transient Control* makes silicon rectifiers reliable by clipping voltage spikes

The new Ledex Transient Control guarantees positive dependability of 200 PIV silicon rectifiers. It's a non-polarized device that automatically clips voltage spikes by providing a low resistance shunt for all potentials above 200 volts—on the AC or DC side. It draws no current in normal operation.

As shown in the actual scope shots above, the control will repeatedly clip transients or reverse voltages to a safe level of 200. To the design engineer, it is a guarantee that the maximum voltage will go no higher than 200. Compact, light, and economical, the new development puts low-cost 200 PIV diodes in a reliability class of their own.

While the device is mainly intended for protection of 115 VAC silicon rectifier circuits, it can also be designed to clip spikes and protect other semi-conductor circuits at lower or higher control voltages.



NEW LEDEX TRANSIENT CONTROL is small ($\frac{3}{4}$ " dia. by $1\frac{3}{8}$ " long), lightweight ($\frac{2}{3}$ oz.) low cost (\$1.60 to \$2.05 in small quantities). Part No. A-46800-001 has 200 volt control and 2" leads.



NEW LEDEX SILICON BRIDGE RECTIFIER is protected by a built-in Ledex Transient Control. Voltage spikes are automatically clipped at 200. The rectifier is sealed in epoxy resin and meets the general requirements of MIL-E-5400 on insulation, terminals, vibration, shock, sand and dust, fungus and salt atmosphere. Operating temperature is -65°C to $+120^{\circ}\text{C}$. Part No. A-46501-001 is rated as follows: 115 volt AC input, 100 volt DC output, maximum surge 50 amp for 8 msec. \$6.80 to \$8.15 in small quantities.

VALUE ANALYSIS RECTIFIER TRANSIENT CONTROL KIT consists of Transient Control, Silicon Rectifier with built-in Control and outline for evaluation tests to compare costs and reliability with your present circuits. Part No. A-47609-001. \$11.00 per kit.

Other Ledex products are ready to go to work as compact solutions to your actuating, stepping or circuit switching applications.

FOR LITERATURE, clip this ad, check boxes above, attach to your letterhead and mail to Ledex Inc., Dayton 2, Ohio; Marsland Engineering, Ltd., Kitchener, Ont.; NSF Ltd., 31 Alfred Place, London, Eng.; AEMGP, 115 Ave. Clement, Boulogne, France.

* PAT. PENDING



CIRCLE 37 ON READER-SERVICE CARD



Reliability Testing and Its Application to the TACAN-AGREE Program

The first major electronic equipment produced in accordance with the Department of Defense's AGREE reliability procedures was the AN/ARN-21C Airborne TACAN built by Hoffman. Dr. A. L. Floyd, responsible for achieving the 150 hr MTBF for production units containing over 5,600 electrical and mechanical parts, first describes the fundamentals of reliability testing; then the design guides and results achieved for the TACAN program are outlined.

Dr. A. L. Floyd
Director of Plans and Programs
Military Products Div.
Hoffman Electronics Corp.
Los Angeles, Calif.

RELIABILITY has often been criticized for "too much talk, too little action." As an excellent rebuttal, consider the achievements resulting from Hoffman's redesign of TACAN airborne navigational equipment, resulting from a well-planned reliability program: reliability was improved by 700 per cent, performance raised by a factor of 10 and, for added measure, at a 30 per cent decrease in unit cost. To further emphasize the reliability feat, the TACAN equipment was the "guinea pig" selected as the first electronic equipment to comply with the DOD AGREE (Advisory Group on Electronic Reliability) Task Group 3 requirements. TACAN equipment that had been built during the first seven years of production provided a MTBF of only 17 hr (when tested to AGREE environmental stresses). This figure was raised to 150 hr MTBF by (1) following design procedures stemming from reliability studies, (2) testing and removing

design causes of failure such as switching transients and misapplication of devices, (3) carefully monitored quality control procedures and (4) reliability testing and failure analysis with follow-up corrective action.

RELIABILITY TESTING

Reliability testing implies determining the reliability of some given equipment, theory or procedure. The first question that must be answered before the test begins is "What is reliability?" In general, reliability means the degree of confidence held that the application of the equipment or theory under consideration will be successful. This definition can be further specialized to the following: reliability is the probability of performing a specified function under given conditions for a specified time interval.¹ By this definition of reliability, three parameters affect reliability: (1) The item under consideration and its tasks; (2) the "given conditions" and (3) the time interval. Thus, when testing for reliability, all of these parameters must be specified and their effect upon the test generally evaluated.

The discussion that follows will be centered on electronic equipments and components, although the concepts are applicable to all reliability tests. For any electrical items being operated under "given conditions," forces are exerted upon the equipment and can cause failure. All of these forces, i.e., temperature, voltage, vibration, time, test procedure, can be combined into one resultant force or stress capable of causing failure. For the present discussion, this force will be identified as the force of mortality, $F(t)$, and considered to be a function of the electrical item's total life time.

For a large sample of items operating under "given conditions", the force of mortality can be determined by the following procedure: All of the items are placed in operation and a continuous record kept of the number of items that have not failed, i.e., survivors S vs time. Experiments indicate that a continuous analytical function can be fitted to this data by use of the following definition: Force of mortality is equal to the number of units that are operating, that is

$$F(t) = - \frac{1}{S} \frac{ds}{dt}$$

t = the total life time of the units (1)

The above equation can be integrated between limits as follows:

$$\int_{t_1}^{t_2} F(t) dt = - \int_{S_1}^{S_2} \frac{1}{S} ds = \ln S \Big|_{S_1}^{S_2}$$

$$= \ln \frac{S_2}{S_1} \text{ or } S_2 = S_1 e^{-\int_{t_1}^{t_2} F(t) dt} \quad (2)$$

Eq. 2 thus gives a method of computing the number of units surviving vs time interval.

Considering now the definition of reliability, the reliability of the equipment to perform a mission successfully, in a time interval given by $\Delta t = t_2 - t_1$, is the probability of selecting a unit out of the sample, S_1 , that will not fail. This is, by definition, the ratio of the number surviving, S_2 , at t_2 divided by the sample size S_1 at t_1

$$R = \frac{S_2}{S_1}$$

$$\text{or } R = e^{-\int_{t_1}^{t_2} F(t) dt} \quad (3)$$

Thus, if the force of mortality function is known for a given item operating under the "given conditions," the reliability of the item to perform successfully a mission over any time interval can be computed by Eq. 3. In particular, if the force of mortality, $F(t)$, is a constant, F , Eq. 3 reduces to

$$R = e^{-F\Delta t} \quad (4)$$

Under the condition of constant force of mortality, the exponent F in Eq. 4 is usually identified as the failure rate for the item and is related to the inverse constant, mean time between failures, T , or mean time to failure, by

$$F = \frac{1}{T} \quad (5)$$

It has been demonstrated that, if the force of mortality, $F(t)$, is known for a given item operating under given conditions, all reliability information can be calculated by Eq. 3. It should be emphasized that the force of mortality varies considerably with the "given conditions" as well as with item life time. *The purpose of all reliability testing is the determination of information about the force of mortality for the given item operated under "given conditions."*

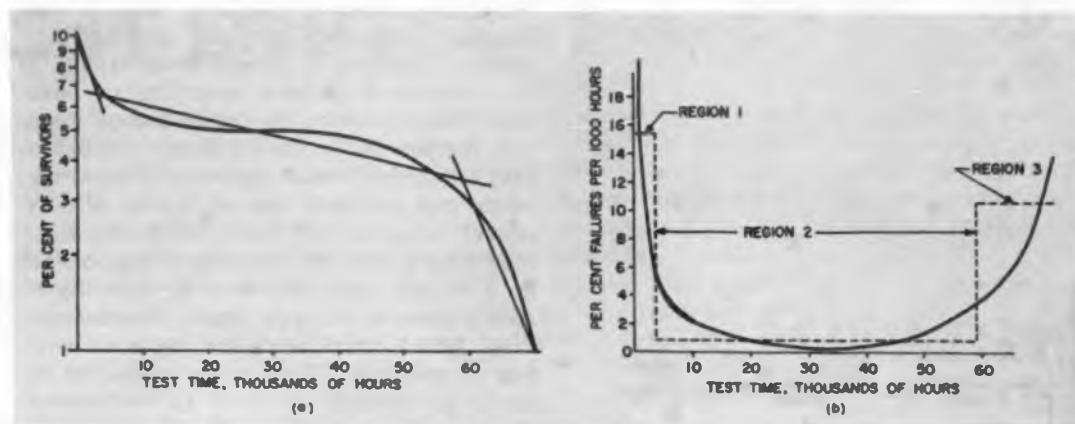


Fig. 1. Typical test data for test-to-failure on individual components. If a large sample of components is operated over a period of time under specified test conditions, the curve in (a) will relate the number of survivors vs time. Three regions of failure are indicated by the straight lines approximating the curve. In (b), the three regions of failure are shown when the number of failures is plotted against time. Region 1 represents early failure due to random effects, region 2 indicates the life span and region 3 shows the wearout period.

General Nature Of The Force Of Mortality

Considerable experience has been accumulated on the nature of the force of mortality. Before designing a reliability test, the effect of test procedure on the force of mortality curve should always be evaluated. The simplest type of force of mortality is associated with unrepairable or unmaintainable units. Typical examples might be electrical components such as resistors, capacitors, and vacuum tubes. If a large sample of such components is placed in operation (on reliability test) under given conditions, a record of per cent survivors (components that have not failed) vs time will give a curve similar to that shown in Fig. 1a. This curve can be approximated by three straight lines representing three regions of failure mode. The first region is called the early failure period and represents high failure rates due to "random" effects. The third region is called the wearout period. Fig. 1b, shows the force of mortality curve corresponding to the failure data of Fig. 1a. The three regions of failure mode are shown by the dotted line. Obviously, one of the tasks of reliability workers is to reduce region 1, early failure period, to a

minimum portion of the total life span of the unit. The unit manufacturer accomplishes this through quality and process controls. The unit user reduces the effect of region 1 by screening processes which overstress the units so that defectives are removed, or by unit burn-in. The second reliability mission is to increase the life span of region 2 and decrease the absolute value of the average failure rate experienced. This is usually accomplished by engineering techniques and is generally a function of design or material choice.

The force of mortality for complex equipments not maintained—i.e., missile or satellite equipments—is very similar to the force of mortality for individual components although the absolute values are shifted due to the complexity. However, many equipments are designed, used and reliability tested where maintenance is considered a part of the "general condition" of operation of the equipment. For purposes of the present discussion, only repair type maintenance will be considered as most reliability tests do not allow use of preventive maintenance. Reliability test procedures for equipments consist of selecting an adequate sample—the



reliability

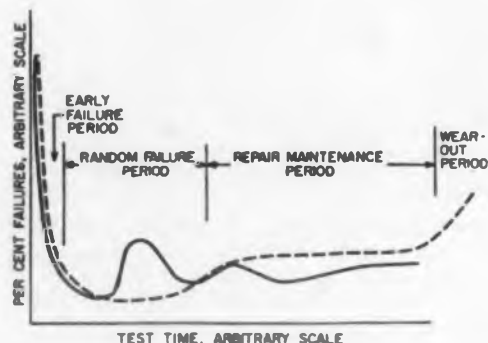


Fig. 2. Force of mortality for complex equipment. The solid curve represents the idealized form where the failure of components other than the one reaching wearout is low. The dotted line indicates the more realistic case where several components approach wearout at about the same time.

method of selection to be discussed in a following section—and placing the sample of equipments on test. When an equipment fails, it is repaired and placed back in test. As the sample size remains constant, the force of mortality is directly proportional to the number of failures occurring per unit time. Usually during the initial phases of the test, the force of mortality is very similar to that for the individual components. However, as the test proceeds, one component or component category will reach its wear-out region long before the remaining components do. This will cause the force of mortality to rise. However, through repair maintenance these failed components are replaced with new components. These new components initially go through an early failure period, then a random period, and finally again to the wearout period.

Thus the force of mortality rises and falls with each cycle the failing components goes through. However, due to statistical variation of time of failure, the width of the rise in the force of mortality caused by the wearout of one component increases with each cycle until finally the force of mortality remains almost constant with life time. The solid-line curve of Fig. 2 shows this effect in

idealized form where the failure of components other than the one reaching wearout is very low and the wearout period is rather sudden.

In most cases the wearout period onset is slow and several components start this period at about the same region in time. The dotted curve of Fig. 2 shows the usual effect on the force of mortality of repair maintenance of equipment. As can be seen by Fig. 2, four idealized periods of failure for equipments can be defined; early failure period, random failure period, preventive maintenance period and wearout period where maintenance becomes excessive. In improving equipment reliability through remedial action, obviously the analysis of the causes of initiation of the repair maintenance period is most important. Also, test specification for reliability acceptance testing must consider the effects of these four periods of failure.

Factors Influencing Environmental Conditions of a Reliability Test

In reliability testing of components or equipment, the environmental conditions, part of the "given conditions," greatly affect the force of mortality for the item under test. If the reliability test is designed to give information on the force of mortality function for a component or equipment in use, the complete reliability test should exactly reproduce the expected environmental conditions. There are many reasons why this is not generally done. One reason is that the cost of complete environmental duplication is extremely high; second, it is desirable to reduce the time required to complete a reliability test.

In general, it is not necessary to completely duplicate all used environmental conditions when performing a reliability test on components or equipments to determine information about the force of mortality under use conditions. Failure analysis of defective components and equipments indicate that only a relatively few environmental conditions contribute any major part of the force of mortality. Thus valid reliability tests may be performed by only simulating the contributing conditions. Most failures that occur can be traced to mechanical or chemical causes which result in catastrophic or performance

Table 1. Comparison of Stress Levels Outlined by the AGREE Procedures for Reliability Testing of Electronic Equipment.

Environmental Conditions	Stress Levels			
	L (Light)	M (Medium)	H (High)	X (Extreme)
Temperature	25 ± 5 C (68 F to 86 F)	40 ± 5 C (95 F to 113 F)	-54 C to +55 C -54 C to +55 C	-65 C to +71 C* (-85 F to 160 F)
Vibration	None	25 ± 5 cps at ±0.5 in. max amplitude	Same as M	Same as L
On-Off Cycling	3 hr "on" plus long enough to stabilize at both high and low temp by actual measurement.	Same as L	Same as M	Same as L
Input Voltage	Nominal so long as within equipment specified voltage range.	Max. specified permissible voltage +0-2%	Same as M	Same as M

* The extremes of temperature will be governed by the latest applicable specifications.

DELAY LINES, INDUCTORS, FILTERS AND CHOKES ... ARNOLD IRON POWDER CORES CUT COSTS

degradation failure in parts or components. Thus it is necessary to simulate in a reliability test only those conditions that would accelerate mechanical or chemical changes. These include temperature, temperature cycling, vibration and/or shock, on and off cycling, electrical stress such as voltage, and atmospheric conditions, such as humidity. Considerable effort has been expended in order to standardize and minimize the number of environmental conditions required to determine the force of mortality function for given components and equipments. The TR-59-416-1⁽²⁾ report on components usually limits these conditions to approximately two. For button mica capacitors, covered in MIL-C-10950B, the failure rate is assumed to vary only with voltage stress and temperature. However, it should be remembered that these restrictions are valid only if the force of mortality, i.e. failure rate, is truly affected by these environmental parameters only. For instance, certain designs of paper capacitors, MIL-C-25A, have force of mortalities that are strongly affected by vibration. If tests are performed without this stress, erroneous results will be obtained.

Standardization of Environmental Test Conditions A Pressing Reliability Need

For electronic equipments, considerable effort has been made to define and standardize the environmental conditions affecting the force of mortality function. For general military electronic equipment, the AGREE, in their report on "Reliability of Electronic Equipment"¹ set four standard levels of environmental stress for reliability testing of electronic equipment. These are Level L, for laboratory equipment; Level M, for mobile and shipboard equipment; Level H, for most airborne equipment; and Level X for extreme environmental use of equipments. Four environmental conditions are outlined; operating temperature, temperature cycling, vibration, and operating voltage. Table 1 presents a comparison of these stresses.

The above environmental stresses appear to be adequate for most general applications of military electronic equipment. However, certain equipments that experience peculiar stresses—i.e., dropped from aircraft—must

Iron powder cores are commonly specified for such applications as delay lines (illustrated below), inductors, filters and filter chokes because of their inherent low cost. And Arnold cores are your logical choice, for the principal reasons of superior dependability and the wide selection available to you.

Arnold's overall magnetic knowledge, and unequalled facilities for manufacture and test, are of prime importance in assuring you a source of

cores that are highly uniform, shipment after shipment. You'll find them dependable, not only in permeability and resultant inductance at high frequencies, but in high mechanical strength and dimensional accuracy as well.

The Arnold line also offers a wider range of shapes and sizes of iron powder cores for your selection than any other one brand on the market. It includes bobbin cores, cups, toroids, plain, sleeve and hollow cores, threaded cores and

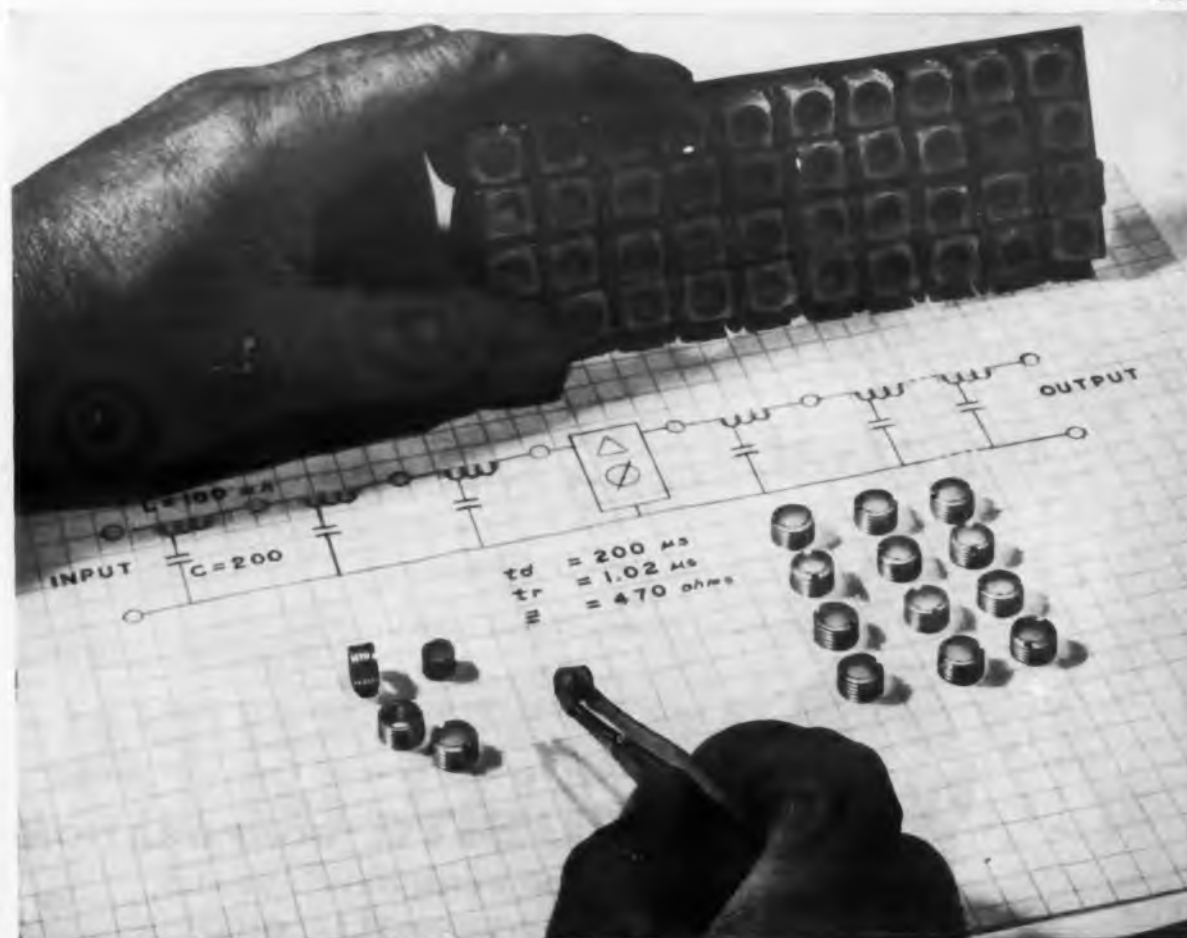
insert cores, etc. Facilities for special cores to your order. Ask for new Bulletin PC-109A. • Write *The Arnold Engineering Company, Main Office and Plant, Marengo, Illinois.*

ADDRESS DEPT. ED-9

ARNOLD
SPECIALISTS IN MAGNETIC MATERIALS

BRANCH OFFICES and REPRESENTATIVES in PRINCIPAL CITIES • Find them FAST in the YELLOW PAGES

2284



CIRCLE 38 ON READER-SERVICE CARD

NEW TR GLASS



WITH A



GRIP LIKE A VISE

now

available

on many

FUSITE

TERMINALS

Never before has a glass been developed that is so compatible for use with 52% nickel alloy leads.

The result is a compression between the glass and pins so tight that twisting and bending of the pins to the breaking point will not cause rupture or leakage. (Determined by Veeco Leak Detector with sensitivity at 10^{-10} std. cc/sec.) Thermal shock is excellent with this new TR-Glass. Salt spray resistance exceeds 100 hours.

Every performance feature is well in excess of Mil Specs. The use of TR-Glass may be considered for all types of Fusite solid glass headers as well as many other style terminals.

Samples on request. Write Fusite, Department C-5



Fusite Corporation, Cincinnati, O.
Woodford Mfg. Co., Versailles, Ky.
Fusite N. V., Konigweg 16, Almelo, Holland
Fusite GmbH, Dieselstrasse 5 Karlsruhe, W. Germany

THE FUSITE CORPORATION

**6000 FERNVIEW AVENUE,
CINCINNATI 12, OHIO**

CIRCLE 39 ON READER-SERVICE CARD



reliability

have these stress levels modified to include all effective environmental stress. Equipments in this latter category are usually single-use equipments where maintenance is not considered part of normal operation.

There are definite advantages to standardizing environmental stress conditions for reliability tests. The only way that reasonably accurate comparison of the reliability for different components and equipments can be made is from test results using identical environmental conditions. At present there appear to be few industry-wide accepted standards for environmental reliability test conditions. One of the most pressing reliability requirements today is standardization of environmental test conditions for reliability tests.

In addition to reliability testing under simulated environmental conditions, sometimes it is desirable to accelerate reliability testing by increasing the environmental stress conditions that contribute to the force of mortality. The interpretation of accelerated reliability test data in terms of actual reliability test data is usually difficult. However, in many cases the cause of failure of an item can be related to one or two parameters. In such cases, the complete force of mortality over the life of the item under test can be approximated in a short test time by performing several reliability tests simultaneously under increasing levels of the stress parameter causing the failure. The most usual effect of increasing stress causing failure is to decrease the time required for onset of the wearout period. If all of the failures are caused by the stress parameter being varied, the same number of failures will occur between the start of test and start of wearout. Thus, the force of mortality will have a higher value due to this compression in time. For items under test that have constant force of mortality, failure rate, over extended periods of time, proportional coefficients can be determined for the life-time contraction due to excess stressing. Thus the force of mortality can be approximately evaluated over the life of an item by performing several reliability tests at different

levels for short periods of time and reducing the data to the desired stress level by proper expansion of the time scale. Extreme care must be exercised in this type of testing to be sure that the stress being varied represents the only cause for failures under consideration.

Establishing Sample Size and Unit Operating Hours for Statistical Test

Two parameters must be considered in the statistical design of a reliability test. The first parameter is the sample size of equipments or units tested. The second is the unit operating hours tested. In general, these two parameters are not independent and usually two or more tests are performed to determine the necessary information concerning the "force of mortality" of an equipment lot. However, for purposes of discussion, the following premise will be followed: The sample size of equipments tested is determined primarily from consideration as to how accurate reliability information obtained from reliability test on the sample represents the reliability status of the equipment universe from which the sample is taken. The second sampling consideration, total equipment operating hours, determines how accurately the reliability information derived from the test represents the reliability status of the sample itself. Each of these considerations will be discussed separately.

The use of these statistical design concepts is best demonstrated by an example. For purpose of this example, assume that an idealized universe of equipments can be assumed to be designed and constructed such that the early failure period is of zero time length and the onset of wear is of infinite time length. Further, assume that in the random period, each equipment has a constant failure rate; the constant is not necessarily the same for all equipments but is approximately distributed in a random manner about some mean value. Now assume that a reliability test is to be run for accepting the universe of equipments based upon a reliability test data obtained from a sample from the universe. As this is to be an acceptance test on these equipments, the con-

NOW!



REPLACE CRYSTAL CANS WITH ENCAPSULATED REED RELAY RELIABILITY

The first "packaged" line!

Used for signalling and switching under dry circuit conditions as in military ground control and similar equipment, Struthers-Dunn encapsulated reed relays out-speed, out-perform and outlast crystal can and other conventional relay types.

Standard types (left)

... with 15 watt contacts; up to 20 poles; body length 1 7/8".

Miniature types (right)

... with 4 watt contacts; up to 12 poles; body length 1.062".

Contamination-proof contacts

... Reed switches with gold contacts hermetically sealed in glass tubes.

Complete mechanical protection

... Switch assemblies with surrounding operating coil encapsulated in epoxy.

Only 1 moving part per pole!

From 1 to 2 millisecond operation

... depending on type.

From 20 to 200 million operations

... Life determined by size and loads.

Mount in any position

... Ideal for either panel or printed board wiring.

Write for Data Bulletins: RR-2 for standard sizes; MRR-1 for miniatures. Address: Struthers-Dunn, Inc., Pitman, N. J.



STRUTHERS-DUNN

PIONEERS IN RELAY RELIABILITY

Sales Engineering Offices in: Atlanta • Boston • Buffalo • Charlotte • Chicago • Cincinnati • Cleveland • Dallas • Dayton • Denver • Detroit • High Point • Kansas City • Los Angeles • Montreal • New York • Orlando • Pittsburgh • St. Louis • San Carlos • Seattle • Toronto • Export: Langguth-Olson Co., New York

CIRCLE 40 ON READER-SERVICE CARD

WHEN IS 2.0% BETTER THAN 0.001%?

When the chips are down, reliability is a crucial concern in the selection of a semiconductor source. Yet when you explore this parameter, you'll find a variety of vendor claims about the reliability of their devices. The statements run a wide gamut of values — and all the claims may be legitimate. One can easily find himself faced by the paradox: 2.0% can be better than 0.001% (for failure rates in %/1000 hours).

How come? Just how reliable are reliability figures anyway? Let's shake ourselves free of the emotion of claim and counter-claim and look at the logic of methodologies. The paradox exists because of basic differences in the different approaches used to reach a final value. In order to reach that final reliability figure, several assumptions must be made. One can be conservative or liberal in the assumptions he chooses to use. Thus, the 2.0% figure may be based on conservative assumptions, the 0.001% on liberal assumptions.

Now that you've come this far, let's dig in deeper. Obviously, a raw reliability figure is not enough — and should not be accepted on face value alone. We should ask what assumptions were made in reaching that figure. What assumptions should one look for? The following are the basic ones:

1. DEFINITION OF FAILURE: Just how is failure defined? Is it so strict as to call any deviation from initial values, however slight, a failure? Is it so liberal as to call any device which still passes current an acceptable one? You can see that the definition of failure becomes a screening system. How coarse or fine one makes that definition is a variable which affects the final reliability figure.

2. FAILURE RATE OVER THE COURSE OF TIME: Here is where one gets hung on the horns of dilemma. What normally happens is that data is taken for a base period of time (usually 1000 hours) and extrapolated. A good family of devices doesn't provide enough failure data in any reasonable length of time for a valid fit to any of the mathematical models of failure rate distributions. What happens then is that the reliability people make one of two assumptions. They may assume a constant failure rate . . . or they may assume a decreasing failure rate. The differences are much like academic arguments, one chooses his side according to his persuasion. The underlying dilemma is that the same set of data can give us two radically different failure rate values . . . depending on which assumption is used. It suffices to say that the constant failure rate assumption is the conservative one.

3. CONFIDENCE LEVEL: The statisticians will talk about the confidence level of the figures provided. Let's take the mystery out of the term. While the mathematicians will take exception to our forced simplification, after a moment's reflection they'll agree. A 90% confidence level, in the long run, means that 90% of the shipments will meet the specified standards and a 60% confidence level means that only 60% will get through. If that is what is wanted, an extra decimal place or two can be squeezed into that reliability figure by reducing the confidence level. The higher the confidence level, the more conservative the resulting reliability statements will be.

4. TESTING PROCEDURES: Just where are the test points? How many and which parameters are to be ob-

served? To what stresses are the devices carried? What methodologies are used? We don't mean to imply that one approach is intrinsically superior to another. But we do mean to say that given exactly the same device, one can get different results according to the testing procedures used. Sometimes the differences can be quite gross. In comparing reliability data, one can't go wrong asking just how conservative or liberal the testing procedures are.

5. ARTIFICIAL ACCELERATION FACTORS: The rack life-testing used to determine reliability values is basically accelerated testing. In "normal" use, devices are not usually subjected to similar strains. Some vendors use the test data exactly as derived. In order to make the failure rate look better, others choose to apply an artificial acceleration factor. Their justification is that such a factor equates the data to normal usage. Obviously, using the data as derived is the conservative procedure.

6. WHICH QUALITY CONTROL PROCEDURES: Most of the commonly used lot acceptance procedures for semiconductors follow Mil. Std. 105. But an alternate is permissible — MIL-S-19500B, Method B. This is the Lambda (λ) concept which specifically limits customer risk. The consumer specifies reliability assurance at a fixed confidence level and shifts the risk to the producer. In terms of the consumer's viewpoint, the Lambda (λ) approach is the conservative one.

If you're enchanted by the complexities of reliability, your own reliability experts would welcome the opportunity to explain the mysteries — and the problems of their profession.

We'll sum up by stating our position. The Raytheon Semiconductor Division has a set policy of always making the conservative assumption. We prefer to present you with the conservative figures which derive from the device itself rather than those based on a projected use of the device.

And when you see reliability ratings, make it a point to read between the lines, that's where real differences exist.

If you would like to know more about Raytheon Reliability, call or write the nearest Raytheon office for any or all of the following Quality & Reliability Bulletins:

Bulletin #221 — "Reliability — Fact or Fancy?" — an illuminating explanation of how to read and analyze reliability ratings.

Bulletin #222 — "Raytheon Reliability Assurance Program" — an informative discussion of how reliability assurance is generated and maintained.

Bulletin #223 — "Reliability of Raytheon PNP Germanium Alloy Junction Transistors" — facts and figures on the reliability of this popular family of devices.

Bulletin #224 — "A.Q.L. — What Is It?" — an enlightening report on the application of basic sampling inspection concepts to the task of specifying quality requirements.

Bulletin #225 — "Reliability of Raytheon High Current, High Frequency PNP Alloy Junction Germanium Transistors" — another comprehensive, fact-filled bulletin on a widely used family of devices.



reliability

ditions for acceptance must be defined before the test is designed. In setting down these acceptance limits the values given by Task Group 3 of AGREE¹ will be followed although other limits could be applied.

The use of a particular equipment dictates a required reliability or, by Eqs. 4 and 5, a required mean time to failure (MTBF). This will be symbolized as T_2 . The first decision that must be made is what percentage of equipments in the universe can have a mean time to failure less than T_2 for acceptance of the universe. Obviously, if zero were the choice, all equipments would have to be tested. Usually this is not desirable so that some other value is chosen. Following AGREE recommendations, assume this value to be 10 per cent. The third consideration is the degree of confidences, in the test results, that the MTBF determined by the sample test is truly greater than T_2 . This cannot be 100 per cent as this would imply that all equipments would be tested for their entire life span. Task Group 3 of AGREE has set this confidence value at 90 per cent ($B = 0.9$). The above considerations are called user or customer considerations. Numerical values were taken from Task Group 3 recommendations although any other values might be chosen if circumstances dictated. The user considerations set forth the conditions determining that the universe should not be accepted.

The preceding information is sufficient to permit design of a reliability test. It fixes the equipment sample size and the total accumulated operating hours sample size. First, a test will be designed based upon these assumptions. Then a second group of simplifying conditions, called producer considerations, will be proposed and a second reliability test (a sequential test) designed to demonstrate the test time can be markedly reduced.

Choice of Equipment Sample Size: The choice of sample size from the universe by the preceding consideration must be such that, if the universe has 10 per cent of the equipments below T_2 MTBF, the test will show to 90 per cent confidence these defec-

RAYTHEON COMPANY

RAYTHEON

SEMICONDUCTOR DIVISION

SILICON AND GERMANIUM DIODES AND TRANSISTORS • SILICON RECTIFIERS • CIRCUIT-PAKS

BALTIMORE, MD., Southfield 10450 • BOSTON, MASS., Decatur 2-7377 • CHICAGO, ILL., National 5-4000 • DALLAS, TEXAS, Lakeside 6-7521 • DAYTON, OHIO, Baldwin 3-8178
DETROIT, MICH., Trinity 3-5330 • ENGLEWOOD CLIFFS, N. J., Lowell 7-4911 (Manhattan, Wisconsin 7-6400) • LOS ANGELES, CAL., Plymouth 7-3151 • ORLANDO, FLA., Garden 3-0518
PHILADELPHIA, PA. (Haddonfield, N. J.), Hazel 8-1272 • SAN FRANCISCO, CAL. (Redwood City), Emerson 9-5566 • SYRACUSE, N.Y., Howard 3-9141 • CANADA, Waterloo, Ont. Sherwood 5-6831

GOVERNMENT RELATIONS: Washington, D. C., Metropolitan 8-5705

CIRCLE 41 ON READER-SERVICE CARD

tives. Thus, the sample size can be computed such that no defective is allowed, one is allowed, etc., by the usual quality control techniques applying laws of probability. First calculate the minimum sample size such that if no defectives are found, then 90 per cent of the time the number of defectives in the universe is less than 10 per cent. Let p be the probability of picking a good equipment out of the universe; let q be the probability of picking a defective equipment out of the universe. By applying the binomial limit law, the relative probability of obtaining 0, 1, 2, 3 defectives is given by evaluating the terms of the expansion

$$(p + q)^n = p^n + npq^{n-1} + \frac{n(n-1)}{2} p^{n-2}q^2 + \dots \quad (6)$$

Thus for a sample size n , the probability of having no defectives is p^n , the probability of one defective is $np^{n-1}q$, etc. The test criteria is that this probability must be less than 10 per cent (i.e., 100% - 90%). Thus the sample size for no defectives is given by

$$0.1 = p^n = 0.9^n \text{ as } p = 0.9$$

$$\text{or } n = 21.75 \approx 22 \quad (7)$$

If one defective is to be allowed, then the second term must be evaluated for n as above. Thus a sample size can be determined $n \approx 59$; the minimum sample size to be tested is 22.

Choice of Operation Hour Sample: In designing the statistical part of the reliability test, it is necessary to determine the number of operating hours to run vs number of failures experienced to assure to a 90 per cent confidence that the equipment has a true MTBF greater than the prescribed value T_2 . The 10 per cent risk of passing equipment with less than T_2 MTBF is called the consumer risk. In designing the test, it is desirable to set a second risk called the producer risk. That is if the true MTBF is T_1 where $T_1 > T_2$ which is the risk that the equipment will be rejected by the test. The ratio of T_2/T_1 is usually called the discrimination ratio. This can be set at any value; however, the recommendations of AGREE assure that it is 2/3. The producer risks can



You can place the utmost confidence in Dale precision resistors even when today's new and unprecedented standards of "missile reliability" are the goals towards which you are designing.

Under any and all conditions, Dale resistors retain their stability because it has been "firmly infixed" by Dale design and methods of manufacture . . . methods which have now reached new levels of achievement as part of Dale's super-high reliability development program.

SPECIAL PROBLEMS? Let us help you with your requirements for special resistance products. We make modifications of standard products, resistor networks, matched pairs, etc. Send us your specs.

PROMPT DELIVERY. Whether your need is for a short "test run" or a large production release, Dale offers prompt service, direct from the factory and through a widespread network of distributors.

Write for Bulletins R-23, R-25 and R-30 with handy cross-reference file cards



DALE ELECTRONICS, INC.

1328 28th Ave., Columbus, Nebraska, U.S.A.

A subsidiary of HATHAWAY INSTRUMENTS, INC.

DALE TYPE RS RESISTORS

WIRE WOUND • PRECISION • POWER
Designed for advanced electronic circuits where space is at a premium. Three configurations: Type RS with axial leads and in most ratings and resistances shown; Type RLS with radial leads; Type RSE for clip mounting.

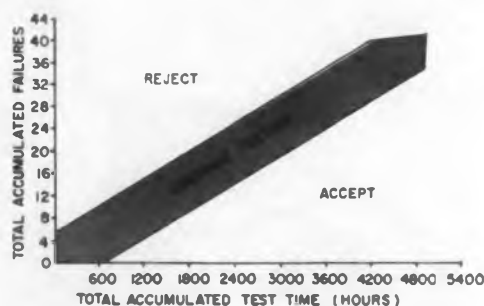
- Rated at 1/2, 1, 2, 2 1/2, 3, 5, 7, 10 watts
- Resistance range from .05 ohm to 175K ohms, depending on type
- Tolerance 0.05%, 0.1%, 0.25%, 0.5%, 1%, 3%
- Temperature coefficient within 0.00002/degree C.
- Operating temperature range from -55° C. to 275° C.
- Smallest in size, ranging from 5/64" by 5/16" to 3/8" by 1-25/32". Ten choices
- Completely protected, impervious to moisture and salt spray
- Complete welded construction from terminal to terminal
- Silicone sealed, offering high dielectric strength and maximum resistance to abrasion
- Meet functional requirements of MIL-R-26C





reliability

Fig. 3. After the reliability test conditions are established, the equipment is run and failures are plotted against operating time. By use of the reliability test criteria curve (MTBF = 150 hr in the curve shown), a decision to either accept, reject or continue tests can be made.



General Design Guide Used to Achieve the TACAN Reliability Goal of 150 hr MTBF.

1. Resistors

Composition: (In general MIL-R-11A). Operate less than 50 per cent wattage.

Film: (In general MIL-R-10509A). Operate less than 75 per cent of rated wattage. The circuits employing them should be capable of satisfactory operation when the resistance values vary ± 2.5 per cent of the rated value for 1 per cent resistors.

Wirewound, Accurate and Power: (In general MIL-R-93A and MIL-R-26B). Operate less than 40 per cent of rated wattage.

2. Capacitors

DC Paper: (In general MIL-C-25A). Operate less than 55 per cent of rated voltage.

Silvered Mica: (In general MIL-C-5A). Operate less than 55 per cent of rated voltage.

Foil Mica: (In general MIL-C-5A). Operate less than 65 per cent of rated voltage.

Button Mica: (In general MIL-C-10950). Operate less than 75 per cent of rated voltage.

Ceramic: (In general MIL-C-20A and MIL-C-11015). Operate less than 40 per cent of rated voltage.

Variable Ceramic: (In general MIL-C-81). Operate less than 40 per cent of rated voltage.

Tantalytic: Very little data available. However, where practicable double case capacitors should be used. Review use with reliability engineers.

3. Transformers and Coils.

Class B Insulation: Maximum hot spot temperature rise should not exceed 20 C.

Specified Insulation: (5,000 hr life at 170 C). This specification is Class T insulation. The maximum hot spot temperature rise should not exceed 50 C.

4. Relays (excluding Choppers).

Sensitive: (Contact current 100 μ a to 1.5 amp, coil power less than 0.1 w).

■ Employ relays with a 90 per cent survival for 50,000 operations.

■ Use between 90 and 10 per cent rated contract current.

■ Maximum number of contact sets used should be less than six.

General Purpose: (Contact current 100 μ a to 10 amp, coil power above 0.1 w).

■ Employ relays with a 90 per cent survival for 50,000 operations.

■ Use between 90 and 10 per cent of rated contract current.

■ Maximum number of contact sets used should be less than 10.

Power: (Contact ratings above 10 amp). Same as for General Purpose.

5. Switches and Plugs.

Use standard practices with quality connectors.

6. Tubes (In general MIL-STD-200 types)

Diodes: Operate below 90 per cent of full power. Maintain heater voltage between 90 and 100 per cent of rated value.

Triodes: Operate below 90 per cent of full power. Maintain heater voltage between 90 and 100 per cent of rated value.

Tetrodes and Pentodes: Operate below 80 per cent of full power. Maintain heater voltage between 90 and 100 per cent of rated value.

Thyratrons: Avoid use. Where required, use will be reviewed by reliability engineers.

7. Semiconductors—Diodes.

Germanium: Not satisfactory for ARN-21C.

Silicon: Operate below 50 per cent of rated wattage.

Selenium Rectifiers: Not recommended although they can be used where necessary below 15 per cent of rated wattage.

8. Crystals.

Stay within specification limits for operation at 125 C.

be set such that 90 per cent confidence will exist in the test result that the equipment will not be rejected if the true MTBF exceeds $T_1 = 3/2 T_2$. This additional information would now allow calculation of the actual number of operating hours required such that an accept decision could be made if the failures experienced were less than some value "a" and a reject decision if the failures were greater than "a + 1." However, the actual MTBF may be considerably less than T_2 or considerably more than T_1 .

In this case, the test time might be considerably shortened if the decision to accept or reject were based on a difference of more than one failure. The design could be constructed this way except that this information is not known until after the test is completed. However, the test can be designed such that the total test time is not fixed; instead, the data obtained during the test is analyzed as it is obtained to determine if sufficient data has been accumulated to reach a conclusion on test results to the confidence required. When a decision can be made, the test is then stopped. This type of test is called a sequential test. In the sequential test, three possible decisions can result after each analysis; in the case under discussion they are: (1) the MTBF is greater than T_1 , (2) the MTBF is less than T_2 , (3) not enough information is available for a decision, continue the test.

Associated with decision 1-2 are the consumer and producer risks discussed. Let α be the risk that the decision is made that the MTBF is greater than T_1 when, in fact, the MTBF is less than T_2 , consumer risk for this case. $\alpha = 1 - 90$ per cent = 0.1. Let β be the risk that the decision will be that the MTBF is less than T_2 when, in fact, the MTBF is greater than T_1 (producer risk), for this case $\beta = 0.1$.

The customary method for carrying out the sequential test is to make a "likelihood ratio" calculation with each variable observation. The "likelihood ratio" is defined as

$$L = P_2/P_1 \quad (8)$$

where P_1 is the possibility that the MTBF is T_2 . Epstein and Sable³ have shown that the risk will not be exceeded if when

$$H_1 \text{ is accepted } L \leq \beta/1 - \alpha$$

$$H_2 \text{ is accepted } L \geq 1 - \beta/\alpha \quad (9)$$

By the present test assumption, P_1 or P_2 , the probability of experiencing N failures

in a given time with T_1 or T_2 MTBF is given by a Poisson distribution—as indicated below:

$$P_1 = \frac{\left(\frac{t}{T_1}\right)^n e^{-t/T_1}}{n!}$$

$$\text{or } P_2 = \frac{\left(\frac{t}{T_2}\right)^n e^{-t/T_2}}{n!} \quad (10)$$

Thus the likelihood ratio "L" for n failures in operating time t is given by

$$L = P_2/P_1 = \left(\frac{T_1}{T_2}\right)^n e^{-\left(\frac{t}{T_2} - \frac{t}{T_1}\right)} \quad (11)$$

Thus combining Eqs. 9 and 11, the following conditions for continuing the test decision are

$$\frac{\beta}{1-\alpha} > \left(\frac{T_1}{T_2}\right)^n e^{-\left(\frac{t}{T_2} - \frac{t}{T_1}\right)} > \frac{1-\beta}{\alpha} \quad (12)$$

This inequality can be transformed as the following

$$\frac{-\ln \frac{\beta}{1-\alpha} + n \ln \left(\frac{T_1}{T_2}\right)}{\frac{T_1}{T_2} - 1} > \frac{t}{T_1} > \frac{-\ln \frac{1-\beta}{\alpha} + n \ln \left(\frac{T_1}{T_2}\right)}{\frac{T_1}{T_2} - 1} \quad (13)$$

Substituting values of α , β , T_1 , this becomes

$$0.81 \ln + 4.4 > t/T_1 > 0.81 \ln - 4.4 \quad (14)$$

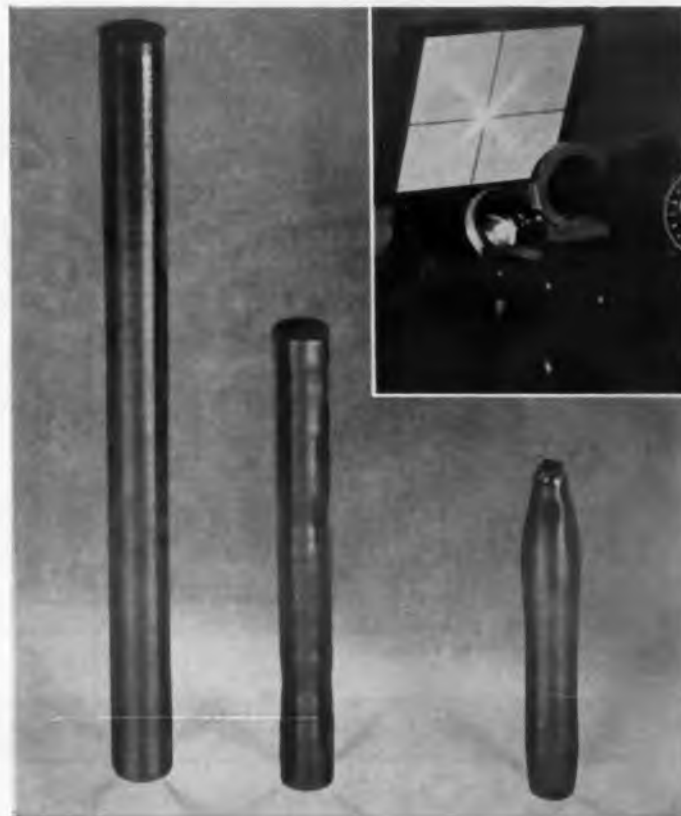


Fig. 4. The AN/ARN-21C Airborne TACAN is the first major electronic equipment to be produced to the DOD AGREE procedures. The complex system, containing over 5,600 electrical and mechanical parts, consists of a receiver-transmitter (RT-220), channel selector and bearing indicators.

SILICON NEWS from Dow Corning

Need 1-0-0 Silicon?

Specify float zoned crystals for these three reasons...



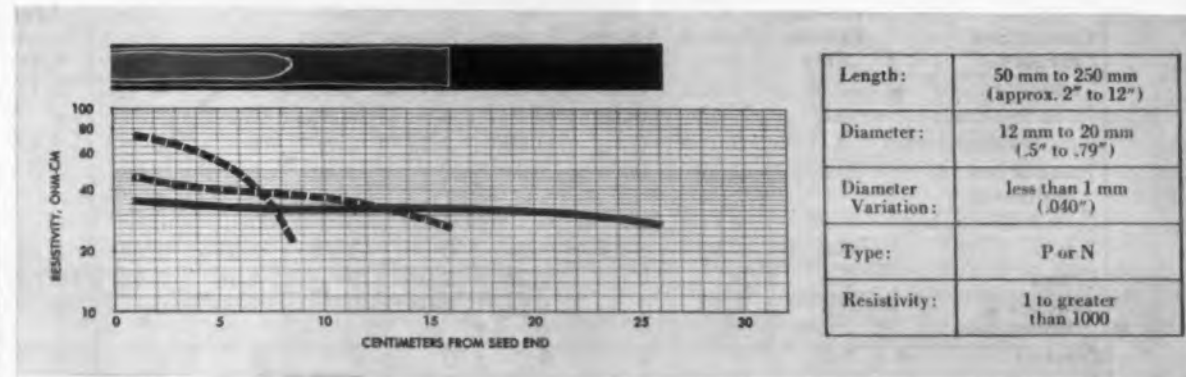
You will find Dow Corning Hyper-Pure (1 0 0) crystals provide a number of definite advantages over Czochralski pulled crystals with (1 0 0) orientation.

More Uniform Dimensions. With Dow Corning vacuum float-zoned (1 0 0) crystals, you get more than twice the useable length of the usual Czochralski crystal . . . better than 50% more than the best premium Czochralski crystal. Physical profile is far more uniform, so wafers have more consistent physical dimensions. Result: crystals that are easier to process . . . less waste.

More Uniform Parameters. Lateral and radial parameters are more uniform throughout the entire length of Dow Corning vacuum float-zoned (1 0 0) crystals. Typical resistivity curves show float zoned crystals vary less from end to end—and the ends are up to three times further apart. This consistent quality—plus uniformity from rod to rod—means fewer rejects . . . increased device yield.

Ease of Handling. For the clean cleavage and nearly waste-free handling of (1 0 0) oriented silicon crystals, plus the advantages of uniform dimensions and uniform parameters, specify Dow Corning crystals. Greater length means less chance for contamination, less waste and easier handling in scribing and scoring wafers.

Whatever your need—float-zoned crystals of (1 0 0) orientation; crystals of (1 1 1) orientation; doped to specification or high resistivity rod; polycrystalline rod or prepackaged one-piece crucible charges—Dow Corning should lead your list of sources.



For free brochure — "Hyper-Pure Silicon for Semiconductor Devices" write Dept. 4021.

Dow Corning CORPORATION

HYPER-PURE SILICON DIVISION • HEMLOCK, MICHIGAN
CIRCLE 43 ON READER-SERVICE CARD

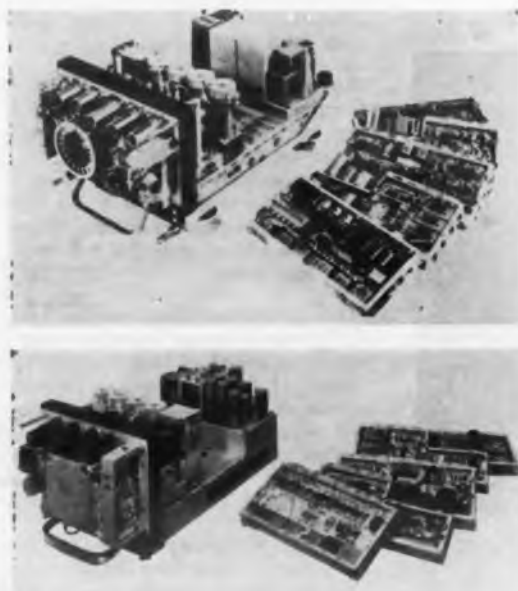


Fig. 5. "Before" and "after" photos illustrating the redesign of modules to meet the new performance requirements set by the Air Force plus the AGREE specifications.

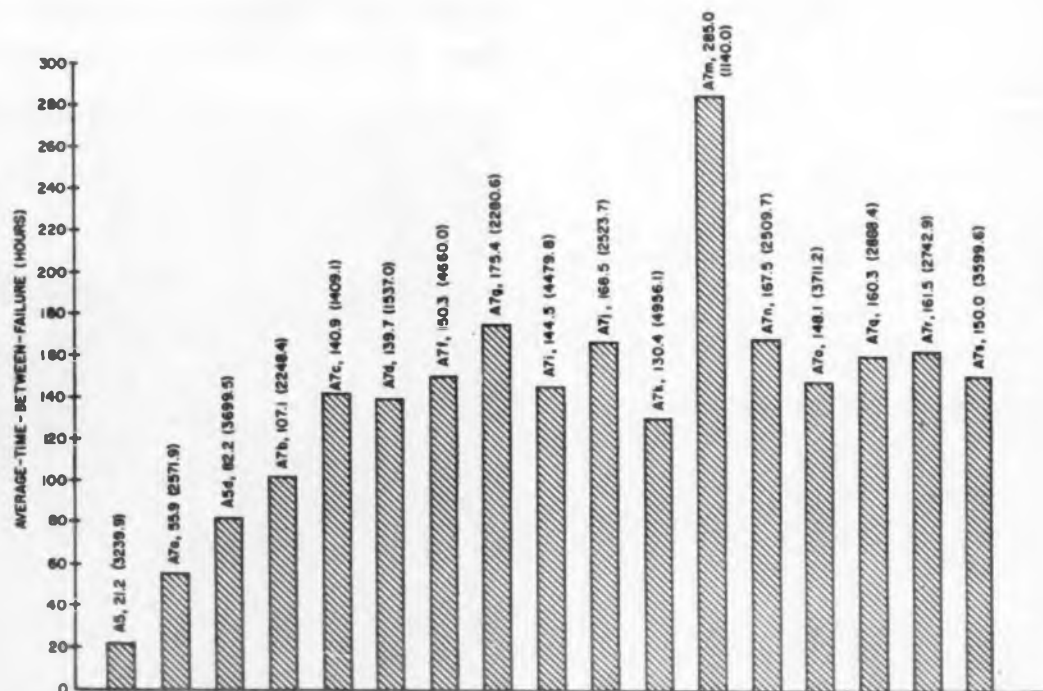


Fig. 6. Average time between failures experienced for RT-220C equipment; the reliability requirement specified a MTBF of 150 hr.

Table 2. Failure Rates for Components of RT-220 Production Units.

Component Category	(a) Predicted Failure Rate	(b) A7f Failure Rate	(c) A7g Failure Rate	(d) A7i Failure Rate	(e) A7j Failure Rate	(f) A7k Failure Rate	(g) A7m Failure Rate	(h) A7n Failure Rate	(i) A7o Failure Rate	(j) A7q Failure Rate	(k) A7r Failure Rate	(l) A7s Failure Rate	(m) Composite Failure Rate	(n) Adjusted Failure Rate
Capacitors	0.08	0.51	0.17	0.09	0	0.16	0.54	0.16	0.11	0.41	0.87	0.55	0.32	0.15
Fixed Resistors	0.09	0.13	0.13	0.13	0	0.06	0	0	0	0	0	0	0.06	0.03
Variable Resistors	0.15	0	0	3.96	2.33	0	0	0	3.17	0	2.14	0	1.27	0.32
Transformers & Inductors	0.27	0.83	0	1.64	0	2.46	0	2.91	0	0.84	2.66	2.03	1.31	0.52
Coils & RF Chokes	0.08	0	0	0	0	0	0	0	0	0	0	0	0.09	0
Tubes	3.8	1.48	3.79	1.54	0	1.74	3.93	2.06	3.25	0.59	2.51	0.48	1.94	1.94
Relays	2.3	0	0	2.24	3.97	0	4.56	3.98	10.78	6.92	0	0	2.96	2.96
Switches & Connectors	0.2	1.13	0	1.18	1.04	0	3.60	0	0	0	0	0	0.57	0.14
Crystals	0.7	0	0	0	0	0	0	0	0	0.27	0.29	0.22	0.06	0.06
Semiconductors	1.0	0.77	3.13	2.40	5.67	2.53	1.63	2.13	0.96	2.47	1.30	2.48	2.21	1.29
Misc. Electrical Parts	1.5	0	0	0	2.48	1.25	0	6.65	4.50	5.77	0	13.85	3.59	3.59
Workmanship	0.03	0.05	0.02	0.04	0.01	0.04	0.04	0.02	0.03	0.02	0	0.02	0.03	0.03

All failure rates in %/1,000 hr. reliability testing

Thus the equipment is accepted if t/T_1 is greater than the number calculated on the left and rejected if less than the number on the right. Fig. 3 shows this relationship in graphic form.

Thus all that remains is to run the equipment under the prescribed operating condition and plot failures vs operating time. By observing the region in which the curve falls, a decision on whether to accept, reject or continue tests can be made.

TACAN-AGREE PROGRAM

The Military Products Div. of Hoffman Electronics Corp. has been carrying out reliability tests on the airborne TACAN Equipment, RT-220 (see Fig. 4) under Task Group 3, Stress Level H, AGREE Procedures since December 1958 (See Table 1). The first test was on RT-220B Equipment which was not designed for Stress Level H. The later test was on RT-220C equipment which was designed for Stress Level H. The theoretical MTBF of the RT-220C at Stress Level H was greater than 200 hr. The statistical design of these tests was identified to the previously discussed design. The contract requirement for MTBF, T_1 , was 150 hr. Throughout these tests, each failure experienced was investigated to determine the cause of failure and, where possible, corrective action was implemented to prevent the failure.

During the period of the contract a total of 25 reliability tests have been run on the RT-220C containing approximately 1,000 components, see Fig. 5. As a result of these tests, a total of 78,381 equipments operating hours of experience were accumulated, 895 failures were analyzed and 1,128 specific corrective actions were taken. Nine major reliability reports were written.

Fig. 6 shows the average time between failures experienced for each test, most probable time between failures. This is due to the effect of the early failure period. The equipment sample size for these tests was 7 for the A5 series of tests and 48 for the A7 series of tests. As can be observed by this figure, the average time between failures appears to level off between 140 and 160 hr. This leveling does not necessarily represent an ultimate limit of the design or state-of-the-art. The leveling off represents primarily the limit of data available for control and corrective action provided by the test. Had the test been run on the same statistical basis with an MTBF goal of say 250 hr, more test time would have been accumulated on



There's a Better Way... to cool a transistor. Electronic engineers tell me ice bags are good to cool off hotheads, hangovers and headaches. I never have any of these ailments, thank goodness. But I know a number of guys who do. I won't mention any names but some of them get pretty feverish over such problems as transistor breakdowns, thermal runaway and general necrosis of the circuitry. These poor souls need the Birtcher treatment, I say. This treatment consists of my cool heat radiators that knock the living plague out of thermal runaway and related disorders. Want a treatment? Write today for my catalog and other panaceas. Also, write me today for your Honorary Membership Certificate to my *Society*. Write to: Charles F. Booher, Secretary, *There's a Better Way Society of America, Inc.*, **The Birtcher Corporation**/Industrial Division, 745 S. Monterey Pass Rd., Monterey Park, California; phone Angelus 8-8584, TWX LA 2177. (I also have special lofts for carrier pigeons.)



*Cool!
Write for my
head throbbing
Radiator Catalog*



B

Sizes available for just about every well transistor. So yours are sick? Maybe I'll provide a radiator cure anyway — no ice bags.

CIRCLE 44 ON READER-SERVICE CARD



Contact Redundancy in New UNION Crystal Case Relays

The UNION 2-pole double throw General Purpose Crystal Case Relay is designed to consistently meet the requirements of Mil-R-5757D and Mil-R-5757/10. Its essential features . . . from minimum size to optimum reliability . . . permit it to be used in aircraft, guided missiles, shipboard and ground control electronic equipment.

A unique torsion-wire armature suspension system and a rugged all-welded frame construction provide a high level of vibration and shock immunity. Contact redundancy, which assures reliability in dry circuit and higher level contact loads, is provided through the use of bifurcated contacts.

Available with 0.2" grid-spaced header or "S" type header, with various mountings, terminals, and operating voltages. Write for Bulletin 1064.



Why UNION Relays Are So Dependable

There's a good reason why our relays are the standard for reliability. For years, we've been building tough, reliable relays for use in airborne and guided missile electronic equipment and similar vital applications where perfect operation under severe environmental conditions is mandatory.

Our engineers created a compact 6-PDT miniature relay with just three major assemblies . . . instead of a fistful of small parts. This was accomplished by using a balanced rotary-type armature that provided a maximum resistance to the severe shock and vibration environment of aircraft and guided missiles. The rotary principle of operation is utilized in all our relays.

We have a reputation for building reliable electronic components and we intend to maintain our tradition for building reliable relays. And we supply these quality relays in quantity. Stocks are now available for prototype requirements in New York, Pittsburgh, Dallas and Los Angeles.



For additional information, write for Bulletin 1017 or call Churchill 2-5000 in Pittsburgh.

MEMBER OF THE NATIONAL ASSOCIATION OF RELAY MANUFACTURERS
 **UNION SWITCH & SIGNAL**
 DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY —
 PITTSBURGH 18, PENNSYLVANIA

CIRCLE 45 ON READER-SERVICE CARD



reliability

each test, more failures experienced and more corrective actions taken. Thus, the average time between failures achieved would further increase. The upper reliability limit for this design is not known or derivable from this data. The failure rates for component categories that are reported below represent those values obtainable within this test time limitation for control.

Failure Rates Experienced For Each Component Category

Table 2 shows the failure rates experienced for each component category listed. Some categories have been combined into one general category for simplification. The first column gives the design estimates for failure rates after testing the RT-220B equipment. The last two columns give the average failure rate achieved over all satisfactory tests and the average failure rate that could have been achieved if the corrective actions had been incorporated on all tests before the test was run. Thus, the last column gives an estimate of the best achievable failure rate as a result of data and corrective action gathered on this series of tests.

Conclusion Based On TACAN Experience

As a result of experience on the TACAN program, several general conclusions seem to follow. These are:

1. Designing equipment according to reliability design data available at start of the project did not in itself result in meeting the reliability requirements, although it was necessary in the chain of reliability activities.
2. Testing and removing design causes of failure—i.e., such as transients during switching, misapplication of tubes, etc.—did not alone result in meeting the reliability requirement.
3. Quality control procedures are not capable of determining that component parts used in building and equipment are satisfactory for reliability requirements if any reasonable economic limits are considered. However, this reliability goal did not require such controls.

New 4-PDT-10-amp Relay Most Compact Rotary Type Available

This new durable relay is designed to meet the requirements of Mil-R-6106. It's a rugged relay featuring exceptionally sturdy terminals and husky contacts for high current applications. Glass-coated cylindrical contact actuators attached to the rotary armature provide square mating of contact surfaces, thereby assuring longer relay life. The balanced rotary armature provides maximum resistance to severe shock and vibration.

This small 4-PDT-10-Ampere relay is currently available with 115VAC and various DC operating voltages. Various mounting styles are provided. Write for bulletin 1069.

4. Reliability testing and failure analysis with corrective action in all phases of company activities associated with the TACAN, RT-220C, (design, production engineering, material procurement, production testing, etc.) resulted in an equipment meeting the reliability requirement.
5. The final reliability achieved was limited by the degree of testing performed on completed equipments for reliability control and corrective action applied as a result of testing rather than design, state-of-the-art, quality control, etc.
6. Testing according to the AGREE statistical requirements for 150 hr MTBF on an equipment having approximately 1,000 electrical components provided sufficient data for reliability control and corrective action to achieve the reliability goal after six tests or a total of approximately 25,500 operating hours. This is 170 multiples of the MTBF specified.

These conclusions are based upon the experience gained with one type of equipment under conditions of medium volume production. Obviously, the experience gained on this equipment will result in a different approach to reliability for future equipments. However, reliability control by exception—i.e., through failure experience—appears to be the most practicable and economic means of achieving a specified reliability goal at this time. ■ ■

References

1. Reliability of Military Electronic Equipment, Report by Advisory Group on Reliability of Electronic Equipment, Office of Secretary of Defense 4 June 1957, J. M. Bridges.
2. Reliability Stress Analysis for Electronic Equipment; TR59-416-1 Jan. 15, 1959, R.C.A.
3. "Sequential Life Tests in the Exponential Case:" B. Epstein and M. Sobel, *Annals of Mathematical Statistics*, pp 82-93 March 1955.
4. *Sequential Analysis*, A. Wald, T. Wiley Sons, New York, 1947.
5. *Handbook of Probability and Statistics with Tables*, Burington May, Handbook Publishers, Inc, Sandusky, Ohio, 1958.

Acknowledgment

The "Reliability Testing" portion of this article was presented at the Seventh National Symposium on Reliability and Quality Control. The results of the TACAN program were taken from Dr. Floyd's paper "Meeting AGREE Reliability Requirements for Airborne TACAN Equipment—History and Results."



SMALL A. C. MOTORS

Consider the many advantages of using Globe precision miniature a.c. motors. The small sampling of electric motors above ranges from 1.07" to 1.675" in diameter; torques range to 4.5 ounce inches continuous duty (up to 200 inch pounds with a Globe planetary gear reducer). A new 3/8" diameter motor has been designed for larger applications.

They are available in induction and hysteresis-synchronous types, 60 or 400 cycles or for variable frequency operation. Universal a.c./d.c. motors are available in 1 5/8" and 2 1/4" frame sizes. Most sizes and types are stocked by Globe for quick prototype delivery, some within 24 hours!

Right now Globe is developing commercial versions of our missile-quality motors. Performance is the same but the cost is engineered out by relaxing environmental requirements. One such motor goes in automatic telephone switching equipment. Another is in a vending machine. There are dozens of others. In these kinds of applications it is essential to have a motor of high reliability, long life, small size, freedom from maintenance, and modest price.

Get in touch with Globe early in the design stage. Very probably Globe has already made a motor close to your requirements. You'll receive a recommendation for your specific job. Please request catalog ACS from Globe Industries, Inc., 1784 Stanley Avenue, Dayton 4, Ohio. Baldwin 2-3741.

GLOBE INDUSTRIES, INC.

PRECISION MINIATURE A. C. & D. C. MOTORS. ACTUATORS.
TIMERS. GYROS. STEPPERS. BLOWERS. MOTORIZED DEVICES

GLOBE

CIRCLE 46 ON READER-SERVICE CARD

Reliability Analysis of A Long Established System— The Hammer and Nail



Are reliability analyses a bit unrealistic when compared to actual field results? Capt. Holmquist, author-lecturer on the reliability of Navy weapons systems, is concerned with the many absurd conclusions stemming from shaky assumptions and questionable data. To prove that "rigged" assumptions and erroneous data can prove almost anything, Capt. Holmquist presents a short analysis on the over-all reliability of the hammer-nail combination. He has applied the same line of logical reasoning used in weapon systems studies.

Try to guess the over-all reliability before reading the article.

Carl O. Holmquist
Captain, U.S.N.
 9518 Justine Drive
 Annandale, Va.

A HAMMER and its associated component, a nail, are considered by a majority of people to be an exceptionally reliable combination or system. Carpenters with various degrees of skill use the hammer and nail in construction work daily in all parts of the country. Our buildings and houses stand as a national monument to the reliability of the hammer and the nail in construction. This should be sufficient proof for anyone, be he scientist or layman, that this system is without a doubt the epitome of reliability in our modern age.

Since the hammer and nail are a combination which is real and, hence, subject to mathematical analysis and the science of statistics and probability, it is possible to investigate rigorously the system reliability of the hammer and nail combination. In this present enlightened age of scientific achievement, it is common knowledge that mathematics is an exact science and that results obtained by formulae are, *a priori*, also exact.

Let us investigate, with conventional mathematical rigor, the over-all system reliability of a hammer in driving a nail. The theory of probability is used extensively throughout

the analysis. All data employed have been obtained from unquestionably reliable sources and have been checked, rechecked and rechecked. The data are considered to be the most accurate available in this country at the present time.

Indisputable Data of Paramount Importance in Analysis

In investigating hammer and nail reliability, the following basic formula is used. Notation used in this formula is defined in the paragraphs following the formula.

$$P_{sh} = P_{ah} \times P_{fh} \times P_{h1h} \times P_{h2h} \times P_{ho} \times P_{an} \times P_{fn} \times P_{hn}$$

P_{sh} is the over-all system reliability of a hammer in driving a nail. The purpose of this investigation is to establish rigorously the reliability of this system.

The first term of the right side of the equation (P_{ah}) is defined as the probability that an average man owns a hammer. Obviously, a man cannot drive a nail without a hammer. A house-to-house survey of the entire country shows that 37.3 per cent of the eligible working force of this country owns a hammer. Hence, $P_{ah} = 0.373$.

P_{fh} is defined as the probability that the average man can find a hammer when he needs it. Experience has shown that ham-

mers, like many other things, are easily lost or misplaced. If there are children around the house, the problem increases in complexity. An extensive survey shows that 30 per cent of the time that a hammer owner looks for a hammer, he cannot find it immediately because it has been lost or misplaced. Hence, $P_{fh} = 0.70$.

The term P_{h1h} is defined as the probability that the handle will not break during the operation of driving a nail. Everyone knows that hammer handles are made of extremely tough and durable wood; hence, the probability of breakage is very low. P_{h1h} is assigned a value of 0.98.

The term P_{h2h} is the probability that the hammer head will not break during the hammering operation. Here again the head of a hammer is made of extremely durable metal, usually steel, and the probability of breakage during the operation is extremely low. P_{h2h} is confidently assigned a value of 0.99.

P_{ho} is the probability that the head of the hammer will not fly off during the hammering operation. Extensive surveys have shown that this failure occurs quite often, at times with disastrous results. P_{ho} was found to have a value of 0.97. However, because of the serious nature of this type of failure, this factor should be given double weight, or $P_{ho} = 0.97 \times 0.97 = 0.94$.

The next term, P_{an} , is defined as the probability that the average man will have a nail to complete the hammer-nail system combination. It is obvious that a man who has not bothered to supply himself with a hammer probably will not bother to obtain nails for the operation either. P_{an} must, therefore, be equal to P_{ah} , or $P_{an} = 0.373$.

P_{fn} is the probability that the average man cannot find a nail even though he owns some. A nation-wide survey has shown that a man normally has 53 times as many nails as ham-

mers in the average household. Obviously, it is much easier to find one of 53 articles than one particular article. After a series of rigorous mathematical analyses, it has been determined that the average man can find a nail 92.1 per cent of the time, or, $P_{fn} = 0.921$.

The last term P_{hn} is defined as the probability that the average man can hit a nail successfully with a hammer. Statistics gathered from governmental sources show that only 7.2 per cent of the working force of America is composed of skilled carpenters and, hence, have experience in hitting nails with hammers. A sampling system has been used to determine the probability that the average inexperienced man can hit a nail with a hammer on the first try without bending the nail, missing the nail, etc. The results of this sampling show that approximately 75 per cent of the time the average man can be expected to hit a nail with a hammer. Considering that 93 per cent of the men of this country are unskilled in hammering, P_{hn} obviously has a value of $0.93 \times 0.75 = 0.696$. This is the only value used in this analysis which is considered to be estimated and not rigorously defensible, since it is based on a sampling process and not on a broad survey.

The Over-all System Reliability Is Rather Surprising

Substituting the above rigorous values into the above likewise rigorous formula, one obtains a rigorous value of 0.057 for P_{sh} as follows:

$$P_{sh} = 0.373 \times 0.70 \times 0.98 \times 0.99 \times 0.94 \\ \times 0.373 \times 0.921 \times 0.696 = 0.057$$

Therefore, this analysis has proved that the over-all system reliability of a hammer in driving a nail is only 5.7 per cent. It is obvious from this evaluation, which is considered conservative, that the reliability of this system must be improved or the future building program of this country will be seriously endangered.

Recommendations Based on the Results Of the Rigorous Analysis

It is strongly recommended that an extensive research and development program be initiated to (a) improve the reliability of the hammer-nail combination, or (b) devise a new system to fill the requirement which has improved reliability. It is further recommended that an ad hoc committee be formed to consider this problem and recommend a course of action to be followed to remedy this gross inadequacy. ■ ■

Question: Can circuits be simplified with increased reliability?

Answer: Yes!

With the Tung-Sol

dynaquad.

—a four-layer device.

Dynaquad is a PNP bistable transistor which makes it possible to accomplish flip-flops, binary counters, solid state relays, shift registers and various forms of logic with a saving of one-third to one-half in components and space. In many circuits it directly replaces a number of transistors and their associated components. In others it permits use of transistor techniques where they previously had not been practical.

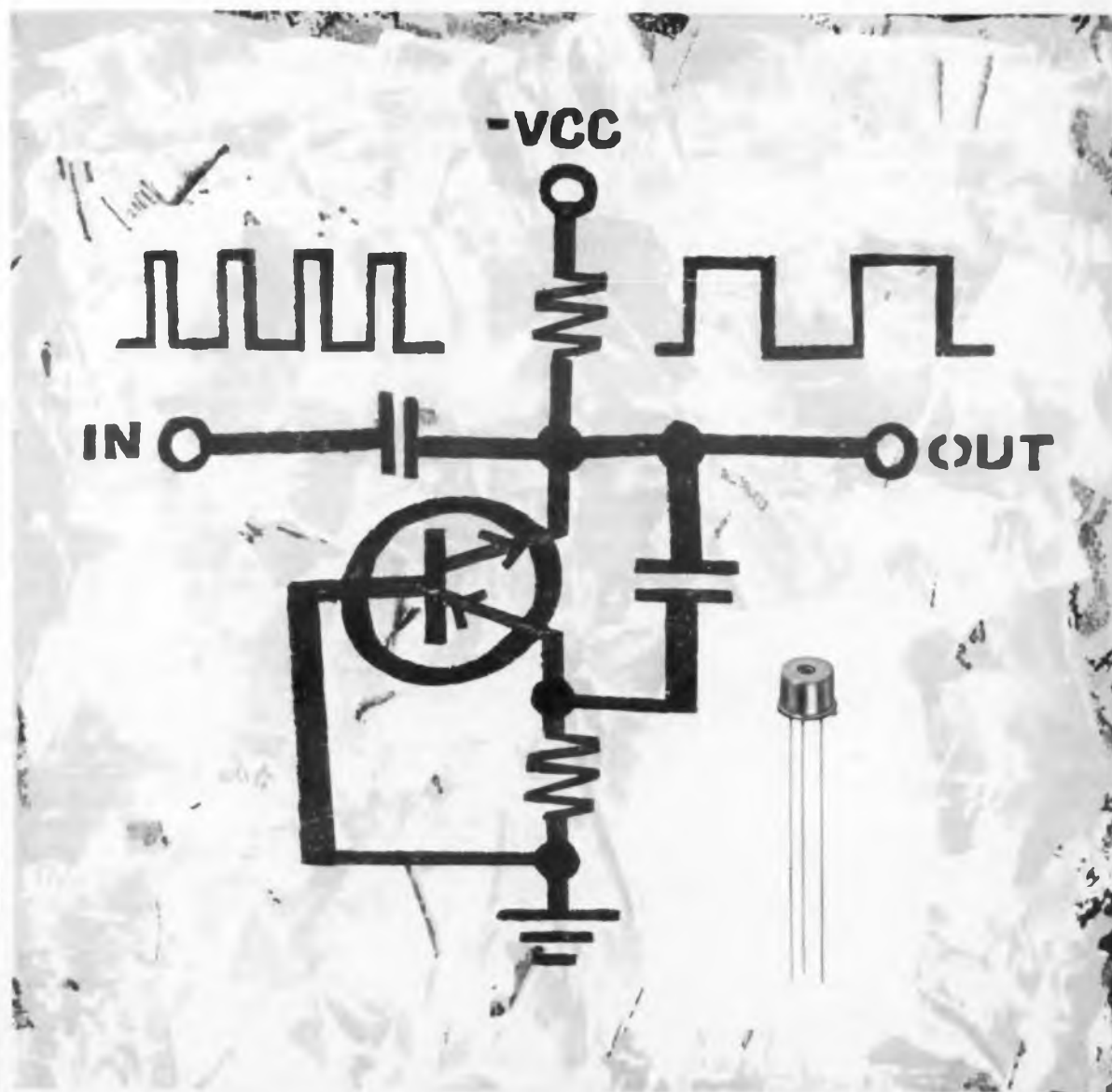
Finding its chief application in the fields of computation and control, the Dynaquad is a new circuit tool for small signal switching, driving and pulse-forming applications.

Tung-Sol's applications engineers have developed 100 kilocycle shift registers and a 1 megacycle reversible ring counter,

using amazingly few components. Circuit diagrams and complete design information are available on request. With great simplicity, bistable, monostable and astable multi-vibrators can be fabricated, using the Dynaquad. One such example is shown below. You are also invited to discuss any special questions you may have with Tung-Sol's applications engineers. Tung-Sol Electric Inc., Newark 4, N. J. TWX-NK193

TECHNICAL ASSISTANCE AVAILABLE THROUGH:
Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.;
Dallas, Tex.; Denver, Colo.; Detroit, Mich.; Irvington,
N.J.; Melrose Park, Ill.; Newark, N.J.; Seattle, Wash.
In Canada: Abbey Electronics, Toronto, Ont.

TUNG-SOL



Two resistors, two capacitors and one Dynaquad make a bistable.

CIRCLE 47 ON READER-SERVICE CARD



reliability



The Reliability Group: Its Organization and Responsibilities

Much has been written on the urgent need for reliable systems and devices. How does a company supplying components for missile and guidance systems create a reliability group to work in harmony with engineering, quality control and production? Dr. Hull, who has labored through the problems involved in organizing such a staff, outlines the duties and responsibilities of a reliability group—and management's obligation to the group.

Dr. Robert W. Hull
Vice President, Reliability
Semiconductor Div.
General Instrument Corp.
Newark, N. J.

RELIABILITY groups, responsible for reporting the efforts of engineering, production, test and quality control, are subject to sharp criticism since misinterpretation of intentions can upset personalities and projects. For this reason, the formation of a reliability group, its responsibilities and its management merit considerable attention during initial organization planning. Large and small companies alike cannot afford the costly and aggravating losses which may stem from poor cooperation between all groups responsible for the development and production of reliable, high-yield devices and products.

Honesty in Exposing Failures Key to Effective Reliability Program

A considerable number of technical papers and articles have illustrated the need for high-reliability in missile and space programs; the lurid prospects predicted as a penalty for faulty military security have been dramatically outlined. Much of the burden for achieving high reliability falls on the shoulders of the component manufacturer. High reliability parts form the backbone of a highly reliable system.

First let us consider the value of reliability to a component manufacturer. To improve his component quality may cost more than his present engineering effort. Extra test facilities may be required; extensive plant modernization or production machinery improvements may be needed. Such expenses cannot be undertaken without some guarantee that the improvement in product quality will justify the cost and risk. In other words, there is a right reliability for the job. Some of this cost rightly belongs to the manufacturer of the component, who will benefit by higher yields and more output product per input dollar. The customer, in turn, receives an improved product.

When a company embarks upon a reliability program, it is first and foremost embarking upon a program of honesty, both within itself and in its dealings with its customers. There must be a sincere desire on the part of each individual to accomplish in reality the goals that have been set. Many reliability programs, costing millions of dollars, have fallen short of their mark because a test operator or supervisor was afraid to make a defect known. All personnel involved in a reliability program must be urged to practice strict honesty in all details, no matter how small. No problem, reliability or any other type, can be solved without first admitting it exists.

The reliability programs presently being conducted on a number of components have as their goal improvements of the general order of 1,000 times. Such an enormous improvement is possible with a program that progresses systematically from step to step, correcting each source of error, each accident, each weakness in design. First, a test program is prepared to ferret defective components, then special tests are run to find hidden or incipient defects. Each defect is analyzed to ascertain its cause as well as means to remove it from the final product. As each major defect is understood and removed, defects of less frequent occurrence become apparent and are, in turn, reduced. Thus, a reliability program involves gradual, measurable accomplishments to steadily upgrade the quality level of a product.

Reliability Group Must Work With, Not Under, Other Groups

An ambitious reliability program requires a properly organized group to carry on the detailed work and coordinate its many phases. This new group will work closely with engineering, production, quality assurance, testing, customer liaison, and marketing. To properly and completely discharge its functions, it must not be subservient to any of these other basic company necessities. Instead, the reliability group must act as an advisor to all of them and must establish and maintain close cooperation in order to solve mutual problems.

Owing to the many areas of responsibility in which the reliability group will work, it is desirable that it have direct responsibility to top management. In fact, this direct responsibility is the best method of demonstrating to customers that the reliability

group can function in an unbiased manner. In the case of a company with several plants or divisions, the reliability group should be responsible to the plant or division management whose product is to be investigated. If a reliability group is to work at more than one plant, it is necessary to organize an on-the-scenes staff at each plant to oversee and carry out various phases of the program. Management must indicate to all departments concerned the importance of the reliability program to the over-all company structure. Furthermore, it must be made clear that findings of the reliability group will not be used as a weapon to penalize sections contributing to product defects. Instead, procedures will be devised to reduce these failings. Definite budgetary procedures must be established at the time the program is undertaken to pay for the costs incurred in setting up new test facilities.

Organization of an Effective Reliability Group

Different requirements prevailing in different companies may slightly alter the details pertaining to a reliability group. However, the general pattern is shown in Fig.1. Note that the reliability group reports directly to the manager, as do the other groups contributing to product design and production. The quality control group is separated from the reliability section.

In some instances, a satisfactory organization has been built up with quality control and process control reporting to the reliability group. This arrangement is particularly advantageous in cases where the entire plant product is to fall under the reliability program. In this way, the best possible liaison exists between the sources of data and their analysis. In addition, there is an occasional need for compromise in quality, not brought about by lack of diligence but rather the result of having set too optimistic a goal; sometimes the customer requests a trade-off in quality to step up delivery. With process control and quality control linked closely with the reliability group, an intelligent course of action on quality compromise can be quickly outlined and put into action.

The difference between quality control and reliability functions is worth special note. Quality control is concerned entirely with compliance of an item or group of items to a specification. Reliability is concerned with the capability of an entire product or production line. It may not be necessary to

Glossary of Common Reliability Terms

Reliability, R or Probability of Survival, P_s , is the probability that a component will perform in a specified manner under specified conditions for a specified length of time.

Reliability Engineering is the exercise of the scientific and technical disciplines, techniques, and skills necessary to achieve reliability objectives.

Confidence is the likelihood that a given statement is true (usually expressed in per cent)

Failure Rate, λ or Hazard is the probability of failure per unit of time for all components still operating at a given time (usually in per cent failure per 1,000 hr). If the failure rate is constant,

$$\lambda = \frac{\text{number of failures}}{\text{total accumulated operating time of all units}}$$

$$\lambda = \frac{1}{\text{MTBF}}$$

Mean Time Between Failures, MTBF, only has meaning in the case of a constant failure rate.

$$\text{MTBF} = \frac{\text{total accumulated operating time of all units}}{\text{number of failures}}$$

$$\text{MTBF} = \frac{1}{\lambda}$$

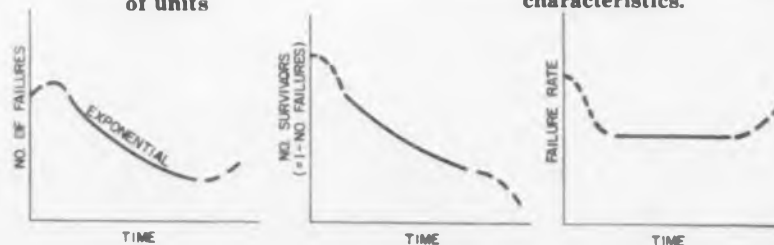
Mean Time to Failure, MTTF, is used with equipment (usually one-shot) and is similar to MTBF.

$$\text{MTTF} = \frac{\text{total operating time of a piece of equipment}}{\text{number of failures occurring during this time}}$$

Each failure is assumed to be repaired so that the earlier condition of reliability is restored.

Mean Time to First Failure, MTTFF is a special case of MTBF.

$$\text{MTTFF} = \frac{\text{accumulated operating time to first failure of a group of units}}{\text{total number of units}}$$



Mean Life is a general term covering both MTBF and MTTF.

Exponential Distribution of failures means that the distribution of the number of failures with respect to time may be expressed $P_s = e^{-\lambda t}$, ($t = \text{time}$) and the failure rate $\lambda = \text{constant}$.

The onset of the constant failure rate may be delayed, in which case the distribution is called delayed exponential. Test data is generally insufficient to demonstrate conclusively whether or not the failure rate is constant when it is very small. Fortunately the errors caused by assuming a constant failure rate are generally not serious when small failure rates are considered.

Failure is defined and agreed upon between consumer and producer. Failure definition depends upon application and may include Drift Failure (specified change in characteristics over a specified period of time) and Catastrophic Failure (defined gross degradation of characteristics).

Lot is a group of similar components which have been grouped in either of two ways:

- All manufactured in a continuous production run from homogeneous raw materials under constant process parameters.
- Assembled from more than one production run and submitted for random sampling and acceptance testing.

Acceptable Quality Level, AQL, is the per cent defects in a given characteristic specified as being acceptable.

Producer's Risk is the probability of rejecting a lot with acceptable characteristics.

Consumer's Risk is the probability of accepting a lot with defective characteristics.

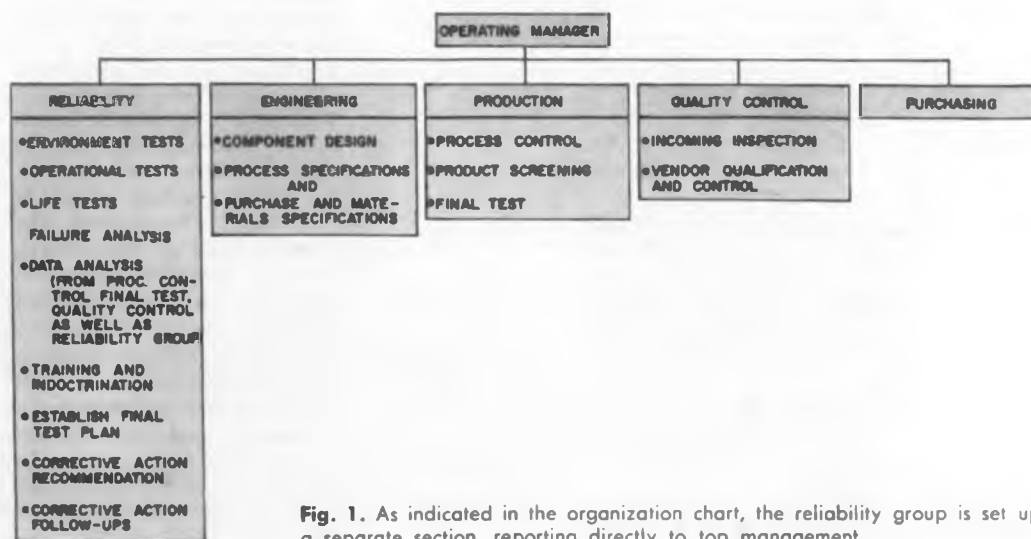


Fig. 1. As indicated in the organization chart, the reliability group is set up as a separate section, reporting directly to top management.

use this full capability to meet a given specification, or it may be that the maximum capability is inadequate and improvements are needed.

Mutual Understanding Between Groups Reduces Bickering

Relations between the production group and the reliability group can be kept friendly so long as each tries to understand the problems and aims of the other. This understanding is furthered by arranging informal get-togethers as well as periodic formal meetings. The educational process of "selling" the reliability concept has been found to work well on an informal basis where the opportunity for individual contact is provided; the "selling" process is an important ingredient of a successful reliability program. Management must recognize the problems facing a reliability group and establish proper programs to permit heads of various groups to work harmoniously toward the same goals. Subordinate employees, from line supervisors to production operators, must be sold the merits of the program and must understand that care and honesty are the goals. Exposing, rather than burying, defects must be encouraged. When this selling job has been adequately done, there is very little clash between diverse interests.

At the completion of a specific reliability program, not only should the product quality improve, but the production rate and the yield should likewise increase. These results stem from the generation of improved operator attitude and more effective tooling. In particular, as process control procedures are improved, (1) process divergence is reduced, (2) the down time caused by loss of control is lowered and (3) production can be channeled to one specific device rather than a group or family.

Product Improvement, Customer Satisfaction Responsibilities of Reliability Group

The reliability group must adopt effective procedures to locate product defects along with means to reduce their occurrence. Each procedure outlined must be qualified with test results stemming from a long series of experiments. Reports must be prepared for management giving progress to date, sources of failure found and suggested methods to reduce them. In addition, the reliability group must supply an analysis of company and competitor component quality and capability plus various test and application information that may be useful to the customer. The future success of the company in the ever-increasing competition for better

components hinges, in part, upon the efficiency and capability of the reliability group.

The reliability group also bears a responsibility to the customer expecting components of stated performance to be delivered. Not only are those tests conducted as specified by the customer, but additional tests may be performed which are considered pertinent to a thorough understanding of the component and its failure mechanisms. All necessary precautions must be taken in production to minimize the fabrication of defective components; even in the event a few defects should slip by, a well-planned test program should spot the majority of these.

Causes of Failure Mechanisms Targets of Reliability Program

The prime purpose of a component reliability program is to acquire thorough knowledge of one's own devices from a collection of accumulated test data. These data are analyzed in a systematic way so as to guide the improvements in design and processing necessary to gradually remove the various failure processes or mechanisms. The gain in knowledge of product failure mechanisms and their removal is the reward of a well-planned reliability program.

The accumulated data allow prediction of test procedures, screening and burn-in process steps and the resulting yields and costs to be expected. It may be possible from these data to qualify the entire output of a production line to a given specification so that only detailed parameters need be measured for selection and acceptance of individual components. The feedback loop of a reliability program is shown in Fig. 2.

The source of the accumulated data is a continuous test program in which a small sample from each production lot is tested under all conditions pertinent to the particular device. The test conditions include life and environmental tests under many load conditions. Routine conditions are severe enough to meet or exceed all MIL and customer requirements. An analysis of the data is made to provide process control information and to serve as a guide to the process engineers engaged in failure analysis and device improvement.

The test program examines not only those devices in production but devices in pilot and even developmental stages; experimental devices and device test runs also must be eval-

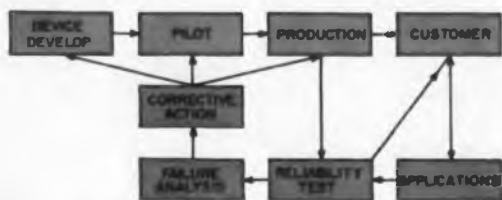


Fig. 2. The feedback loop of a reliability program minimizes product "distortion" and amplifies product "output."

uated. Purchased samples of competitive devices and new devices must be evaluated on a routine basis as a guide to one's relative capability in the industry.

Four Major Factors Contribute to Component Reliability

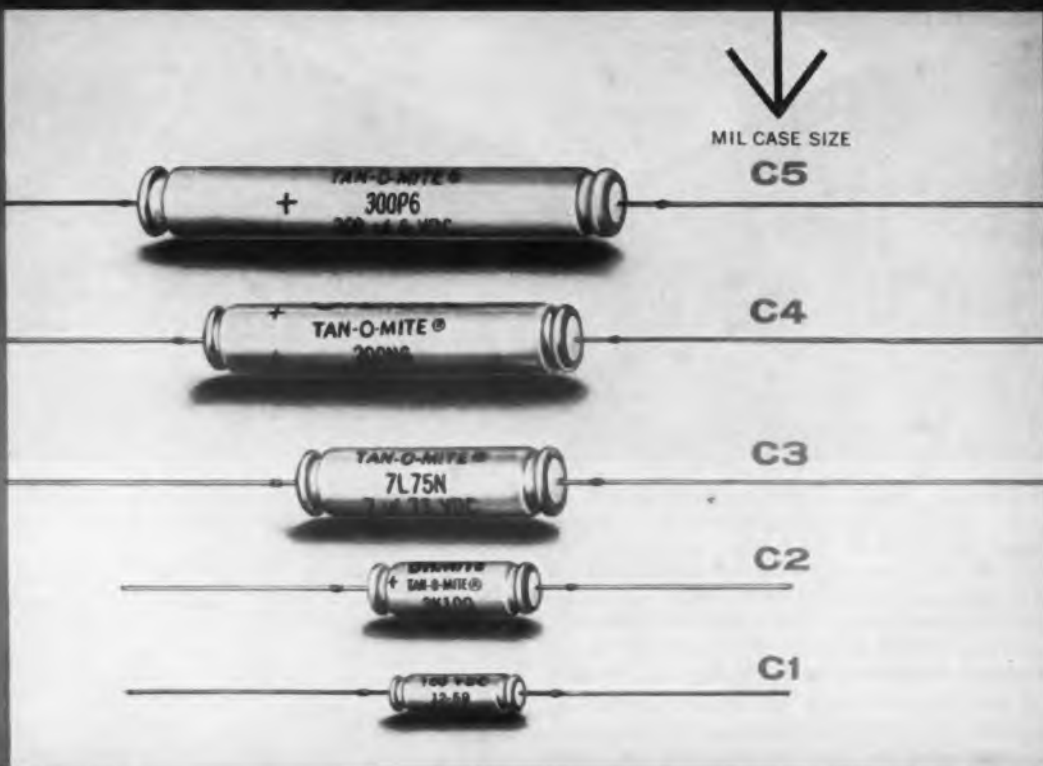
The reliability of any component depends upon the manufacturing process, the selection program and the device application. All three must be considered in realizing the best achievement of reliability. If the reliability achieved by these three programs is not adequate, it is then necessary to add a fourth program, namely process improvement or device development.

A manufacturing process for a high reliability device is one which operates in a precisely known and controlled way. All materials and all operations performed are described by precise specifications. Process control tests are set up to verify adherence to specifications. Any deviation is cause for immediate corrective action. In order to evaluate the finished product, all work in process is identified. A correlation is made between observed test results and the process parameters or materials which were used in producing that particular lot. Running process averages are maintained at intermediate test points so that deviations may be observed and corrected before large quantities of substandard parts are produced; substandard lots are naturally not used for high-reliability applications.

By careful manufacturing control, a minimum number of marginal quality components come off the production line. It is next necessary to generate a test procedure in which defective devices, or those with incipient defects, can be culled from an otherwise high quality lot. The reliability test program has already established the mechanical and

All 5 MIL Tantalum Foil Capacitor Sizes From OHMITE

MEET MIL-C-3965B - ALL VALUES IN STOCK



Plain and Etched

Whether you need *immediate delivery* from stock on prototypes, or production quantities of tantalum foil capacitors, Ohmite can handle your requirements.

Tan-O-Mite® Series TF foil capacitors now include all five MIL sizes in both plain and etched types, polar and nonpolar units, insulated and uninsulated cases—all in ratings to 150 VDC. Capacitance values for plain foil units range to 400 mfd; etched foil units, 580 mfd.

Write for Specification Bulletin 152G which lists 200 stock values, including all MIL values, and shows a *handy scale for conversion* between "equivalent series resistance," "power factor," and "dissipation factor."



OHMITE MANUFACTURING COMPANY
3643 Howard Street, Skokie, Illinois

Rheostats
Power Resistors
Precision Resistors
Variable Transformers
Tantalum Capacitors
Tap Switches
Relays
R.F. Chokes
Germanium Diodes
Micromodules

CIRCLE 48 ON READER-SERVICE CARD



Fig. 4. Human errors in reading and recording the enormous amount of data involved in reliability testing could greatly affect the final failure figures. Thus, an additional refinement, to enhance the reliability program, involves the design and installation of automatic recording equipment. An automatic set-up for reading and recording transistor test data is shown. (Photo courtesy of General Instrument Corp.)

parameter. In general, where high reliability is specified, as much care should go into the application of the device as went into its manufacture.

To verify failure rates in the order of 0.01 to 0.001 per cent per thousand hours, enormous amounts of data must be accumulated. Human errors are to be expected while reading meters, jotting down figures and transposing figures to cards; however, these human errors cannot be tolerated since they will have a significant bearing on the extremely low failure rate figures. For this reason, an added refinement for a well-prepared reliability program should include automatic equipment to measure and record data, see Fig. 4. Finally, statistical analysis and correlation of the collected data should be performed by machine to further reduce the human error factor. ■ ■



® TRADEMARK OF AMP INC.

AMP
GENERAL OF

AMP products and engineering assistance are available

STOP

eyeletting or thru-plating
printed circuit boards!



Use AMP
CIRCUITIP* Terminals

... AMP's tapered terminal, crimped to electronic component leads with precision-engineered, high-speed, automatic application machines.

CIRCUITIP Terminals give you quick, secure mounting of components at lowest installed costs anywhere.

ADDITIONAL FEATURES: • Mechanical retention of components prior to soldering • crimp configuration to aid capillary action of solder • standardization of hole size • bridging and offsetting of components for air circulation • heat sink in tip to help dissipate heat and protect costly components • uniform solder fillets • automatic trimming and bending of component leads • absence of radial wire protection ideal for increased board density. **Send for complete information today.**

INCORPORATED

OFFICES: HARRISBURG, PENNSYLVANIA

Available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

CIRCLE 50 ON READER-SERVICE CARD



Variation Research—The Science of Forcing Defects to Reveal Themselves

“Why depend on trial and error experiments or sheer guesswork to explain quality variations,” author Shainin asks, “when the contributing factors can be forced to expose themselves?” Variation research coupled with the statistically designed experiment can rapidly lead to the “Vital Few” causes of product malfunction. Only when these causes are under control can the “constant failure rate” assumption used in reliability calculations be considered valid.

The faster, less costly road to a reliable product is described and case histories presented to illustrate the technique. Author Shainin is shown conducting an in-plant training program on statistical techniques.



Dorian Shainin, Vice President
Director of Statistical Engineering
Rath and Strong, Inc.
Boston, Mass.

	A HIGH	A LOW
B LOW	(1) 20.40 R HIGH (2) 20.50	(5) 20.80 R LOW (6) 20.40
B HIGH	(3) 22.90 R LOW (4) 23.10	(7) 23.00 R HIGH (8) 22.90

Fig. 1. Results of a series of test runs on two units of a complex pneumatic assembly are charted on a “Latin Square” diagram. The two units selected (High and Low) represent extreme variations in supply-line pressure required for proper operation. Two subassemblies (A and B), suspected of being the cause of the performance variation, are removed from the remainder R of the units and reassembled in various combinations (A Low, R High, B High, etc.).

DON'T ATTEMPT to maintain key factors in a search for causes of an effect at constant values—instead, look for variations, encourage them, probe means to achieve differences in results. Such is the philosophy of variation research and its supporting statistically designed experiment, a pair of modern tools for locating causes of deviation in product and process quality. The traditional scientific approach, involving the preparation of a series of assumptions and then conducting experiments to confirm or disprove them, is time-consuming and often fruitless; often, new hypotheses must be drawn up and additional experiments run. Basically, the conventional approach to locate causes of product variation is a “hit or miss” proposition.

Simultaneous Consideration of Many Factors Key to Statistical Experiment

Tracking down factors affecting product quality is generally a long, tedious and frus-

trating assignment. Relevant factors are usually charted, lengthy measures to control tightly numerous operations must be established and drawn-out experiments conducted. Despite all efforts over an extended length of time, it is not unusual to remain confronted with an endless series of variables, with quality still far from the desired level.

Conventionally the experimenter sets certain factors at constant values and observes the effects of one other factor at a time. Statistical engineering involves the simultaneous consideration of many (all, if necessary) of the possible reasons for product malfunction. Hypotheses, hunches and guesswork are not neglected in the procedure, but do not seriously hamper the experiments if they prove to be incorrect. Many of the possible causes in large groups can be directly adjudged as irrelevant after a short period of gathering of key data; this permits concentrated efforts to be applied to the few remaining possibilities.

The unusual degree of objectivity offered by the statistical approach is based on the following logic:

1. Every effect has one or more causes.
2. Relatively few causes, rather than several, have a controlling influence on the effect. Call these the “Vital Few” causes.
3. Causes and effects are not constant—they vary.
4. If the variation of an effect is studied in a particular way, it can lead to the single cause (or to the combination of causes) of that effect. That particular way is to dissect a group of all possible causes into smaller groups, eliminate those associated with trivial variability; dissect the smaller group or groups with relatively large variability into still smaller groups, eliminating again those

with trivial variability. Case histories show that this successive elimination procedure only has to be carried out two or three steps (sometimes only one) to unearth quite unexpected causes.

An important difference, as compared to current engineering analysis, is brought out by this approach. One does not look at past or current data that happen to be available when a problem arises, and draw any valid statistical inferences from the data, because data have to be gathered in a different way to be properly discernible. Statistical engineering is first planning how the data shall be gathered with a view toward the later analysis of these data.

There is nothing wrong with taking a side excursion whenever the data have been gathered by a plan and an unexpected, but plausible, engineering inference is suggested by the results. Go after it; see if you can turn the effect off and on. If you cannot, return to the sequence of objective, process-of-elimination, statistical steps. Just keep the difference in mind. You are then equipped with two important tools; sometimes one, sometimes the other does the better job. Often one helps the other do the job.

5. Being able virtually to turn a difficulty on and off obviously represents clear evidence that you are ready to form decisions as to ways to control the effect. Despite its elementary nature, in far too many cases this checking action has been deemed unnecessary, and a costly engineering error has been made.

Case Study #1: Unit-to-Unit Variation In Production of Complex Pneumatic Device

Consider the case study³ involving unit-to-unit variations encountered in the manufacture of a complex pneumatic unit. A relatively high percentage of units coming off the assembly line required much higher supply-line pressure than other units despite numerous changes in dimensions, tolerances, assembly steps and test procedures. The statistical engineer, convinced that perform-

ance variation was caused by physical differences he was unaware of, selected two units from a day's production; one was tagged "High," the other "Low." Each represented the extreme variation in pressure required for proper operation.

Next, a short conference with several design engineers and the statistical engineer led to the possibility that either of two sub-assemblies in the unit was the possible cause of variation, the difference in pressure required. The pair of subassemblies was removed from each unit and tagged "A" and "B"; the remainder of each unit was termed "R." Thus, six components were on hand for the test—an "A," "B" and "R" from "Low" and another three from "High." Units were reassembled and checked in the following manner:

- (1) A High, B Low, R High
- (2) A Low, B Low, R Low
- (3) A High, B High, R Low
- (4) A Low, B High, R High

Using the "Latin Square" to Determine Effects of Variables

Experiments were conducted twice for each combination for a total of eight tests. To reduce the possibility of incorrect results due to unforeseen environmental factors, the tests were run in random sequence. The readings (in lb/sq in.) were placed in a "Latin Square" diagram along with the number of the test run, see Fig. 1.

Here is how the Latin Square permits a rapid check on the differences caused by a change in one particular variable:

1. The effect of A High differing from A Low is evidenced by the difference between the average of the four readings in each vertical column.
2. The effect of B Low changing to B High is shown by the average of the four readings in each horizontal row.
3. The effects of R High differing from R Low can be seen by averaging the diagonal readings; upper left and lower right readings represent the common presence of R

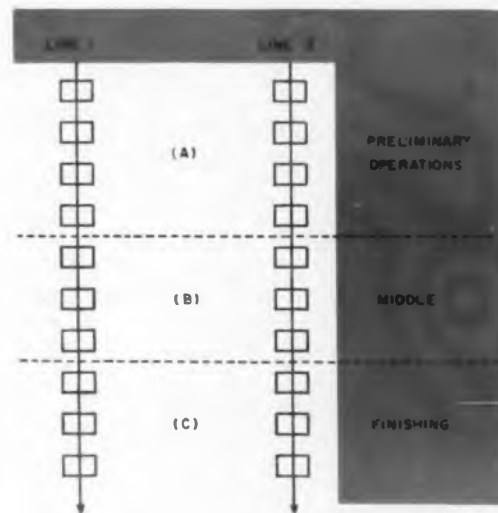


Fig. 2. Parallel production lines, line 1 and line 2, for fabricating micro-alloy transistors produced devices which varied in critical parameters significantly with time. The series of manufacturing steps was divided into three distinct operations, A, B and C and various combinations of operations were used to process small runs.

High while lower left and upper right are with R Low.

From the balanced Latin square, the main effects of any one variable are indicated while those of the other two variables are neutralized.

This computation rapidly revealed that subassembly B was responsible for a large variation between the units. Upon close examination of B subassemblies, it was noted that a difference in length existed between a fulcrum and an actuating point on an arm. By more closely controlling this dimension in later production runs, performance variations were markedly reduced.

Case Study #2: Improvement in Yield of Semiconductor Production

In the course of investigating the performance of parallel production lines for micro-alloy transistors, of various type numbers, a variation analysis study was con-



reliability

	1A		2A	
	1C	2C	1C	2C
1B	①	⑥	④	⑧
2B	⑦	③	⑤	②

Fig. 3. The combinations used to track down the variation in transistor quality output is shown. The encircled number in each box indicates the production path number.

"Why Resort to the Statistically Designed Experiment?"

Key Advantages Include

1. Obtaining leads to the causes of production variations is considerably quicker with statistical techniques than conventional "trial and error" quality-assurance approaches. A number of case histories, illustrating how one or two weeks of carefully selected experiments have solved problems plaguing companies for years, bear evidence to this fact.

2. The rapid answers obtained permit almost immediate production modifications to upgrade the product or process yield; rejects drop, delivery is stepped up and savings can be realized in a short time.

3. Production is, in most cases, rarely slowed up since experiments are often brief but searching. Generally only a small number of units are involved in the test. On-line production changes are kept to a minimum.

4. The statistical evaluation of product quality can be continued to upgrade the product quality beyond the initial goals set.

5. The statistically designed experiment is not limited to giant organizations; small companies can make use of the technique since the preparation of tests, the actual experiments and final analyses are generally fast and relatively inexpensive without the need to temporarily halt or slow down operations.

6. Interactions due to several variables can be spotted.

7. More information per test run can be obtained than with conventional approaches.

8. The optimum combination of controlling factors can be established.

9. This approach can lead to important variables which may otherwise elude the searcher.

But Bear in Mind

1. The statistically designed experimental procedure is not a "do-it-yourself" project. A small but qualified group of statistical-engineering personnel is needed. A large company may easily set up a group for training in this approach; smaller firms could make use of a consultant to set up the program and assign the part-time services of one or two people to collect and analyze the data with the consultant. Skill must be developed to

- recognize the identifying signs of variability and
- refrain from identifying specific causes until the probability of success is high.

2. The statistical experiment is a well established philosophy—but immediate results cannot be guaranteed every time. Solid engineering background in the problem areas involved and close teamwork among production, engineering and management members are important ingredients for reaching a rapid solution.

ducted. It revealed that distributions of critical parameters varied significantly with time, from line to line. The parameters giving trouble were I_{cbo} , I_{ebo} , h_{fe} (β), and V_{pl} .

Engineers studying these statistical results reasoned that certain factors logically could cause the difficulties, but one by one these process inputs were modified with no significant effects on the outputs.

During a period when one line was running at a higher yield than another (although both lines were presumably operating to identical specifications) a series of short experiments were planned to isolate further the causes of the failure of several units to meet specifications.

Line 1, at that time, was the "better" line; line 2 was the "worse" one. The series of manufacturing steps was divided into three distinct groups of operations as shown in

Fig. 2.

The plan was to process small, equal-sized lots of product through each one of the eight distinct paths through which transistors could be made. The normal paths are 1 and 2; the new combinations, using some of both lines, are 3 to 8.

Path 1:	1A	—	1B	—	1C
Path 2:	2A	—	2B	—	2C
Path 3:	1A	—	2B	—	2C
Path 4:	2A	—	1B	—	1C
Path 5:	2A	—	2B	—	1C
Path 6:	1A	—	1B	—	2C
Path 7:	1A	—	2B	—	1C
Path 8:	2A	—	1B	—	2C

Fig. 3 shows the diagram of this experimental plan, from which it can be seen that section A's effect (line 1 compared to line 2) will show up as a difference between the average result under 1A and that under 2A. All other sections will have contributed equally to these two averages, and so their main effects will be neutralized. The eight distinct paths are circled in Fig. 3.

In a similar way, the main effect of B can be separated from A and C; and that of C from A and B. Also this plan, called a full-factorial experimental design, can evaluate the interactions of one part of a line with one or two other parts.

A table of random numbers determined the sequence with which one line of the eight was run after another. Then the eight

were run again, using still another random sequence. The average difference between runs with the same line would represent experimental error caused by any other factor not characteristic of a section of a line.

Interestingly, no two parameters were revealed as being influenced by similar sections or by the same combination of sections. No wonder previous, conventional engineering trouble shooting was running into difficulties.

It was determined that h_{fe} (Beta) values were highly dependent upon sections A and B, while totally indifferent to whichever section C the units were processed in. The best units came from paths 1 and 6, while the worst were products of paths 5 and 2. Medium results were obtained in the remaining paths.

Likewise, I_{cbo} , I_{ebo} reverse current values were the result of an interaction among factors in all three sections. While path 1 gave good results, an unexpected outcome emphasized the relatively great amount of information available from the statistically designed experiment: path 6, made up of two sections of line 1 and one section of line 2, was even better.

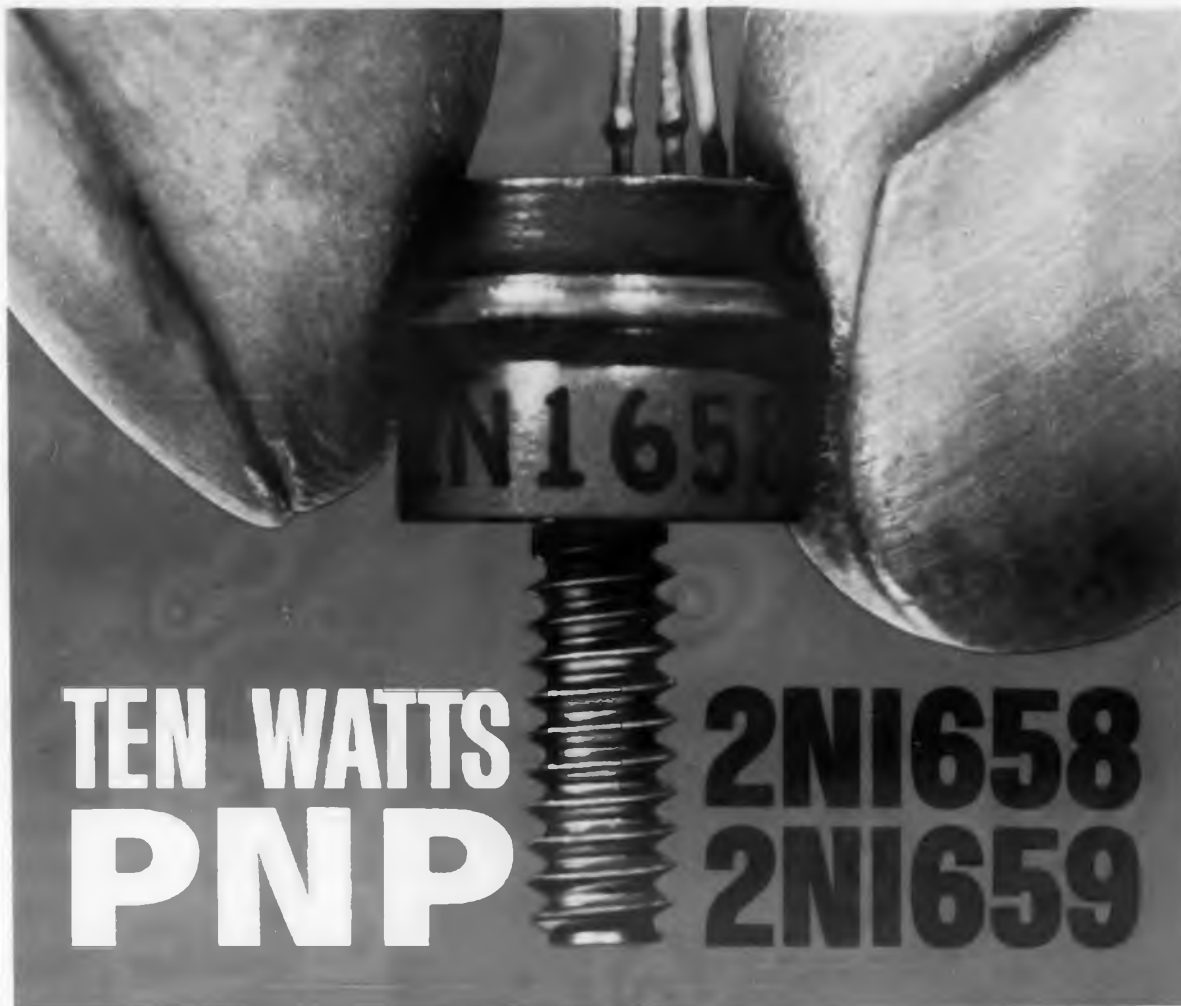
Punch-through voltage V_{pt} turned out to be a function primarily of which section A was involved. The best units came from paths 1, 6, 7 and 3; while the worst went through 4, 8, 5 and 2.

With the results of these tests in hand, it was possible to begin a systematic search for the specific inputs and combinations of inputs which were responsible for yield variation. Trade-offs were made to reach optimum conditions for all important parameters.

Without the benefit of running tests through all possible paths, the important interactions would have been missed. Through the discovery of these rather subtle phenomena, yields were increased and it was possible to establish new and different, more effective controls to maintain the much higher yields.

Process of Elimination Rapidly Pinpoints Key Variables

Suppose neither subassembly A or B were responsible for variations and a large difference in averages turned out to be in R,



TEN WATTS
PNP

2N1658
2N1659

Looking for a compact 1 to 10 watt Germanium Power Transistor with this kind of top level performance?



ACTUAL SIZE

Top reliability is built into each Honeywell transistor. Vacuum baked, given rigorous life and dynamic tests, each is enclosed in a new cold-welded miniature case with threaded mounting stud.

Designed for general use, the Honeywell 2N1658 and 2N1659 are ideal for servo amplifiers, relay drivers, high power unit driver stages, and as medium power switches. Measuring only 0.35 inches in diameter, they handle one to ten watts!


You'll want data sheets, including characteristic curves and servo amplifier circuit diagram, for your files. Fill out and mail the coupon today!

- *Leakage*— I_{CBO} less than 0.5 ma at 80v, 2N1658—60v, 2N1659
- *Saturation voltage*— $V_{CE(SAT)}$ less than 0.25v
- *Floating potential*— V_{EBF} less than 0.25v
- *Thermal resistance*— Θ_{J-MB} 5° C/watt max. (T_J max., 100° C)
- *Gain*— h_{FE} 30 min @ 0.2 amp; h_{FE} 20 min @ 1.0 amp
- *Frequency response*—500 kc minimum gain bandwidth product
- *Power dissipation*—15 watts at 25° C, 6 watts at 70° C

MINNEAPOLIS-HONEYWELL REGULATOR CO.
SEMICONDUCTOR DIV. • MINNEAPOLIS 8, MINN.
Yes, send me bulletins on the new Honeywell 2N1658 and 2N1659.

NAME _____
FIRM _____
ADDRESS _____
CITY _____ STATE _____
STATE _____ PHONE _____ (3)

Honeywell

 Semiconductor Products

CIRCLE 51 ON READER-SERVICE CARD

RELIABILITY

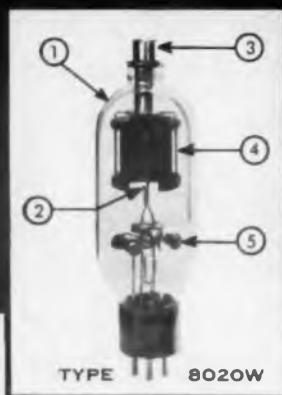
UNDER GLASS



Largest—and most complete—line of Power Vacuum Diodes Available

For over a quarter of a century, United Electronics Company has lead the industry in the design and production of power rectifier tubes. Now, as a part of the Ling-Temco-Vought Complex, United Electronics offers you the largest and most complete assortment of power vacuum diodes available. Employing specially processed electronic graphite anodes (which, because of their "black body" characteristics, far surpass any metal anode in heat dissipation), these tubes are designed to meet the critical size requirements, environmental conditions, and high power needs of modern electronic systems. A forward-moving company, United Electronics maintains a continuous research program, in anticipation of the demands of the aerospace age.

Write for United's new condensed catalog showing operating characteristics, electrical and physical data, and applications.



FEATURES

1. hard glass envelope — for higher temperatures.
2. non-frangible filament — increases ruggedness.
3. large circumference kovar top cap seal.
4. special Graphite Anode — 50% increase in plate dissipation.
5. dual enclosed getter traps — long gas-free life.
6. operates as a rectifier or a surge limiting diode in many industrial applications.

**UNITED
ELECTRONICS
COMPANY**

A SUBSIDIARY OF

LTV
LING-TEMCO-VOUGHT, INC.

42 SPRING STREET • NEWARK 4, NEW JERSEY
CIRCLE 65 ON READER-SERVICE CARD



reliability

what would the next step be? Two other sub-assemblies, C and D, would be selected and the experiment repeated. Eventually, by the process of elimination, the source of variation would be found.

If large differences are found in readings *within* boxes, this would indicate test equipment or environmental condition difficulties. If all the readings in one of the four boxes were markedly different than those in the other three, this would indicate an interaction among two or more parts. Interaction is also indicated when, say, one R Low box shows fairly high readings while the other R Low box shows fairly low results. To solve interaction problems, the "factorial" designed experiment is recommended. Both techniques are similar in principle but the factorial design involves running every possible combination at least twice.

Basic Rules for Applying the Variation Research Technique

1. Start to compile data as soon as you have any hardware—even before you may have many difficulties. Such data can often lead to important changes to *prevent* difficulties.
2. Instead of spending excessive time putting out fires, reserve some time for fire prevention.
3. Contrary to conventional experimental philosophy, don't try to keep certain things constant; look for variation, encourage it, rack your brain to bring about differences in results. Let this nonagreement lead you to the reasons for it. Instead of keeping unwanted influences out by holding them constant, force them by statistical planning to show their total effect in a separate, residual term.
4. There are a large number of statistical, analytical techniques to identify the nature of variations. Among these are Multi-Vari charts, statistical control charts, numbered histograms and correlation analyses. Those applicable to working with small numbers of hardware are of particular interest to industrial experimenters. Variability may be

The Logic Behind Variation Research

1. Every effect has one or more causes.
2. Relatively few causes (called the Vital Few) have a controlling influence on the effect.
3. These few major causes are not constant in their action on the quality of the end product (the effect).
4. By careful analysis of the variations in final product output, one part of the total variations can be expected to reveal itself as more dominant than the others; a cause or causes associated with this particular part is one or more of the "Vital Few."

Thus, every effect is considered to have one or more predominant causes. Since causes vary in intensity, corresponding variations in an effect are considered an output of related causes. By analyzing the variations in effects by appropriate statistical techniques, factors affecting product quality are revealed by the process of elimination.

encouraged with only one unit of product available:

- (a) By operating the unit repeatedly and using the lack of agreement in results to provide useful information.
- (b) By disassembling, reassembling and rerunning the unit to get a still different variation for profitable analysis.
- (c) By purposely modifying the severity and/or kind of environment to artificially cause still more variability in the product's responses.

Be patient. Take steps to develop skill to practice statistical engineering like a professional. Recognize that engineering is dynamic, requiring new knowledge and approaches as it continues to develop at a faster and faster pace. ■ ■

References

1. "Statistical Methods for Research Workers", Sir Ronald A. Fisher, London, Oliver and Boyd, Ltd., 1925.
2. "The Design of Experiments", Sir Ronald A. Fisher, London, Oliver and Boyd, Ltd., 1935.
3. "The Statistically Designed Experiment: A Tool for Process and Product Improvement", Dorian Shainin, Harvard Business Rev., July-August 1957.
4. "Statistics: A New Approach", W. Allen Walls and Harry V. Roberts, The Free Press, 1956, p 119 and pp 479-481.

BUILT FOR ROUGH DUTY IN TIGHT SPACES



MODEL MMS-22 SCREWLOCK CONNECTOR
SHOWN ACTUAL SIZE

Continental's Series 22 Micro-Miniature Connectors are designed expressly for jobs that demand the ultimate in miniaturization without sacrifice of performance. Their ruggedness is service-proven daily in hundreds of aircraft, missile, computer and other applications where severe shock and vibration are normal environments.

Series 22 Connectors are available in a range of 14 sizes, providing 5 to 104 contacts, to meet virtually every requirement for high density connection in minimum space. All feature glass-filled Diallyl Phthalate moldings, self-aligning phosphor bronze contacts, gold plated over silver, and can

be supplied with beryllium contacts on order. Reversed guide pins and sockets assure positive polarization, and all sizes are available with screwlocks, protective shells and hoods.



DESIGNERS' DATA FILE

To help you select the micro-miniature connector that best meets your design requirements, Continental's Con-Dex File MM provides complete electrical, mechanical and dimensional data on the Series 22 Micro-Miniature Connectors. Write for your copy to: Electronic Sales Division, DeJur-Amsco Corporation, Northern Boulevard at 45th St., Long Island City 1, New York (Exclusive Sales Agent) RAvenswood 1-8000.

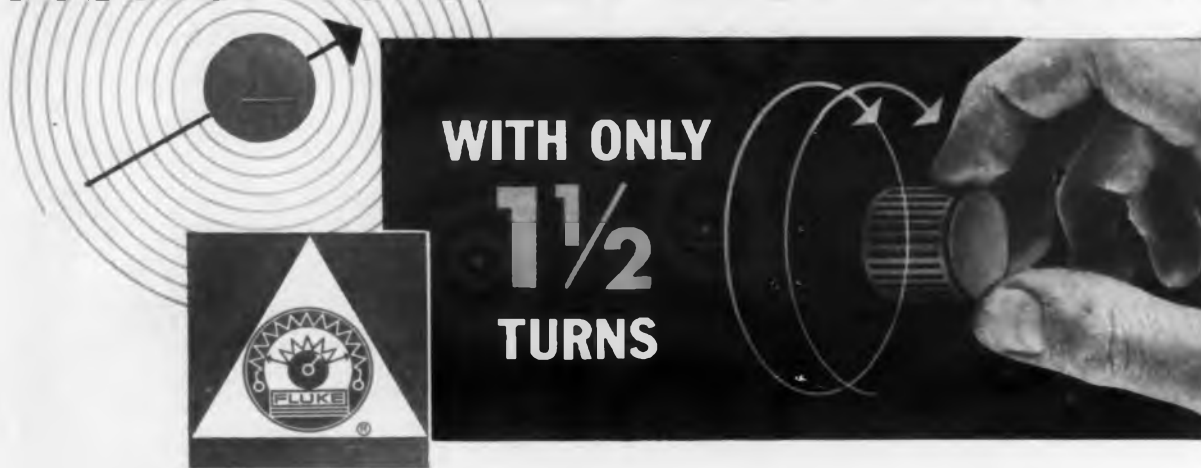
MICRO-MINIATURE • SUB-MINIATURE • MINIATURE • PRINTED CIRCUIT • RIGHT ANGLE PIN & SOCKET • CENTER SCREWLOCK

CONTINENTAL CONNECTORS

CONTINENTAL CONNECTOR CORPORATION • WOODSIDE 77, NEW YORK

CIRCLE 52 ON READER-SERVICE CARD

NEW-Fluke Precision Potentiometers Provide 10 TURN RESOLUTION...



-Save: Time-Space-Effort-Cost

The **FLUKE** Model 20A Vernier Potentiometer provides resolution equivalent to that of 10 turn helical potentiometers with only 550° of shaft rotation. At the same time, the 20A requires only a fraction of the space occupied by helical potentiometers, and, in fact, occupies less space than many single turn, low resolution potentiometers.

This high resolution, small size, and ease of operation, is achieved by a unique **FLUKE** patented design. A schematic of the Model 20A is shown below. Basically, the Model 20A consists of a main resistance element and a concentric smaller vernier. The vernier element is connected to the main element through two contacts spaced 30° apart. This spreads any 30° segment of the main winding over the 270° of vernier rotation. The vernier slider is rotated by the potentiometer shaft. As the shaft is turned and the vernier slider completes its rotation, a mechanical stop causes the vernier frame to turn, moving the spaced vernier contacts along the main element. This method provides a coarse adjustment at either end of the vernier adjustment.

This unique design results in a versatile, high performance potentiometer. For example, thin card-type windings reduce residual reactance and allow operation at much higher frequencies than other potentiometers with similar DC specifications. The one and one-half turn control of

the entire adjustment range allows substantial time savings in frequently adjusted or multiple potentiometer installations such as analog computers and data logging systems. Equipped with a screwdriver slotted shaft, the Model 20A also makes an ideal high resolution trimmer.

The Model 20A is available from stock in resistance values ranging from 100 ohms to 25 K ohms, and can be provided with a calibrated readout dial and lock-type knob.

If greater resistance values are required, write for information on the **FLUKE** Models 21A, 22A, and 30A. The Model 21A and 22A have increased power ratings and are available in resistance values to 100 K. The Model 30A features resolution of 20 times that of the 20A series, resistance values from 1 K to 100 K, and a power rating of 5 watts.

MODEL 20A PARTIAL SPECIFICATIONS

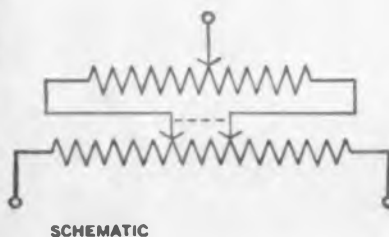
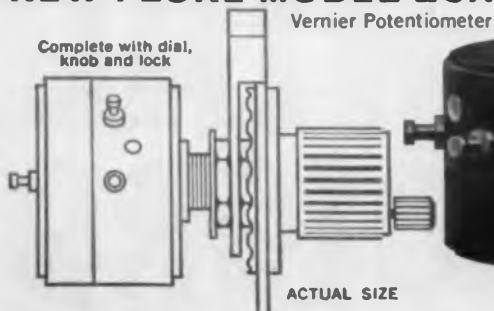
Standard Tolerance: ±5%, available to ±1% on special order
Linearity: ±0.5%.

Resolution: 1000 ohms, 1 part in 5600. Increased resolution for higher values.

Power Rating: 2 watts at 20° C, derated to 0 at 100° C.

Price: As shown, \$8.50.

NEW FLUKE MODEL 20A



JOHN FLUKE MFG. CO. INC.

P. O. Box 7428

Seattle 33, Washington

MANUFACTURERS OF ELECTRONIC TEST AND MEASURING INSTRUMENTS FOR LABORATORY-PRODUCTION LINE

CIRCLE 53 ON READER-SERVICE CARD



reliability

Military Standards and Specifications on Reliability

MIL-STD-105E (DOD-ARMY) 12/31/58	Sampling Procedures and Quality Tables for Inspection by Attributes	Control
MIL-STD-108D (BUSHIPS) 6/27/58	Definitions of and Basic Requirements for Electric and Electronic Equipment	Equipment, Navy General
MIL-P-116C (DOD) 2/27/57	Methods of Preservation	Environment
MIL-T-152A (DOD) 12/14/55	Treatment—Moisture and Fungus-Resistant, of Communications, Electronic and Associated Equipment	Environment
MIL-C-172C (DOD) 12/8/58	Cases; Bases; Mounting; and Mounts, Vibration (For use with Electronic Equipment in Aircraft)	Environment
MIL-STD-200E 3/2/60	Electron Tubes and Semiconductor Devices, Diode	Parts
MIL-STD-202A 10/24/56	Test Methods for Electronic and Electrical Component Parts	Quality Control
MIL-STD-210A (DOD-S&L) 8/2/57	Climatic Extremes for Military Equipment	Equipment
MIL-STD-242 (SHIPS) 3/15/55	Electronic Equipment Parts (Selected Standards)	Parts
MIL-STD-414 (DOD-S&L) 6/11/57	Sampling Procedures and Tables for Inspection by Variables for Percent Defective	Quality Control
MIL-STD-415A (ARMY-SIG.) 3/31/58	Test Points and Test Facilities, Design Standards for	Equipment
MIL-STD-439 (AER) 5/1/58	Electronic Circuits	Circuits and Modules
MIL-STD-441 6/20/58	Reliability of Military Electronic Equipment	Reliability
MIL-STD-446 (AER) 4/28/59	Environmental Requirements for Electronic Component Parts	Parts

This listing was presented by H. L. Wuerrfel of RCA at the Seventh National Symposium on Reliability and Quality Control in his paper, "Military Specifications Affecting Reliability."

New Daystrom Series 319 Potentiometers Can Be Adjusted In Seconds After Ganging

It can be done. 24 cups of the Daystrom 319 Series potentiometers ganged within six inches. *Most important,* phasing of individual cups can be accomplished after installation, and with no interference to adjacent cups. *Results:* finite adjustments • many hours and dollars saved in installation costs • re-phasing in a matter of seconds!—The Daystrom 319 Series is ideal for multi-channel applications. Exclusive Daystrom design techniques result in unusual stability to shock, vibration, and other severe environmental influences. The 319 is rated at 2 watts in *still air*, operates over a range of — to +150°C, is available in resistances from 100 ohms to 200 kilohms, and meets or exceeds all applicable military specifications. Write for further data.

A handy tabulation of government documents related to reliability standards and testing procedures. Only those parts specifications which contain explicit reliability information are included.

SPEC BUL 508 (USAF) 5/11/59	Reliability Monitoring Program for Use in the Design, Development, and Production of Air Weapon Systems and Support Systems	Reliability
SPEC BUL 510 (USAF-WADD) 6/30/59	Guides for Reliability Organization	Reliability, Organization
MIL-STD-701 8/15/58	Transistors	Parts
MIL-T-945A (DOD) 3/7/50	Test Equipment, for Use with Electronic Equipment, General Specification	Equipment
MIL-E-2036A (NAVY) 4/4/52	Enclosures for Electric and Electronic Equipment (Naval Shipboard Use)	Environment
MIL-E-4158B (USAF) 1/3/58	Electronic Equipment Ground, General Requirements for	Equipment
MIL-T-4807A (USAF) 10/7/58	Tests, Vibration and Shock, Ground Electronic Equipment, General Requirements for	Environment
MIL-T-4864C (USAF) 10/1/58	Trainers, Operational Procedure, General Requirements for	Equipment
MIL-E-4976A (USAF) 3/3/59	Environmental Testing, Ground Support Equipment, General Specification for	Testing
MIL-W-5088B (ASG) 6/18/56	Wiring, Aircraft, Installation of	Wiring
MIL-E-5272C (ASG) 4/13/59	Environmental Testing, Aeronautical and Associated Equipment, General Specification for	Environment
MIL-E-5400D (ASG) 11/30/59	Electronic Equipment, Aircraft, General Specification for	Equipment
MIL-E-5422D (ASG) 11/1/57	Environmental Testing, Aircraft Electrical Equipment	Environment
MIL-I-006651B (USAF) 1/23/59	Electrical-Electronic System Compatibility and Interference Control Requirements for Aeronautical Weapons Systems and Associated Subsystems	Weapons Systems
MIL-W-008160C (USAF) 4/7/59	Wiring, Guided Missile, Installation of, General Specification for	Wiring



DAYSTROM, INCORPORATED
POTENTIOMETER DIVISION

ARCHBALD, PENNSYLVANIA • LOS ANGELES, CALIFORNIA

CIRCLE 54 ON READER-SERVICE CARD



FREE

LINDSAY STRUCTURE

Design MANUAL

- descriptive information
- technical data and explanations
- instructions for specification

The Modern Method of Using "Pre-Tensed" Sheet Metal in Light Structures of Tremendous Strength and Rigidity. For Producing: Buildings, Rooms, Partitions • Bodies for Trucks, Trailers • Housings for Equipment of All Kinds • AND for an Unlimited Number of Other Applications

You'll find the answer to any questions you may have about Lindsay Structure in this comprehensive 68-page manual. This unique metal structure is widely used in the construction of enclosures, housings, cabinets, trucks and trailers of all sizes and shapes — for use indoors or out, mobile or stationary, industrial, military and commercial applications, including shielded structures. Lindsay Structure is extremely flexible to design requirements, and is available in a wide range of metals. Ideal for pilot models and production runs, high-strength, low-weight ratios of Lindsay Structure components can readily solve your enclosure problems. Write today to get your copy of this new manual right away!

S

INTERNATIONAL STEEL COMPANY

LINDSAY STRUCTURE DIVISION

1733 EDGAR STREET • EVANSVILLE 7, INDIANA

INTERNATIONAL STEEL COMPANY • LINDSAY STRUCTURE DIVISION
1733 Edgar Street • Evansville 7, Indiana

Send free copy of Lindsay Structure DESIGN Manual to:

NAME _____ TITLE _____
COMPANY _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____

CIRCLE 55 ON READER-SERVICE CARD



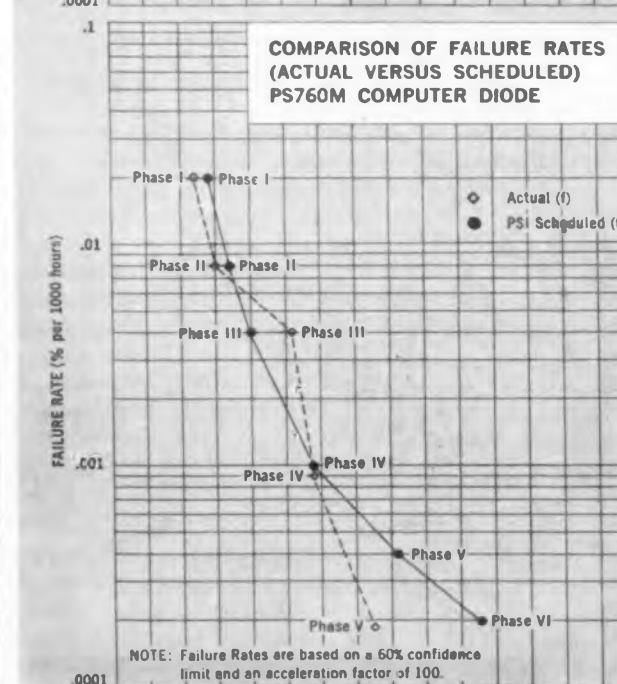
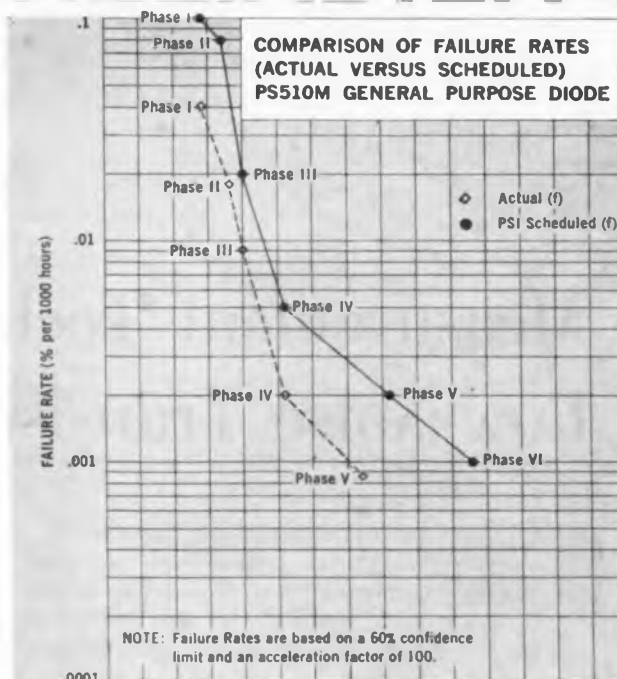
reliability

MIL-E-8189B (ASG)	Electronic Equipment, Guided Missiles, General Specification for	Equipment
MIL-I-8700 (ASG) 8/27/54	Installation and Test of Electronic Equipment in Aircraft, General Specification for	Testing
MIL-D-9310B (USAF) 6/19/59	Data for Aeronautical Weapons and Support Systems	Weapons Systems
MIL-S-9372B (USAF) 2/25/55	Shields, Electron Tubes Dispersing	Parts, Tubes, Shields
MIL-W-9411A (USAF) 6/19/59	Weapons Systems, Aeronautical, General Specification for	Weapons Systems
MIL-D-9412C (USAF) 6/10/58	Data for Ground Support of Weapons Systems, Support Systems, Subsystems, and Equipment	Weapons Systems
MIL-Q-9858 4/9/59	Quality Control System Requirements	Quality Control
MIL-E-16400C (NAVY) 7/1/59	Electronic Equipment, Naval Ship and Shore, General Specification for	Equipment
MIL-T-18306A (BUAER, NAVY) 1/1/55	Test Equipment and Test Bench	Equipment
MIL-E-19100A (SHIPS) 7/5/57	Electronic Training Equipment, Naval Shipboard, General Specification for	Equipment
MIL-E-19600A (WEP) 12/1/59	Electronic Modules, Aircraft, General Requirements for	Circuits and Modules
MIL-R-19610 (AER) 9/15/56	Reliability of Production Electronic Equipment, General Specification for	Reliability
MIL-Q-19614 (AER) 2/1/58	Quality Assurance Provisions, Modules, Electronic, for Use in Aircraft	Quality Control
MIL-N-19900A (SHIPS) 8/15/58	Nuclear Propulsion Control and Instrumentation Equipment	Equipment
MIL-T-21200A (ASG) 11/30/59	Test Equipment for Use with Electronic and Fire Control Systems, General Specification for	Equipment
MIL-Q-21549A (NOrd)	Quality Control System Requirements	Quality Control
MIL-R-22256 (AER-BUWEPS) 11/20/59	Reliability Requirements for Design of Electronic Equipment or Systems	Reliability
MIL-E-0025366B (USAF) 8/18/58	Electric and Electronic Equipment and Systems, Guided Missiles, Installation of, General Specification for	Equipment
MIL-R-25717C (USAF) 3/9/59	Reliability Assurance Program for Electronic Equipment	Reliability
MIL-H-25946 (USAF) 11/26/57	Human Factors Data for Maned Aircraft Weapon Systems	Environment
MIL-T-26046 (USAF) 3/26/57	Trainers, Guided Missile, Maintenance, Classroom, General Requirements for	Equipment
MIL-D-26207 (USAF)	Human Factors, Data for Guided Missile Weapons Systems	Environment
MIL-C-26244 (USAF) 1/31/58	Capacitors, Fixed, Paper (or Paper-Plastic) Dielectric, d-c, High-Reliability, (Hermetically Sealed in Metallic Cases)	Parts
MIL-R-26474 (USAF) 6/10/59	Reliability Requirements for Production Ground Electronic Equipment	Reliability

MAIL THIS
COUPON
TODAY

RELIABILITY...PROVED

MIL-R-26484 (USAF) 6/2/58	Reliability Requirements for Development of Electronic Subsystems or Equipment	Reliability
MIL-M-26512 (USAF) 6/18/59	Maintainability Requirements for Weapon Systems and Subsystems	Maintainability
MIL-I-26550 (USAF-WADD) 11/25/58	Indicator, Elapsed Time	Testing
MIL-I-26600 (USAF) 6/2/58	Interference Control Requirements, Aeronautical Equipment	Environment
MIL-R-26667A (USAF) 6/2/59	Reliability and Longevity Requirements, Electronic Equipment, General Specification for	Reliability
MIL-R-26674 (USAF) 6/18/59	Reliability Requirements for Weapon Systems	Reliability
MIL-R-27173 (USAF) 7/6/59	Reliability Requirements for Electronic Ground Checkout Equipment	Reliability
EXHIBIT 58-10 (AFBM) 6/1/59	Reliability Program for Ballistic Missile and Space Systems	Reliability
EXHIBIT 59-32 (AFBM)		
EXHIBIT 2629 (USAF-RADC)	Reliability Requirements for Ground Electronic Equipment (Production and Pre-Production)	Reliability
AD 114247 (ASTIA)	Reliability Factors for Ground Electronic Equipment	
AD 131152 (ASTIA)	Air Force Ground Electronic Equipment—Reliability Improvement Program	
AD 148556 (ASTIA)	Philosophy and Guidelines—Prediction on Ground Electronic Equipment	
AD 148801 (ASTIA) (RADC TN-58-183)	Methods of Field Data Acquisition, Reduction and Analysis for Ground Electronic Equipment Reliability Measurement	
AD 148868 (ASTIA) (RADC-TR-58-111)	RADC Reliability Notebook	
AD 148977 (ASTIA) (RADC TN-58-307)	The Prediction and Measurement of Air Force Ground Electronic Reliability	
WADC-TR-56-498	Human Engineering Guide for Equipment Design (Woodson)	
PB 121839	NEL Reliability Design Handbook (Now BuShips)	
PB131678	Reliability Stress Analysis for Electronic Equipment	
AGREE Report 6/4/57	Reliability of Military Electronic Equipment	Reliability
RELIABILITY POLICIES AND PROCEDURES (AFBM-STL) 7/14/59	Reliability Policies and Procedures	Reliability
ACGMR REPORT 4/58	DOD Proposed Reliability Monitoring Program for Guided Missile	Reliability
PSMR-1 Vols. 1 & 2 5/60	Parts Specification Management for Reliability	Reliability
NAV-AER 16-1-519	Handbook of Preferred Circuits	
NEL	Suggestions for Designers of Electronic Equipment	



PACIFIC SEMICONDUCTORS, INC., tests indicate failure rate of .00018% per 1,000 hours ACHIEVED for silicon computer diodes... .0009% per 1,000 hours ACHIEVED for silicon general purpose diodes

PSI—qualified supplier of all silicon computer and general purpose diodes for the “Minuteman” ICBM guidance system—has undertaken a production and evaluation program designed to furnish “Minuteman” with ultra-high-reliability diodes. The program is being supported by the Air Force Ballistic Missile Division through the Autonetics Division of North American Aviation.

The ultimate reliability objective is a maximum failure rate of .0002% per 1,000 hours for silicon computer diodes, and .001% per 1,000 hours for silicon general purpose diodes—levels heretofore unattainable in the semiconductor industry. To achieve and prove this objective, more than 250,000 silicon diodes are being used to generate in excess of a billion diode hours of test information.

Results to date indicate that PSI is currently supplying “Minuteman” computer diodes with an indicated failure rate of .00018% per 1,000 hours, and general purpose diodes with an indicated failure rate of .0009% per 1,000 hours.

Because of the huge quantity of high reliability diodes required in the “Minuteman” program, PSI has been able to make thousands of diode measurements and use these data to control processes. Since the same controls are applied to *all* PSI manufacturing processes—and *not just to a limited and specially isolated line*—PSI is able to supply high-reliability silicon diodes in large quantities and on a regular basis.

If you are associated with a program requiring ultra-high reliability semiconductor devices, you are invited to take advantage of the vast and growing fund of information and large volume production capacity available only at PSI. For full details, write to Richard A. Campbell, Executive Vice President, Pacific Semiconductors, Inc., 14520 Aviation Blvd., Lawndale, California (Los Angeles County).

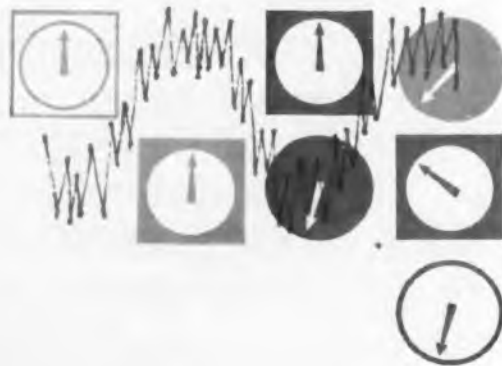


Pacific Semiconductors, Inc.



A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE INC.

CIRCLE 56 ON READER-SERVICE CARD



Measurement Techniques for Low-Noise Transistor Input Stages

In a previous article (ED, Sept. 13, p 48) William Rheinfelder discussed the general design objectives for low-noise transistor input stages. Here, he defines and describes the measurements the engineer must often make on these circuits.

William A. Rheinfelder
Applications Engineer
Motorola Semiconductor Products, Inc.
Phoenix, Ariz.

NOISE figure, F , has been defined to provide a figure of merit for receiver performance. It is given by the ratio of input signal-to-noise ratio, to output signal-to-noise ratio, and can be conveniently measured using a noise generator. The procedure most generally used is to increase the generator output until noise power in the output is doubled. At this point the noise of the generator is the same as that produced by the circuit. The equivalent noise above ideal thermal noise (the noise figure) can be read directly off the generator. The effective noise bandwidth need not be determined. This procedure may be used only when the amplifier under test has a constant gain with signal, and a linear meter is used to read the output.

A more accurate method, and one which must be used when agc or a nonlinear meter is employed, uses a 3-db attenuator. First, a measurement of noise is made with the generator turned off. Then a 3-db pad is inserted between the noise generating

circuit and the nonlinear amplifier. The noise generator is adjusted until the same reading is obtained on the output meter. A nonlinear meter may be used. Since the output voltage is unchanged, agc and gain will be the same as before and no error is introduced.

Contribution of noise by the following amplifiers may be taken into account by using the formula:

$$F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} \quad (1)$$

where

- F = over-all noise figure
- F_1 = noise figure of first stage
- F_2 = noise figure of second stage
- F_3 = noise figure of third stage
- G_1 = power gain of first stage
- G_2 = power gain of second stage

If the 3-db attenuator method is used, no correction is necessary for the noise contributed by the amplifier following the pad. This is shown in the discussion which follows.

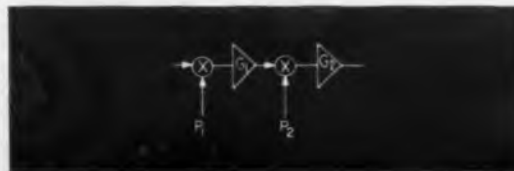


Fig. 1. Simplified diagram of two-stage amplifier, where P_1 and P_2 represent noise powers contributed by each stage.

The noise power applied to the input of the second stage, Fig. 1, is

$$P = P_1 G_1 + P_2 \quad (2)$$

where

- P = total noise power into second noise-free stage
- P_1 = noise power into first stage including noise due to the first stage
- P_2 = noise contributed by the second stage
- G_1 = power gain of first stage

To double the noise power in the output a new input noise power P_1' is required, so that

$$2P = P_1' G_1 + P_2 \quad (3)$$

and

$$P_1' = \frac{2P - P_2}{G_1} \quad (4)$$

Substituting P from Eq. 2, we obtain

$$P_1' = 2P_1 + \frac{P_2}{G_1} \quad (5)$$

The generator is calibrated to read correct noise figure if the input noise power

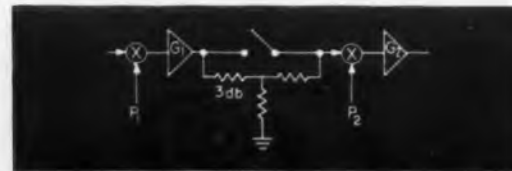


Fig. 2. Simplified diagram of two-stage amplifier shows location of 3-db pad used when making noise-figure measurements.

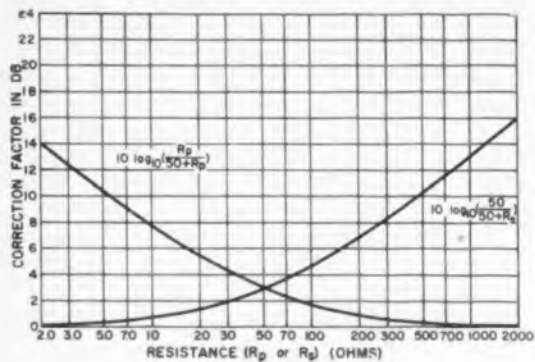


Fig. 3 Correct noise-figure reading is obtained from noise generator after correction factors, necessary when series or parallel resistors are placed between generator and circuit, are subtracted.

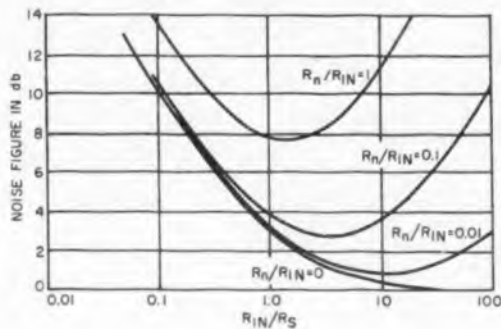


Fig. 4. Equivalent noise resistance of a transistor circuit is found with the aid of these noise-figure curves.

across the generator, the loss factor is $R_p / (R_o + R_p)$, and the available power is

$$P_{AV} = \frac{E^2 R_o}{4 R_o (R_o + R_p)} \quad (11)$$

The correction factors $R_o / (R_o + R_p)$ and $R_p / (R_o + R_p)$ have been converted to decibels and are plotted in Fig. 3 for $R_o = 50$ ohms. This decibel figure must be subtracted from the reading on the noise generator to obtain the correct noise figure when the series or parallel resistors are used between the generator and circuit under test.

How to Measure Equivalent Noise Resistance

In measuring the equivalent noise resistance directly with transistor circuits certain difficulties arise. First, let us describe the direct method used with vacuum tubes.

With the operating dc conditions maintained, the input is shorted (by-passed) for the frequencies under test. The noise output voltage is observed. A resistance is then inserted between input and ground which doubles the noise voltage in the output. This resistance value is the equivalent noise resistance.

This method may not be used with transistors because base current rather than base-emitter voltage is involved. In a modification of this method one might think of using the open circuit input noise as a reference and then proceeding as with tubes.

A better, indirect method of determining the equivalent noise resistance makes use of the curves shown in Fig. 4. These curves are perfectly general and true for any four-terminal network. They present plots of noise figure vs mismatch ratio. The point of minimum noise figure is shifted to one side depending upon the curve parameter that is a function of noise resistance.

The procedure is to measure the noise figure vs source resistance (mismatch ratio) as described above. The point of minimum noise figure is best obtained by plotting a curve. Optimum mismatch ratio can then be determined for best noise figure.

From Fig. 4 the parameter of the curve may be determined and the equivalent noise resistance calculated if the total input resistance of the transistor in parallel with the tuned circuit resistance is known. These can be measured separately.

It must be remembered that when these methods are applied to transistors, it takes two equivalent noise resistances to

is doubled; that is:

$$P_1' = 2 P_1$$

According to Eq. 5, a correction is needed.

Let us now consider the 3-db method, Fig. 2. In the case without pad, Eq. 2 still holds. After inserting the pad, and adjusting the noise generator for the same noise power in the output, we have:

$$P = P_1' \frac{G_1}{2} + P_2 \quad (6)$$

or

$$P_1' = \frac{2(P - P_2)}{G_1} \quad (7)$$

Substituting P from Eq. 2, we obtain:

$$P_1' = 2 P_1$$

The generator reading will be correct and independent of the noise of the second stage or the gain of the first stage. Thus, if the noise figure of a whole receiver is to be measured the 3-db pad should be placed after the noise producing stages because only the noise figure of the stages ahead of the 3-db pad will be measured.

Another way to take the noise in the second stage into account is as follows:

The first stage transistor is removed and a noise voltage E_1 is observed in the output. Stage 1 is put back into operation and, with the noise generator off, E_2 is read in the output. The generator is now adjusted until a voltage $E_3 = \sqrt{2E_2^2 - E_1^2}$ is indicated in the output. The noise figure of the first stage can be read directly off the generator. Since the output voltage changes, this method implies a linear amplifier and meter.

Frequently it is desired to measure noise figure as a function of source resistance. Since mismatching takes place, the generator reading will be incorrect because the noise actually applied to the circuit will be less than indicated. Hence, a certain correction must be subtracted from the noise figure reading obtained from the noise generator meter.

The noise figure is the ratio of the signal-to-noise ratios of the input to the output. If the correction is made properly no change in input signal to noise must result due to the change in source resistance. It is not possible to correct the reading by calculating the actual noise power going into the circuit because of the mismatch. Instead, available noise power must be used for a correction. The input signal to noise remains unchanged and a correction noise figure reading is obtained.

The available noise power is simply:

$$P_{AV} = \frac{E^2}{4 R_o} \quad (9)$$

where E = generator voltage

R_o = source resistance.

This power is dissipated in the load only under matched conditions and, at all other times, is less. If a resistance R_s is connected in series with R_o the available noise power is reduced by the factor $R_o / (R_o + R_s)$. The available noise power is, therefore:

$$P_{AV} = \frac{E^2}{4(R_o + R_s)} \quad \text{with a series resistance } R_s \quad (10)$$

If a parallel resistor R_p is connected

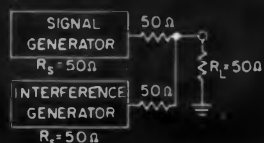


Fig. 5. Receiver cross modulation is measured by connecting two generators in parallel, through a matching network, to the circuit under test.

adequately describe circuit performance.

A new equivalent noise circuit for transistors has been developed by the author and will be described in a subsequent article. This circuit permits the analytical treatment of an input circuit for optimum noise performance. The use of equivalent noise resistances thus seems impractical with transistors. However, if a determination is desired for some other reason, the methods outlined above may be used in some modification, depending on the equivalent circuit.

How To Determine The Optimum DC Operating Conditions

Determining the optimum dc conditions is usually a time-consuming process because many dependent variables are involved. Since only one can be varied continuously, the other adjustments must be done in steps.

For instance, it is quite likely that a different current is optimum for a different source resistance, or collector voltage, or slight mistuning, etc. Hence merely to minimize the noise figure by adjusting the current and leaving everything else constant, only gives the minimum of one of many curves. Only if a complete set of measurements is available can one determine which of the many minima is best. This tedious process can be shortened by observing the slope of the minimum.

For instance, it may be found that noise figure varies quickly with current changes and slowly with voltage changes. It would therefore be advisable to make the current continuously variable and change the source resistance and voltage in steps.

How To Measure Cross Modulation

The most accurate measurement of cross modulation is made with two signal generators connected through a matching net-

work to the circuit under test. It is important to first check whether any cross modulation is caused by the connection of the two generators. After this check proves satisfactory the receiver may be tested.

The generators are connected in parallel using a matching network as shown in Figs. 5 and 6. Since the input resistance of the circuit under test may change with level, it is advisable to use the value of the available generator power output. Each generator can then be adjusted for twice the voltage plotted because of the loss in the matching network. We shall call the two generators the "signal generator" when it is set to the same frequency as the receiver, and the "interference generator" when its frequency varies.

Both generators are modulated with the same percentage am, for instance 30 per cent. First, the signal generator with modulation is turned on and a convenient carrier level set, say 1 mv. The demodulated audio signal is read on an audio vtm. The frequency is varied to obtain a maximum reading on the meter.

Next, the signal generator is turned off and the interference generator with modulation is turned on. Its frequency is adjusted outside the if pass band. However, its level may be made equal to the signal generators, for instance 1 mv. If the signal generator is now turned on without modulation, the cross modulation can be read on the vtm.

Cross modulation is expressed as a cross modulation index—the percentage of undesired modulation on the desired carrier produced by a 100 per cent modulated interference generator. A 100 per cent modulated interference generator producing 10 per cent modulation, or a 50 per cent modulated interference generator producing 5 per cent, have the same modulation index of 10 per cent. Since both signal and interference generators are modulated at the same percentage, it is necessary only to obtain the ratio between the two vtm readings to calculate the cross modulation index. (The first reading is taken with the modulated signal generator on and the interference generator off; the second reading with modulated signal generator and unmodulated signal generator on).

It is possible to vary the dc operating conditions for the lowest cross modulation index. Also, one can vary the interference carrier level to obtain a given cross modulation of 1 per cent (40 db down) or 5

per cent (26 db down) and plot it versus dc conditions. Generally, a null will be found where the characteristic curve has least third order curvature. This would be the best dc operating point.

How To Measure Effective Selectivity

Effective selectivity can be measured as follows: First, with modulated signal generator tuned to the frequency received by the receiver, a certain level is set, say 1 mv. Next the modulation of the signal generator is turned off, and the interference generator, both carrier and modulation, is turned on. The level of the interference generator is adjusted until a specified cross modulation index is reached. Plotted on the ordinate is the ratio of interference to signal generator voltage and on the abscissa frequency deviation between interference and signal generator.

The voltage or frequency of the signal generator may be used as a parameter. The measurement should be made over the whole frequency range of the receiver including image and if frequencies, etc. Curves so obtained are a true measure of selectivity and are much wider than the if selectivity of the receiver.

Intermodulation may be tested by using two generators with their frequency difference equal to the frequency tuned in by the receiver. All other details and ways to plot the results are analogous to the cross modulation tests just described.

How To Measure Noise Modulation

While noise modulation behaves in the same way as intermodulation (not as cross modulation) and can be measured similarly, it is usual to measure it together with the normal age characteristic of the receiver. The input signal is varied from 1 μ v to 1 v, while the output signal is plotted with

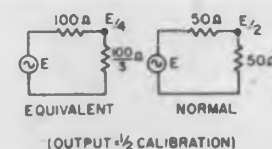


Fig. 6. Equivalent circuit for the measurement circuit of Fig. 5.

Riddle:

What has all
the gold or silver
it needs but
doesn't have a nickel
to its name?

GIVE UP? The answer is General Electric's gold or silver-plated tungsten or molybdenum wire.

There's no alloying action between the plated metal and a nickel undercoat because—quite simply—no nickel exists anywhere in General Electric's plated wire.

It's strictly gold or silver on tungsten. Or gold or silver on moly. Nothing in-between!

You get standard weight percentages of plate on moly—5-7% on smaller diameters, 3-5% on larger. Tungsten is generally all 5-7%. In both cases, we'll gladly review requests for special weight percentages.

General Electric puts only one piece of wire on a spool—a long, long, long piece. Elongation ratings are exceptionally good. There's no delayed yield point on the stress-strain curve. You can choose either a high luster or dull finish. get

Progress Is Our Most Important Product

GENERAL  ELECTRIC

experienced engineering help, and count on fast delivery.

Fill in, tear out and mail the coupon if you're interested in nickel-free high quality tungsten or moly wire with gold or silver plating.

General Electric Co.
Lamp Metals & Components Dept. ED-19
21800 Tungsten Road, Cleveland 17, Ohio
(In Canada, it's Canadian General Electric Co., Ltd.,
Component Sales, 221 Dufferin St., Toronto 3, Ontario.)

Check as many as you wish.

- Send me samples for testing.
 I'd like more specific information.
 I'd like engineering assistance.

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

CIRCLE 25 ON READER-SERVICE CARD

CIRCLE 26 ON READER-SERVICE CARD FOR AMPHENOL-BORG >

The cost of miniaturization just dropped 20%

Trends can be overpowering. Once established, they're tough to reverse.

Take the cost of miniaturization, for example. As electronic packages get smaller, price tags get bigger. No one seems surprised. It's a trend.

There's a reason, of course. Tiny things are hard to build, especially with-in space-age reliability requirements.

Amphenol designers decided that if ever a trend needed reversing—it was this one.

"How" was another question. They knew that conventional miniaturized pin and socket connectors were about as small as they were ever going to be. The spring member in the female contact (necessary for a snug, low-resistance connection) took up valuable space and set a lower limit for practical center-to-center contact spacing. The spring was obviously holding up progress in miniaturization. It had to go.

So, it went.

►Amphenol designers developed the Wire-Form Poke-Home® contact, a male contact that supplies its own tension and can be crimped or welded before assembly. Overnight, contact spacing plunged from .175 inch to .100 inch. And, best of all, the new contact was less costly to manufacture. (It's built on automatic equipment.)

The trend reversal was well on its way. Amphenol designers had a new contact—the next step: putting it to work in connectors.

To answer the need for an economical micro-miniature rack and panel connector, the Micro-Rac was unveiled. Space-saving Wire-Form contacts and an integral-body-dielectric construction made it possible to pack 20% more connections in the same space—and at nearly half the previous cost. As for reliability, after 1,000 repeated insertion and withdrawal cycles, the Micro-Rac retained its original low resistance characteristics.

►Next came the Strip Connector, six-inch lengths of Lexan* plastic with contact holes on .100 inch centers. A do-it-yourselfer's delight, strips can be cut and stacked to suit hundreds of applications where a connector is a must—but for which no other economical connector exists. Example: strips can be stacked to form micro-miniature programming boards or instrumentation terminations. They also

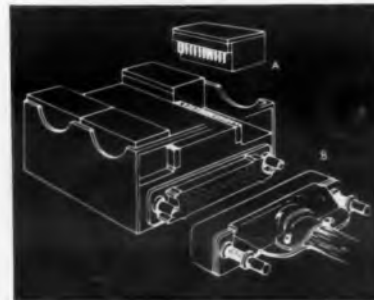
can be used as economical tape cable connectors, modular connectors, logic card connectors, to mention a few.

Wire-Form contacts can be used separately, too. Example: contacts can be crimped or welded to modules and plugged into special eyelet-type receptacles on printed circuit boards. Non-modular components, such as transistors, become pluggable by crimping Wire-Form contacts to their leads.

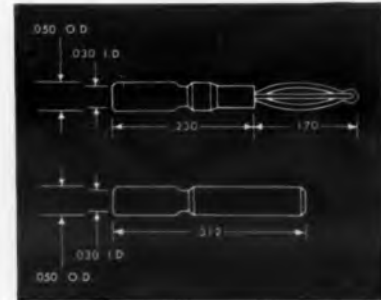
And that was that. The trend was reversed.

►If you would like more information about Wire-Form Poke-Home contacts, Micro-Rac 52- and 104-contact rack and panel connectors, Strip Connectors (or any Amphenol Connector for that matter) call your Amphenol Sales Engineer. Or, write to Dick Hall, Vice President, Marketing, Amphenol Connector Division, 1830 S. 54th Avenue, Chicago 50, Illinois.

* Registered TM General Electric Co.



The Amphenol Wire-Form contact at work. Multi-purpose Strip Connectors (A) connect modules to chassis; Micro-Rac Connectors (B) connect chassis to cable assembly.



Acting like four spring fingers, Wire-Form beryllium-copper beam sections assure a low resistance connection (.0025 to .0030 ohm) even after 1,000 insertion-withdrawal cycles.

AMPHENOL

Connector Division / Amphenol-Borg Electronics Corporation



PLOT MEASUREMENTS

INSTANTLY, ACCURATELY, ECONOMICALLY
WITH ROHDE and SCHWARZ

Z-g DIAGRAPHS



RANGE: 30 to 2400 MC

The Diagraphs employ the directional coupler principle. Measurements can be read directly on a Smith chart or a special transmission-line chart without any arithmetical or graphical evaluation work, thereby saving time, expense, and eliminating error. A large number of accessories is available such as baluns, variable shorts, etc.

THE DIAGRAPHS OFFER 4 MEASURING USES:

- **Impedance and Admittance Measurements:** Wide-band response diagrams on aerials, transformers, load resistors, filters and other networks can be traced within minutes.
- **Measuring Transmission Characteristics:** Transfer characteristics of multi-terminal networks and semi-conductors can be plotted directly on a transmission-line chart.
- **Phase Angle Measurement:** Take phase angle readings between 2 voltages from $+180^\circ$ to -180° directly on a polar coordinate system.
- **Use as a Measuring Receiver:** The built-in superheterodyne receiver can be used as a linear measuring receiver.

Specifications

Frequency Range	Type	Ω
30 to 420 mc	ZDU	50°, 60 and 75
300 to 2400 mc	ZDD	50° and 60

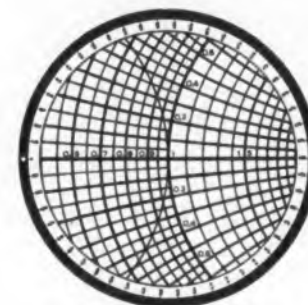
WRITE TODAY FOR DIAGRAPH DATA SHEET

* NORMALLY STOCKED

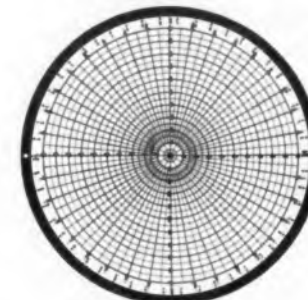


ROHDE & SCHWARZ

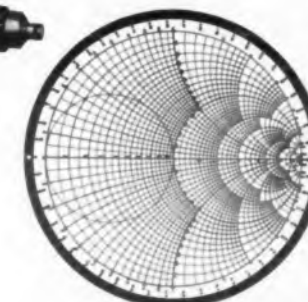
111 Lexington Ave., Passaic, N. J. • PRescott 3-8010



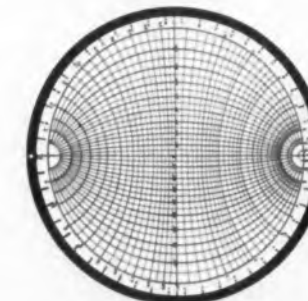
Expanded Smith Chart



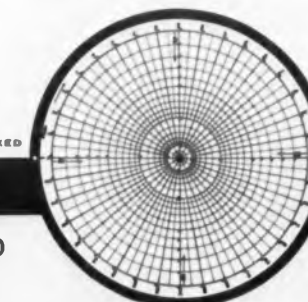
Reflection Coefficient



Smith Chart (Rectangular Coordinates)



Carter Chart (Polar Coordinates)



Attenuation and Phase Angle

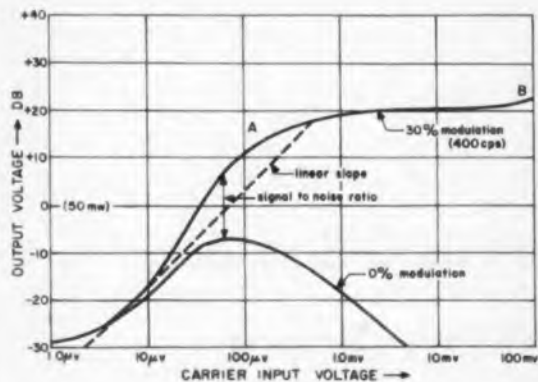


Fig. 7. Curve shows that as agc becomes effective (A) unmodulated carrier (noise) signal decreases and signal to noise rises. At B last if stage overloads and agc loses control.

30 per cent and with zero modulation. The difference between the two curves is the effective signal to noise ratio. Noise modulation shows itself as an increase of the lower curve with voltage.

Without noise modulation the output with unmodulated carrier (noise output) is constant until agc becomes operative. At this point the noise should decrease with the gain. A typical curve is shown in Fig. 7. Delayed agc is used as can be seen. At A the delay voltage is overcome and full agc becomes effective; below this point there is no agc. At B the last if stage overloads and agc loses control. This area also causes severe modulation rise and increased noise.

Generally the curves must be taken on the receiver during its developmental stage. They give a true picture of actual performance. Output should be plotted in decibels (0 db = 50 mv) on a linear scale, and input on a 6-cycle log scale. The volume control of the receiver should be used as a multiplier so that the audio amplifier is never overloaded.

For instance, if a reading of 50 mv is reached, the volume control is used to reduce the voltage to one tenth and the voltmeter is switched one range. This method has now been accepted as standard, because it provides the receiver designer with a wealth of information in a short time. Fig. 7 also indicates, for example, that several stages are underbiased because the gain increases with signal at small signal levels before agc becomes effective. ■ ■



MIL-S-901B reliability at 40 fathoms

must be an unqualified certainty — not a mere promise. Hi-G provides that certainty in its line of AC or DC high performance relays which have passed the severe shock requirements of MIL-S-901B of 2000 ft. lbs. Excellent relay stability is achieved through the rigid mechanical construction and proven design features found in every Hi-G relay.

The rotary balanced armature, permanent magnet stabilization, full length armature bearing supported at both ends, contacts closer to the header, solid pole pieces and coil, and rugged can and terminal construction are the built-in qualities that provide superior shock immunity.

Standard catalog relays are rated at an operating shock of 50G for 11 MS. Units are available with operating shock ratings of any value up to the requirements of MIL-S-901B.

Time delay units can be designed to MIL-S-901B and to meet individual customer rating specifications.

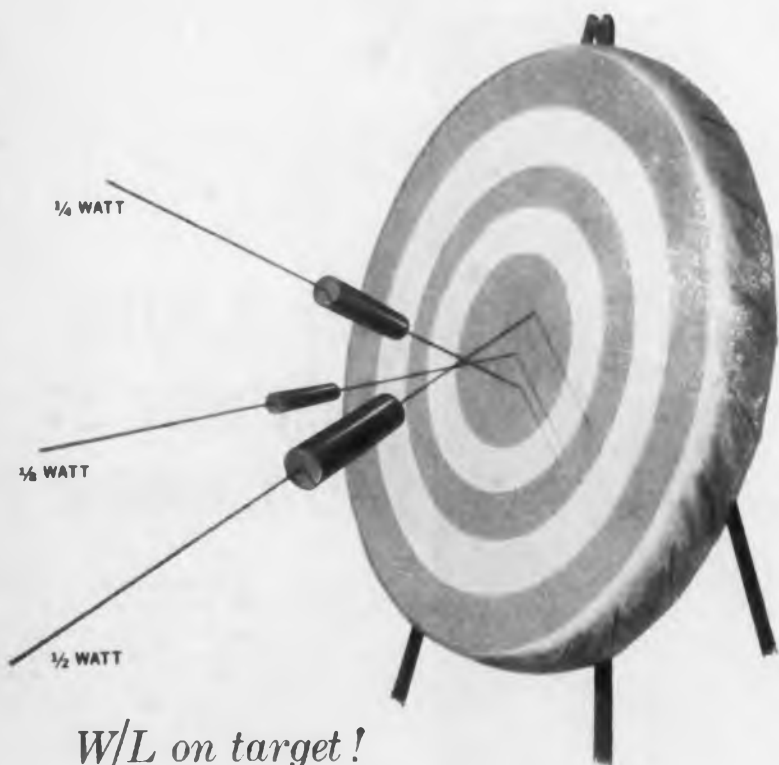
Send your relay requirements for prompt engineering evaluation — today.



THE ONLY COMPLETE LINE OF BALANCED ROTARY RELAYS

Hi-G INC.

BRADLEY FIELD, WINDSOR LOCKS, CONN.



W/L on target!

New METOHM line exceeds MIL-R-10509D

As a supplement to the unexcelled VITROHM resistors, Ward Leonard now offers to designers of commercial, military and industrial electronic equipment a line of molded metal film precision resistors, designed and tested to exceed the requirements of MIL-R-10509D, characteristics B, C and E. You can stake your reputation on Ward Leonard resistors.

Available in $\frac{1}{8}$, $\frac{1}{4}$ and $\frac{1}{2}$ watt sizes, W/L METOHM precision resistors feature the highest degree of built-in reliability and operating stability. Temperature coefficients, over the range -55°C to $+175^{\circ}\text{C}$, may be as low as ± 25 parts per million. Standard tolerance $\pm 1\%$. Tolerances down to $\pm 0.1\%$ on special order.

METOHM TYPE	MIL EQUIVALENT	RATED WATTS	OHMIC VALUES		MAX. VOLTAGE RATING
			MIN.	MAX.	
WL 60	RN 60	$\frac{1}{8}$	30	500K	250 V.
WL 65	RN 65	$\frac{1}{4}$	50	1 meg.	300 V.
WL 70	RN 70	$\frac{1}{2}$	50	1.5 meg.	350 V.

Write for complete specifications and a list of distributors. Ward Leonard Electric Co., 77 South Street, Mount Vernon, New York.

0.10



RESULT-ENGINEERED CONTROLS

WARD LEONARD

ELECTRIC CO.

MOUNT VERNON
NEW YORK

RESISTORS • RHEOSTATS • RELAYS • CONTROLS • DIMMERS
CIRCLE 58 ON READER-SERVICE CARD

Low Hysteresis G-Sensor Features High Output

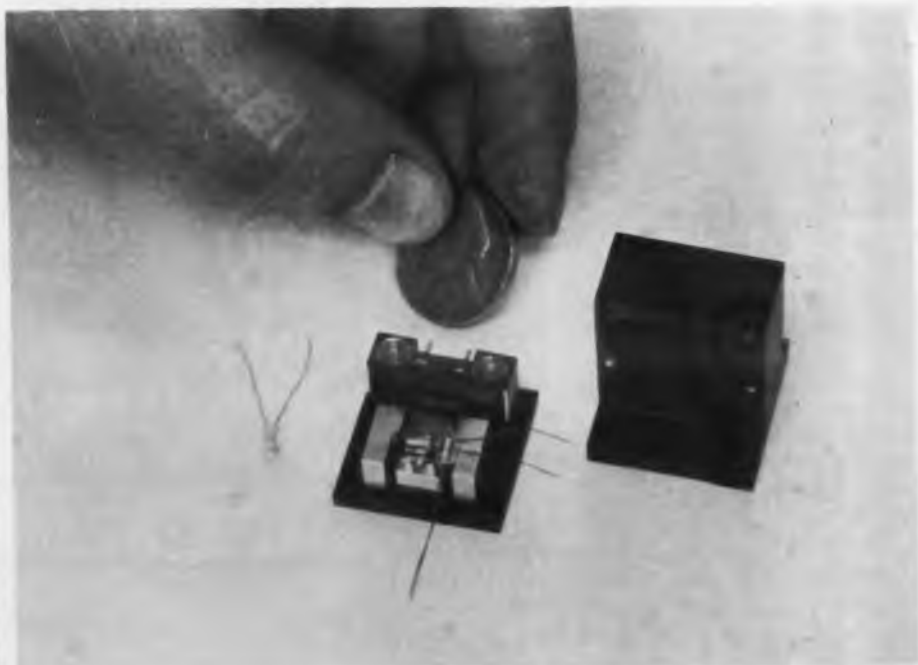
AN ACCELEROMETER output of 0 to 5 v makes it possible to use this 1-cu.-in. transducer without expensive low-level amplifiers. The accelerometer's regular, predictable nonlinearity—no more than 1 per cent—permits easy programing into computers and other equipment.

Normally, with nonlinearity programed out of a transducer's data, the next most important problem is hysteresis. In the accelerometers manufactured by Data Sensors, Inc., 13112 S. Crenshaw Blvd., Gardena, Calif., hysteresis is said to be virtually eliminated. It is rated at 0.25 per cent, compared with the 1 to 2.5 per cent found in conventional strain-gage accelerometers.

The new accelerometer is designed with a microminiature light source, a cantilever pendulum acting as a shutter and two photo transistors. The flexure of the cantilever, under the force of acceleration, modulates the quantity of light seen by the phototransistors. Output from the phototransistors is ± 2.5 v with 10 v excitation, a transfer efficiency of 50 per cent. Strain-gage accelerometers may have only 4 or 5 per cent transfer efficiency.

One-Flexure Design Minimizes Hysteresis

According to Julian Hernandez, vice president of engineering for Data Sensors, the 0.25 per cent hys-



teresis figure is only a formality. "Hysteresis is so small we can't properly measure it", he said.

"The reason for this is there is only one flexure—at the point where the cantilever beam bends. There are no other mechanical restraints on the system; consequently, no other source of mechanical hysteresis."

Another benefit of the photo transistor technique is reported to be the high natural frequency for the transducer. Compact, simple construction permits an inherently high natural frequency. In this case it is about 500 cps; later models will have natural frequencies on the order of 1 kc, dependent to some extent on range.

Frequency response of the transducer is flat to 200 cps. Other specifications for the accelerometer are: nonlinearity, 1 per cent; drift, 0.1 per cent in 24 hr; repeatability, 0.1 per cent of full scale; temperature error, ± 1 per cent per 100 F; resolution, infinite.

Compactness Suited To Aerospace Needs

Of interest to aerospace instrumentation engineers is the transducer's size (1.3 cu in.) and low per cent of full scale; temperature weight (2 oz). No additional weight or space is required for amplifiers to provide a standard, voltage-controlled oscillator with ± 2.5 v; excitation for the device is 10 v or 28 v unregulated dc.

The operating principle of the new accelerometer can be applied to the design of transducers for sensing load, displacement, angular position and torque.

The accelerometer costs about \$500, the company reports; availability is 30 days, on receipt of order.

For more information on these high-output, low-hysteresis accelerometers, turn to the Reader-Service Card and circle 251.

**DORSETT'S
3 NEW
SILICON
SOLID STATE
SUBCARRIER
OSCILLATORS
FOR FM TELEMTRY**

To meet increased demand for a wide range of subcarrier oscillator configurations Dorsett Electronics now offers its extremely reliable solid state subcarrier oscillator in three new package forms.

Dorsett's three new configurations provide the systems engineers with unmatched mechanical flexibility in telemetry system design, without sacrificing component reliability and stability.

These new subcarrier oscillators are only a few of the many state of the art telemetry components currently in production at Dorsett Electronics. Put Dorsett's experience to work for you on your next telemetry requirement. Your inquiries and specifications will receive a prompt reply.

SPECIFICATIONS

Input:	0 to 5 volts, or -2.5 volts to $+2.5$ volts.
Output:	Adjustable from 0 to .5 volts RMS into 80 load impedance. Fixed output at least 3 volts RMS into 100K or higher load impedance.
Power Requirements:	28 volts DC at 10 milliamperes.
Linearity:	Deviation from the best straight line less than .25%.
Distortion:	Less than .75% harmonic distortion.
Amplitude Modulation:	Less than 1db across the band.
Input Impedance:	500K for Channels 1 through 18. 250K for Channels A through E.
Electrical Stability:	No more than $\pm .5\%$ FBW change in center frequency or deviation sensitivity for a supply voltage change of $\pm 10\%$.
Temperature Stability:	Less than 2% FBW change in center frequency or band-width for a 50°C change within the range of -55°C to $+100^\circ\text{C}$.
Acceleration:	100G Linear
Vibration:	20G, 55 to 100 cps
Shock:	100G for 11 milliseconds
Altitude:	Unlimited
Size:	0-18 1.75 in. x 1.36 in. x .74 in.
	0-20 2.25 in. x 1.00 in. x .80 in.
	0-28 1.27 in. x 1.25 in. x 1.25 in.
Connector:	Cannon DE-9P.
Controls:	Output, Centering, Deviation Sensitivity



DORSETT ELECTRONICS, INC.

P. O. BOX 862 • NORMAN, OKLAHOMA • JEFFERSON 4-3750

CIRCLE 59 ON READER-SERVICE CARD

0.5 nanosecond
the time it takes for light
to cross the palm of your hand



Lumatron developed and delivered the first commercial nanosecond sampling oscilloscopes — in 1958. Today Lumatron model 112A's outperform all others — 0.2 ns risetime (2 kmc bandpass), 3mv/cm sensitivity, sweep speeds to 0.05ns/cm. Lumatron also pioneered automatic switching time measurements. Today's improved Model 400A series instruments measure all switching and delay characteristics in transistors, diodes and circuits — from 0.5 ns to 2 us, with better than 5% accuracy, 5,000 tests per hour. You push a button — the Test Set does the rest.



If you do nanosecond work, write now for free data chart, and detailed specifications

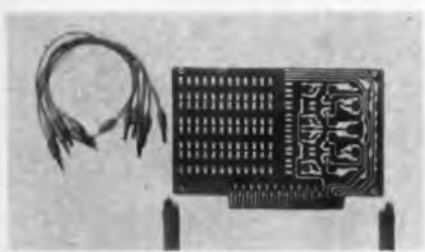
LUMATRON
Electronics, Inc.

116 Twenty-fourth Street, New Hyde Park, N. Y. • Pioneer 7-3200

CIRCLE 60 ON READER-SERVICE CARD

PRODUCT FEATURE

Building-Block Circuit Boards



ENGINEERING TIME and development costs for circuit breadboarding are reduced by these quality printed-circuit mounting boards. Available in two basic types, the Proto-Card is so designed that the components themselves provide most of the circuit connections.

Manufactured by Circuit Structures Laboratory, Laguna Beach, Cal-

if., Proto-Cards can be used for preliminary circuit development and testing by "tacking-in" circuit elements.

The all-purpose type has five power buss lines and isolated transistor and component pads. The transistor card has eight collector output lines and 16 input lines, with printed leads to the connector pins. Fifteen of the connector lines are terminated at eyelets to provide maximum flexibility for input wiring.

The digital circuit type has four power lines, eight collector output lines and 16 input lines, with printed leads to the connector pins. The eight transistor emitters are bussed to a common line. A variety of digital circuits can be formed by adding the active and passive circuit elements to



form the desired circuit functions.

A prepared drawing sheet comes with each card to simplify the development of schematic diagrams. Each card comes ready for use.

Proto-Cards can be used to mount functional circuits for first-article electronic equipment. The procedure recommended is as follows:

1. Complete the blank schematic sheet supplied with the Proto-Card by laying in the circuit interconnections. Build the circuit as you design by making quick, solderless, connections on a CSL Circuit Builder. This device and its use were covered in the March 16, 1960 issue of *ELECTRONIC DESIGN*. All components will be in the open and connections are easily accessible for test and revision.

2. Transfer the breadboarded circuit to a CSL Proto-Card. Only a minimum of jumper wiring is required since all of the basic circuits are provided for a variety of analog and digital devices. Components are soldered into place by standard assembly techniques.

3. Circuit interconnections can be formed by patch-cord interconnections on the model 84100 Inter-Card Patch Panel. The over-all performance and circuit compatibility can be determined from tests on the prototype cards interconnected through the patch panels.

4. Design errors can be corrected easily by changing the circuit elements and interconnections on the Proto-Cards. Marginal circuit conditions can be determined by introducing variations in circuit parameters on the prototype circuit cards.

The final packaging of first-article electronic equipment can be simplified using CSL Chassis Modules or card holder modules with the associated connector mounting frames. The card holders have a capacity of 27 Proto-Cards.

The Proto-Cards offered at this time are available in four models, each in a left- and right-hand version. All are available within 10 days after receipt of order at \$7.50 each, in lots of one to nine, and \$6.60 each, in lots of 50 to 99.

For further information on these time-saving devices, turn to the Reader-Service Card and circle 252.

Newest Hermetically Sealed SHAPE

- Extremely small size provides maximum capacity per unit of chassis area.
- Ideal alternate for axial lead tubulars when space and weight is critical.
- Meets all MIL-SPEC. environmental requirements.

This rugged, dependable 50 Volt series was developed specifically for military applications. It combines the thin, flat shape of popular Good-All instrument grade 601PE capacitors with a hermetically sealed metal case of oval cross-section.

SPECIFICATIONS

Winding Construction — Extended foil (non inductive) MYLAR® Dielectric.

CASE — Metal enclosed, Hermetically sealed.

Temperature Range — -55°C to $+125^{\circ}\text{C}$ at full rated voltage.

Life Test — 250 hours at 125% of rated voltage and 125°C .

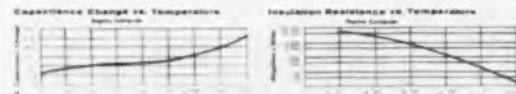
Vibration — Meets all requirements of specifications MIL-C-25C and MIL-C-19978A.

Temperature and Immersion Cycling, and Moisture Resistance — Meets all requirements of specifications MIL-C-25C and MIL-C-19978A.

Insulation Resistance — Greater than 75,000 megohms when measured at 100 volts D.C. at 25°C for a maximum of 2 minutes.

Capacity Tolerance — Available to $\pm 20\%$ $\pm 10\%$ $\pm 5\%$.

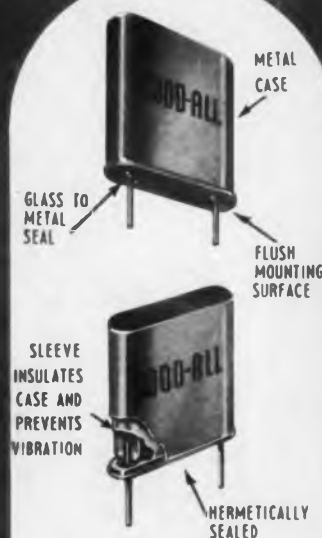
The 605 is capable of being produced to **HIGH-RELIABILITY** specifications comparable to MIL-C-14157 and MIL-C-26244(USAF)



*No Heat Treatment for Polyester Film

Write for detailed literature

GOOD-ALL ELECTRIC MFG. CO.

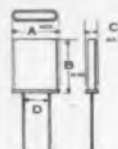


605 SERIES CAPACITORS

50 VOLT DIMENSIONS

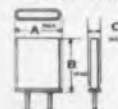
CAP. MFD	A	B	C	D
.01	.426	.534	.176	.200
.022	.426	.534	.176	.200
.033	.560	.575	.235	.300
.047	.560	.575	.235	.300
.068	.560	.575	.235	.300
.10	.760	.575	.355	.500
.15	.760	.575	.355	.500
.22	.760	.790	.355	.500
.33	.760	.790	.355	.500

CASE VARIATIONS



TYPE 605

Available only in values (.01 to .068)



TYPE 605P

Available only in values (.10 to .33)

Good-All
CAPACITORS

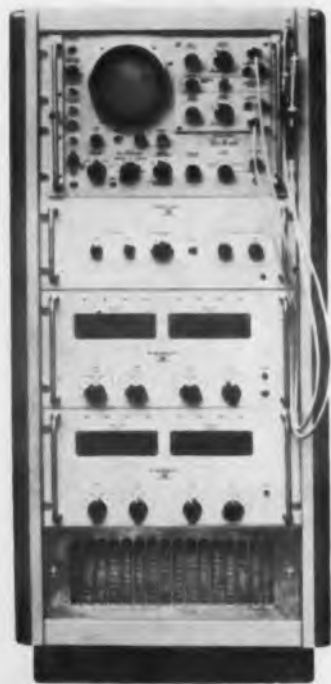
Available at
Authorized
Distributors

OGALLALA, NEBR.

CIRCLE 61 ON READER-SERVICE CARD

NEW PRODUCTS

Covering all new products generally specified by engineers designing electronic original equipment. This issue features the new products to be displayed at the National Electronic Conference to be held at Chicago, Oct. 9 to 11. Use the Reader-Service Card for more information on any product. Merely circle number corresponding to that appearing at the top of each description.



Waveform Measuring System 258 Automatically Tests Transistors

Transistor testing is facilitated by this automatic waveform measuring system. Designated model DY-5844, the system measures the time interval between any two points on stimulus and response test pulses. Unskilled persons can operate the equipment, or the system can be automated for unattended operation. Accuracy is better than 4% of full scale. The system measures delay, rise, storage, and fall time of transistors, diodes, magnetic cores and various high-speed components and circuits. Parameters are measured in 1/4 sec. Information is presented on an oscilloscope and a digital display.

Dymec Div., Hewlett Packard Co., Dept. ED, 395 Page Mill Road, Palo Alto, Calif.

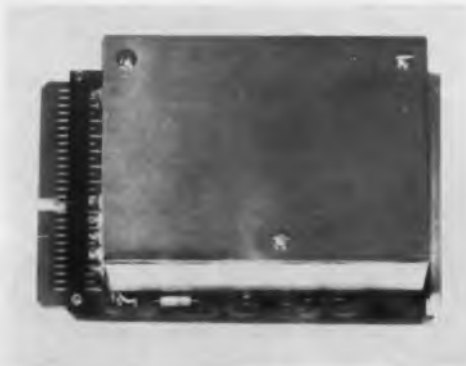
P&A: \$8,000 to \$12,000; 10 to 16 weeks.

Acoustic Serial Memory 259 Stores 1,600 Bits at 16 Mc

Using a fused-silica acoustic delay line, this digital serial memory has a 1,600-bit capacity. Designated model SM-40, the device provides pulse delays of 20 to 100 μ sec and operates at 8 to 16-mc frequencies. Without requiring carrier modulation, the module accepts up to 16 million bits per sec. The package, a plug-in unit, contains all necessary input-output logic, and is compatible with the firm's H-PAC digital modules. Temperature control is unnecessary.

Computer Control Co., Inc., Dept. ED, 983 Concord St., Framingham, Mass.

P&A: \$997; 6 to 8 weeks.



Tape Transport Device 256 Controls Speed and Tension

Made to regulate take-up reel speed and tension on tape transports, this device provides resistance variations equivalent to variations in tape tension. Forces of 5 to 15 g move an actuator over a distance of 1/8 in. Contacts, arranged in a bank, are actuated sequentially as the force increases. External resistors connected to the contacts regulate the power to be fed to the take up motor. The contacts handle up to 240 w and have a life estimated at more than 200 million operations.

Electric Regulator Corp., Dept. ED, Pearl St., Norwalk, Conn.

P&A: \$50 in single units; one week.

General Electric High Reliability Tantalytic* Capacitors



Subminiature Slip-Ring 257 Contains 28 Circuits

Designed for inertial guidance equipment, the model 1408 slip-ring cartridge measures less than an inch long and 3/8 in. in diam. The cylinder contains 28 circuits. Circuits in the assembly can handle from 0.5 to 2 amp continuously, and withstand 500 v dc. The cartridge has a torque of only 40 gm-cm. Noise is low. Contact surfaces, made of precious metal, resist corrosion and are compatible with a fluorocarbon environment.

Slip-Ring Co. of America, Dept. ED, 3612 W. Jefferson Blvd., Los Angeles 16, Calif.

P&A: about \$650; 6 weeks.



Converter Takes 15,000 255 Readings Per Sec

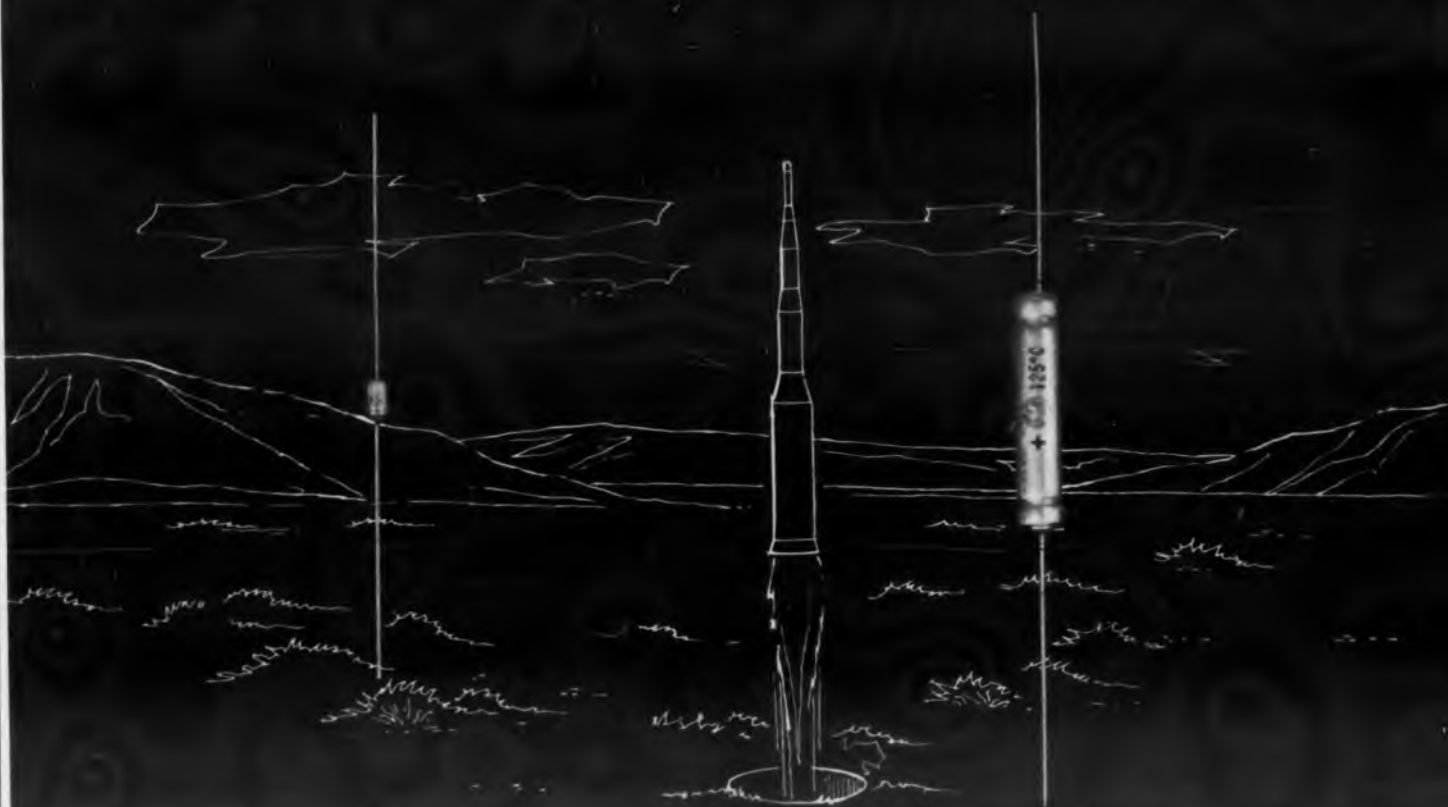
With an error no greater than 1% plus one digit, this analog-to-digital converter takes 15,000 voltage readings per sec. Designated model 5000, the converter uses precision high-frequency resistors, a stable comparison amplifier and a temperature-regulated power supply to achieve its accuracy. Made to operate as a digital voltmeter, the instrument has bi-polar operation. Input amplifier setting time is 4 μ sec; kick-back is negligible. An adapted converter, model 5000B, has straight binary output. The units are completely transistorized.

Non-Linear Systems, Inc., Dept. ED, Del Mar, Calif.

P&A: \$6,950; from stock.

See at NEC Show Booth 3.

CIRCLE 62 ON READER-SERVICE CARD ►



SOLID FOIL

Both now qualified for MINUTEMAN Both now available for other programs

Both Solid and Foil General Electric High Reliability Capacitors are now qualified for the unprecedented MINUTEMAN missile reliability program.

Perfected and qualified under separate MINUTEMAN development contracts, G-E solid and foil types now approach final objectives—a failure rate of .001% / 1000 hours (under specified test conditions).

To prove such reliability, General Electric logs 250,000 unit test hours each week. The total now surpasses 5,000,000 sequential test hours—smaller samples do not satisfy high-reliability objectives!

So that tomorrow's units will equal those produced today, General Electric calls on unique in-process

controls. An outstanding example is the Integrated Reliability Data System which measures and controls each variable from incoming material test to field performance.

To help the customer calculate system reliability, General Electric will provide reliability test data on each rating. This information is up-dated every 1000 hours.

The MINUTEMAN-qualified capacitors described are now available for all electronic systems. For specs, contact your G-E Sales Engineer. For descriptive bulletins, write to Section 430-05, General Electric Co., Schenectady, New York. Capacitor Department, Irmo, South Carolina.

* Reg. Trade-mark of General Electric Co.

Progress Is Our Most Important Product

GENERAL  ELECTRIC

New Products Directory

A complete index of all new products contained in this issue of ELECTRONIC DESIGN, including page and reader-service numbers.

Category	P	RSN	Category	P	RSN	Category	P	RSN	Category	P	RSN
Amplifiers			component kit	149	409	switch	191	471	fm tuner	82	527
chopper stabilizing	157	696	connector sleeve	158	646	switches, coax	200	460	magnetic modulator	124	363
dc	88	484	fastener	94	478				navigation system	165	554
dc differential	141	395	insulating cloths and tapes	155	608	MW Equipment			noise meter	89	488
dc recording	170	607	jack	170	637	amplifiers	192	449	receiving system	170	621
follower	157	689	knobs	99	668	attenuation measurement					
low-noise	107	657	lamp	94	590	system	194	672			
magnetic	171	498	lamp, pilot	155	496	receiver system	191	470	Readout Equipment		
pulse	172	645	lamp, straight filament	115	697	synchronizer	194	465	data plotter	146	437
vertical	127	443	limit stop	119	530	transmission line	98	679	decade scalar	155	686
video	112	512	logic symbol markers	103	563	transmitter, beacon	132	372	decimal digit indicator	138	371
			nylon	86	537				digital	137	436
Antennas			oscilloscope cart	139	380	MW Hardware			photoelectric	116	510
loop	164	639	rotary seal	108	575	crystal mount	196	583	potentiometer recorder	170	627
			semiconductor bases	172	693				printing tube	167	599
Cabinets and Enclosures			semiconductor mount	151	404	MW Materials					
vertical rack enclosure	102	566	serial number markers	103	562	adhesive	195	464	Rectifiers		
vertical rack enclosure	103	567	socket, relay	161	492	ferrite crystals	198	386	bridge	100	681
			three conductor plug	121	388	foam	196	481	heavy duty	122	351
Cable and Wire			teflon tubing	128	545				high voltage	137	440
aluminum strip conductor	167	599				MW Test Equipment			selenium	153	353
film insulated wire	130	552	Logic Circuits			radar test set	193	674			
retractile cords	107	573	acoustic serial memory	111	570	radar test set	195	462	Relays		
			acoustic serial memory	78	259				dc	143	402
Capacitors			core memory systems	100	571	MW Tubes			latching	144	401
ceramic	139	357	digital comparator	133	359	traveling wave	193	675	microvolt	118	531
feed-through	97	700	digital linkage system	132	547				military	142	406
flat	159	647	memory storage circuit	82	521				static	140	361
storage	118	520	modules, 5 mc digital	105	569						
tantalum	121	412	NOR	103	568				Resistors		
tantalum foil	133	421	shift register device	132	367				ceramic-metal	150	553
uhf	122	546	transistor-case	89	477				epoxy-molded	119	524
						Motors			precision	129	429
Coils and Solenoids			Materials and Compounds			explosion-proof	162	532	wirewound	168	650
subminiature solenoids	135	423	aluminum oxide	169	550	fractional horse-power	97	403			
			beryllia oxide	169	606	power operators	159	685	Servo Devices		
Cooling Equipment			clear cement	146	429				brakes and clutches	99	683
blowing equipment	157	695	conductive adhesive	172	558	Ovens			brakes and clutches	125	444
cooling-heating module	152	557	conductive molding compound	162	439	batch	136	391	servo drive	138	379
fan	145	418	epoxy	165	626	crystal	143	398	slip-ring cartridge	79	257
fan, dc	169	499	epoxy	168	609						
heat sink	86	534	gold salts	160	638	Potentiometers					
heat sink	130	365	metal-plastic compound	152	555	multi-turn	156	643	Standards		
heat sink kit	153	415	potting compounds	147	426	trimmer	127	432	frequency	105	561
temperature controllers	160	644	silicon resins	128	541	trimmer	142	396	frequency	129	446
			tungsten-rhenium	118	438				frequency	147	434
						Power Supplies			voltage, ac	143	411
Connectors			Meters			battery charger	113	535			
cable	83	618	horsepower	122	355	battery substitute	146	425	Sundries		
kit	126	366	modern-styled	106	591	converter, frequency-to-dc	148	413	belts	94	579
kit	169	622	modern-styled	111	666	dc	90	595	mass spectrometer	134	373
quick-disconnect	134	417	panel	123	442	dc	121	378			
rack and panel	152	385	recording voltmeter	162	533	dc-to-dc dynamotor	163	525			
			voltmeters, expanded	173	487	generator, induction	116	624	Switches		
Counters						high-voltage	156	692	accelerometer	165	687
bi-directional	166	619	MicroWaves			magnetic multiplier	123	441	coaxial	149	405
electronic	174	815	MW Antennas			modular	110	682	lever	100	678
instrument	128	448	dielectric	190	473	regulated	95	489	limit	131	559
phase-angle	171	500	general	104	689	static inverter	145	382	locking	106	677
10-mc	98	572	parabolic	195	467	wideband converter	116	701	pulse	115	494
			standard-gain	198	466	Production Equipment			rotary index mechanism	165	600
Delay Lines						alloying furnace	150	474	stack	164	670
general purpose	129	430	MW Devices			clean room	147	424	static power transfer	135	551
			attenuators	196	374	component sorter	140	416	switchlight	124	364
Diodes			attenuators, variable	192	451	control system, numerical	123	433			
computer	136	556	circulators	193	588	controls	83	479	Tape Equipment		
miniature	87	529	circulators	200	453	humidity controller	137	543	computer tape	146	427
voltage-regulator	112	486	de-blocks	200	669	infrared detector tester	120	511	miniature recorder	112	513
Zener	154	508	feed horns	198	422	liquid level control	144	397	recorder-reproducer	160	649
			filters	192	459	machine tool control	115	503	recording system	164	620
Drafting Equipment			fresnel-zone plates	190	472	marking machine	91	580	recording system	167	497
portable drafting kit	153	399	isolators	194	461	shouldering pot	140	400	tape head	151	392
			shutter	201	454	vapor degreaser	158	694	tape head, monaural	134	420
Environmental Chambers			shutter switch	201	450				tape punch	136	407
refrigeration chamber	150	548				Radio Frequency Equipment			tape punch	167	648
						attenuators	82	526	tape punch	96	586
Hardware						crystal selector	91	688	transport tension control	78	256
breadboard component kit	150	358									

LERMER RIGID PLASTIC CONTAINERS

OFFER UNIQUE PACKAGING ADVANTAGES FOR ELECTRONIC/ELECTRICAL INSTRUMENT COMPONENTS

For the utmost in ease of packaging, visibility, safety and protection, nothing compares with the desirable features of Lerner RIGID plastic containers for diamond tools, drills, gauges, ball bearings, jewels, etc.



- Printed or decorated up to 4 colors on crystal clear, transparent or opaque colors
- Largest line of RIGID plastic containers
- 1/5 the weight of glass — greatly reducing ever-increasing shipping and handling costs
- Lightweight and shatterproof — with rigid wall protection
- Economical — with customer re-use value
- Also made of new high density polyethylene — Poly-Opal* Are chemically inert, stain resistant and have lower permeability to moisture and gases than conventional polyethylene. Write for full-color catalog, samples and prices. *T.M.

Also a complete line of flexible acetate containers.



**LERMER
PLASTICS, INC.**
572 South Avenue, Garwood, N. J.

PIONEERS AND SPECIALISTS IN PLASTIC CONTAINERS SINCE 1919

CIRCLE 63 ON READER-SERVICE CARD
ELECTRONIC DESIGN • September 27, 1961

Category	P	RRR
Telemetry		
general purpose equipment	145	414
receiver	125	435
system	87	519
transmitter	124	358
tuning forks	106	656
Terminals		
ceramic-to-metal	141	389
headers	126	368
push-type	135	549
wire-wrap	114	387
wire-wrap block	168	629
Test Equipment		
analog-to-digital converter	79	255
cable continuity tester	151	410
circuit tester	130	369
coating tester	146	544
continuity tester	90	691
controls analyzer	88	482
core memory tester	147	431
dc microvoltmeter	99	663
insulation leakage tester	96	475
magnetic field detector	113	538
meter, multiple function	166	630
micro-micro-ammeter	111	664
micro-micro-ammeter	120	485
micro-volt-ammeter	104	65R
ohmmeter, digital	148	352
oscilloscope	97	360
oscilloscope	141	394
radiation test set	83	528
relay timer	91	581
squb tester	163	523
transient voltage indicator	154	507
transistor waveform measurer	78	25R
vibration monitor	154	628
voltmeter	110	665
voltmeter, recording	139	376
vtvm	164	690
Thermoelectric Devices		
thermistor temperature controllers	158	610
thermocouple, miniature	128	542
thermostat, bi-metal	120	506
thermostat, metal-cased	129	540
Times		
electronic crystal case	148	362
missile	152	408
solid-state	156	688
Tools		
lab kit	96	594
mylar film punch	174	655
soldering iron	86	536
terminal swaging	174	501
wire stripper, rotary	102	560
Transducers		
angular accelerometer	125	447
angular accelerometer	142	384
displacement	131	370
pressure	126	381
pressure	135	393
strain gage	95	598
strain indicator	131	377
temperature	138	354
Transformers		
matching	160	601
pulse	133	383
ratio	98	574
3-phase	95	604
Transistors		
germanium	127	445
silicon	186	419
Tubes		
cathode ray, fiber optic	114	699
power triode	149	375
receiving	173	102
rectifier	98	663
thyatron	88	616
shielded-grid triode	173	483
Vacuum Equipment		
general system	137	539
Voltage Regulators		
galvanometer protector	114	698
galvanometer protector	144	390
induction	105	544
overvoltage protector	161	480
spark gap, 10,000 amp	113	522
static	102	565
voltage references	172	605



Let's face it...

Today's Pulse Circuitry Demands Fast Rise Time Components

High speed signal circuits as well as solid state power supply circuits can be improved and simplified by the use of SAGE non-inductively wound resistors. Such parts are currently supplied in values from 1 ohm through several thousand ohms. This valuable circuit feature can be provided on any SAGE or MIL wattage size.

No compromise is made with other superior performance features long associated with SAGE precision power resistors, such as:

- High temperature operation to 275°C ...
- Temperature coefficient less than 20 ppm/°C
- Typical 1000 hour load life change less than .5%
- Fully insulated, 1000 volt rms test on axial lead units

Lower inductance of the order 30 to 1 is achieved by special SAGE winding technique.

EXAMPLE: Regular SA2W resistor (MIL RW59 size) 380 Ω reads approximately 3.5 u hy at 1 Mc. Comparable NSA2W 380 Ω unit reads .12 u hy.

Specify SAGE for your **NON-INDUCTIVE**
Power Resistor Requirements



SAGE ELECTRONICS CORP.
Country Club Road • East Rochester, N. Y.

CIRCLE 64 ON READER-SERVICE CARD

NEW PRODUCTS

RF Attenuators

526



Range is dc to 500 mc for this rotary adjustable attenuator that is made in seven types, four with 75 ohms impedance and three with 50 ohms impedance. Power dissipation is either 0.25 or 0.50 w, according to the model. Units can attain zero db and proceed in steps of 0.1 db. Custom built models are available.

Ortho Industries Inc., Dept. ED, 7 Paterson St., Paterson 2, N. J.

FM Radio Tuner

527



If bandwidth is 450 kc at 6 db down for good stereo reception of the main and subcarrier signals. Tuner model 311-0009 is designed for receiving multiplex fm broadcasts. Unit incorporates automatic frequency control and age is the rf stage.

Waller Corp., Dept. ED, Industrial Center, Crystal Lake, Ill.

Memory Storage Unit

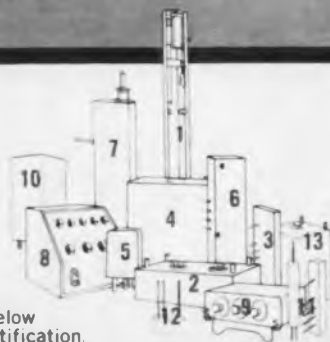
521



For analog computers, unit can store answers or values to problems for presentation later when the operator wants to compare new values to those previously computed. Two values at a time can be stored in one memory package.

Electronic Associates, Inc., Dept. ED, Long Branch, N. J.

ESC WORLD'S LEADING



Refer to chart below for product identification.

ELECTROMAGNETIC AND MAGNETOSTRICTIVE DELAY LINES • NETWORKS • FILTERS

E S C products are available from stock or, depending on your requirements, will be designed to your exact specifications. For custom requirements we will produce a prototype and submit a detailed laboratory report on all parameters and test equipment used. When your prototype is ready for production, our rigid Inspection and Quality Control Procedures ensure that each electrical and mechanical characteristic is exactly as specified.

1	Magnetostrictive Delay Line	20M01 and 50M02
2	Miniature Transponder Delay Line	52-44
3	Miniature Modular Computer Delay Line	15-89 through 15-94
4	Miniature Delay Line	37-74
5	Miniature Bandpass Filter	AC, AD, AF, AH, AJ, ZJ, ZH, ZF, ZD, ZC
6	Miniature Continuously Variable Delay Networks	700
7	Continuously Variable Delay Line	400 and 500
8	Push Button Decade Delay Line	200
9	Direct Readout Variable Decade Delay Line	100
10	Lumped Constant Delay Lines	Standard LC Series and Millisecond Series
11	Distributed Constant Delay Lines	Cylindrical and Printed Board Type
12	Subminiature Lumped Constant Delay Line	16-92
13	Audio Delay Lines	

The units shown are typical of the products — both standard and custom — designed and produced by E S C for radar, missiles, communications, computing and other critical applications.

Examples of ESC's engineering achievements are our new Miniature Delay Line, type 37-74, with a delay time/rise time ratio of better than 35:1 in a less than 3½ cubic inch package; and our new Miniature Transponder Delay Line, type 52-44, with a ratio of better than 40:1 in a six cubic inch package.

In all cases the components shipped by E S C will conform with the most rigorous military specifications.

For complete information on the hundreds of different models manufactured by E S C, write or call today for a catalog or specific technical literature.



ESC

ELECTRONICS CORP.

254 BERGEND BOULEVARD • HALLANDALE BEACH, FLA. 33009
INTERNATIONAL DIVISION • 15 MOORE STREET • NEW YORK, N.Y. 10014

PRODUCER OF DELAY LINES



Distributed constant delay lines • Lumped-constant delay lines • Variable delay networks • Continuously variable delay lines • Step variable delay lines • Video transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

Transistorized Controls 479



Pulse logic monitoring devices continuously check and control automatic machine operations. Units will stop a machine immediately upon detecting any malfunction such as misfeed, improper positioning, improper parts transfer, buckling, and end of material. Visual signals alert the supervisor and the machine is instantly stopped.

Weldotron Corp., Dept. ED, 907 Frelinghuysen Ave., Newark 14, N. J.

Cable Connectors 618

Aluminum arc-proof power cable connectors can be installed hot in 45 sec, if necessary, with complete safety to the lineman. Interlocking parts and spring action employed in the fittings make it impossible to install the connectors in any way but the correct way.

Steele Manufacturing Co., Inc., Dept. ED, 2103 Loop 323 E., Tyler, Tex.

Radiation Test Set 528



A complete system for measuring and evaluating radiometric parameters is offered in model 16-110 infrared radiation test set. Components are a motor-chopper assembly, detector-preamplifier assembly, and synchronous rectifier amplifier units.

Barnes Engineering Co., Dept. ED, 30 Commerce Road, Stamford, Conn.



Accurate, automatic measurements of TI semiconductor reliability are provided with CART (Central Automatic Reliability Tester). This unique TI facility life tests 30,000 operating devices at a time to assure maximum reliability.

You Get Predictable Semiconductor Reliability From Unique TI Skills

HERE'S WHY: *Data from well over one-billion life-test hours — ensures the quality assurance techniques that give you statistically predictable device performance. TI can run operating life tests on 90,000 semiconductor devices at one time — more than 500-million unit hours per year!*



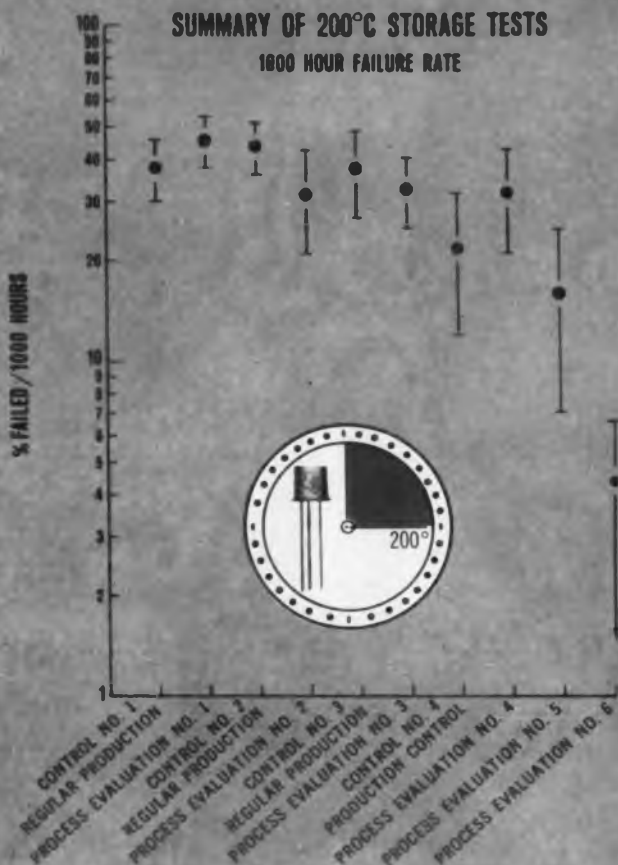
TI leadership in production and test equipment — TI's semiconductor plant houses more than 800 separate automatic facilities, designed for fail-safe, dependable production and testing. For example, TI-built CART minimizes possible machine and human error. Testing 30,000 devices at a time under both accelerated and derated conditions, CART automatically measures and records each parameter.

Punched-card readouts are computer-processed and used for predicting performance and evaluating process changes. Result: uniform product reliability — possible only with rapid, accurate mechanized equipment.

TI maintains an independent Quality Assurance department for every existing product line. Completely separate from product departments, these QA groups measure on-line production as well as finished device reliability. Result: Quality Assurance is your representative at TI — specifically organized to assure you of predictable TI product reliability.

TEXAS





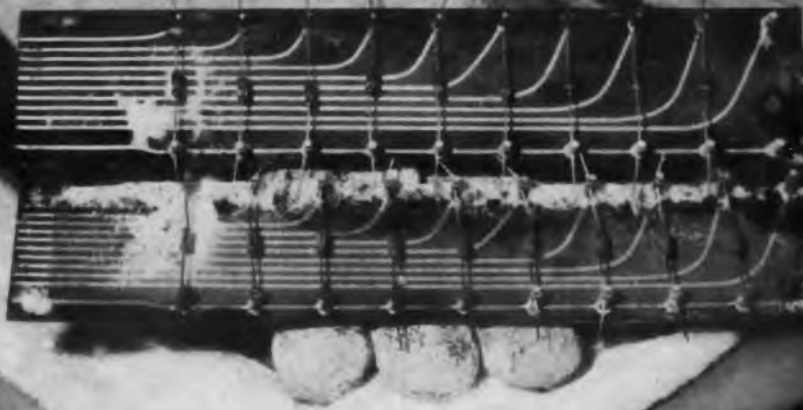
From TI Transistor Products Division Continuing Process and Product Analysis Assures Maximum Transistor Reliability

The test graph above demonstrates TI's constant search for new ways to achieve the ultimate in product reliability. Several hundred TI 2N705 germanium mesa transistors from five experimental production processes were subjected to 200°C storage life tests (twice the normal maximum rated temperature for the 2N705 device). Severe as these tests were, one process (No. 6 above) yielded failure rates as low as 5%/1000 hours. Result: An improved process technique, now standard at TI, for producing higher temperature devices.

Besides aiding in developing process technologies, reliability testing at TI also plays an important role in maintaining highest possible manufacturing standards. The manufacture of 2N705 transistors, for example, includes 100% inspection at several production points. At one of these points, 100% hermetic-seal inspection is performed by a mass spectrometer method. Additional QA sampling inspection is performed at selective control points during production. This kind of quality assurance testing — from process analysis to finished device — means built-in product reliability.

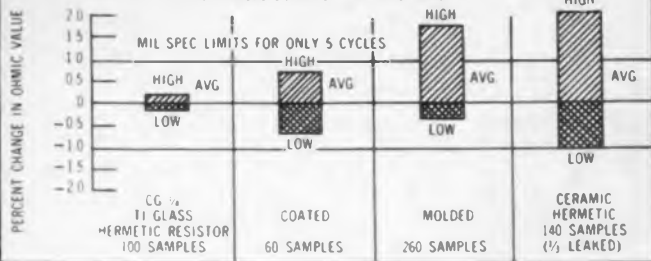
INSTRUMENTS INCORPORATED

13500 N. CENTRAL EXPRESSWAY
P. O. BOX 5012 DALLAS 22, TEXAS



EXTREME THERMAL SHOCK TEST DATA SUMMARY

50 CYCLES DURATION -65°C TO 155°C



From TI Components Division Comprehensive QA Program Proves Reliability of TI Hard-Glass Resistors

A comprehensive Quality Assurance program was an integral part in the successful development of TI's high-reliability hard-glass resistor. Tests far more rigorous than those in common use were devised to prove out the basic design and materials for this superior product. In the *Extreme Thermal Shock Test Data Summary* above, resistors remained 45 minutes in a cold chamber (-65°C), then went to a heated oven (155°C) for 45 minutes, then returned to the cold chamber. At each temperature, the units were loaded at full rated power for 15 minutes. Fifty cycles produced the results shown in the chart above... 0.21% maximum change, 0.04% average change.

Extended Load-Life Tests to 3000 hours demonstrated a failure rate for hard-glass resistors of 0.04×10^{-6} with a 95% confidence level under a variety of temperature and power conditions. In this test, a failure was defined as any resistance change in excess of 3%.

TI hard-glass resistor QA tests also include extended moisture, short-time overload, acceleration, shock, vibration, and hermetic seal... typical of QA programs on all TI products. Regularly published data from these programs prove, with statistical evidence, TI product reliability.



For detailed reliability information about any TI semiconductor product or component, write on your company letterhead (attention mail station 472), outlining your specific requirements.

NEW PRODUCTS

120-V Soldering Iron 536



For do-it-yourself fans as well as production-line operations. The Pen-line-120 is available with 30- and 50-w integral tip-and-heater assemblies. A 40-w assembly with 20 ironclad and copper tips will be introduced soon. Pyramid, chisel, spade, and cone tips, 3/16 to 3/8 in. will be offered.

General Electric Co., Dept. ED, Schenectady, N. Y.

P&A: under \$5; in quantity, late September.

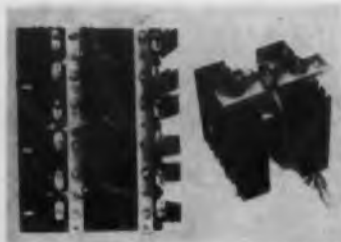
Nylon Hardware 537



Toughness, chemical resistance, and non-conductivity are features of nylon drawer handles and cabinet hinges. Rust-resistance has led to their use by the Navy in electronic installations. The hinges have low friction facing and a non-abrasive surface that require no lubrication.

Hardware Designers, Inc., Dept. ED, P. O. Box 4, South Hackensack, N. J.

Heat Sink 534



Effective heat dissipation in a small volume is claimed for mod-





Available in 7 JEDEC types.
Shown above, 2N681 Tristor is enlarged 6 times.

Westinghouse announces new 16-amp "Rock-Top" Trinistor[®] controlled rectifier

Proven "Rock-Top" quality is now available in JEDEC 2N681 Trinistor Controlled Rectifier series! These latest additions to the Westinghouse power semiconductor family incorporate the field-proven design features of the broadest line of medium and high-power switching devices. Such features as hard-soldered junctions and hermetically welded cases provide an extra assurance of reliability at no extra cost. Additionally, each device is 100% tested to maximum ratings. These new devices from Westinghouse, world leader in silicon technology, are backed by production experience with high-power semiconductors for military and industrial applications.

Westinghouse 2N681 series Trinistors are ideal for such applications as: motor speed control ■ temperature control ■ inverters ■ static switching. For more information, or technical assistance, call or write: Westinghouse Electric Corporation, Semiconductor Dept., Youngwood, Penna. *You can be sure... if it's Westinghouse.*

SC-1049

For prompt delivery, order from these Westinghouse distributors:

EASTERN

ACR SEMICONDUCTOR INC. Birmingham 5, Ala./FA 2-0588
CAMERADIO Pittsburgh, Pa./EX 1-4000
CRAMER ELECTRONICS, INC. Boston, Mass./CO 7-4700
ELECTRONIC WHOLESALERS, INC. Melbourne, Florida/PA 3-1441
GENERAL RADIO SUPPLY CO., INC. Camden, N. J./WO 4-8560
GENESEE RADIO PARTS CO. Buffalo, N. Y./TR 3-9661
KARN ELLERT ELECTRONICS, INC. Baltimore, Md./TU 9-4242
MILGRAY ELECTRONICS New York, N. Y./RE 2-4400
RADIO & ELECTRONIC PARTS CORP. Cleveland, Ohio/UT 1-6260
SCHWABER ELECTRONICS Long Island, N. Y./PI 8-6570
Silver Spring, Md./JU 5-7023

MIDWESTERN

E. C. I. SEMICONDUCTORS, INC. Kansas City, Mo./WE 1-0019
ELECTRONIC COMPONENTS FOR INDUSTRY CO. St. Louis, Mo./WO 2-9916

HALLMARK INSTRUMENTS CORP. Dallas, Texas/RI 7-8933
INTER-STATE RADIO & SUPPLY CO. Denver 4, Colo./TA 9-8257
LENER CO. Houston, Texas/CA 4-2663
MIDLAND SPECIALTY CO. El Paso, Texas/RE 3-9555

RADIO DISTRIB. CO. Phoenix, Ariz./AL 8-8254
SEMICONDUCTOR SPEC., INC. Albuquerque, N. M./CM 7-0236
S. STERLING CO. Indianapolis, Ind./ME 7-5571
UNITED RADIO, INC. Chicago, Ill./NA 2-8960
Detroit, Mich./BR 3-2900
Cincinnati, Ohio/MA 1-6530

WESTERN

ALMAC ELECTRONICS CORP. Seattle, Wash./PA 3-7310
ELMAR ELECTRONICS Oakland, Cal./TE 4-3311
HAMILTON ELECTRO SLS. Los Angeles, Cal./BR 2-9154
NEWARK ELECTRONICS CO. Palo Alto, Cal./DA 1-7541
Inglewood, Cal./OR 4-8440

el 2507 heat sink. Under a load of 75 w, the unit provides a thermal resistance of 0.68 C per w. It measures 4 x 4 x 4 in. Bus bars and mounting-hardware variations permit a wide range of applications in bridge circuits demanding adequate convection cooling.

Astro Dynamics, Inc., Dept. ED, Northwest Industrial Park, Burlington, Mass.

Availability: from stock.

Telemetry Equipment 519



For simple digital telemetry applications such as the telemetry of kilowatt-hours on electrical utility systems or positive displacement on pipelines the equipment is designated type DL. Data are transmitted over any telegraphic channel in binary-coded decimal form by means of long and short pulses and spaces.

Westinghouse Electric Corp., Dept. ED, P. O. Box 2099, Pittsburgh 30, Pa.

Miniature Diodes 529



Resistance to moisture, contamination, and mechanical stress is featured in a new line of milliminiature gold-bonded germanium glass diodes. They are one-eighth the size of standard subminiature types. The package is glass encapsulated.

Clevite Transistor, Dept. ED, Waltham, Mass.

Westinghouse



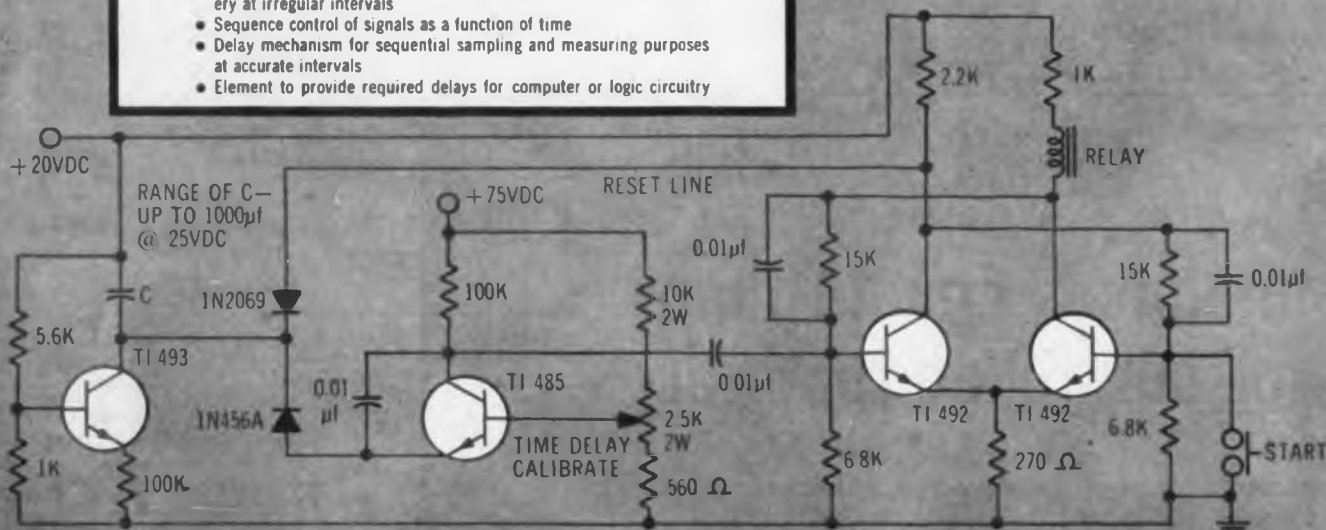
Variable Delay Timing Circuit

Typical Applications

- Safety device for sequential application of signals
- Warm-up delay mechanism for starting complex machinery
- Automatic on/off control to facilitate adjustment of process machinery at irregular intervals
- Sequence control of signals as a function of time
- Delay mechanism for sequential sampling and measuring purposes at accurate intervals
- Element to provide required delays for computer or logic circuitry

Features

Time Delay From 25 milliseconds to 3 minutes
Self Resetting or Externally Cycled
Temperature Range -40°C to $+125^{\circ}\text{C}$
ON/OFF Relay Actuator



HOW TO GET HIGH TEMPERATURE STABILITY AND INDUSTRIAL ECONOMY

With New TI Low-Cost Silicon Industrial Transistors ...

You can assure your customers optimum circuit performance up to 125°C when you design-in new, low-cost TI silicon industrial transistors. Priced comparable to lower-temperature industrial devices, these new TI silicon industrial units provide the high performance your industrial designs require.

Get greater margins of operational safety by applying these new silicon industrial transistors to your process control, communication, aviation system, electronic instrumentation, and computer applications today.

CHARACTERISTICS					APPLICATIONS			
TYPE	MIN BV _{CEO}	DC Beta Range	MAX I _{CEO} @ 100°C	f _{αB} (typ)				
TI 480	50 v	9-36 @ 5 ma	50 µa @ 30 v	1 mc	TI 480			
TI 481	80 v	9-36 @ 5 ma	50 µa @ 30 v	1 mc	TI 481			
TI 482	20 v	>20 @ 30 & 150 ma	50 µa @ 10 v†	60 mc		TI 482	TI 482	
TI 483	40 v	20-60 @ 150 ma	50 µa @ 30 v†	60 mc		TI 483	TI 483	
TI 484	40 v	40-120 @ 150 ma	50 µa @ 30 v†	60 mc		TI 484	TI 484	
TI 485	20 v	15-60 @ 10 ma	20 µa @ 15 v†	200 mc				TI 485
TI 486	80 v	20-80 @ 200 ma	300 µa @ 60 v‡	15 mc		TI 496		
TI 487	80 v	20-80 @ 200 ma	300 µa @ 60 v‡	15 mc		TI 487		
TI 492	40 v	15-45 @ 1 ma	50 µa @ 30 v	8 mc	TI 492			
TI 493	40 v	15-45 @ 10 ma	50 µa @ 20 v	20 mc	TI 493			
TI 494	40 v	40-125 @ 10 ma	50 µa @ 20 v	20 mc	TI 494			
TI 495	40 v	120-250 @ 10 ma	50 µa @ 20 v	20 mc	TI 495			
TI 496	40 v	>10 @ 3 ma	75 µa @ 40 v	1 mc				TI 496

† AC Beta † I_{CEO} @ 125°C ‡ I_{CEO} @ 150°C † 100 µa to 20 ma **20 ma to 500 ma † BV_{CEX} † TRADEMARK OF BURROUGHS CORPORATION



SEMICONDUCTOR COMPONENTS
DIVISION
PLANTS IN DALLAS, TEXAS
BEDFORD, ENGLAND
AND NICE, FRANCE



TEXAS INSTRUMENTS
INCORPORATED
13500 N. CENTRAL EXPRESSWAY
P. O. BOX 5012 DALLAS 22, TEXAS

NEW PRODUCTS

DC Amplifier

484



Push-pull dc amplifier model 1058 was originally designed for use in airborne speed-control applications, but can also be used in many applications where the input is from elements such as thermocouples, strain gages and photoelectric cells. The output can be used with devices such as torque motors and relays with hydraulic or pneumatic servos.

Lumen, Inc., Dept. ED, P. O. Box 905, Joliet, Ill.

Hydrogen Thyratrons 616

Uses include radar transmitters, linear accelerators and other pulse switching equipment. Thyatron type CX1140 is for use as a pulse modulator switch and type FX297 is for use as an inverse diode. Piv for both types is 25 kv. Average plate current is 1.25 amp; peak plate current is 500 amp for the FX297 and 1,000 amp for the CX1140.

English Electric Valve Co., Ltd., Dept. ED, Chelmsford, England.

Controls Analyzer

482



For servomechanisms and feedback control systems, model 440 controls analyzer has a brushless rotating transducer which develops sinusoidal and sinusoidally modulated test signals of 0.03 to 300 cps. Carrier frequencies to 5,000 cps can be accommodated. A self-contained response channel is included.

Superior Manufacturing & Instrument Corp., Dept. ED, 36-07 20th Ave., Long Island City 5, N. Y.

Control Synchros 422

Size 23, for 400-cps operation, made to meet MIL-S-16892 and FXS-1066. A typical unit in this line of control synchros, model VCX23/344a transmitter, has an input impedance of 480 ohms at 85 C, 1.5-deg nominal phase shift, 90 gm per cm² moment of inertia, and ± 8 min electrical error maximum.

Vernitron Corp., Dept. ED, 125 Old Country Road, Carle Place, L. I., N. Y.

Logic Element 477



Miniature logic elements, called Micrologic, are available in gate and half-shift register which match the firm's buffer, half-adder and counter adapter. Average dissipation is 3 mw, and temperature range is -55 to $+125$ C. The elements look like transistors, but have eight leads.

Fairchild Semiconductor Div. of Fairchild Camera and Instrument Corp., Dept. ED, Syosset, L. I., N. Y.

P&A: \$120; in small quantities.

Noise-Field Intensity Meter 488



Covers 14 kc to 1,000 mc in three ranges. Model T-X/NF-105 noise and field intensity meter is compatible with existing NF-105 units. Nominal bandwidth is 1 kc and sensitivity is 0.1 mv full scale. Accessory items also available include a 36-in. loop antenna, a 41-in. vertical antenna and a line probe.

Empire Devices, Inc., Dept. ED, Amsterdam, N. Y.

CIRCLE 67 ON READER-SERVICE CARD ➤



10 years without periodic maintenance!

The reed relays in the new Cubic V-70 series of digital voltmeters assure you of a decade of flawless service. These relays (which replace the stepping switches used in conventional DVMs) have been life-tested for 100 million operations—the equivalent of over ten years of normal operation. The V-70 covers the full DC range from 1 millivolt to 999.9 volts. Balance time is 500 milliseconds; maximum readout time, 750 milliseconds; absolute accuracy is 0.01% plus or minus 1 digit. The meter has no vacuum tubes or moving parts; it operates in any position and is heat and shock resistant; the relays require no maintenance. The V-70 series offers the highest operating speed available in its price range: V-70, only \$1,580; V-71 (with automatic ranging and polarity), \$2,200. For further information, write to Department ED-109.



INDUSTRIAL DIVISION
SAN DIEGO 11, CALIFORNIA • ROME, ITALY

OTHER OFFICES: LOS ANGELES, CALIFORNIA—ROME, ITALY (CUBIC EUROPA S.p.A.) • REPRESENTATIVES IN PRINCIPAL U.S. AND CANADIAN CITIES

have you tried BIRD?

READ RF WATTS DIRECTLY

Today everyone who measures RF power in coaxial systems wants the answer in watts. The BIRD Model 43 THRULINE reads watts!

Connect the Model 43 between transmitter and antenna or load. The meter reads RF power directly. Measure forward or reflected power instantly.

No calibration charts. No adjustments. No calculations. No auxiliary power.

Plug-in elements are used to cover 2 to 1000 mc, and powers to 1000 watts.

BIRD Quick-Change (QC) Connectors eliminate adapters. Any standard series of coaxial line fittings may be accommodated.

Write, TWX or call us for complete specifications on the Model 43 and other BIRD products.

Price:

Instrument only \$95.00 each

Plug-in elements \$30.00 each

FOB, Factory



BIRD Model 43
Thruline Wattmeter



BIRD

ELECTRONIC CORPORATION

30303 Aurora Rd., Cleveland 39 (Solon), Ohio
Churchill 8-1200 TWX CGN FS 679

Western Representative:

VAN GROOS COMPANY, Woodland Hills, Calif.

See us at NEC—Booth No. 500

CIRCLE 69 ON READER-SERVICE CARD

NEW PRODUCTS

DC Power Supplies

595



Sub-miniature, solid state, high voltage dc power supplies are self-contained and provide either regulated or non-regulated outputs. Ac types operate from a 105-125 source, 60 or 400 cps; dc types from a 25 to 29 volt input. Outputs for all types correspond to 1, 3 or 5 kv dc with a standard current rating of 100 μ amp. Regulation is better than 0.5% for input and load variations; ripple is less than 0.5% rms. Units are encapsulated in transformer type housings.

Electronic Research Associates, Inc., Dept. ED, 67 Factory Place, Cedar Grove, N. J.
P&A: from \$105; from stock.

Rectifier Tube

603

Supplying 840 v at 165 ma or 730 v at 275 ma, rectifier tube type 5R4WGB is a military standard 200E preferred type used in power supplies for airborne, mobile and shipboard radars and communications equipment. Maximum piv is 2,900 v at an altitude of 35,000 ft. and 1,850 v at 60,000 ft.

Raytheon Co., Industrial Components Div., Dept. ED, 55 Chapel St., Newton 58, Mass.

Continuity Tester

691



Exploding bridgewire checkout unit is used to test exploding bridgewires and provide the user with a positive indication of wire and circuit continuity in units such as exploding bridgewire igniters, pressure cartridges, and other exploding bridgewire devices. Voltages in the mv region are used to perform the checkout.

Special Devices, Inc., Dept. ED, 16830 W. Placerita Canyon Road, Newhall, Calif.

THE *Lavoie* LA-303 ROBOTESTER

Criterion FOR CRITICAL CHECKOUT



Where time and reliability are critical, the Robotester sets the pace in precision electronic checkout. New levels of speed and accuracy are made possible through pre-programmed acceptance standards. High speed sampling and comparison yield split second recognition, isolation and identification of abnormal functions. Up to 100 tests per minute can be made between any two of 250 circuit points randomly selected. When out-of-tolerance value is met, operation stops, and the isolated faulty circuit is identified by digital readout.

Fast set-up and changeover, with the versatility and flexibility of tape programming, put the Robotester out front in the battle for absolute reliability.

MEASURES:

- Resistance
- Insulation Resistance
- Voltages AC & DC
- Impedance

Write for complete technical details and applications.

Lavoie Laboratories, Inc.

MORGANVILLE, NEW JERSEY

CIRCLE 70 ON READER-SERVICE CARD
ELECTRONIC DESIGN • September 27, 1961

WHEN
YOU
FLY



**THIS IS THE CABLE
THAT HELPS MAKE SURE
YOU HAVE A SEAT!**

At a major airline's electronic reservation center, a computer locates one seat in a million in seconds to confirm your reservation.

The Rome cable inside the computer connects the many control panels that take in the data from 135 reservation and ticket agents in the New York area, as well as from other cities along the Eastern Seaboard.

And what kind of cable is it? Custom made, of course, with 75 conductors; slim and trim for quick, easy connections; insulated and jacketed with Rome Synthinol (PVC) compound that can stand up to oils, acids, alkalies, grease, gasoline and flame.

Our experience in instrumentation cables for telemetering, data recording, circuit control testing and electronic computers is broad. So when you bring us your cable problem, Rome Cable Division has the know-how and facilities to deliver precisely what you need.

Bulletin RCD-400 will give you a good introduction. Write for it. Or address specific questions to Rome Cable Division of Alcoa, Dept 11-91, Rome, New York.



CIRCLE 71 ON READER-SERVICE CARD
ELECTRONIC DESIGN • September 27, 1961

Digital Relay Timer

581



Measures time characteristics of relays. Applications include production testing, receiving inspection testing, etc. Ranges are 1.999 to 199.9 with accuracies from 0.001 msec to 0.1 msec. Timer will accommodate relays with up to six poles, with contact forms A, B, C and D. Display is direct reading, four digits plus decimal point.

Leach Corp., Dept. ED, 18435 Susana Road, Compton, Calif.

Price: \$2,295.

Crystal Adapter

688



Accommodates 50 crystals which allows selection of as many as 50 crystal controlled channels from the front of the company's NC-400 general communications receiver. This assures fixed channel reception of practically any frequency. Designation is MX-400.

National Radio Co., Melrose, Mass.

Price: approximately \$50.

Marking Machine

580



For wire and tube, wire marking machine KW-7 marks wire or tube with its own individual circuit number or code reference at 2 to 10 in. intervals along the entire length of each wire, thus eliminating the need for color coded wire.

Kingsley Machine Co., Dept. ED, 850 Cahuenga Blvd., Hollywood 38, Calif.

**NOWHERE IN THE WORLD WILL
YOU FIND SUCH A VARIETY
OF FASTENERS UNDER
ONE ROOF**

EYELETS, RIVETS, GROMMETS, WASHERS, HOLE PLUGS
SNAP FASTENERS, FERRULES, TERMINALS, STAMPINGS
and many similar fasteners are made in enormous variety and quantity. Made from most any metal and in all finishes. We also make a complete line of machines for attaching eyelets, rivets, etc.

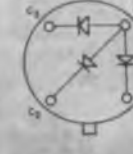
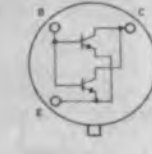
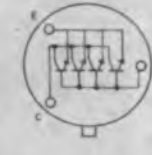
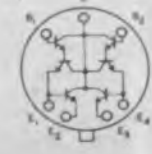
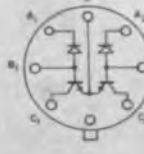
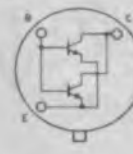
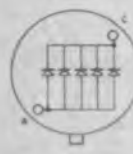
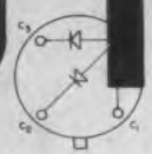
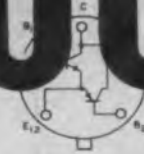
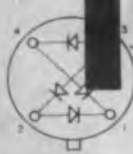
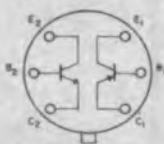
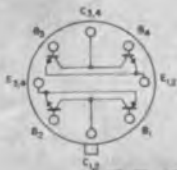
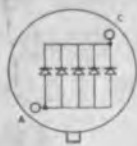
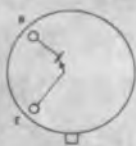
Send for our general catalog which illustrates over 1000 metal articles.



84 FRANKLIN AVENUE EDWIN B 84 FRANKLIN AVENUE
STIMPSON
BROOKLYN 5, N.Y., U.S.A. COMPANY, BROOKLYN 5, N.Y., U.S.A.

84 FRANKLIN AVENUE, BROOKLYN, N. Y.

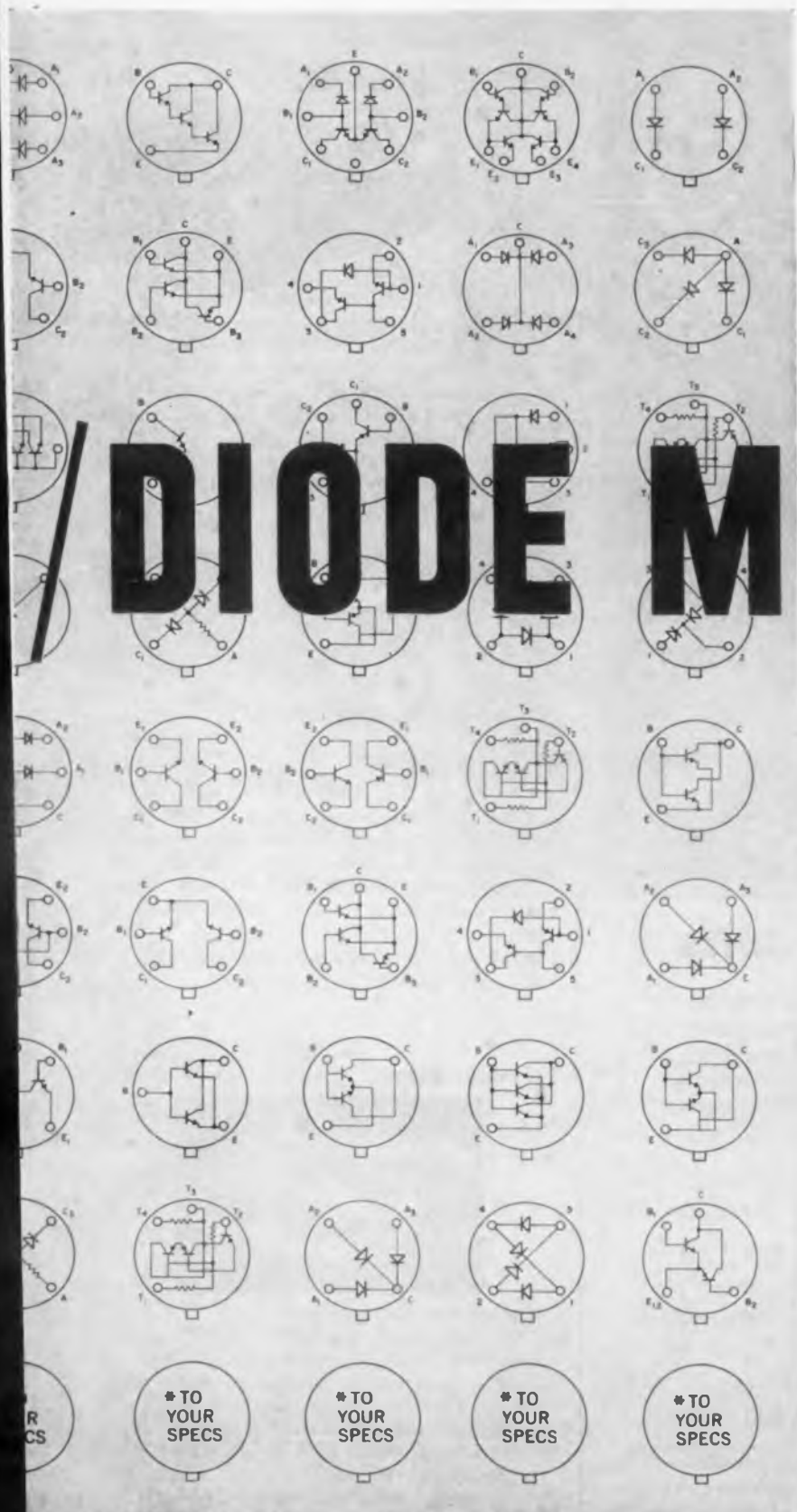
CIRCLE 72 ON READER-SERVICE CARD



MORE THAN
100 T



TRANSISTOR



FROM FAIRCHILD

DIODE MULTIPLES

- **Lower Assembly Cost... Greater Reliability**

Fewer soldered connections reduce assembly cost... provide increased circuit reliability.

- **Up to 80% Space Reduction**

Space savings with increased design flexibility.

- **PLANAR Stability Assures Matched Performance**

Electrical match available... thermal match provided through heat conductive header.

- **Standard Transistor Packaging**

Combinations of transistors or diodes are assembled in a **single** TO-5 type package. TO-18 type packages available.

- ***To Your Own Specifications**

Assemblies to your specifications available on quantity orders.

Write for Special Products Handbook... contains specifications, outline drawings and commentary.

FAIRCHILD

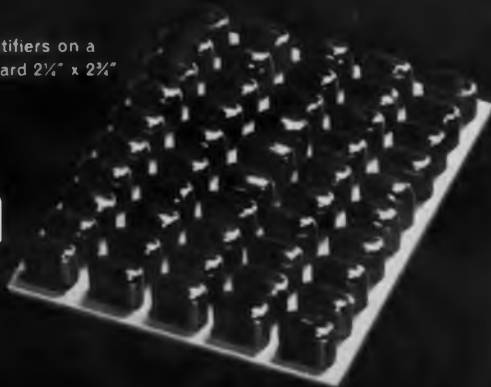
SEMICONDUCTOR

545 WHISMAN ROAD, MOUNTAIN VIEW, CALIF. - YORKSHIRE 8-8161 - TWX - MN VV CAL 853

A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

New Sarkes Tarzian Silicon Rectifiers

Compact— 50 rectifiers on a
printed circuit board 2 1/4" x 2 3/4"



Doubler socket

Half-wave socket



Sockets from Fastex Division, Illinois Tool Works

for plug-in sockets and printed circuits

This new series of silicon rectifiers is especially suited for use in printed circuit assemblies, or can be plugged directly into special sockets to facilitate assembly and servicing. Insulated case—1 1/32" x 3/16" x 1/4" high—eliminates many mounting problems. Leads are on 7/32" centers.

Reliability is excellent—in part because the construction minimizes axial strain on the junction. Special Tarzian oversize junctions increase inrush current protection, contribute to low voltage loss, and lengthen useful life in this as in other Tarzian silicon devices. Prices are realistic.

Complete line catalog available. Application engineering assistance is also available without obligation. Send for data sheet.

Tarzian Type	Amps DC (85°C)	PIV	Maximum RMS Volts	Maximum Recurrent Peak	Amps Surge (4MS)
12	.75	200	140	7.5	75
14	.75	400	280	7.5	75
16	.75	600	420	7.5	75



SARKES TARZIAN, INC.

World's Leading Manufacturers of TV and FM Tuners • Closed Circuit TV Systems • Broadcast Equipment • Air Trimmers • FM Radios • Magnetic Recording Tape • Semiconductor Devices

SEMICONDUCTOR DIVISION • BLOOMINGTON, INDIANA

In Canada: 700 Weston Rd., Toronto 9 • Export: Ad Auriema, Inc., New York

CIRCLE 74 ON READER-SERVICE CARD

NEW PRODUCTS

Self-Locking Fastener

478



Clip-on, self-locking fastener type LHA4972 can be used on any sheet-metal or fiber-glass assembly where the 0.02-in. clip thickness between mating surfaces can be tolerated. A locating eyelet formed on the base plate snaps into a hole drilled or punched in the sheet.

Elastic Stop Nut Corp. of America, Dept. ED, 2330 Vauxhall Road, Union, N. J.

Subminiature Lamps

590



Drawing 5 ma, Micro Lamps operate on 1.2 or 1.5 v. Light output is 40 to 60 millilumens. Minimum life is 1,000 hr. Five types are available with sizes ranging from 0.134 in. length x 0.039 in. diam. to 0.177 in. length x 0.079 in. diam.

Miniature Lamp Engineering Co., Dept. ED, 350 Broadway, New York 13, N. Y.

Polyester Belts

579



Endless flat flexible belts are available in any length. Belts made of DuPont Mylar come in widths from 1/4 in. or less to 60 in., and thickness from one to 10 mils or more. Belts made of DuPont Cronar are available with standard perforations and widths from 16 to 70 mm, and thickness of 4 or 7.5 mils.

International Ultrasonics, Inc., Dept. ED, 331 Centennial Ave., Cranford, N. J.

Power Supply

489



Chopper-stabilized, dual-regulated power supply model PS/200/3.5 provides simultaneous outputs at 0 to 200 ma of -300 and $+300$ v dc. Hum, noise and ripple are less than $200 \mu\text{v rms}$; load regulation, line regulation and drift are within 0.001% . Uses are simulation, analog computing and sensitive-instrument applications.

Embree Electronics Corp., Dept. ED, West Hartford, Conn.

Three-Phase Transformers

604

Size is $1 \times 1 \times 17/32$ in. for the series SX transformers. Units are hermetically sealed in accordance with MIL-T-27A, grade 5, class R. Primary windings can be provided to handle any voltage up to 200 v at 400 cps. Secondary windings can be provided to produce any voltage up to 200 v at 2 watts output.

Titan Transformer Co., Dept. ED, 229 Binney St., Cambridge, Mass.

Semiconductor Strain Gage

598



An ultra-thin semiconductor strain gage, model MS632-120 has a U-shaped configuration with leads on the same end. It is proof-tested to 3,000 microstrain, and has an ultimate strain capacity of 5,000 microstrain. Gage factor is 110 with a resistance of 120 ohms. Operational temperature range is from -320 to $+400$ F.

Micro Systems, Inc., Dept. ED, 319 Agostino Road, San Gabriel, Calif.

P&A: \$98 for a package of four; immediate.

CIRCLE 75 ON READER-SERVICE CARD

General Instrument Planar Transistors



At last! A truly passivated planar! New 2N708 silicon switch

For high speed logic switching with assured reliability, the General Instrument 2N708 npn silicon planar switch features the unique Molecular Shield™ surface-passivation process. ■ Here's a planar that is stable, reliable and uniform...lot by lot...with excellent gain characteristics as well as extremely low leakage current. Designed for switching applications, this type, as well as others in the popular 2N706 class, utilizes the latest planar techniques. ■ Extensive tests have proved that this type of transistor construction offers definite circuit advantages. Life tests, for example, indicate little degradation as a result of operation and storage at high temperatures. ■ The immediate availability of the 2N706 series in production quantities should be of interest to designers now using our silicon mesa transistors. The 2N708 is also available in limited quantities. For microtransistors, pancake-package transistors...for all your silicon planar and mesa transistors, call the sales office or franchised distributor nearest you. Or write for complete details to General Instrument Semiconductor Division, 65 Gouverneur St., Newark 4, N. J.

Abbreviated Specifications—General Instrument NPN Silicon Planar Transistors

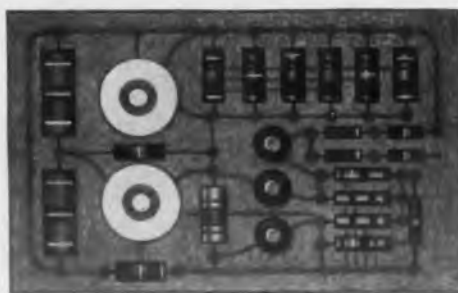
Type	V_{CE0}	V_{CEB}	h_{FE}	T_s
2N706	25v	20v	20	60 nsec
2N706A	25v	20v	20	25 nsec
2N706B	25v	20v	20	25 nsec
2N708	40v	20v	30	25 nsec

GENERAL INSTRUMENT SEMICONDUCTOR DIVISION
GENERAL INSTRUMENT CORPORATION





printed circuits now live longer in severe environments



BTR® (Broad Temperature Range)
ELASTOMER BONDED BETWEEN
EPOXY-FIBERGLASS SHEETS



Lord Dyna-damp® Circuit Boards
Introduce higher reliability
and greater design freedom

Higher reliabilities are now within reach—Lord has added built-in damping to printed circuitry.

Here's what Lord Dyna-damp Circuit Boards can mean for your aerospace application: control of resonant response . . . amplitudes and G levels reduced to only 1/2 the response of standard boards . . . protection of sensitive components against vibration, shock, noise . . . tighter spacing of boards in high-density packages . . . freedom to use lighter, smaller, less rugged components.

Excellent damping is unaffected by time, operating temperature, frequency,



FIELD ENGINEERING OFFICES
ATLANTA, GEORGIA - Cedar 7-9247
BOSTON, MASS. - Hancock 5-9135
CHICAGO, ILL. - Michigan 7-8010
DALLAS, TEXAS - Riverside 2-1202
DAYTON, OHIO - Balmori 4-0351
DETROIT, MICH. - Elgin 7-2150
KANSAS CITY, MO. - Westport 1-3138
LOS ANGELES, CAL. - Hollywood 4-7693
NEW YORK, N. Y. - Esperanza, N. J. - New York City - Bryant 9-2042
Paramus, N. Y. - Diamond 2-6225
PHILADELPHIA, PA. - Pennsylvania 9-8509
SAN FRANCISCO, CAL. - Embarcadero 7-6790
WINTER PARK, FLA. - Midway 7-5501
In Canada—Railway & Power Engineering Corporation Limited

LORD MANUFACTURING COMPANY • ERIE, PA.

CIRCLE 76 ON READER-SERVICE CARD

weathering, corrosive conditions, normal processing.

You can use Dyna-damp Boards with no change in your processing. They can be soldered, etched, solvent-cleaned, thru-plated, drilled, sheared, punched. Available in 18" x 18" size with NEMA G-11 skin (MIL Spec. P-13949B). Unclad, or clad one or both sides with 2 oz. copper. Three thicknesses: 1/16", 3/32", 1/8".

Get detailed information on this latest advance in vibration/shock/noise control from your nearest Field Engineering Office listed here or the Products Dept., Erie, Pennsylvania.

NEW PRODUCTS

Laboratory Kit

594



Two models, SK-1 and SK-2, of laboratory service kits combine three functions in one housing. Included are a 25-w pencil type iron for printed circuit soldering, a continuity checker and convenience outlet box. SK-1 has a 6-v iron, SK-2 has a 110-v iron.

C.B.C. Electronics Co., Inc., Dept. ED, 2601 N. Howard St., Philadelphia, Pa.

Tape Punch

596



Model P76 tape punch is for punching 5, 6, 7, and 8-channel paper or mylar-aluminum tape at the rate of 20 characters per sec. It measures 15 in. in width, 14-1/2 in. in depth and is 21 in. in height with cover open. Weight is 40 lb.

General Instrument Corp., Systematics Div., Dept. ED, 3216 W. El Segundo Blvd., Hawthorne, Calif.

Availability: 30 days.

Insulation-Leakage Tester

475



Breakdown tests and insulation leakage can both be measured by model 8527 test set. The Hypot section provides 0 to 1.5 kv ac, continuously variable, with readout lights to indicate breakdown and leakage current above a preset value. The Vibrotest megommeter section measures insulation resistance to 50 K.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago, Ill.

CIRCLE 79 ON READER-SERVICE CARD ➤

COPYRIGHT 1961

BRUSH INSTRUMENTS

DIVISION OF CLEVITE CORPORATION

CLEVELAND, OHIO

**unmatched
peak in
penmanship . . .**



The totally new **Brush Recorder Mark 200** made these incredibly crisp tracings. No other recorder in existence can match them. Note the line width. It never varies . . . regardless of writing velocity, regardless of chart speed. The writing mechanism is electrically signaled by the position-seeking "Metrisite" transducer . . . no parts to wear, infinite resolution, verifiable dynamic $\pm 2\%$ accuracy. Traces are permanent, high-contrast, reproducible . . . on low cost chart paper. The Mark 200 has but three standard controls . . . attenuator, pen position, chart speed. Such fidelity, simplicity and economy are possible with no other direct writing recorder. Write for details . . . they'll speak for themselves.

brush **INSTRUMENTS**
DIVISION OF
37TH AND PERKINS **CLEVITE** CLEVELAND 14, OHIO
CORPORATION



PRECISION HIGH FREQUENCY ATTENUATORS

DC TO 500 MEGACYCLES

- 50, 70, or 90 ohm impedance
- High-Frequency, Precision Teflon & Silver Switches
- 1% Carbon Film Resistors ■ Fully Shielded Units
- Up to 101 db ■ Fixed 0 or 10 db insertion loss
- SWR: 1.2 : 1 max up to 250 mc
1.4 : 1 max 250 to 500 mc
- Min. Insertion*: 0.1 db at 250 mc; 0.2 db at 500 mc
- Accuracy: At Full Attenuation: 0.5 db at 250 mc, 1.2 db from 250 to 500 mc
- Price: (Model 20) \$79.00 f.o.b. factory
(\$87.00 F.A.S. N. Y.)

*Zero insertion loss (Model 20-0) \$75.00 f.o.b. factory

KAY ELECTRIC COMPANY
DEPT. ED-5 • MAPLE AVENUE • PINE BROOK, N. J. • CAPITAL 6-4000

Write for
Catalog Information

KAY ELECTRONIC INSTRUMENTS

Sweeping Oscillators
Frequency Markers

Audio Spectrum Analyzers

Pulse — Pulsed RF Generators

Precision Attenuators

Random Noise Generators

Kilo-Sweeps®

Rada-Sweeps®

Ligna-Sweeps®

Sona-Sweeps®

Marka-Sweeps®

Vari-Sweeps®

Mega-Sweeps®



CIRCLE 78 ON READER-SERVICE CARD

AC Gear Motors

403



Fractional horse-power ac gear motors are available in hysteresis synchronous and low-slip induction types. Both can be supplied to meet customer requirements, with a torque range of up to 300 oz-in. at 1 rpm in the induction units. Lengths of the units are from 3-1/4 to 6 in.

Ashland Electric Products, Inc., Dept. ED, 32-02 Queens Blvd., Long Island City 1, N. Y.

Feed-Through Capacitors

700



Eyelet feed-through capacitors have an integral form for mounting, eliminating the need for solder preforms in chassis assembly operations. Type 7427 has a center lead, type 7528 has no lead; both have a capacity of 1,000 pf with a 500 vdc.

Aerovox Corp., Hi-Q Div., Dept. ED, Myrtle Beach, S.C.

Wide Band Oscilloscope

360



Range is dc to 5 mc on oscilloscope model ES-150. Sensitivity is 70 mv per in. for dc and 25 mv rms per in. for ac. Frequency response is down 3 db at 4.5 mc and down 5 db at 5 mc. Rise time is better than 0.08 μ sec. Input impedance is 1.5 meg.

Precision Apparatus Co., Inc., Dept. ED, 70-31 84th St., Glendale 27, N. Y.

Price: \$149.95.

PULSE POINTERS

Precision E-P double pulse generator provides separate or mixed output

Features fast rise time and calibrated controls

One of the most flexible units in the broad *Electro-Pulse* instrument line, the precision double pulse generator provides an excellent general-purpose instrument combining high versatility and high accuracy.

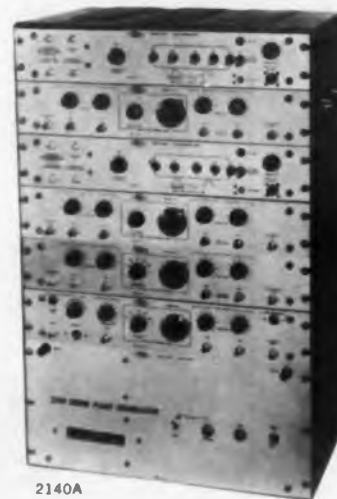
A multiplicity of output signals (both separate and mixed), high power, accuracy to 0.5%, fast 0.02 μ sec rise time, and rep rate to 100 kc make the instrument applicable to a broad range of pulse simulation and control problems.

Integral accurate calibrated controls make it easy to set up reliable output parameters on the instrument itself, rather than relying on calibration and monitoring equipment. Add traditional *Electro-Pulse* modular flexibility . . . and you realize impressive savings both in time and dollars.

A standard of comparison for pulse generating equipment, the instrument is particularly adaptable to programmed operation in conjunction with semi-automatic checkout systems.

The precision pulse generator has been specified as standard ground support and test equipment for major digital computers and as part of aircraft weapons systems.

Other applications include: telemetry development, radar echo simulation, RF and microwave modulation, and a broad range of transient test and general pulse circuitry applications.



2140A

For special applications, the modular block units may be interconnected, as required, by front panel patching or special plug-in signal cables to give a broad variety of configurations.

Where extensive modifications are called for, the instrument can be furnished in fully equivalent modular plug-in form, allowing even greater flexibility in tailoring to custom applications.

One of 33 cataloged instruments in the broad *Electro-Pulse* line (which includes as many as 200 standard pulse and digital circuit modules—both tube and transistor types), the E-P precision pulse generator couples advanced pulse techniques and circuitry with traditional Servo Corp. instrument quality and reliability.

Fill in coupon for details.



2320A

E-P Time Delay and Gate Generators

Generate trigger-type outputs at accurately controllable delays from external triggers or from an internally generated sync pulse. E-P gate pulse and linear triangle outputs are also available, with precise control of duration.



2210A

Servo Corporation of America
111 New South Road
Hicksville, L. I., N. Y.

Gentlemen:

- Please send detailed catalog.
- Please contact me for demonstration.
- Please send me a free SERVO slide rule.

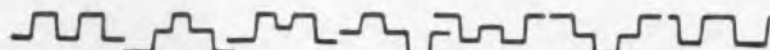
(name)

(title)

(organization)

(address)

(city, zone, state)



A few of the mixed output possibilities: 0.5 μ s wide; 25 v pulses; 93 ohm load.



Electro-Pulse Products

SERVO CORPORATION OF AMERICA

111 New South Road • Hicksville, L. I., N. Y. • WE 118-9700

Sales & service offices coast-to-coast • Representatives in major cities

single pulse generators • double pulse generators • word generators • pulse train and pulse code generators • time delay and gate generators • current generators and core testers • modules

CIRCLE 80 ON READER-SERVICE CARD

NEW PRODUCTS AT NEC

Rigid Coaxial Line

679



For high-power transmissions, this rigid coaxial transmission line is available in either aluminum or copper. The 75-ohm line is 6-1/8 in. in diameter; 50-ohm line comes in different sizes. Straight sections, connectors, elbows, hardware and accessories are available. The line can be pressurized and dehydrated.

Technical Appliance Corp., Dept. ED, Sherburne, N. Y.

Price: \$13 per ft.

See at NEC Show Booth 850.

Ratio Transformer

574



Accuracy of 0.001% is provided by the model RT-60 ratio transformer. Operating range is 50 to 10,000 cps. Unit has high input impedance, low effective series impedance, and low phase shift. Five decades of shifting are provided. Housed in a cast aluminum case, the instrument is made as a bench model, but can be adapted for rack mounting.

Gertsch Products, Inc., Dept. ED, 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

P&A: \$275; from stock.

See at NEC Show Booth 709.

10-Mc Frequency Counter

572



Accurate within one count at 10-mc frequencies, the model 5370 counter has digital display output. Oscillator stability is 3 parts in 10^7 per week. Sensitivity is 0.2 v rms. Instrument measures frequencies from dc to 10 mc, time intervals from 0.3 μ sec to 10^7 sec, periods from 0 to 10 mc, and ratios from 1 to 10^7 from dc to 10 mc. Circuitry is all solid-state.

Beckman Instruments, Berkeley Div., Dept. ED, 2200 Wright Ave., Richmond 3, Calif.

P&A: \$2,750; available in November.

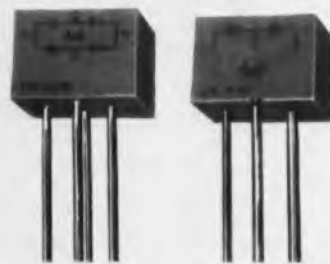
See at NEC Show Booth 644.

New from Mallory

Hermetically sealed 125°C silicon



Cut your costs



rectifiers at economical prices

For the first time, you can now get a glass-to-metal sealed silicon rectifier capable of 125°C operation . . . at a cost substantially lower than that of "top hat" types. It's the new Mallory Type D rectifier. It brings you a combination of small size, premium performance and down-to-earth economy which opens broad design opportunities in home instruments and commercial and industrial products.

New performance. Take a look at the specifications for three typical ratings. Compare forward drop, leakage current and ambient temperature ratings against any other

rectifier in this price range. Peak reverse voltage ratings from 50 to 600 volts are available.

New miniaturization. Only 0.240" in diameter and 0.405" long, the Type D is ideal for high density packaging. It can be supplied with an insulating sleeve.

New reliability. The Type D is the result of over four years of Mallory research in semiconductor development and production. Our unique cell construction and manufacturing techniques, coupled with the most exacting quality control, assure exceptionally high level of product quality delivered to your plant.

Our engineers are well qualified to help you utilize the new characteristics of Mallory silicon rectifiers in your present or planned circuits. Write today for data and for a consultation.

Mallory Semiconductor Company
Du Quoin, Illinois

P. R. MALLORY & CO. Inc.
MALLORY

with Mallory packaged rectifier circuits

You can reduce prime component costs, and make important added savings in stocking, handling, wiring and assembly costs with Mallory rectifier circuits.

In a single compact package, encapsulated in moisture-impervious resin, you get a complete full wave or doubler circuit . . . ready to mount on a chassis or printed circuit, ideally suited for automated assembly, with cold case for maximum mounting flexibility. The same basic rectifier elements are used as in the Type D sealed rectifier . . . high in reliability,

premium in performance. Type VB doubler circuits come as a 3-terminal package with 400 and 600 PRV ratings, delivering .5 ampere at 100°C and .75 ampere at 50°C ambient. Type FW full wave rectifiers are 4-terminal packages; rated 200, 400 or 600 volts; 1.0 ampere at 100°C, 1.5 amperes at 50°C. Full wave center tap circuits with positive or negative polarity can be supplied.

Write for our new Technical Data Bulletins: No. 11-8 on the Type FW, and 11-9 on the Type VB.

CIRCLE 81 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

DC Microvoltmeter

663



Inputs from 100 μ v to 1000 v full scale are available on the model 127A-L dc microvoltmeter in 15 ranges. Input impedance is 1 to 60 meg. Output is 2.5 v dc at 1 ma. Basic accuracy is 1%. Instrument has individual calibration controls.

Millivac Instruments, Inc., Dept. ED, P. O. Box 997, Schenectady, N. Y.
P&A: \$395; 2 to 4 weeks.

See at NEC Show Booth 8.

Brakes and Clutches

683



Fractional horsepower brakes and clutches have diameters from 1 to 4 in. Torque ratings are 1.5 to 240 lb-in. Devices operate at cycle rates of 50 per sec.

Warner Electric Brake and Clutch Co., Dept. ED, Beloit, Wis.

See at NEC Show Booth 841.

Contour Switch Knobs

668



Positive finger grip is said to be assured on these series M-1177 and 1178 contour switches. Knobs are made for the firm's Telever line of switches. Red, black, and milky-white knobs are available.

Switchcraft Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

See at NEC Show Booth 537.

PERFORMANCE RELIABILITY WITHOUT COMPROMISE

FOR ON-COURSE GUIDANCE



MINIATURE
INERTIAL REFERENCE

GYROS



ZERO-ONE

The finest inertial gyro available
Trimmed drift rate: 0.01 degrees/hour
Size: 2.8 inches by 2.0 inches
Weight: 0.7 pounds
Angular momentum: 280,000 cgs units

Qualified engineers seeking rewarding opportunities in these advanced fields are invited to get in touch with us.



REEVES INSTRUMENT CORPORATION
A Subsidiary of Dynamics Corporation of America
Roosevelt Field Garden City, New York

9RV61

CIRCLE 82 ON READER-SERVICE CARD

NEW PRODUCTS AT NEC

1-Kw Bridge Rectifier

681



Occupying less than 0.25 cu in., the model 7702-2 bridge rectifier provides 1 kw dc power. Device is rated at 2,000 v piv, 750 ma average forward current. Reverse current at 25 C is 1 μ a max. Operating ambient temperature is -55 to +150 C. Unit is epoxy encapsulated; circuit is insulated from mounting stud.

Varo Inc., Dept. ED, 2201 Walnut St., Garland, Tex.

See at NEC Show Booth 845-847.

Lever Switches

678



Single and multiple lever switches, series LK and MLK, have two or three positions, locking or non-locking. Contacts are silver or palladium, rated 3 amp, 300 w max. Switch extends 2-3/32 in. deep behind mounting panel. Units are made for talk-listen applications.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

See at NEC Show Booth 537.

Core Memory Systems

571



From 20,480 to 163,840 bit storage capacities with access times of 2.5 to 4 μ sec and read-write cycle times of 5 to 10 μ sec are obtained with this line of 1-mc S-PAC digital modules, series TCM. Cards measure 19 x 18 x 24-1/2 in. Ambient temperature range is 0 to 50 C.

Computer Control Co., Inc., Dept. ED, 983 Concord St., Framingham, Mass.

P&A: about \$0.25 per bit; 2 to 4 months.

See at NEC Show Booth 214.

**Immediate
delivery!**
ELMENCO
CAPACITORS
in quantities up to
500 Per Item
CONTACT THESE AUTHORIZED
ELMENCO INDUSTRIAL DISTRIBUTORS

ARIZONA: Radio Specialties & Appl. Corp., 917 N. 7th St., Phoenix.

CALIFORNIA: Brill Elect., 610 E. 10th St., Oakland; Electronic Supply Corp., 2085 E. Foothill Blvd., Pasadena; Federated Purchaser Inc., 11275 W. Olympic Blvd., L. A. 64; Hollywead Radio & Electronics Inc., 5250 Hollywood Blvd., Hollywood 27; Newark Electronics Corp., 4747 W. Century Blvd., Inglewood; Pacific Wholesale Co., 1850 Mission St., San Francisco 3; Peninsula Elect., 656 S. 1st St., San Jose; Shanks & Wright Inc., 2045 Kettner Blvd., San Diego; Shelley Radio Co. Inc., 2008 Westwood Blvd., L. A. 25; R. V. Weatherford Co., 6921 San Fernando Rd., Glendale 1; Zack Electronics, 654 High St., Palo Alto.

COLORADO: Denver Electronics Supply Co., 1254 Arapahoe St., Denver 4.

DISTRICT OF COLUMBIA: Capitol Radio Wholesalers Inc., 2120 14 St., N.W., Wash., D. C.

FLORIDA: Elect. Supply, 1301 Hibiscus Blvd., Melbourne; Elect. Supply, 81 N. E. 9th St., Miami.

ILLINOIS: Newark Electronics Corp., 223 W. Madison St., Chicago 6.

MARYLAND: D & H Distributing Company, Inc., 2025 Worcester St., Baltimore 30; Kern-Elliott Electronics, Inc., 2050 Rock Rose Avenue, Baltimore; Wholesale Radio Parts Co. Inc., 308 W. Redwood St., Baltimore 1.

MASSACHUSETTS: Cramer Electronics Inc., 811 Boylston St., Boston 16; Radio Shack Corp., 730 Commonwealth Ave., Boston 17.

NEW JERSEY: Federated Purchaser Inc., 1021 U.S. Rte. 22, Mountainside; General Radio Supply Co., 600 Penn St., Camden 2; Radio Elec. Service Co., Inc., 513 Cooper St., Camden 2.

NEW MEXICO: Electronics Parts Co., Inc., 222 Truman St., N. E., Albuquerque; Midland Specialty Co., 1712 Lomas Bl. N.E., Albuquerque; Radio Specialties Co., Inc., 209 Penn Ave., Alamogordo.

NEW YORK: Arrow Elect. Inc., 525 Jericho Turnpike, Mineola, L. I.; Electronic Center, Inc., 160 5th Ave., N. Y.; Harvey Radio Co., Inc., 103 W. 43rd St., N. Y. 36; Lafayette Radio Elect. Corp., 100 Sixth Ave., N. Y. 13; Stack Industrial Elect. Inc., 45 Washington St., Binghamton, Terminal Hudson Elect. Inc., 236 W. 17th St., N. Y. 17.

NORTH CAROLINA: Dalton-Noge Radio Supply Co., Inc., 938 Burke St., Winston-Salem.

PENNSYLVANIA: Ajmo Radio Co., 913 Arch St., Philadelphia; George D. Barbey Co. Inc., 622 Columbia Ave., Lancaster; George D. Barbey Co. Inc., 2nd & Penn Sts., Reading; D. & H. Distributing Co., Inc., 2535 N. 7th St., Harrisburg; Phila. Elect. Inc., 1225 Vine St., Phila. 7; Radio Elec. Service Co., Inc., 701 Arch St., Phila. 6; A. Steinberg & Co., 2520 N. Broad St., Phila.; Wholesale Radio Parts Co., Inc., 1650 Whitford Rd., York.

TENNESSEE: Electra Distributing Co., 1914 West End Ave., Nashville 4.

TEXAS: All-State Elect. Inc., 2411 Ross Ave., Dallas 1; Busacker Elect. Equip. Co. Inc., 1216 W. Clay, Houston 19; Engineering Supply Co., 6000 Denton Dr., Dallas 35; Midland Specialty Co., 500 W. Paisano Dr., El Paso; The Perry Shankle Co., 1801 S. Flores St., San Antonio.

UTAH: Carter Supply Co., 3214 Washington Blvd., Ogden.

WASHINGTON: C & G Radio Supply Co., 2221 Third Ave., Seattle.

CANADA: Electro Sonic Supply Co., Ltd., 543 Yonge Street, Toronto 5, Ont.

ARCO electronics inc
NEW YORK • DALLAS • LOS ANGELES
Exclusive Supplier of ELMENCO Capacitors to
Distributors and Jobbers in U.S.A. and Canada

CIRCLE 83 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

**SELECTED BY
RCA
FOR
A HIGH
RELIABILITY
* PROJECT**



Here is MEASURED RELIABILITY!

Ten thousand El-Menco high reliability dipped mica capacitors were put on life test at 85°C with 225% of the rated DC voltage applied in accordance with an RCA high reliability specification.

*After 22,000,000 actual test unit-hours no** failures of any type occurred*

The accumulated 22 x 10⁶ test unit-hours without any failures can be used to calculate many different failure rates depending upon the confidence level desired. However, we shall explore the meaning of the results at a 90% confidence level.

Assuming no acceleration factor for either temperature or voltage, we have verified a failure rate of approximately .01% per 1000 hours. (Actually, there is a temperature effect and it has been found that, with the DC voltage stress remaining constant, the life decreases approximately 50% for every 10°C rise in temperature. There is also a voltage effect such that, with the temperature stress remaining constant, the life is inversely proportional to the 8th power of the applied DC voltage.)

Assuming no temperature acceleration factor and assuming the voltage acceleration exponent is such as to yield an acceleration factor as low as 100, we have nevertheless verified a failure rate of approximately .0001% per 1000 hours.

Assuming no temperature acceleration factor and assuming the voltage acceleration factor is on the order of 250 (test results are available to confirm this) we have accumulated sufficient unit-hours to verify a failure rate of less than .00005% per 1000 hours!

Note that all the above failure rates are calculated at a 90% confidence level!

* The El-Menco high reliability dipped mica capacitors are being supplied to the Radio Corporation of America for a high reliability military ground electronics project.

** A failure was defined as follows:

1. A short or open circuited capacitor occurring during life test.
2. A part whose capacitance changed more than $\pm 2\%$ and whose capacitance did not fall within the original tolerance of $\pm 5\%$.
3. A part whose final dissipation factor exceeded .002.
4. A part whose final insulation resistance measured less than 100,000 megohms.

Write for a copy of our "Reliability Study of Silvered Mica Capacitors".

El-Menco
Capacitors

THE ELECTRO MOTIVE MFG. CO., INC.

Manufacturers of El-Menco Capacitors

WILLIMANTIC CONNECTICUT

• molded mica • mica trimmer • dipped mica • silvered mica films
• tubular paper • mylar-paper dipped • ceramic feed thru • ceramic discs
Arco Electronics, Inc., Community Drive, Great Neck, L.I., New York
Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada
WEST COAST MANUFACTURERS CONTACT:
COLLINS ELECTRONIC SALES, INC., 535 MIDDLEFIELD ROAD, PALO ALTO, CALIFORNIA

CIRCLE 84 ON READER-SERVICE CARD

a New and superior latching P&B relay



LIES FLAT FOR GREATER PACKAGE DENSITY, HIGHER PERFORMANCE



This DPDT, permanent magnet, latching relay is superior on these counts: (1) shorter height for maximum compactness between stacked circuit boards; (2) greater sensitivity (80 milliwatts); (3) better vibration resistance (30 g to 2000 cps); (4) better shock resistance (100 g).

Designated the FL Series, this relay meets all applicable sections of MIL-R-5757D, MIL-R-6106C and ABMA #PD-R-187.

Call your nearest P&B representative today for complete information about the whole P&B family of microminiature relays.

FL SERIES SPECIFICATIONS

Contact Arrangement: DPDT

Shock: 100 g for 11 milliseconds with no contact openings.

Vibration: .10g; max. excursions, 10 to 50 cps, 20 g from 50 to 2000 cps. No contact openings.

Linear Acceleration: 400 g minimum with no contact openings.

Pull-In: 150 milliwatts, approx. (standard) at 25°C. coil temperature.

80 milliwatts, approx. (sensitive) at 25°C. coil temperature

Operate Time: 3 milliseconds max. at nominal voltage at 25°C. coil temperature

Dimensions: .485" high, 1.100" long, .925" wide



Printed circuit board using 4 FL relays was designed by the Martin Company, Orlando, as part of ground support equipment for a major missile project.

THERE'S A **P&B**
CRYSTAL CASE RELAY
FOR YOUR PROJECT

Diode in relay case is used for arc suppression in special applications. Four diodes form full-wave bridge rectifier for 400 cycles.



Non-latching or latching relays in conventional crystal cases with or without shoulder brackets, studs or mounting plates. All types of terminals are available.



Terminals spaced on .200" grids are available on all P&B microminiature relays. These carry a "G" suffix (SCG and SLG) and are .890" high, .800" wide, .400" deep, max.

These 3 relays are shown slightly reduced in size.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONICS PARTS DISTRIBUTOR



POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY • PRINCETON, INDIANA
IN CANADA: POTTER & BRUMFIELD, DIVISION OF AMF CANADA LIMITED, GUELPH, ONTARIO

NEW PRODUCTS AT NEC

Vertical Rack Cabinet Enclosure 566

A variety of colors are available in this series of vertical rack cabinet enclosures. Hardware made especially for the cabinets includes extruded black anodized hinges, handles, pulls, and nylon-protected panel screws. Sides are readily removable from outside. Corners are reinforced. Side struts can be moved or removed for equipment installation. Doors are removable and do not sag.

Equipto Electronics Corp., Dept. ED, 319 N. Webster St., Naperville, Ill.

See at NEC Show Booth 744.

Static Voltage Regulator 565



Nominal output of 115 v is adjustable from 110 to 120 v on the Sta-Vo-Trol static voltage regulator. Rated output is 1 kva. Accuracy is within 0.25% bandwidth. Unit has Zener-diode sensing, remote response and sensing, and has no moving parts.

General Electric Co., Transformer Div., Dept. ED, 100 Woodlawn Ave., Pittsfield, Mass.

See at NEC Show Booth 605-613.

Rotary Wire Stripper 560

Portable rotary wire stripper operates where bench models are inconvenient, as in stripping wires from large panels, air frames, heavy harnesses and multi-conductor cables. Designated model 79, the device strips extruded or wrapped insulations, including Teflon, without nicking the conductor. Complete unit weighs 7-1/2 oz; hand-piece weighs 12 oz.

Carpenter Manufacturing Co., Inc., Dept. ED, P. O. Box 217, DeWitt 14, N. Y.

P&A: \$250; two weeks.

See at NEC Show Booth 804.

◀ **CIRCLE 85 ON READER-SERVICE CARD**

IN ELECTRONICS...AVIONICS...ASTRONICS

STEMCO THERMOSTATS

RANK FIRST
IN
PRECISION TEMPERATURE CONTROL

In today's military and commercial projects, you can't afford to overlook any one of these important areas: Reliability, Size, Availability, Economy.

And because Stevens is in production now on the largest number of different types and styles of bimetal thermostats, all these advantages are yours automatically when you specify Stemco thermostats.

1st in Reliability. Proven designs, latest production techniques, most stringent inspection procedures.

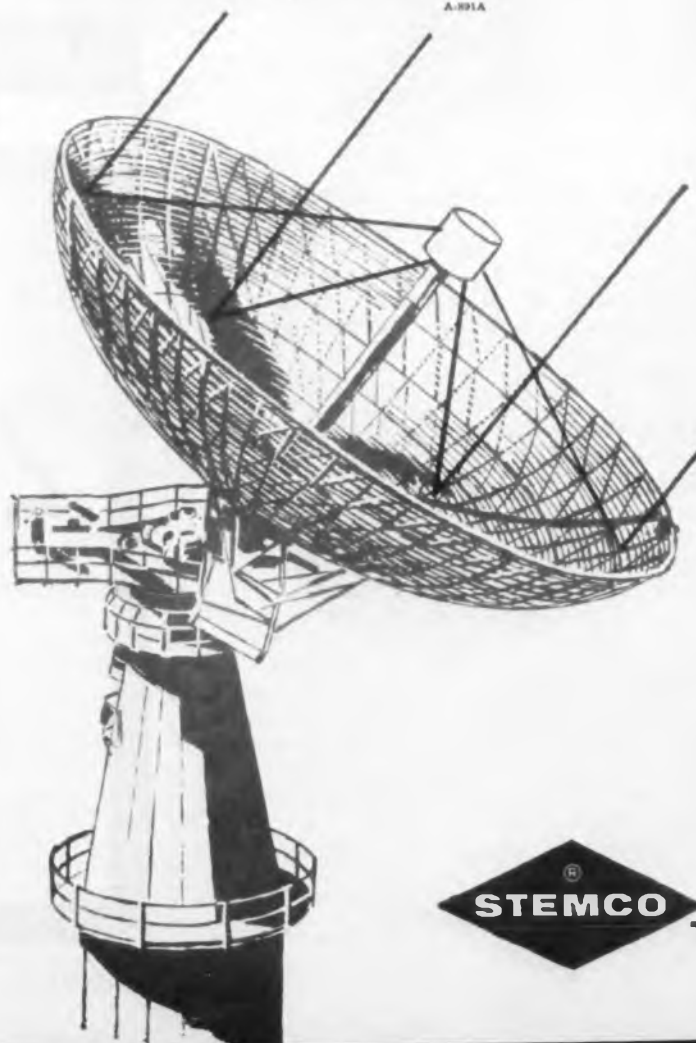
1st in Size. Stemco thermostats score in compactness and lightness without sacrificing performance.

1st in Availability. Tooling for most types is in existence. Flexibility of design cuts lead time on other types.

1st in Economy. Mass production of many standard Stemco types with hundreds of terminal arrangements and mounting brackets cuts your costs.

**Refer to Guide 400EO for U.L. and C.S.A. approved ratings.*

A-391A



TYPE A* semi-enclosed. Bimetal disc type snap action thermostats; give fast response to temperature changes. Can be made to open on rise or close on rise. Single-throw with double make and break contacts. Operation from -20 to 300°F. Lower or higher temperatures on special order. Average non-inductive rating 13.3 amps, 120 VAC; 4 amps, 230 VAC and 28 VDC. Various mountings and terminals available. Bulletin 3000.

TYPE A hermetically sealed. Electrically similar to semi-enclosed Type A. Various mountings, including brackets, available. Bulletin 3000.

TYPE MX hermetically sealed. Snap acting bimetal disc type units to open on temperature rise. 2 to 6°F differentials as standard. 1 to 4°F differentials available on special order. Depending on duty cycle, normal rating 3 amps, 115 VAC and 28 VDC for 250,000 cycles. Various terminals, mountings and brackets available. Bulletin 6100.

TYPE MX semi-enclosed. Construction and rating similar to MX hermetically sealed type. Bulletin 6100.

TYPE M hermetically sealed. Bimetal disc type, snap acting thermostats. Also available in semi-enclosed. Operation from -20 to 300°F. Lower and higher temperatures available on special order. Depending on application, rated non-inductive 10 amps, 120 VAC; 3 amps, 28 VDC. Various terminals, wire leads and brackets available. Bulletin 6000.

TYPE C hermetically sealed. Also semi-enclosed styles. Small, positive acting with electrically independent bimetal strip for operation from -10 to 300°F. Rated at approximately 3 amps, depending on application. Hermetically sealed type can be furnished as double thermostat "alarm" type. Various terminals and mountings. Bulletin 5000.



Rack Cabinet Enclosures 567

Vertical rack cabinet enclosures have sloping fronts. Sides are easily removed from outside of cabinet. Side strut supports can be moved or removed to facilitate equipment installation. Slope inclines at 15 deg.

Equipto Electronics Corp., Dept. ED, 319 N. Webster St., Naperville, Ill.

See at NEC Show Booth 714.

NOR Circuit Modules 568

Operating at 1 mc rates, this line of NOR circuit modules includes a dual NOR circuit, a dual power driver, and a converter. Designated models U-301, U-302, and U-303 respectively, the units combine to make flip-flop, one-shot, and multivibrator circuits. Power requirements are ± 12 v and -6 v dc, $\pm 5\%$. Signal amplitude is between -5.5 and -12.6 v.

Engineered Electronics Co., Dept. ED, 1441 E. Chestnut Ave., Santa Ana, Calif.

P&A: \$12 to \$29; stock to 2 weeks.

See at NEC Show Booth 533 to 535.

Logic Symbol Sticker Kit 563

For use with the firm's modules, this kit contains a complete set of symbol stickers for digital logic circuits. They are drawn in ink, photographically reduced, and printed on acetate overlay with a pressure-sensitive backing. Stickers are useful in preparing engineering drawings and handbooks.

Computer Control Co., Inc., Dept. ED, 983 Concord St., Framingham, Mass.

Availability: from stock.

See at NEC Show Booth 214

Serial Number Markers 562

For marking electronic components, these serial number markers come in 0.06 x 0.2 and 0.12 x 0.2 in. sizes. Markers adhere to component body in ambient temperatures up to 300 C. Special information such as company trademark can also appear on markers. A variety of materials are available.

W. H. Brady Co., Dept. 138, Dept. ED, 727 W. Glendale Ave., Milwaukee 9, Wis.

See at NEC Show Booth 229.

CIRCLE 86 ON READER-SERVICE CARD >

STEMCO

THERMOSTATS

STEVENS manufacturing company, inc.
P.O. Box 1007, Mansfield, Ohio

COLOR ILLUMINATED LEVERS!

A NEW
LEVER SWITCH WITH
"INDICATOR-TYPE"
LIGHTING



It's Red

It's White

It's Amber



Patent Applied For

THE SWITCHCRAFT "LEVER-LITE"

For the first time, an illuminated switch designed to color code your switching positions! One switch, one lamp — replaces an ordinary switch and up to 3 indicator lamps. Reduces panel space! Eliminates costly wiring!

The "Lever-Lite" Switch, Series 25000, combines fast action multiple-circuit switching — in 2 or 3 position action — locking or non-locking types with "human-engineered" illuminated colors. The serrated lever actuator adds dimensional visibility for greater operator reaction. Your choice of these colors — Red, Green, Amber, White. Utilizes a miniature 6V screw base lamp.

The "Lever-Lite" is applicable to many control panels where space is at a premium — illumination is desirable and where the proven dependability of leaf-type switching is needed. Write for Bulletin E-505.

BOOTH 537 • Nat'l Elec. Conf. • Amphitheater • Chicago • Oct. 9-11

SWITCHCRAFT

CIRCLE 87 ON READER-SERVICE CARD

NEW PRODUCTS AT NEC

DC Micro-Volt-Ammeter

658



With 1% basic accuracy, the model MV-07B dc micro-volt-ammeter offers recorder output. Full-scale ranges are from 10 μ v to 1 kv and 10 μ ma to 1 ma. Readings are subject to drifts of 2 μ v and 2 μ ma.

Millivac Instruments, Dept. ED, P. O. Box 997, Schenectady, N. Y.

P&A: \$495; 2 to 4 weeks.

See at NEC Show Booth 8.

Stack Switches

670



Miniature and telephone-relay stack switches have welded silver or palladium contacts. Springs are nickel silver; spacers are paper-base phenolic. Miniature units, called Tini-Stack, are 1-3/4 in. long.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

See at NEC Show Booth 537.

Microwave Antennas

680



Dual-polarized microwave antennas operate from 5,925 to 7,425 mc. Feed can be pressurized; guy wires are not needed. Heated or unheated radomes designed especially for the antennas are available. Diameters of 4, 6, 8, and 10 ft are in stock.

Technical Appliance Corp., Dept. ED, Sherburne, N. Y.

P&A: \$600 to \$1,500; from stock.

See at NEC Show Booth 850.

TRANSISTOR TRANSFORMER SELECTOR KIT

save valuable time
in optimizing circuitry



\$2950
user net

Available off-the-shelf
from franchised
distributors.

Model No. 400K

APPLICATIONS FOR SERVO, AUDIO,
INSTRUMENTATION AND CONTROL CIRCUITRY

Set of 9 transformers covers impedance range of 150 through 200,000 OHMS

Matches most new transistor impedance ratings

FULL DESIGN DATA ENCLOSED

1. Nomographs and circuitry for determining correct impedances
2. Power versus DBM chart
3. Guide to MIL-T-27A
4. Cross Reference index
5. Outline drawings

CIRCLE 88 ON READER-SERVICE CARD

Do you know?

29

Yes, 29 Hi-Q engineers and electronic specialists are ready at all times to work "on your staff"...qualified by experience to analyze your resistor/capacitor applications. New units can be designed to meet your specific requirements, if necessary...even if you are looking for the smallest ceramic capacitor in the world! Want further info? Simply write today to...

Hi-Q
Division

AEROVOX CORPORATION 1005 SENECA ST.,
CLEAN, NEW YORK

NOW...2 YEAR WARRANTY
ON ALL
HI-Q CAPACITORS & RESISTORS

CIRCLE 89 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

Induction Voltage Regulator 564

Rated up to 10,000 kva, the Inductrol induction voltage regulators have 97% to 99% efficiency. Standard single-phase units are rated up to 600 v, 240 va; standard three phase units, 600 v, 720 va. Higher ratings are available on special order. Regulators have drift-free control, 100% overload capacity, and compensation for load, power factor, and frequency. There are no brushes or contacts.

General Electric Co., Transformer Div., Dept. ED, 100 Woodlawn Ave., Pittsfield, Mass.

See at NEC Show Booth 605-613.

5-Mc Digital Modules 569



Transistorized flip-flops and other logic circuits are available in modular form. Part of the S-PAC line, the units operate at 5-mc frequencies, and have as many as four flip-flops to a board. Mounted on glass epoxy cards, 4-1/2 x 7 in., the circuits plug into the firm's S-BLOC mounting chassis. Modules made to military specifications are available on special order.

Computer Control Co., Inc., Dept. ED, 983 Concord St., Framingham, Mass.

Availability: 6 to 8 weeks.

See at NEC Show Booth 214.

Frequency Standards 561

Transistorized oscillator is combined with a tuning-fork resonator in these frequency standards, series 300. Output frequencies are from 400 to 3,000 cps, accurate to 0.05% from -55 to +85 C, to 0.01% from 0 to +85 C. No oven is required at these temperatures. Output is 0.5 v ptp sine-wave or 15 v ptp square wave. Units measure 1-17/64 x 1-17/64 x 1-3/4 in. and weigh less than 2.9 oz.

Melpar, Inc., Special Products Div., Dept. ED, 3000 Arlington Blvd., Falls Church, Va.

Price: \$91 for 50 to 100.

See at NEC Show Booth 143.

Advertisement

"Teflon" Terminals



A complete line of insulated terminals in miniature and subminiature stand-offs and feed-thrus, receptacles, plugs, jacks, and probes is available off-the-shelf from Microdot's Lerco Division. Uncontaminated Teflon* is used exclusively for the insulating bushing. These precision manufactured terminals withstand temperatures from -100°C to +250°C, are resistant to vibration and corrosion, and are unaffected by solvents, acids, or bases. Available in white and a variety of color codes. *Du Pont trademark.

Microdot Inc., 220 Pasadena Avenue, South Pasadena, California

CIRCLE 771 ON READER-SERVICE CARD

Weldable Strain Gage



Precise, rugged gage is capable of continuous operation at 750°F and dynamic test to 1500°F. These gages employ one-piece etched wire filaments in swaged stainless steel tubes, and are suitable for use from cryogenic to elevated temperatures. They are also available with inherent temperature compensation (no dummy gages required). Easy installation through the use of stored-energy welding equipment eliminates complicated bonding and curing processes. Also available in integral lead strain gage versions.

Microdot Inc., 220 Pasadena Avenue, South Pasadena, California

CIRCLE 772 ON READER-SERVICE CARD

CIRCLE 773 ON READER-SERVICE CARD ►

MICROMINIATURE MULTI-PIN CONNECTORS



Visualize 61 contacts in the diameter of a dime . . . think of slashing connector weight requirements by 33% . . . estimate the dollar savings in time and inventory of a connector with complete interchangeability of parts. This unique combination of advantages—and more—are built-in features of Microdot's new multi-pins.

In airborne and ground support applications where size, weight and reliability are vital factors, Microdot's unique new multi-pin connector stands alone. Available in three shell sizes and a variety of mounting versions, these rugged connectors are adaptable to a wide range of specific applications (you specify from a wide variety of standard, interchangeable multi-pin component parts to arrive at a connector tailored to your specific application).

Inserts are available in a variety of straight power, straight coaxial, and power-coaxial layouts. Power contacts are interchangeable without changing inserts, allowing hermaphroditic contact arrangements (a mixture of male and female contacts within the same plug or receptacle, allowing hot leads to both plug and receptacle). Closed entry, pure coin silver socket contacts allow heavy currents with low temperature rise. Contact resistance is almost nil. Write today for detailed descriptive literature, Bulletin MP-O.

SIZE DESIGNATION	PLUG O.D.	NO. OF COAXIAL CONTACTS	NO. OF POWER CONTACTS
A	$\frac{3}{8}$ "	up to 7	up to 19
B	$\frac{3}{4}$ "	up to 12	up to 37
C	1 $\frac{1}{4}$ "	up to 18	up to 61

Microdot Multi-Pins are available in disassembled "Kit" form or, if you prefer, factory assembled with Microdot cable.

MICRODOT INC.

220 Pasadena Ave. / South Pasadena, Calif.



NEW PRODUCTS AT NEC

Switch for Shock Environments

677



Actuator is locked in switching position in the Shock-Lock Telever switch. Knob must be twisted to lock or unlock switch and a plunger must be pushed to move actuator. Switch cannot be accidentally switched despite shock, vibration, or fatigue.

Switchcraft Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

See at NEC Show Booth 537.

Modern-Styled Meters

591



With 4-1/2 in. scales, the model 2041 Aristocrat meters have modern styling. Arc is 100 deg. Mountings have either 2, 3, or 4 studs. Mechanisms are available with self-shielded core magnets or with external magnets. Normal accuracy is 2%. Dc sensitivity is as low as 20 μ a; rectifier-type ac units are also available.

Sun Electric Co., Dept. ED, 6323 Avondale Ave., Chicago 31, Ill.

P&A: \$7.90 up; stock in November.

See at NEC Show Booth 612.

Tuning Forks

656



No oven is needed with these miniature tuning forks. Accuracy is within $\pm 0.05\%$ over a temperature range of -55 to $+85$ C, and with-

HOW CAN YOU BE SURE



OF SWITCH RELIABILITY?

You can be sure of OAK switches because of

OAK EXPERIENCE

Oak has been in the switch business for almost 30 years. In this time, we've produced more than 350,000,000 switches of all types—rotary, push-button, lever, slide, and snap. Our extensive experience in switch design can, in many cases, enable us to render your switching needs into an effective, yet simpler and less costly design.

You can be sure of OAK switches because of

OAK PRODUCTIVE CAPACITY

We have recently consolidated our entire assembly operation in our new 206,000 sq. ft. plant in Crystal Lake, Ill. With its more efficient layout, with new production equipment, and Oak's highly-skilled employees, we will be able to reduce delivery time on your switch orders. Our goal, in time, is to provide you with the shortest delivery cycle obtainable.

You can be sure of OAK switches because of

OAK RESEARCH and DEVELOPMENT

Oak has pioneered the development of the double-wiping spring clip that assures positive, high-pressure contact under normal conditions throughout the life of a switch. Oak researchers have developed special new alloys for contacts that retain their tension under high temperature operation. Our development engineers are constantly striving to find better ways to handle all your switching needs.

You can be sure of OAK switches because of

OAK CRAFTSMANSHIP

Oak craftsmanship begins with careful, exacting quality control from raw materials to finished product. Oak tool engineers design new or adapt existing fabricating and assembly equipment to meet ever-changing production needs. Their special know-how enables Oak to produce parts to more critical tolerances without a corresponding increase in cost.

FOR DETAILED SPECIFICATIONS ON ALL OAK SWITCHES SEND FOR OUR COMPREHENSIVE 4TH EDITION SWITCH CATALOG



OAK MANUFACTURING CO.

CRYSTAL LAKE, ILLINOIS

telephone: Crystal Lake, 459-5000

ROTARY AND PUSHBUTTON SWITCHES • TELEVISION AND FM TUNERS • SUBASSEMBLIES
APPLIANCE CONTROLS • CHOPPERS • ROTARY SOLENOIDS • VIBRATORS

CIRCLE 91 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

in $\pm 0.01\%$ from 0 to $+85$ C. Frequencies from 400 to 3,000 cps are available. Resonating element is of an invar-type alloy, supported at a nodal point. Shock and vibration are withstood; output is sinusoidal; starting time is less than 7 sec. Units measure 1-17/64 x 1-17/64 x 1-3/4 in. and weigh 2.6 oz.

Special Products Div., Melpar, Inc., Dept. ED, 3000 Arlington Blvd., Falls Church, Va.
Price: \$53 for 50 to 100.

See at NEC Show Booth 143.

Low-Noise Amplifier

657



Gain of 10 to 80 db ± 10 db is selectable in 10-db steps. Model VS-68A low-noise amplifier uses both transistors and vacuum tubes. It has two 6-v internal dry cells and uses an external 12-v battery for power. Frequency response is 3 db down at 2 cps and 180 kc. Output impedance is less than 2 K, with 0.1 v maximum rms output. Input impedance is 10 K and 10 meg. Distortion is 1% at 50 mv ptp, 2.5% at 100 mv ptp.

Millivac Instruments, Inc., Dept. ED, P. O. Box 997, Schenectady, N. Y.

P&A: \$495; 2 to 4 weeks.

See at NEC Show Booth 8.

Retractable Coil Cords

573



Extending to 25 ft from 48 in. retracted length, these retractable coil cords are made for communication cord and test lead wire. Shorter lengths are available. Conductors can be individually shielded or pigtailed. Jackets, neoprene, withstand constant use and resist oil and weather damage.

Alpha Wire Corp., Dept. ED, 200 Varick St., New York 14, N. Y.

See at NEC Show Booth 337.

107

Another CMC First...

100 mc SOLID STATE Universal Counter-Timer



KEY SPECIFICATIONS

FREQUENCY

0 cps to 100 mc

TIME INTERVAL

0.02 μ sec to 10⁹ sec

PERIOD

0 cps to 10 mc

INPUT SENSITIVITY

1.0v rms

GATE TIMES (FREQUENCY)

1 μ sec to 10 sec in 8 decade steps or external. Reads in cps, kc, mc.

FREQUENCY OUTPUTS

0.1 cps to 1 mc output in decade steps

ACCURACY

± 1 count \pm stability
 ± 10 nanosecond \pm stability

STABILITY

Short term: ± 1 part in 10⁶
Long term: within 5 parts in 10⁶

PRICE, F.O.B. FACTORY

\$3,950; inline readout \$200 extra

WEIGHT 25 LBS.

* SEVEN BASIC FUNCTIONS, including dc to 100 mc frequency measurements without heterodyning techniques * Time interval measurements with 10 nanosecond resolution * Straight or totalizing counting * Frequency ratio measurement * Period measurement * Sensitivity better than 1.0v rms * Power consumption 50 watts * Decade count-down time base (no adjustments necessary) * Two year free service warranty * No vacuum tubes * Connector on rear providing standard 1-2-4-8 BCD output for operating printer, punch, etc.

Model 728B is a production unit, not a showpiece prototype. Demonstrators are now in the hands of CMC engineering reps. Call, wire or write to arrange a demonstration. Complete technical data plus a copy of our new 20 page short form catalog is yours for the asking.



**Computer
Measurements
Company**

12970 BRADLEY AVENUE • SAN FERNANDO, CALIFORNIA
EMPIRE 7-2161

NEW PRODUCTS AT NEC

Direct-Reading Ohmmeter

661



Accurate to 1% over the entire scale, the model MV-279B ohmmeter has 14 full-scale ranges from 1 ohm to 2.5 meg, each with an individual calibration control. Measurement power source is a 1.4-v mercury cell, operating at constant current.

Millivac Instruments, Dept. ED,
P. O. Box 997, Schenectady, N. Y.
P&A: \$165; 2 to 4 weeks.

See at NEC Show Booth 8.

Rotary Seal

575



Hermetically sealed rotary seal is made for precision potentiometers. Back-lash is 0.05 deg at 1 oz-in. applied torque load. Maximum torque to turn shaft is 0.5 oz. Case measures 1/2 in. OD x 1/2 in. long. Operating speed is 100 rpm; life is estimated at 250,000 revolutions continuous. Device is constructed of stainless steel, and withstands 35-g vibration from 20 to 2,000 cps.

Mechtronics Corp., Dept. ED,
11431 Joanne Place, Culver City,
Calif.

P&A: \$200 each in quantities of
100; 30 days.

See at NEC Show Booth 721.

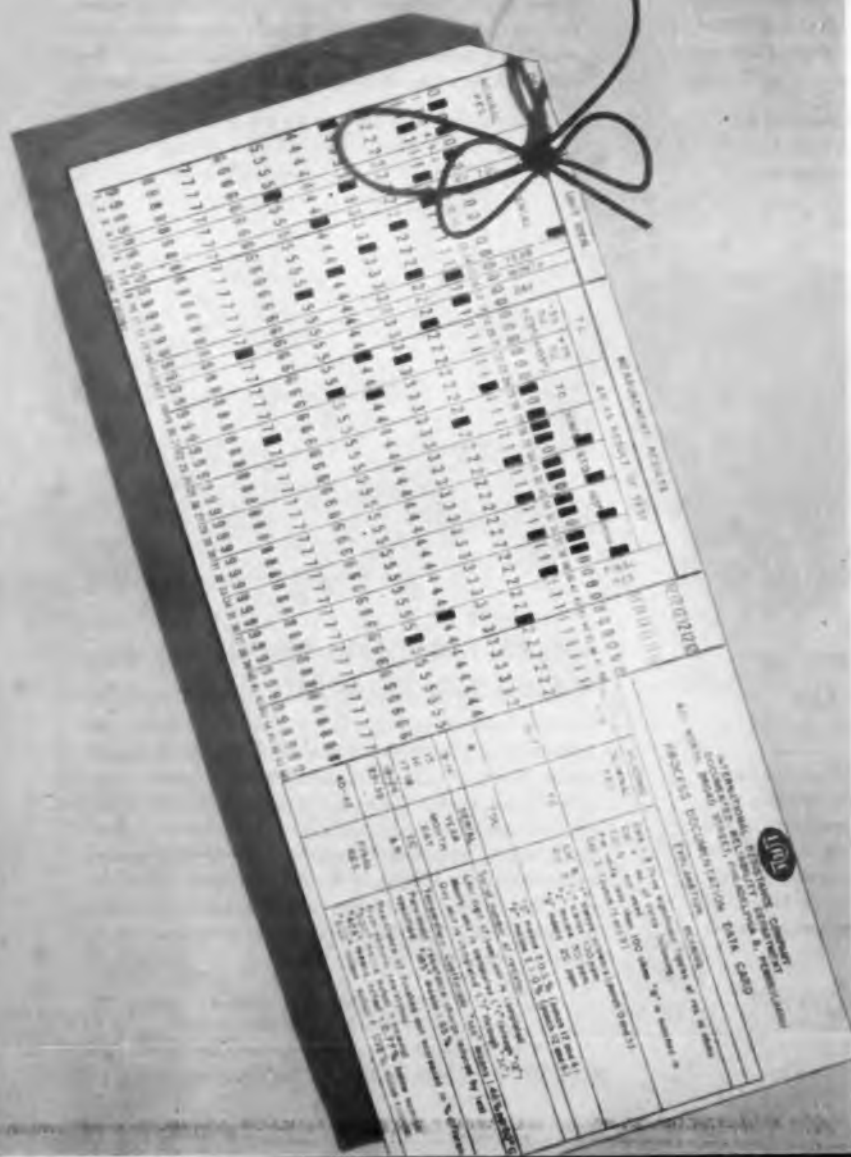
CIRCLE 96 ON READER-SERVICE CARD ➤

◀ CIRCLE 95 ON READER-SERVICE CARD

if it's news, expect it first from IRC

Now available...
resistor reliability
developed for MINUTEMAN

DOCUMENTED RELIABILITY



XLT resistor developed for
Minuteman missile

XLT offers you proven reliability

IRC's new subminiature, hermetically sealed, evaporated metal film resistor provides DOCUMENTED RELIABILITY in the form of an individual punched data card carrying the complete production history of each unit.

Every control, guidance and computer system can now benefit by the 99.9996% resistor reliability developed for MINUTEMAN. Quantity production above Minuteman requirements is now available for other applications. Type XLT is rated $\frac{1}{8}$ th watt at 125°C.

Send for new brochure, "Resistors with Documented Reliability." International Resistance Company, Documented Reliability Dept., 401 North Broad Street, Philadelphia 8, Pa.

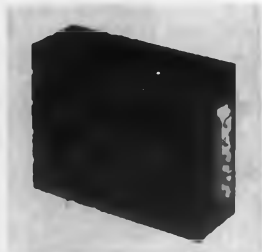


When Reliability Counts Most

NEW PRODUCTS AT NEC

Modular Power Supplies

682



Magnetic-amplifier regulated power supplies, called Power-Bloc modules, have ratings from 1 v, 10 amp to 30 v, 0.8 amp. The magnetic amplifier is used to balance a bridge rectifier network, said to produce considerably faster response than conventional magnetic-amplifier supplies. Modules, epoxy-sealed with aluminum housings, measure as small as 4 x 2 x 5-3/8 in. Units can replace central high-current supplies.

Varo Inc., Dept. ED, 2201 Walnut St., Garland, Tex.

Price: \$150 to \$295.

See at NEC Show Booth 845-847.

Battery-Operated AC Voltmeter

665



From 5 cps to 1 mc vms voltages are measured by this battery-operated ac voltmeter. Unit is completely transistorized. Full-scale ranges are from 0.001 to 300 v rms. Input impedance is 2 meg. Noise is less than 2% full scale on all except lowest range, where it is 4%. Accuracy is $\pm 3\%$ of full scale from 5 cps to 500 kc and $\pm 5\%$ from 500 kc to 1 mc. Batteries, two mercury cells, have 300-hour lives and can be checked while in the unit. Weight is less than 4-1/2 lb.

Radiation Electronics Co., Dept. ED, 5600 Jarvis Ave., Chicago 48, Ill.

P&A: \$240; six weeks.

See at NEC Show Booth 239.

Accuracy Is Our Policy

The series number of the rf oscillator manufactured by Trak Electronics Co., Inc., Wilton, Conn., which appeared on p 91 of the June 7 issue of ELECTRONIC DESIGN, should be the SO series rather than the 50 series.



ENGELHARD HYDROGEN DIFFUSION PURIFIER

This Hydrogen Purifier removes all impurities (including oxygen, nitrogen, argon, water vapor, hydrocarbons, etc.) from hydrogen gas streams. Produces hydrogen of highest purity obtainable from dissociated ammonia, steam reformed natural gas or propane, commercial hydrogen purchased in cylinders and other hydrogen containing gas streams. No trace of impurities detectable in purified gas. Ultra-pure product hydrogen obtained at lowest cost. Available in standard sizes: 100 c.c. per hour, 20 SCFH, 75 SCFH, and 150 SCFH. Larger sizes custom built to requirements. Write for literature.

INDUSTRIAL EQUIPMENT DIVISION
GAS EQUIPMENT SECTION
113 ASTOR STREET • NEWARK, N. J.
CIRCLE 793 ON READER-SERVICE CARD



HERMACH-ENGELHARD MULTI-RANGE TRANSFER VOLT-AMMETERS FOR LAB STANDARD ACCURACY

Hermach-Engelhard multi-range transfer volt ammeters provide laboratory standard accuracy in reading voltages or current with an error not exceeding 0.05% through a frequency range from d-c to 50,000 cps. These readings are obtained without the use of correction factors directly from the instrument itself. Bureau of Standards certificates are provided on request. Write for complete technical data.

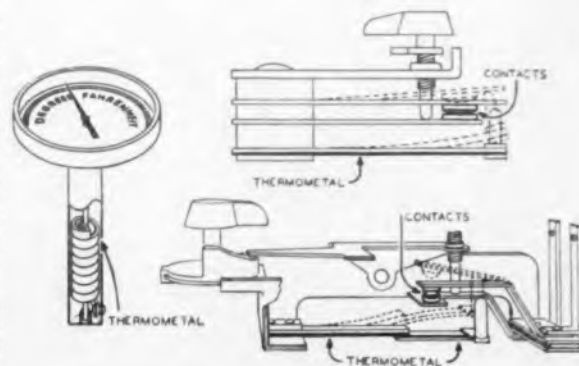
INDUSTRIAL EQUIPMENT DIVISION
INSTRUMENTS AND SYSTEMS SECTION
850 PASSAIC AVENUE • E. NEWARK, N. J.
CIRCLE 794 ON READER-SERVICE CARD

A GAS GENERATOR FOR THE MOST EFFICIENT AND ECONOMICAL PRODUCTION OF N₂, H₂ FORMING GAS MIXTURES



... provides the most economical and efficient method for the production of pure nitrogen—completely free of oxygen—with a hydrogen content precisely controlled at any desired percentage between 0.5% and 25%. Gas mixtures are supplied at a fraction of cylinder supply cost. • The Nitroreal Generator is automatic except for startup, with no need for operating personnel. The unit performs instantly, efficiently anywhere in the range of from 25% to 100% of rated capacity. Installation requires only a 110 volt line, water, air, ammonia lines and drain facilities. ... The catalyst lasts indefinitely—minimum maintenance costs.

INDUSTRIAL EQUIPMENT DIVISION
GAS EQUIPMENT SECTION
113 ASTOR STREET • NEWARK, N. J.
CIRCLE 795 ON READER-SERVICE CARD



CONTROL TEMPERATURE, CURRENT AND VOLTAGE WITH THERMOMETAL®

Leading manufacturers rely on the dependable performance of Wilco Thermometal in electrical appliances, thermal cutouts, heating controls and many other applications involving the indication and accurate control of temperatures, electrical currents, voltages, etc. Thermometal is supplied in strip form, rolled and slit to close tolerances and tempered to specification. Thermometal elements and sub-assemblies are also supplied to specifications, with or without contacts attached. Send for literature.

H. A. WILSON DIVISION
U.S. HIGHWAY 22 • UNION, N. J.
CIRCLE 796 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

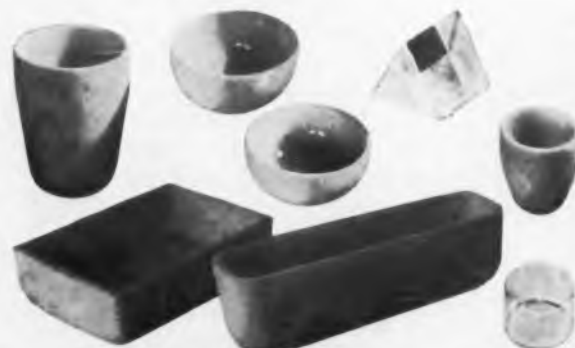


FOR LOW COST PURIFICATION AND DRYING OF HYDROGEN AND OTHER GASES

The Deoxo Catalytic Purifier removes oxygen to less than one part per million from hydrogen gas. It can also be used with other gases such as Nitrogen, Nitrogen-Hydrogen Mixture, Argon, Helium, and Carbon Dioxide. • A combination unit, the Deoxo Dual Puridryer, contains the Deoxo Catalytic Purifier plus an extremely efficient automatically operated drying unit. Removes oxygen to less than 1 PPM from hydrogen and dries the purified gas to a low point of minus 100°F. It will also purify and dry other gases in a similar manner.

INDUSTRIAL EQUIPMENT DIVISION
GAS EQUIPMENT SECTION
113 ASTOR STREET • NEWARK, N. J.

CIRCLE 797 ON READER-SERVICE CARD



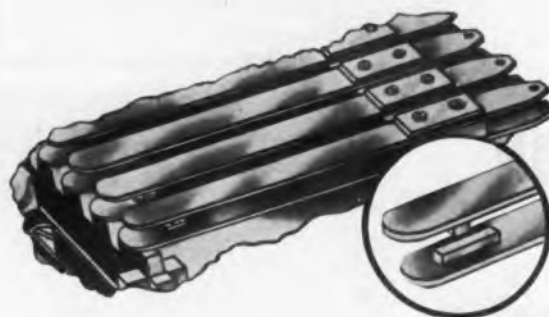
LOOK TO AMERSIL FOR ALL HIGH PURITY FUSED QUARTZ REQUIREMENTS

Amersil manufactures and fabricates high purity fused quartz for ultraviolet transmission application, laboratory ware and production equipment. These products include standard apparatus, plain tubing in many intricate fabrications, crucibles, trays, cylindrical containers and piping in a full range of sizes up to 25" in diameter. Ingots and plates are available in general commercial quality as well as in special optical grades. Amersil engineers are also prepared to assist in developing fused quartz and silica equipment for special requirements.

AMERSIL QUARTZ DIVISION
685 RAMSEY AVENUE • HILLSIDE, N. J.

CIRCLE 798 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961



ECONOTAPE CONTACTS ARE MOST EFFICIENT FOR ELECTRICAL RELAYS

High reliability welded contacts and contact assemblies available for your relays. Weld strength guaranteed. • Overall contact height held within $\pm .00025$. Assemblies are available in gold, platinum, palladium, silver and their various alloys—both solid and laminated. Single contact usable for various contact ratings, for wet and dry circuitry—assemblies protected for shelf life and handling. Designs for attachment to header by welding or brazing. Complete electrical and mechanical design services available.

D. E. MAKEPEACE DIVISION
PINE & DUNHAM STREET • ATTLEBORO, MASS.

CIRCLE 799 ON READER-SERVICE CARD



SALES OFFICES: CHICAGO • DALLAS • DETROIT • HOUSTON • LOS ANGELES • NEW YORK • ORLANDO • PROVIDENCE • SAN FRANCISCO • WASHINGTON, D. C.

Please send literature as indicated below, addressed to my attention:

- Deoxo Purifier—Puridryer Econotape
 High Diffusion Purifier Thermometal
 Fused Quartz Nitronal Generator
 Hermach-Engelhard Volt-Ammeters

NAME.....
TITLE.....
FIRM.....
STREET.....
CITY..... ZONE..... STATE.....

DC Micro-Micro-Ammeter

664



In twenty ranges the model 111A-L dc micro-micro-ammeter covers 100 μa to 250 ma full scale. Shunt-resistance ranges from 1 meg to 0.004 ohm. Output is 2.5 v, 1 ma dc. Basic accuracy is 1%. Voltage drop is about 1 mv. Instrument has individual calibration controls.

Millivac Instruments, Inc., Dept. ED, P. O. Box 997, Schenectady, N. Y.

P&A: \$120; 2 to 4 weeks.

See at NEC Show Booth 8.

Modern-Styled Meters

666

Accurate to 2%, the Gem Line of meters is modernly styled in 2-1/2 and 3-1/2 in. cases. Designated models 2821 and 2831, the meters have shock-resistant movements, self-shielded core magnets, and anti-static acrylic covers. Standard dc and rectifier-type ac meters are available.

Sun Electric Corp., Dept. ED, 6323 Avondale Ave., Chicago 31, Ill.

P&A: \$5.06 and up; stock.

See at NEC Show Booth 612.

Acoustic Serial Memory

570



Stores 1600 bits at 16 mc. Digital serial memory with pulse delays ranging from 20 to 100 μsec at operating frequencies of 8 to 12 mc is available in a compact plug-in package. Designated type SM-40, the unit is self-contained and compatible with the firm's H-PAC digital modules. Delay line, fused silica, has a temperature coefficient of ± 2 ppm per C max, requiring no temperature compensation below 35 C.

Computer Control Co., Inc., Dept. ED, 983 Concord St., Framingham, Mass.

P&A: \$997; 6 to 8 weeks.

See at NEC Show Booth 214.

THE WEDGE-ACTION MARK II RELAY

...Strong Link to Reliability

No longer must your design make allowances for unreliable relays. Use the Mark II relay with complete confidence. Shock it with 100 G's . . . freeze it at -65°C or roast it at 200°C . . . give it 30 G's vibration from 5 to 2000 cps . . . or switch it from dry circuit levels to 2 amps.

The Mark II can take such punishment because of its exclusive contact action. The moving contact slides with a wedge action . . . it cleans itself . . . and the increasing pressure during overtravel virtually eliminates contact bounce, chatter and other relay problems.

Make the relay the strong link in your system . . . specify the Mark II. Literature now available.

ELECTRO-TEC CORP.



Dimensions: 1-7/8 x 1-3/16 inches

TWX-032-08-01 CApital 8-1500

West Caldwell, N. J.
Blacksburg, Va.—Ormond Beach, Fla.



**MODELS AVAILABLE
AT COMPETITIVE PRICES**

This equipment is manufactured under exclusive license in ten western states by PACIFIC SCIENTIFIC COMPANY, P.O. Box 22019, Los Angeles, California

CIRCLE 92 ON READER-SERVICE CARD

NEW PRODUCTS

Voltage-Regulator Diodes

486



Silicon Zener voltage-regulator diodes have nearly a 90-deg Zener response and low dynamic resistance. JEDEC type 1N3000 diodes, rated at 1 w, need no heat sink and dissipate maximum power to 25 C. JEDEC type 1N2900 diodes, rated at 10 w, for chassis or cooling-fin assembly, dissipate maximum power to 55 C.

Fansteel Metallurgical Corp., Rectifier-Capacitor Div., Dept. ED, N. Chicago, Ill.

Availability: stock.

Video Amplifier

512



With four signal outputs, model TDA2 transistorized video-pulse distribution amplifier is interchangeable with tube-type amplifiers without alteration of existing cables. It has its own power supply and draws 4 w at 115 v. Input impedance is 75 ohms; outputs are also terminated at 75 ohms.

International Nuclear Corp., Dept. ED, 501 Elysian Fields, Nashville 11, Tenn.

Miniature Recorder

513



Size is 3-1/16 x 5-5/8 x 1-1/16 in. for this instrument that is designated Amprobe Recorder. Unit will accommodate any signal that can be converted to an equivalent electrical signal. Paper feeds at speeds up to 15 in. per hr. It is available in a number of versions, each in several ranges.

Amprobe Instrument Corp., Dept. ED, 630 Merrick Road, Lynbrook, N. Y.



Gamewell made this special completely from scratch.

Every part of this rotary switch was newly designed by Your Engineered Specials service to meet a customer's special requirements. The unit provides bi-directional operation at 160 rpm max. It is rated at 28 VDC, 60 ma ... has high vibration and shock resistance ... and -55° to +150°C. temperature range.

Although this design called for only six poles and 11 switching segments, many more could have been provided.

Gamewell's YES service has developed answers to hundreds of special "pot" problems. Interested? Write for the full story.

***your
Engineered
Specials service**



THE GAMEWELL COMPANY, POTENTIOMETER DIVISION,
1425 CHESTNUT STREET, NEWTON UPPER FALLS 64,
MASS. A SUBSIDIARY OF E. W. BLISS COMPANY.

CIRCLE 93 ON READER-SERVICE CARD

Magnetic-Field Detector 538



DC magnetic fields as low as 1/4 gauss can be measured by model 501 detector. Based on the "Hall-Effect" principle and utilizing high-gain Siemens Hall generators, the unit operates without amplifiers. It provides a center to full scale deflection of 0 to 5 gauss. Power is supplied by only one mercury cell, resulting in compactness.

Halltest Div., Instrument Systems Corp., Dept. ED, 129-07 18th Ave., College Point, N. Y.

Battery Charger 535

Automatic shutoff and cycling mode are incorporated in model 2-271 transistorized universal battery charger. It can charge from one to 32 battery cells (total range, 0 to 50 v) at a constant current adjustable from 0.1 to 10 amp. Batteries can be accurately charged at sites far removed from the charger.

Electro Development Corp., Dept. ED, 4530 Union Bay Place N.E., Seattle 5, Wash.

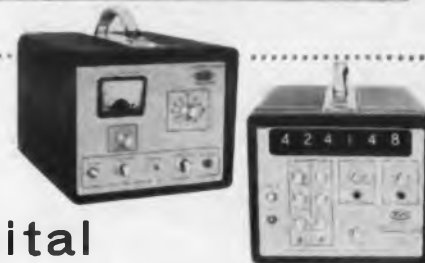
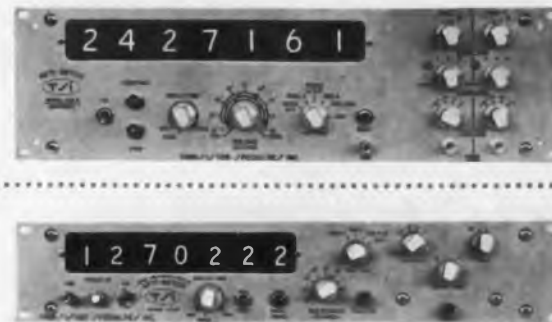
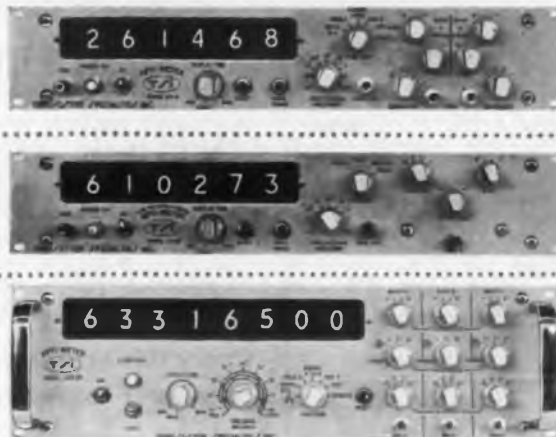
Spark Gap 522



Peak currents of over 10,000 amp can be handled by the triggered spark gap type GP-15. Unit is ceramic-metal with 70 kv hold-off voltage. Triggering is accomplished by a pulse of 25 kv. Delay time is 0.5 μ sec at 80% of maximum hold-off voltage. No filament voltage is required.

Edgerton, Germeshausen & Grier, Inc., Dept. ED, 160 Brookline Ave., Boston 15, Mass.

CIRCLE 94 ON READER-SERVICE CARD ►



This is the industry's only 100% Solid-State line of Digital Timer/Counter/Frequency Meters

- **Optimum Reliability**
Solid-state design runs cool. Improved circuitry yields wider operating margins.
- **In-Line Nixie Readout**
No reading ambiguity.
- **Exceptional Stability**
Exclusive crystal-oven design and low-level, buffered oscillator circuitry.
- **Pre-Designed Options**
Available on short delivery at modest add'l charge: Printer readout, programmable preset, programmable attenuation, BCD formats, etc.
- **Ultra-Compact**
Function for function, the smallest, lightest package available.
- **High Sensitivity**
Unique TSI "level-sampling" amplifier. Highest gain-bandwidth product. Eliminates duty-cycle anomalies.
- **Complete Flexibility**
Standard two-channel models provide all needed functions, plus self-test Mode. (See chart)

MODEL	COUNTING RATE, PPS	NUMBER OF DIGITS	CRYSTAL CLOCK RATE	NUMBER OF CHANNELS	FUNCTIONS*					SIZE† STYLE°	SENSITIVITY MV RMS	ACC'Y STABILITY	
					C	F	FR	P	PD				FS
361	0-10'	6	1MC	2	✓	✓	✓	✓	✓	✓	A/C	10.	1 count 3 parts in 10 ⁶ per week
361-R	0-10'	6	1MC	2	✓	✓	✓	✓	✓	✓	3½"/R	10.	
363	0-10'	7	1MC	2	✓	✓	✓	✓	✓	✓	A/C	25.	
363-R	0-10'	7	1MC	2	✓	✓	✓	✓	✓	✓	3½"/R	25.	1 count 5 parts in 10 ⁶ per week
365	0-10'	7	10MC	2	✓	✓	✓	✓	✓	✓	A/C	25.	
365-R	0-10'	7	10MC	2	✓	✓	✓	✓	✓	✓	5¼"/R	25.	
365-RC	0-10' plus extender to 220MC	7	10MC	2	✓	✓	✓	✓	✓	✓	5¼"/R	25.	1 count 5 parts in 10 ⁶ per week
365-RP	0-10' (Programmable)	7	10MC	3	✓	✓	✓	✓	✓	✓	5¼"/R	25.	
371	0-10'	6	1MC	1	✓	✓	✓	✓	✓	✓	A/C	10.	same as 361
371-R	0-10'	6	1MC	1	✓	✓	✓	✓	✓	✓	3½"/R	10.	
373	0-10'	7	1MC	1	✓	✓	✓	✓	✓	✓	A/C	25.	
373-R	0-10'	7	1MC	1	✓	✓	✓	✓	✓	✓	3½"/R	25.	same as 365
375	0-10'	7	10MC	1	✓	✓	✓	✓	✓	✓	A/C	25.	
375-R	0-10'	7	10MC	1	✓	✓	✓	✓	✓	✓	5¼"/R	25.	
420	Freq. extender 10MC-220MC	—	—	1	—	—	—	—	—	—	A/CX	2.0	—
420-R	Freq. extender 10MC-220MC	—	—	1	—	—	—	—	—	—	3½"/RX	2.0	—
430	Period Multiplier X100	—	—	1	—	—	—	—	—	—	A/CX	—	—
430-R	Period Multiplier X100	—	—	1	—	—	—	—	—	—	3½"/RX	—	—

*C = Counts action per Time interval; F = Frequency; FR = Frequency ratio, A/B; P = Period; PD = Period A to B; FS = Frequency standard outputs brought out.

†A = 8¾" x 10¼" x 12½" cabinet, inch dimension is panel height on rack units.
°C = Bench cabinet, CX = occupies part of cabinet, R = st'd 19" rack, RX = st'd half rack (9½" wide).

TRANSISTOR SPECIALTIES
INCORPORATED ■ Sophisticated Digital Instrumentation
TERMINAL DRIVE, PLAINVIEW, NEW YORK • WELLS 5-8700



METERS

You can SEE and READ



New Series 1025-1026
Interchangeable with Round
Bakelite Case Types

Brilliantly new in their high visibility polystyrene cases are these modern type meters by HOYT which give a true reading at a glance! Here longer scale length and the elimination of shadows plus clean design add up to a topnotch combination to incorporate in any panel.

The famous HOYT high torque movement with precise and rugged craftsmanship gives you what you've been looking for in meters. These models are directly interchangeable with all round Bakelite meters, and are available in all AC and DC ranges as Ammeters, Milliammeters, Microammeters, Voltmeters and Millivoltmeters. Similar styles #1037 3½" and #1069 6" meters are also available for any modern panel meter application.



The HOYT square plastic case series (#649 and #653 shown) is available in 2½", 3½" and 4½" types. Just right for use where equipment needs to be revised to meet modern design requirements. These instruments are interchangeable with square Bakelite meters and can be supplied with a frosted or colored band on the case front in any AC and DC range. Extra long scales in shadow free cases give you the most value and quality for your money.

Write us for the NEW HOYT PANEL METER Brochure showing a complete line of plastic and Bakelite models.



BURTON-ROGERS COMPANY

Sales Division, Dept. ED-9

42 Carleton Street, Cambridge 42, Mass.

CIRCLE 97 ON READER-SERVICE CARD

NEW PRODUCTS

Galvanometer Protector

698



Coil burn-out of the firm's magnetically damped galvanometers is prevented by this protector device. A replaceable insert permits repeated use of the device. Insertion resistance of the unit is 4 ohms nominal at 75 F. Phase shift is 1 deg max from dc to 10 kc. With the input open circuited and the output terminated in a 27 ohm load, the protector does not generate more than 1 μ v when subjected to an environment where the temperature is changing at the rate of 1.8 F per sec between 0 and 150 F.

Consolidated Electrodynamics Corp., Dept. ED, 360 Sierra Madre Villa, Pasadena, Calif.

Contact Terminals

387

Wire-wrap terminals, series FD-900, are for both single and double sided printed-circuit boards. Units have glass-reinforced dielectric and gold-plated beryllium-copper contacts. Terminals accept up to four 20-gage wires, each wrapped five times.

Methode Electronics, Inc., Dept. ED, 7447 W. Wilson Ave., Chicago 31, Ill.

Fiber Optic Tube

699



Fiber optic cathode ray tubes print recording directly from the tube face without the use of conventional lens systems at speeds up to 50 times faster than possible with conventional systems. Model SC-3303, electrostatically focused and deflected, is for the experimenter who wishes to determine the advantages of fiber optics; model SC-3304, electromagnetically deflected and focused, is for small spot size. Active fiber optic area is 2-3/4 x 1/4 in., composed of one mil fibers on one mil centers.

American Optical Co., Dept. ED, Southbridge, Mass.

P&A: SC-3303, \$795, SC-3304, \$995; from stock, Oct. 1, 1961.

HOW TO SAVE TIME WHEN YOU NEED CORNING COMPONENTS IN A HURRY

Check this list for the Corning Electronic Components distributor located nearest to you... Clip and save.

You can get *immediate delivery* from him at factory prices on virtually the full line of top-reliability Corning components... tin oxide resistors, from the 6¢ C line through the environment-proof NF type; capacitors, axial lead and wafer types; shock- and vibration-resistant precision trimmers; rugged, high stability inductors and inductor kits, and printed circuit grid boards and grid board kits.

All you need: your distributor's name, a telephone and a purchase order. Your distributor will do the rest... quickly.

CORNING ELECTRONIC COMPONENTS DISTRIBUTORS

ARIZONA PHOENIX Radio Specialties & Appliances Corp. TUCSON Standard Radio Parts, Inc.	MASSACHUSETTS BOSTON Cramer Electronics, Inc. Radio Shack Corp. MICHIGAN DETROIT Ferguson Electronic Supply MINNESOTA MINNEAPOLIS George Spencer, Inc. NEW JERSEY MOUNTAINSIDE Federated Purchaser, Inc. NEW MEXICO ALAMOGORDO Radio Specialties Co., Inc. ALBUQUERQUE Radio Specialties Co., Inc. NEW YORK BUFFALO Radio Equipment Corp. NEW YORK CITY AREA Interstate Electronics, Inc. Milgray Electronics, Inc. Milo Electronics Corp. Terminal Hudson Electronics, Inc. POUGHKEEPSIE Higgins & Sheer Electronic Distributors ROCHESTER Rochester Radio Supply Co., Inc. SYRACUSE Morris Distributing Co., Inc. UTICA Valley Industrial Electronics, Inc. VESTAL Federal Electronics, Inc. NORTH CAROLINA WINSTON-SALEM Dalton Hege Inc.	OHIO AKRON The Sun Radio Company CINCINNATI Hughes-Peters, Inc. CLEVELAND Radio and Electronic Parts Corp. COLUMBUS Hughes-Peters, Inc. DAYTON Sreppo, Inc. OKLAHOMA TULSA Oil Capital Electronics Corp. OREGON PORTLAND United Radio Supply PENNSYLVANIA PHILADELPHIA Herbach & Rademan, Inc. Radio Electric Service Co. PITTSBURGH Cameradio Company SCRANTON Fred P. Pursell TENNESSEE NASHVILLE Electra Distributing Company DALLAS TEXAS Adleta Company HOUSTON Busacker Electronic Equipment Co. UTAH SALT LAKE CITY Kimball Distributing Co. VIRGINIA NORFOLK Priest Electronics, Inc. WASHINGTON SEATTLE Seattle Radio Supply, Inc. WASHINGTON, D.C. Electronic Wholesalers, Inc. Silberne Radio & Electronics Co.
-----------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------



CORNING ELECTRONIC COMPONENTS

CORNING GLASS WORKS, BRADFORD, PA.

CIRCLE 98 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

New

CORNING CYFM CAPACITOR has reliability you can see

You get total protection against environment for less money than ever before

The new Corning CYFM capacitor gives you reliability at a markedly lower cost than that of any like capacitor.

The CYFM goes far beyond MIL-C-11272B specs. It has proved its performance through more than 3,000,000 hours of testing. It took a 50-day MIL moisture test and a 96-hour salt spray test with no measurable effects. We stopped testing only when it became evident that no more significant data could be developed. The CYFM went through other tests, with solvents, fluxes, boiling salt, and steam, to make sure it is the most completely sealed capacitor you can buy.

You'll see why the CYFM can take such torture when you check its design. We stack alternate layers of stable ribbon glass and aluminum foil. Then we weld the foils to the bead-terminal assembly, which has a glass bead sealed to the Dumet wire lead. With heat and pressure, the entire capacitive element is frozen in glass for complete protection against environment and for struc-

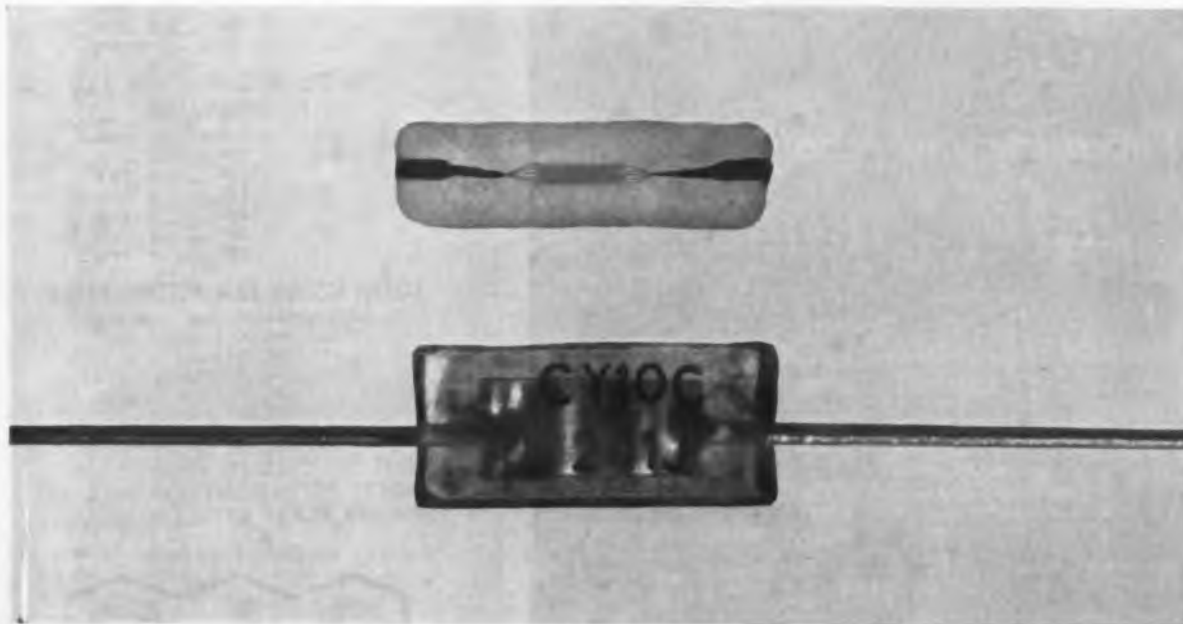
tured protection against physical shock.

True glass-to-metal seals at the weld area and along the leads bar moisture. The seal of the leads to the glass shifts stresses from the leads to the entire monolithic unit, guarding the capacitance area. Of course, you get electrical performance to match this environmental stability, since the CYFM has our glass-foil capacitor construction.

The CYFM is machine made . . . each capacitor is the same as every other, to give you uniformity which hand production cannot match.

You can get immediate delivery on the CYFM in four types. The CYFM-10 gives capacitance values from 0.5 to 300 pf; the CYFM-15, from 220 to 1200 pf; the CYFM-20, from 560 to 5100 pf, and the CYFM-30, from 3600 to 10000 pf.

For the rest of the story on this capacitor, send for our data sheet. Write to Corning Glass Works, 540 High St., Bradford, Pa.



This is the CYFM capacitor. 6 times actual size. The dark areas between the ends of the glass and the capacitance element are your visual proof of the complete glass-to-metal seal.



CORNING ELECTRONIC COMPONENTS

CORNING GLASS WORKS, BRADFORD, PA.

CIRCLE 99 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

Machine-Tool Control

503



A measuring system called the Moire Fringe Measuring System, is designed for continuous-path control of machine tools and can also be used to coordinate machine tool tables. Its essential element is a length of optical diffraction grating. Measurements are in units of 0.001 to 0.00005 in.

Ferranti Electronics Inc., Dept. ED, Industrial Park No. 1, Plainview, L. I., N. Y.

Availability: made to order.

Straight Filament Lamp

697



Ribbon type filament used in this lamp results in a gain of directional candlepower at no increase in wattage. The filament is spring tensioned and remains straight during operation, permitting precise location with reference to the surface to be illuminated. It is particularly useful in punched card readout devices.

Chicago Miniature Lamp Works, Dept. ED, 1500 N. Ogden Ave., Chicago 10, Ill.

Pulse Switches

494



Ratings are 2 to 10 amp for standard transistorized pulse switches. Pulse repetition rates are from 2 to 1,000 cps; duty cycles are from 10% to 80%. Functions generated include automatic cycling, triggered pulsing, timing control and pre-coded pulsing. Special units can be made to order.

Applied Magnetics Corp., Dept. ED, 1407 Norman Firestone Road, Goleta, Calif.

Availability: stock.

115

MISSILES

Sparrow
Hawk
Talos
Sergeant
LaCrosse
Nike Hercules
Nike Ajax
Bomarc
Shark
Polaris
Mace
Matador
Pershing
Titan
Atlas
Minuteman
SubRoc
Mauler
Skybolt

AIRCRAFT

F-102
F-105
F-104
B-52
B-47
B-58
B-70
A3J
F4H
S2F-1
F11F



the world's most accurate and reliable

precision potentiometer

The mirror-smooth conductive film resistance element, produced by advanced solid-state techniques, mated with precious metal multi-fingered wipers and all-welded precision construction results in:

- INFINITE RESOLUTION
- LINEAR AND NON-LINEAR OUTPUTS TO 0.01%
- MICROVOLT OPERATIONAL NOISE
- LIFE GREATER THAN 30 MILLION REVOLUTIONS

LINEAR AND ROTARY POTENTIOMETERS IN ALL SIZES AND SHAPES. WRITE FOR FREE CATALOG

COMPUTER INSTRUMENTS CORPORATION
92 MADISON AVENUE • HEMPSTEAD, L. I., NEW YORK



AVAILABLE FROM STOCK!

C. I. C. PRECISION FILM POTS

You can have any of these precision film pots on their way to you within hours. No need to wait for "custom" pots.

LINEAR SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Linearity
1/2"	1K	± .5%
	10K	± .5%
	50K	± .5%
7/8"	1K	± .5%
	10K	± .5%
	50K	± .5%
1-3/32"	1K	± .25%
	10K	± .25%
	50K	± .25%
2"	1K	± .5%
	10K	± .5%
	50K	± .5%
3"	1K	± .25%
	10K	± .25%
	50K	± .25%
2"	5K	± .25%
	20K	± .25%
	50K	± .25%
3"	5K	± .1%
	20K	± .1%
	50K	± .1%
2"	5K	± .05%
	20K	± .05%
	50K	± .05%

SINE-COSINE SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Conformity
1-3/32"	10K	± .75%
	20K	± .75%
2"	10K	± .25%
	20K	± .25%
3"	10K	± .15%
	20K	± .15%

LINEAR MOTION FILM POTENTIOMETERS

Size	Resistance	Stroke	Linearity
1" Sq.	10K	1" Stroke	± .5%
	20K	1" Stroke	± .5%
	10K	2" Stroke	± .25%
	20K	2" Stroke	± .25%
	10K	3" Stroke	± .1%
	20K	3" Stroke	± .1%

WRITE OR CALL IN YOUR ORDER! POTENTIOMETERS WILL BE IN YOUR PLANT WITHIN 24 HOURS!

FIRST IN FILM POTS



COMPUTER INSTRUMENTS CORPORATION
92 MADISON AVE., HEMPSTEAD, L. I., N. Y.

CIRCLE 101 ON READER-SERVICE CARD

◀ CIRCLE 102 ON READER-SERVICE CARD

NEW PRODUCTS

Induction Generator

624



The equivalent of 50 kw can be induced into a square inch of surface by the Thermonic dual frequency induction generator. Shallow depth penetration at normal operating frequencies of 5 to 8 mc permits efficient coupling of high power to small diameters. Output control of all frequencies is by saturable reactor.

Induction Heating Corp., Dept. ED, 181 Wythe Ave., Brooklyn 11, N. Y.

Photoelectric Reader

510



Single-package photoelectric reader model 200 is for applications such as position control, cueing, sorting and inspecting by number shade, color and size. The lamp and photocell are separated by an opaque shield which optically divides the lens. Control units can also be furnished.

Melpar, Inc., Special Products Div., Dept. ED, Falls Church, Va.

Wideband Converter

701



The VLF-1 Caliverter, a vlf to hf wideband converter provides reception of vlf signals on a standard hf communications receiver. Transistor circuitry and Zener-regulated ac supply are contained in a basic 6-1/2 x 3 x 4 in. enclosure. Sensitivity is less than 0.1 μ v, and output is at 5,000 mc plus the vlf frequency.

Aerospace Research, Inc., Dept. ED, 94 Massachusetts Ave., Cambridge 39, Mass.

P&A: \$269.50; from stock.



new twist in hook-up wire - WATERTIGHT!

WATERTIGHT Synkote[®] hook-up wire ends failures caused by moisture or other penetrations. It's 100% watertight through the strands, and flexible at extreme temperatures. Resistant to flame and abrasion. Available in a full range of sizes. Rigidly manufactured and tested to Mil-W-16878D-Type FFW and Mil-C-915A. Developed and engineered to meet today's exacting requirements for electric motors, transformers and coils, and tomorrow's new demands in missiles, aircraft, naval vessels, electrical and electronic equipment. Watertight Synkote[®] hook-up Wire — **PLASTOID** CORPORATION — a new twist you should know more about! Write today. 42-61 24TH STREET / LONG ISLAND CITY 1, N. Y. / 81 8-8200



Inside this portable recording oscillograph...
**A FOCUSED PRECISION OPTICAL SYSTEM
TO ASSURE HIGHEST TRACE RESOLUTION**

The high-efficiency optical system of CEC's 5-124 Recording Oscillograph concentrates more high actinic light on the record... permits a writing speed of 50,000 ips with trace widths of 0.010" or less.

Optics are specially treated for higher light transmissibility. This means "big" oscillograph capability in a portable, low-cost instrument. The 5-124 easily records and resolves phenomena occurring in intervals as short as 500 microseconds... boasts 18-channel capacity... delivers ready-to-read print-out records that eliminate processing problems.

Among the 5-124's standard features are pushbutton control, intensity control, unexposed footage indicator, individual input connectors and automatically regulated galvanometer lamp circuit. These optional features are available: grid lines (1/10" or mm), trace identification and numbering, full-width timing lines and galvanometer block heaters.

For complete information, call your nearest CEC sales and service office or write for Bulletin CEC 5124-X19.

Data Recorders Division

CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A DIVISION OF Bell & Howell • FINER PRODUCTS THROUGH IMAGINATION

NEW PRODUCTS

Storage Capacitors 520



Discharge is as low as 1 μ sec. Designated as HI-PAK, the units have near zero self-inductance. Standard designs are available in metal housings and in a polyester wrap, resin filled fabrication.

Dearborn Electronic Laboratories, Inc., Dept. ED, P. O. Box 3431, Orlando, Fla.

Tungsten-Rhenium Alloys 438

In wire and strip form. A tungsten-26% rhenium alloy can be produced in wire sizes as fine as 0.0005 in. in diameter and in

continuous lengths of over 2,000 ft. Physical properties include very high tensile strength at high temperatures, excellent electrical resistivity and a melting point of about 5,800 F.

Hoskins Manufacturing Co., Dept. ED, 4445 Lawton Ave., Detroit 8, Mich.

Microvolt Level Relay 531



Reliability under extreme military and commercial environments is claimed for the 3PDT Micro-Scan relay for sampling, multiplexing, time-sharing, and control circuiting. The 3PDT permits

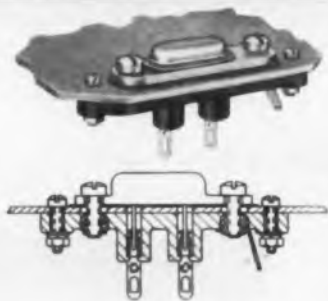
AUGAT

SPACE SAVER SOCKET

Designed for the Complete Series of Clevite Spacesaver Power Transistors

The Spacesaver Socket fastens beneath the chassis, allowing direct mounting of the transistor, with a mica insulator, to the chassis. In this way, the transistor is provided with maximum heat dissipation by conduction.

Three socket insulation materials available: black phenolic, melamine or diallyl phthalate.



The socket's narrow width permits full utilization of the space saving size of its mating transistor.

For complete specifications, write for Data Sheet No. 760.

AUGAT BROS., INC.

31 PERRY AVENUE, ATTLEBORO, MASS.

CIRCLE 106 ON READER-SERVICE CARD

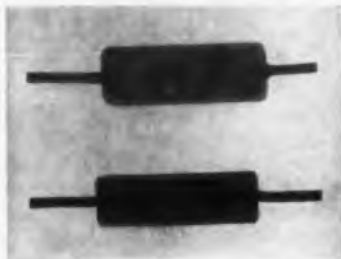
◀ CIRCLE 105 ON READER-SERVICE CARD

complete switching of low-level two-wire transducer data.

James Electronics, Inc., Dept. ED, 4050 N. Rockwell St., Chicago 18, Ill.

P&A: \$30 to \$40; samples from stock.

Epoxy Molded Resistors 524



Ratings from 1/10 to 1 w are available for a new series of epoxy moulded carbon and metal film resistors. Units exceed all requirements of MIL-R-10509D, characteristics B, D and F for the carbon film, and C and E for the metal film. Resistors maintain stability without change in

characteristics in shock tests from -60 to +365 F.

Key Resistor Corp., Dept. ED, 321 W. Redondo Beach Blvd., Gardena, Calif.

Availability: 30 days.

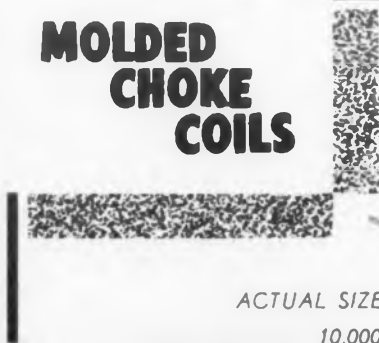
Precision Limit Stop 530



Settings from 0 to 100 turns are possible in a precision limit stop only 7/8 in. in length. Hardened pins that make radial contact allow for precise stops without binding. Impact speed is 1/5 of the input speed.

Dynamic Gear Co., Dept. ED, Amityville, L. I., N. Y.

MOLDED CHOKE COILS



ACTUAL SIZE
10,000 UH



Nicknamed the "Micro Mite", these reliable, rugged coils exhibit high Q, very low distributed capacity, all concentrated into an amazingly small package.

Miller's new "Micro Mite" coils are perfect for use where weight, space and high Q considerations are involved. Their volumetric reduction ranges up to 80%, with current ratings approximately 75-300 millamps and standard series values up to 10,000 uh.

The "Micro Mite" coil construction permits miniaturization without the use of ferrite materials, thus maintaining temperature stability to 125° C. These hermetically sealed molded coils conform to MIL-C-15305A.

ASK FOR OUR MICRO-MITE BULLETIN

J. W. MILLER COMPANY • 5917 So. Main St., Los Angeles 3, Calif.

CIRCLE 107 ON READER-SERVICE CARD

CIRCLE 108 ON READER-SERVICE CARD >



Cary Electrometers measure insulation resistance of 10^{15} ohms at potentials of one volt or less with $\pm 1\%$ accuracy

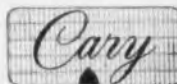
Provide fast accurate leakage measurements; eliminate instrument loading of the test circuit

In addition to measuring large resistance values Cary Electrometers are used for measuring charging phenomena, hysteresis and photo effects of semi-conductors and insulating materials. Applications include air ionization studies, measurement of ion currents in mass spectrometry, radioactivity measurements of solids, liquids and gases and Hall effect studies.

Cary Electrometers detect currents as small as 10^{-17} amperes; charges to 6×10^{-16} coulombs; and voltages as low as 20 microvolts.

High stability (less than 5×10^{-17} amperes steady drift), high accuracy ($\pm 0.25\%$ using a precision potentiometer), and operation independent of changes in vacuum tube and component characteristics are just a few of the features contributing to the superior performance of Cary Electrometers.

Choose from several models: MODEL 31 for measuring currents from grounded sources and voltages from ungrounded sources; MODEL 31V for voltage measurements from grounded sources; MODEL 31-31V for measuring voltage or current from grounded sources.



INSTRUMENTS

Electrometers • UV-Visible - Near IR and Raman Spectrophotometers

Additional information
on Cary Electrometers and Accessories
is yours for the asking.
Write for data file M14-91

APPLIED PHYSICS CORPORATION • 2724 So. Peck Rd., Monrovia, Calif.

calibrate all your
precision equipment
with the new **YEW**

VERSATILE DC17 RANGE PORTABLE STANDARD VOLT-AMMETER



MODEL MPF-17R

	Range	Scale Div.	Approx. Resistance or Voltage Drop
Voltage	1000 300 100 30 10 3V		1000: V
Current	30 10 3 1A 300 100 30 10 3 1mA 50mV (for external Shunts)	150 100	Approx. 50mV (50mV: 53 7:±)

highly accurate readings
especially recommended
for research institutes

- These all-in-one units may be substituted for many single range units. Accuracy of both units within $\frac{1}{2}$ of 1% f.s.d. Calibration certificate accompanies each unit.
- Recommended for general testing where long, easy-to-read scales are desired.
- Simple foolproof operation. Range selector peg gives secure contact.
- Both AC and DC instruments are shielded from external magnetic fields.
- Working principle MPF-17R moving coil type. Shunts and multipliers self-contained. Working principle SPF-13R moving iron type. Transformers self-contained.
- Units supplied with fitted velvet lined storage case.
- Compact in size, units measure only $7\frac{1}{8} \times 10\frac{1}{4} \times 4\frac{3}{8}$.

AC13 RANGE VOLT-AMMETER

MODEL SPF-13R

	Range	Scale Div.	Approximate Power Consumption
Voltage	750 300 150 75 30V	150	7.5VA in any range
Current	30 15 7.5 3 1.5 0.75 0.3 0.15A	150	2.1 1.2 1.0 0.9 0.8 0.8 0.7 0.5VA

Other YEW portable standards available:
Rectifier Type Milliammeters and Voltmeters,
Thermocouple Type High Frequency Milliammeters and
Voltmeters, Electro-Dynamometer Type Wattmeters

Write today for literature.

YOKOGAWA ELECTRIC WORKS, INC.

40 Worth Street, New York 13, N. Y.

In Canada: Stark Electronic Sales Co., Ajax, Ontario



NEW PRODUCTS

Infrared-Detector Tester

511



For space and satellite programs. The infrared-detector production tester is for large-volume production testing of multi-element, infrared-sensitive photoconductor arrays in guidance and surveillance. It records signal, noise, noise-to-signal ratio, cell current, cell voltage and other parameters.

Infrared Industries, Inc., Western Div., Dept. ED, Santa Barbara, Calif.

P&A: \$180,000; 90 to 120 days.

Bi-Metal Thermostat

506



Fixed-setting thermostat model MS has single-pole, single-wire controls. Contacts open with a rise in temperature. Range is 70 to 600 F. It has a ceramic body, push-on lugs and fine silver contacts.

American Thermostat Corp., Dept. ED, South Cairo, N. Y.

Micro-Micro Ammeter

485



Low-drift, micro-micro ammeter model R660 has a highly stable, temperature-compensated, transistorized amplifier with an electrometer-tube input arranged to produce almost 100% feedback. A total of 20 ranges cover from 3×10^{-3} to 1×10^{-12} amp. Drift is less than $\pm 2\%$ of full scale per week after an initial warm-up of 10 min.

Radiation Technology, Inc., Dept. ED, Atlanta, Ga.

Centralab®

introduces

four styles of

**HOT MOLDED CARBON
POTENTIOMETERS**

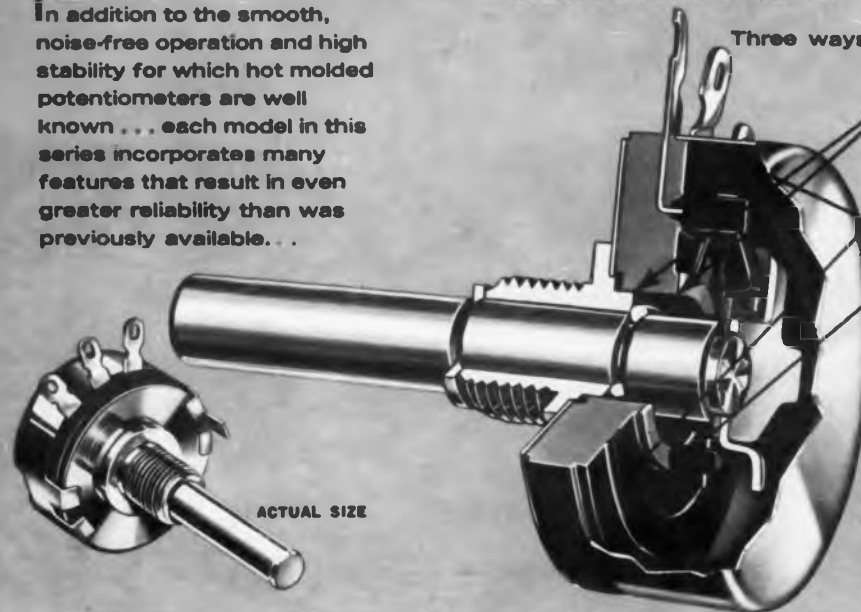


For smooth, noise free operation and high stability . . . The widest selection anywhere . . . Designed to meet **MIL-R-94** environmental and test requirements

Centralab . . . producer of carbon potentiometers for over 35 years

CENTRALAB'S MODEL A (RV4 Style)

In addition to the smooth, noise-free operation and high stability for which hot molded potentiometers are well known . . . each model in this series incorporates many features that result in even greater reliability than was previously available . . .



Three ways better than other hot molded units

1. Greatly increased high voltage capability, due to the wide clearance between the bushing and the collector track.
2. Greater freedom from contamination of dirt, carbon particles and sealing compounds, due to the elevated resistance track construction.
3. Exceptionally long noise free operation that actually improves with use, provided by the carbon composition material of which both the collector and pick-off brushes are constructed.

SPECIFICATIONS:

RATING: 2 watts at 70° C.

SIZE: 1-3/32" diameter, 37/64" deep from mounting surface.

CONSTRUCTION: Completely enclosed. All metallic parts are non-magnetic and corrosion resistant. Available in tandem, triple or dual concentric construction.

ROTATION: 312° ±3°.

TORQUE: 1.0 to 6.0 ounce inches

RESISTANCES: Linear taper, 50 ohms to 5 MEG. Log taper, 100 ohms to 2.5 MEG.

MODEL N



This intermediate size potentiometer has never before been offered. Rated at 3/4 watt, the Model "N" can replace 2 watt units in many military and commercial applications where size is important.

A flush resistance track is protected against contamination by the raised rim of the insulating base. Although small in size, the model "N" also has carbon composition pick up and collector brushes for long, noise-free operation.

The one-piece metal case and bushing is spun over the molded insulating base to provide a near-perfect seal. Triple shaft seals and water-tight panel seals can be supplied.

SPECIFICATIONS:

RATING: 3/4 watt at 70° C.

SIZE: 23/32" diameter, 1/2" deep from mounting surface.

CONSTRUCTION: Completely enclosed. All metallic parts are non-magnetic and corrosion resistant.

ROTATION: 300° ±3°

TORQUE: 5.0 ounce inches average.

RESISTANCES: Linear taper, 50 ohms to 5 MEG. Log taper, 100 ohms to 2.5 MEG.

MODEL P (RV6 Style)



Although much smaller than the Model "N", the Model "P" is rated at 1/2 watt and is similar in external construction.

The resistance track is hot molded, flush type. An outstanding feature of the Model "P" is the single carbon brush that serves both collector and pick-off purposes. The one-piece aluminum case is spun over the insulating base to provide a near-perfect seal.

This unit meets all applicable military requirements.

SPECIFICATIONS:

RATING: 1/2 watt at 70° C.

SIZE: 1/2" diameter, 15/32" deep from mounting surface.

CONSTRUCTION: Completely enclosed.

ROTATION: 290° ±3°.

TORQUE: 1.5 ounce inches.

RESISTANCES: Linear taper, 100 ohms to 5 MEG. Log taper, 500 ohms to 2.5 MEG.

MODEL T



This unique trimmer resistor, or locking-type trimmer potentiometer, is the only hot molded, single turn unit available on today's market. Rated at 1/3 watt, it has been designed primarily for printed-circuit board applications.

The Model "T" has a positive screw actuated lock and is extremely resistant to shock, vibration and acceleration.

These units can be encapsulated in a rigid resin without damage.

SPECIFICATIONS:

RATING: 1/3 watt at 70° C.

SIZE: 19/32" diameter, 11/32" deep from mounting surface.

CONSTRUCTION: Open (however, rugged construction permits potting of all types).

ROTATION: 300° ±3°.

TORQUE: Locking type.

RESISTANCES: Linear taper, 500 ohms to 5 MEG.

IMMEDIATE DELIVERY FROM STOCK

A full range of values of all four types of Centralab hot molded carbon potentiometers are available in quantity, from stock, through Centralab industrial distributors.

Centralab

THE ELECTRONICS DIVISION OF GLOBE-UNION INC.
900 E. KEEFE AVENUE • MILWAUKEE 1, WISCONSIN
In Canada: Centralab Canada Ltd. P.O. Box 400, Ajax, Ontario

CIRCLE 103 ON READER-SERVICE CARD

DC Power Supply

378



Output is 28 v, 1 amp maximum for power supply model 205A. Unit is for use with the company's line of step-servo components. It is hermetically sealed in a 3 x 4-1/4 x 5 in. can. Unit requires 115 v, 60 cps, 40 w, single phase. The module weighs 6 lb.

Automation Development Corp., Dept. ED, 11824 W. Jefferson Blvd., Culver City, Calif.

P&A: \$99; from stock to four weeks.

Three-Conductor Plug

388

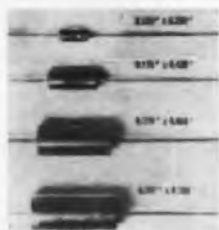


For polarized applications, this plug has a 0.206 in. diameter shaft. Model S-260 has a plastic handle and screw type terminals; model S-290 has a shielded handle. Sleeve, tip and body are machined from brass and bright nickel plated. Terminals are brass, hot tin-dipped screw-type. Insulation is nylon.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

Solid Tantalum Capacitors

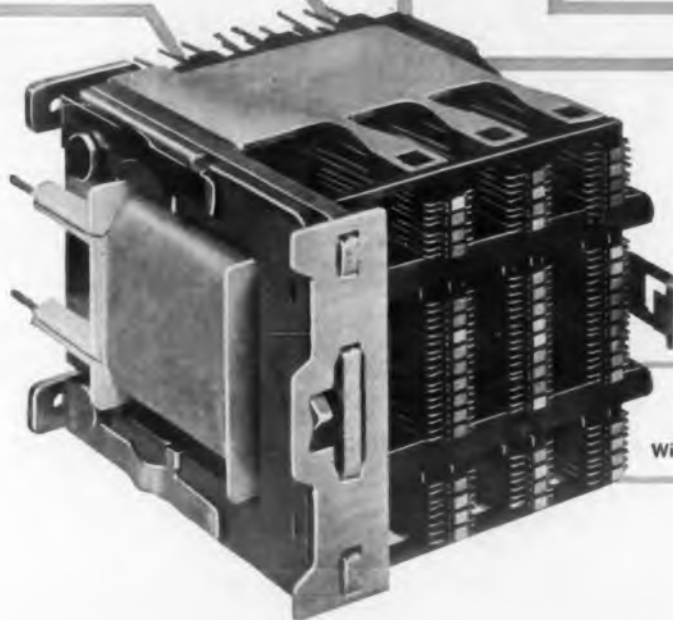
412



Rated at 0.0071 to 0.82 μ f. Part of the Tanti-Cap line of solid tantalum capacitors, the units are available in 20 or 35-v dc ratings with tolerances of $\pm 10\%$ or $\pm 20\%$. Case dimensions are 0.125 x 0.250 in. Requirements of MIL-C-26655A are met. Units are made for satellite projects, transceivers and common-carrier systems.

Texas Instruments Inc., Dept. ED, P. O. Box 5012, Dallas 22, Tex.

◀ CIRCLE 103 ON READER-SERVICE CARD



AE Series WQA
Quick-Acting
Wire-Spring Relay

TO THE ENGINEER who wants to transfer 51 circuits simultaneously

If you need simultaneous transfer of a large number of circuits without fail, take a look at AE's new WQA relay. It will do the work of four or more heavy-duty, general-purpose relays each with maximum spring pile-ups, and sustain 50 million or more operations without readjustment.

In the WQA relay, all moving springs pass through holes in a unique actuating "card." Moved directly by the armature, the card in turn actuates all the moving springs. This method of operation pre-establishes exact timing and sequence of all spring operations, and at the same time assures perfectly syn-

chronized "break-before-make" on all circuits. Contact capacities on WQA relays can be custom-tailored to your needs, with either one, two or three levels of contact assemblies available, each with a capacity of 17 Form C combinations. Other Forms available.

Our circuit engineers will be pleased to work with you in adapting the WQA to your specific design. Or, if you wish, they'll take on the complete packaging job.

If you'd like more information on the WQA relay, address your request for Circular 1957 to: Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.

**AE
CAN
DO**



AUTOMATIC ELECTRIC

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS



CIRCLE 111 ON READER-SERVICE CARD



UPI Photo

INSTANT DISCHARGE OF STORED ENERGY

The sting of the *Vespa Crabro* hornet is immediate! Faster yet — in as little as 0.1 microsecond — tough HI-JUL high energy storage capacitors dependably deliver full discharge of stored energy with negligible power loss.

APPLICATIONS-

nuclear systems • explosive initiating circuits • low impedance pulsers
• plasma research • radiation • magnetic field generation and controls
• explosive forming • welding • photoflash. Designs for customers' special applications are also available.

Unique *cartwheel* construction of rugged HI-JUL capacitors minimizes self-inductance and reduces series resistance to a minor value. Other excellent features: electrode terminations provide low contact resistance, high ringing frequency, maximum Joules (watt-second) per cubic inch and per pound.

Units offered in metal housings and in a recent Dearborn development of economical polyester-wrap, resin-filled fabrication, offering extremely low inductance characteristics previously restricted to metal housings.

WRITE FOR BULLETIN 8-TB-61

Dearborn

ELECTRONIC
LABORATORIES INC.

P. O. Box 3431 • Orlando, Florida • TErrace 8-5400

March 1968

CIRCLE 112 ON READER-SERVICE CARD

NEW PRODUCTS

Horsepower Meter

355



Continuous measurement of shaft horsepower is possible with the Thor power meter. Unit is mounted directly on the shaft and transmits readings to a remote location without wires, slip rings, or other physical connections between rotating equipment and other stationary equipment. Accuracy is within 1%. Unit weighs 3.5 lb.

Unilectron, Inc., Dept. ED, 129 Binney St., Cambridge 42, Mass.

UHV Capacitors

546

For dc filtering, nuclear accelerators, pulse networks, radar and high-voltage test equipment, these uhv capacitors are rectangular, bakelite tubes. Nine ranges cover 50 to 250 kv dc. They can be operated at 60 C for 10,000 hr and may be used to 0 C. Dielectric construction consists of a plastic film and multi-layers of thin kraft paper impregnated with mineral oil.

Corson Electric Manufacturing Corp., Dept. ED, 540 39th St., Union City, N. J.

Heavy Duty Rectifier


351



Oil-immersed, fin-cooled rectifier measures 10 x 12 x 12-1/4 in. Continuous operating current is 5 amp; piv is 50 kv. Maximum power dissipation is 50 kw and maximum ambient operating temperature is 55 C. Unit is made for transmitter power supplies and has radio, radar and loran applications.

North American Electronics, Inc., Dept. ED, 71 Linden St., West Lynn, Mass.

TEC-LITES
U.S. PAT. NO. 2,988,874



**CUSTOM
DESIGNED
TO GIVE
YOU
PRECISELY
THE
INDICATOR
YOU
NEED!**

Only specifically designed indicators can meet the critical electro-mechanical specifications and high reliability levels demanded for computers, data processing and control systems.

TEC engineers, who conceived the self-contained transistorized indicator, have designed literally hundreds of special TEC-LITES . . . indicators, "button-lites", switches and readout units . . . to give designers the *exact* device they need! Your problem may be met with one of these special units or a new TEC-LITE created to your specifications.

Write for detailed information on custom TEC-LITES . . . designed to give you precisely the indicator you need!

**ORIGINATOR OF PATENTED
TRANSISTORIZED INDICATORS**



**Transistor
Electronics
Corporation**

3357 Republic Ave. • Minneapolis 26, Minn.
TWX MP 331 • WE 9-6754

Magnetic Multiplier 441



Accuracy is 1% full scale. Magnetic multiplier model 300AX is for converting the product of two electrical inputs into a single proportional ac output. A dc input from 0 to $\pm 100 \mu\text{A}$ plus an ac input from 0 to 2.3 v, phase reversing, generates a phase sensitive ac output from 0 to 1.2 v. Unit is operable from 300 to 1,000 cps.

Transmagnetics, Inc., Dept. ED, 40-66 Lawrence St., Flushing 54, N. Y.

P&A: \$99 and up; 2 to 3 weeks for samples.

Numerical Control System 433

For machine tools. The point-to-point numerical control system is for boring, drilling and similar machine tool operations that require positioning in one plane. It can be programmed to within 0.0001 in. and has full control of acceleration and deceleration. Accuracy is 0.001 in. It is transistorized, modular.

Thompson Ramo Wooldridge Inc., Dept. ED, 455 Sheridan Ave., Michigan City, Ind.

Panel Meters 442



Suspension type panel meters use a short narrow band tightly suspended on special spring terminals to support the coil and its moving counterparts. Instruments are available in 2-1/2, 3-1/2, 4-1/2, 6, 7 and 8 in. case sizes.

Triplett Electrical Instrument Co., Dept. ED, Bluffton, Ohio.

CIRCLE 241, 242 ON READER-SERVICE CARD ►



NEW PRODUCT ADVANCES FROM Transitron

ACTUAL SIZE



ACTUAL SIZE



TMD-914 and TMD-916 DIFFUSED SILICON MICRODIODES MICRO-EQUIVALENTS of the 1N914 and 1N916

Duplicating the specifications of the popular 1N914 and 1N916, these microminiature very fast switching silicon diodes offer low capacitance and are designed for use in extremely high speed transistorized computer circuitry. Their durable construction in an all-glass package features TRUE hermetic sealing and a unit capable of providing long-term reliability under extreme environmental conditions.

Recovery time: 0.004 micro-second.

SPECIFICATIONS AT 25°C

	TMD-914	TMD-916
Maximum Forward Voltage at 10mA	1 Volt	1 Volt
Maximum Inverse Current at 20V	.025 μA	.025 μA
Minimum Inverse Voltage at 100 μA	100 Volts	100 Volts
Maximum Capacitance at 0 Volts	4 μpF	2 μpF

For further information, write for Bulletin PB-71C. Circle 241 on Reader-Service Card

6.3 VOLT CERTIFIED SILICON VOLTAGE REFERENCES

Now, for the first time in the industry, silicon voltage references that have exhibited voltage stabilities as low as $\pm 0.002\%$ for 1000 hours are being CERTIFIED and offered by Transitron. These significant features are associated with each unit:

- Actual readings recorded periodically over 1000 hours included with each certification document.
- Serialization of units for convenient reference to their production and life test histories at Transitron.

Manufacturers of missiles and precision instruments who require a stable voltage reference of small size and weight may look to Transitron for these references which are certified at point of purchase.

Type	Certified* Voltage Stability (%)	Voltage Range at $I_z = 7.5\text{mA}$ at 25°C (Volts)		Temperature Stability Maximum Voltage Change (+25°C to +100°C) at $I_z = 7.5\text{mA}$ (Volts)	Maximum Dynamic Resistance at $I_z = 7.5\text{mA}$ at 25°C (Ohms)
		Min.	Max.		
1N3501	± 0.01	6.2	6.5	≈ 0.006	12
1N3502	± 0.01	6.2	6.5	≈ 0.003	12
1N3503	± 0.005	6.2	6.5	≈ 0.006	12
1N3504	± 0.002	6.2	6.5	≈ 0.006	12

*Voltage References certified for voltage stability observed during 1000 hours operation.

For further information, write for Bulletin TE-1352F-1.

Circle 242 on Reader-Service Card

Transitron



electronic corporation
wakefield, melrose, boston, mass.

SALES OFFICES IN PRINCIPAL CITIES THROUGHOUT THE U.S.A. AND EUROPE • CABLE ADDRESS TRELCO

For quantities 1-999 call your nearest Transitron Industrial Distributor.

When your specs require



connectors . . .

Use Greomar!

Greomar is geared to meet any requirement in RF connectors! And right now over 700 firms "Use Greomar" to meet their most critical needs.

Greomar is geared for leadership. This year alone we designed 500 new connectors! These include:

- 3 new rigid line series. Foamflex, Styroflex, Styrofoam Spirafil-T and Coaxitube lines.
- the new miniature Red Line series.
- the new Tefseal hermetic seal connectors that may eliminate glass seal types.

Now in R & D, we're working on new high temperature connectors . . . a new subminiature series . . . new radiation connectors . . . new high frequency connectors for K Band and beyond . . . new side-launch Stripline adapters.

Greomar is geared for delivery. Standards can be shipped in hours from our stock of 2000 types . . . 750,000 assembled units . . . 8,000,000 parts. If custom adapting to your spec's is required, we'll handle it with speed and efficiency unmatched in the industry. If it's a new design, our Model Shop will handle prototypes — fast!

**Military designation for RF Connectors.*

NEW 8 PAGE HANDBOOK

Just off the press! Latest listing of standard Greomar connectors and fittings. Send for your copy today . . . save time in specifying and ordering.



GREMAR MANUFACTURING COMPANY, INC.
 WAKEFIELD, MASS. Tel. 245-4580
 RELIABILITY THROUGH QUALITY CONTROL

CIRCLE 115 ON READER-SERVICE CARD

NEW PRODUCTS

Miniature Magnetic Modulator 363



For dc-to-ac proportional conversion in servo and control systems, the model 202 magnetic modulator requires 26-v, 400-cps excitation. Unit converts 0 to 30 μ a dc into 0 to 0.42 v, 400 cps ac. Load impedance is 10 K. Input current drift is less than 0.3 μ a over a -25 to +105 C range. Device measures 23/32 x 23/32 x 15/16 in., and is hermetically sealed and potted.

Transmagnetics, Inc., Dept. ED, 40-66 Lawrence St., Flushing 54, N. Y.

P&A: \$70 up; 1 to 2 weeks for samples.

Telemetry Transmitter 356



For human or machine stress, the Midas, miniature data acquisition system, is an fm/fm, multi-channel telemetry system. It is capable of sensing and transmitting respiration rate, heartbeat, pressure, strain, acceleration and other phenomena. A three-channel unit measures 1-3/8 x 1-3/8 x 6-1/4 in.

Unilectron, Inc., Dept. ED, 129 Binney St., Cambridge 42, Mass.

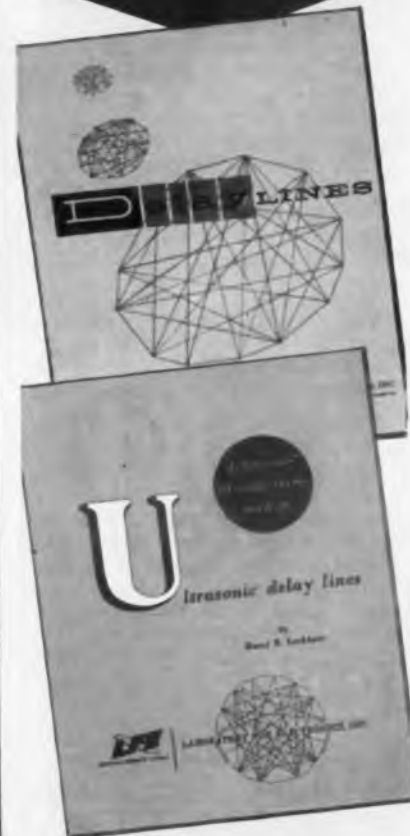
Miniature Switchlights 364



Push-button switches are lit by standard panel lamps. Release mechanism is solenoid-activated, permitting devices to be switched off remotely. Contact arrangements up to 4pst and dpdt are available. Units are rated at 28 v dc, 125 v ac, 2 amp. Solenoid coils are available for 6, 12, or 28 v operation.

Pendar, Inc., Dept. ED, 15755 Arminta St., Van Nuys, Calif.

**GET LATEST DATA...
 ULTRASONIC DELAY LINES**



Write today for **NEW CATALOG** . . . complete, timely specs on the industry's most complete line . . .

ALSO get your copy of "Definitions of terms used in Ultrasonic Delay Lines" a helpful guide to accurate specifying prepared by H. H. Lockhart, Manager, Delay Line Operations.



LABORATORY FOR ELECTRONICS, INC.

Computer Products Division
 1075 COMMONWEALTH AVENUE
 BOSTON, MASSACHUSETTS

CIRCLE 116 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

Angular Accelerometer 447



Spin-up acceleration can be monitored with angular accelerometer model 4575. Ranges are available from ± 500 to $\pm 1,500$ rad per sec². Linearity is within 0.05%; resolution is better than 0.0001% of full scale. Nominal output is ± 7.5 v. Weight is 4 oz.

Donner Scientific Co., Dept. ED, Concord, Calif.

P&A: \$710; 30 days.

Telemetry Receiver 435

For use at 216 to 260 mc. Said to perform in any known telemetry system, model TMR-2A telemetry receiver meets standard fm-fm and pdb/fm applications as well as pcm/fm requirements for systems using up to 1 million bits per sec. It has a front-panel selectable video bandwidth filter with 12-db per octave roll-off.

Defense Electronics, Inc., Dept. ED, Washington-Rockville Industrial Park, 5451-B Randolph Road, Rockville, Md.

P&A: \$2,495; 30 to 60 days.

Brakes and Clutches 444



Torque ratings of 1.5 to 240 lb-in. are available on miniature fractional hp electric brakes, clutches and clutch-brake packages. Diameters of the units range from less than 1 in. to 4 in. Units, useful at up to 50 cps, are made for aircraft components, servos, data equipment, and similar applications.

Warner Electric Brake & Clutch Co., Dept. ED, Beloit, Wis.

CIRCLE 117 ON READER-SERVICE CARD ➔

MATCHED CHOPPERS



SILICON CHOPPERS

From 1 mV "on"
to 80 V "off"

NOW IN TO-18
and
TO-5 CASES

SPERRY
SEMICONDUCTOR

DIVISION OF
SPERRY RAND CORPORATION
NORWALK, CONNECTICUT

SINK YOUR TEETH INTO THESE FACTS . . .

- High breakdown ratings — 50 to 80 volts
- Two point control of current/voltage offset parameters
- Matched pairs to standard tolerance of 100 μ v
- 10 million-to-1 minimum "off" to "on" resistance ratio
- Typically 30,000 megohms reverse resistance
- Typically 50 ohms forward resistance
- High temperature stability
- Unlimited quantities available
- Available from local Sperry Authorized Distributors

Don't gamble — you put your experience on the line when specifying for analog computers, D.C. amplifiers, electronic commutators and multiplex equipment.

Sperry now offers you a complete series of silicon transistors for single use or matched pairs that have the best combination of chopper characteristics — plus an extra margin of safety which provides true design flexibility.

Type Number	Type Number	BV _{CEO} (Volts)	BV _{CES} (Volts)	BV _{ES0} (Volts)	V _z (max) Offset Voltage (mV)	I _z (max) Offset Current (μ A)	The Bite 1 — 99	The Bite 100 — 999
2N941	2N1917	-8	-25	-25	1.0	1.0	\$ 9.75	\$7.50
2N942	2N1918	-8	-25	-25	3.0	3.0	7.80	6.00
2N943	2N1919	-18	-40	-40	2.0	1.0	12.35	9.50
2N944	2N1920	-18	-40	-40	3.0	1.5	8.77	6.75
2N945	2N1921	-50	-50	-50	4.0	2.0	5.20	4.00
2N946	2N1922	-80	-80	-80	4.0	2.0	6.50	5.00

Write for 16 page Technical Application Bulletin #2107 and new Chopper transistor data sheets on types 2N1917 through 2N1922 and 2N941 through 2N946.

SEMICONDUCTOR IS OUR MIDDLE NAME . . . SEMICONDUCTOR INTEGRATED NETWORKS (SEMI-NETS®). TUNNEL DIODES, MESA AND ALLOY SILICON TRANSISTORS AND DIODES
SALES OFFICES: CHICAGO, ILLINOIS; LOS ANGELES, CALIFORNIA; OAKLAND, NEW JERSEY;
MEDFORD, MASSACHUSETTS; SYKESVILLE, MARYLAND; FOREST HILLS, NEW YORK.
SEMICONDUCTOR OPPORTUNITIES AVAILABLE TO QUALIFIED ENGINEERS
*Trade Mark, Sperry Rand Corporation

METOX

insulated
power
resistors



- **HANDLE MORE WATTS PER SIZE.** This is particularly so in the higher resistance values.
- **OFFER HIGHER RESISTANCE RANGES PER SIZE.** For example, up to 47K in the 4W F32 size.
- **ARE VIRTUALLY NON-INDUCTIVE.**
- **INSURE RELIABILITY.** Comprehensive tests have proved that operating these resistors under the most arduous conditions will not cause failure.
- **HAVE SUPERIOR SURGE AND OVERLOAD PERFORMANCE.** The application of ten times the rated load for 5 seconds results in a typical resistance change of less than 0.5%.
- **A PRICE AS COMPELLING AS THE PERFORMANCE . . .** Resulting from control and efficiency in manufacture.

UNIQUELY DIFFERENT AND RADICALLY NEW!

The Welwyn F Series power resistors are composed of a metal oxide element, bonded to a porcelain rod at red heat. This process results in a resistor which is extremely rugged, both electrically and mechanically. The durable coating is intended to provide an insulating cover rather than to protect the element which in itself is highly resistant to mechanical damage and effects of moisture.

WELWYN TYPE DESIGNATION	MAXIMUM LENGTH	POWER RATING	RANGE OF VALUES*
F32	29/32 inches	4 Watts	20 \sim to 47K
F33	1-5/16 inches	6 Watts	30 \sim to 56K
F34	1-23/32 inches	8 Watts	40 \sim to 68K
F35	2-3/32 inches	10 Watts	50 \sim to 75K

*Rated Wattage may be dissipated up to that resistance value set by a potential limitation of 500 V/inch.

Where less than full Wattage is involved, potentials up to 1000 V/inch may be applied.



Welwyn INTERNATIONAL INC.

For further information write for data sheet W-1014.
3355 EDGECLIFFE TERRACE, CLEVELAND 11, OHIO
Factories in Canada and England

CIRCLE 118 ON READER-SERVICE CARD

NEW PRODUCTS

Variable Reluctance Pressure Transducer

381



Error band is 1% on the model A-40-1 variable reluctance pressure transducer. Tolerance is $\pm 2\%$ under any operable environmental conditions. Device has high power output and low output impedance, and can drive meter movements directly.

Astromics Div., Mitchell Camera Corp., Dept. ED, 611 W. Harvard St., Glendale 4, Calif.

P&A: \$595; 45 days.

Terminal Headers

368



A variety of shapes is available in this line of molded terminal headers. Headers are molded from a mineral-filled phenolic of high mechanical and dielectric strength. Pins are gold-plated brass. Units come in configurations suitable for transformers, electrolytic capacitors, plug-in modules, tube sockets and other plug-in components.

U. S. Engineering Co., Dept. ED, 13536 Saticoy St., Van Nuys, Calif.

Miniature Connector Kits

366



All components for assembling miniature connectors are provided by these kits. Units can be assembled with 6, 12, or 18 pin contact configurations. Assembly is accomplished by staking sockets and pins in place with tool provided, soldering wires to contacts, and snapping plastic hood into place.

Omega Precision, Inc., Dept. ED, 757 N. Coney Ave., Azusa, Calif.

P&A: \$50; from stock.



NEW UHF WIDE RANGE HIGH POWER OSCILLATOR AND POWER SUPPLY

The model 1241 is the only commercially available device featuring wide band coverage 200 mc to 2500 mc, at these high power levels — 40 W at 200-400 mc, 25 W at 400-1050 mc and 10 W at 950-2500 mc. This versatile, high-level signal source is furnished in two, rugged, transit cabinets. One cabinet contains the Cavity Oscillator and the other, the Power Supply and Modulator. External amplitude modulation or internal amplitude modulation is provided.

Write

TODAY FOR TECHNICAL
INFORMATION.

**MAXSON
INSTRUMENTS
DIVISION**

475 Tenth Avenue
New York 18, New York

MAXSON ELECTRONICS CORPORATION
CIRCLE 119 ON READER-SERVICE CARD

Vertical Amplifier

443



High-grain amplifier 162D has maximum sensitivity of 5 mv per cm, with 11 other ranges to 20 v per cm. With scope 170A, rise time is less than 10 nsec. Differential input is provided, with 40-db common mode rejection. Isolation between inputs is at least 80 db.

Hewlett-Packard Co., Dept. ED, 1501 Page Mill Road, Palo Alto, Calif.

P&A: \$225; 10 weeks.

Trimmer Potentiometer 432

Microminiature trimmer potentiometers are rated at 1 w at 50 C, derating to zero at 175 C. Weighing 3/4 g, they have a high-temperature plastic case, wirewound resistance element, moisture-resistant seal and Teflon-insulated lead wires or locked-in terminal pins. Both continuous and clutch-stop models are available.

Techno-Components Corp., Dept. ED, 18232 Parthenia St., Northridge, Calif.

Germanium Transistors 445



Withstand high voltages. Germanium transistors 2N1924, 2N1925 and 2N1926 are rated to 60 v and have a high gain characteristic. Applications include af switching circuits and high-voltage amplifier circuits.

General Electric Co., Kelley Building, Dept. ED, Liverpool, N. Y.

P&A: \$1.25 to \$1.65 ea, OEM; stock.

CIRCLE 120 ON READER-SERVICE CARD ►



Cinch Hinge Connectors eliminate contact damage caused by the high insertion and extraction forces encountered with ordinary multi-contact (20-100) Connectors... ideal for use in space-limited areas.

The exclusive Cinch Hinge Connectors are available with 20-100 contacts. Hinge Connectors are ideal for applications where a reliable multi-contact connector is needed for use in a limited area. The ingenious Hinge and Latch principle is foolproof and provides added reliability.

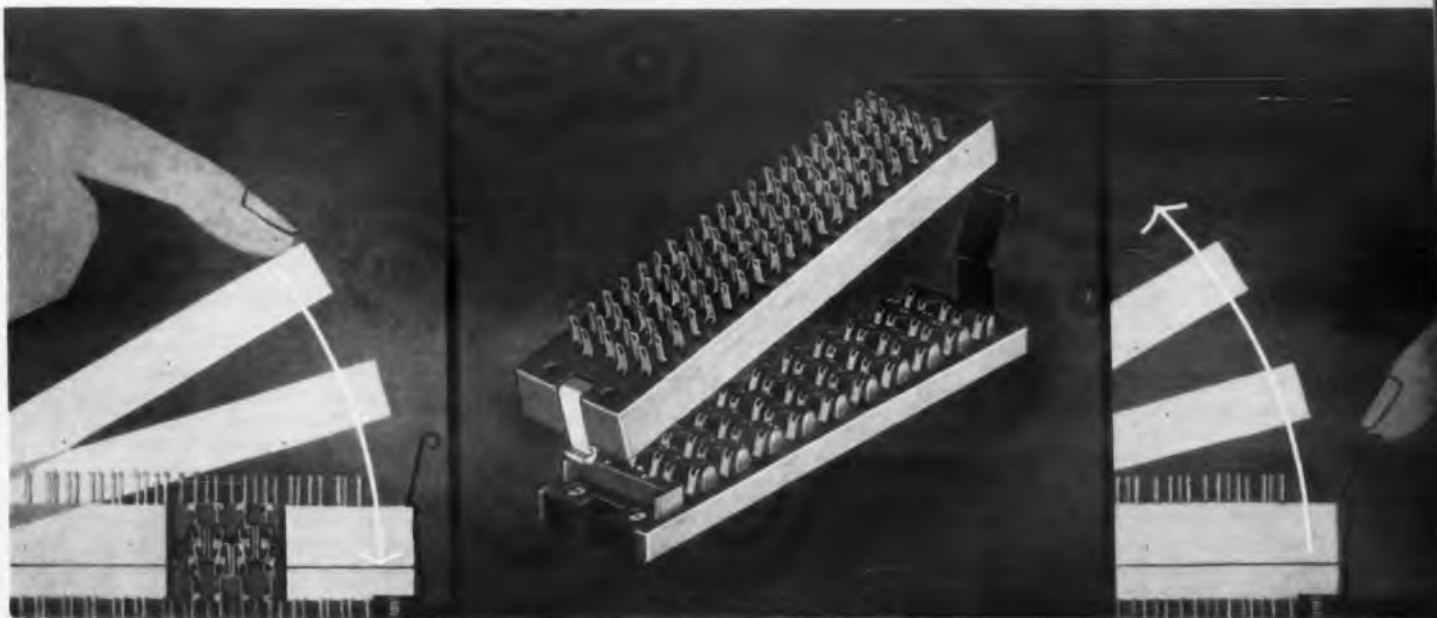
Use of this unique series of connectors eliminates damage to contacts caused by the excessive insertion and extraction forces encountered with ordinary connectors having large numbers of contacts. **Only one finger is necessary** to operate the latching device to open and close Cinch Hinge Connectors.

Another feature of the Cinch Hinge Connector is the design of the contacts. **Positive Contact** is always maintained because of the **pressure action** of the wiping contacts. This flexible contact design eliminates high insertion and extraction forces and provides added reliability.

In addition to the Standard Hood for use with 20-100 contact Hinge Connectors, Cinch now has a **new space-saving shallow hood** available for 20-50 contact hinge connectors. Both can be supplied with cable entry holes in top or end, with or without cable clamps and/or liners.

For further information, contact the nearest Cinch Sales Office in your area.

...AN INGENUOUS CONNECTOR



CINCH MANUFACTURING COMPANY

1026 South Homan Avenue, Chicago 24, Illinois

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California; St. Louis, Missouri.

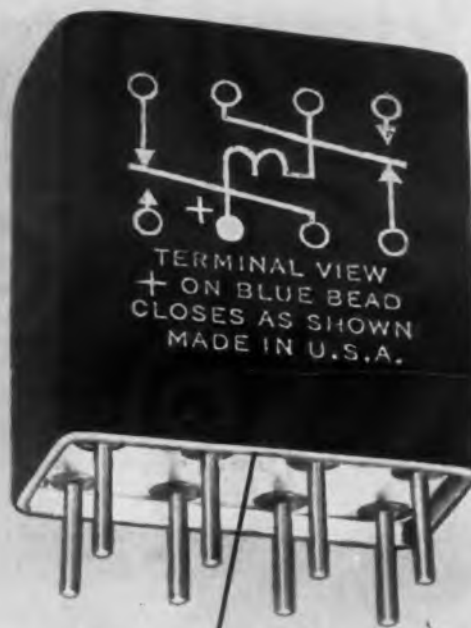


A DIVISION OF UNITED-CARR FASTENER CORPORATION, BOSTON, MASSACHUSETTS

GENERAL ELECTRIC SEALED RELAYS — UNMATCHED FOR RELIABILITY



Contacts positively carried—no spring bias All-welded coil leads, contacts and frame supports Matched-action armature and contact structure



Welded header seal

Enlarged three times

Inside and out... new latching relay features exclusive design advantages

It takes an x-ray to "get inside" General Electric's new polarized, dpdt magnetic-latching relay with exclusive welded header. Contaminants can't!

Inside, a unique contact and armature structure provides positive follow-through and snap-action closure even on low-power pulses. There's no hang-up or sluggish action because electromagnetic forces are matched to armature and contact load throughout the actuating cycle.

Good vibration and shock performance is also provided by having the armature "carry" the movable contact through a ceramic link. This push-pull action

with no spring bias provides secure contact mating in either pole position.

Effective combination of electro and permanent magnets cuts power requirements with no sacrifice in environmental capabilities. Operate sensitivity is 50 mw for single-coil type, 75 mw for dual-coil.

Relays withstand 30g vibration, 100g shock. Terminations are grid spaced; five mounting forms and a variety of coils are offered as standard.

For more information, contact your G-E Sales Engineer. Or write for Bulletin GEA-6628, General Electric Co., Schenectady, N. Y. Specialty Control Department, Waynesboro, Va. 792-21

Progress Is Our Most Important Product

GENERAL  ELECTRIC

NEW PRODUCTS

Thermocouple 542

Accurate, miniature Monitemp Mark III thermocouple holds heat dissipation to a minimum. A stainless-steel retaining nut, independent of the thermocouple, permits installation without twisting the cable.

The Advanced Products Co., Dept. ED, 59 Broadway, North Haven, Conn.

Instrument Counters 448



Dual bank counter model 4-4-Y-9425-R-AC is made for digital readout applications where plus and minus, right and left, or directional readings are required. Instrument counter model 4-D-9268, single bank, has luminous figures. Torque is 0.3 in. oz; counter is capable of speeds to 1,500 rpm.

Durant Manufacturing Co., Dept. ED, 1929 N. Buffum St., Milwaukee 1, Wis.

Teflon Tubing 545

Meets Mil specs. Extruded Teflon tubing can be furnished to meet exact customer specifications. Compounding of Teflon with metals and other materials for special applications can also be provided.

Timely Technical Products, Inc., Dept. ED, 100 Pine St., Verona, N. J.

Silicon Resins 541

Metal-filled silicon resins, designated Epocast H-1759 systems, are rubber-like materials filled with steel, bronze or lead. Applications include aircraft, electronics, missile, construction, nuclear-radiation shielding and consumer products.

Furane Plastics Inc., Dept. ED, 4516 Brazil St., Los Angeles 39, Calif.

Delay Line 430

For air-traffic controls, radar, airborne equipment, and similar applications. Model 52-44 transponder delay line has a delay-to-risetime ratio of 40:1. Impedance is 470 ohms; attenuation is 4 db; temperature range is -55 to +125 C. Dimensions are 1 x 2 x 3 in., and weight is 6 oz.

ESC Electronics Corp., Dept. ED, 534 Bergen Blvd., Palisades Park, N. J.

Rubidium Frequency Standard 446



Accurate to 5 parts in 10^{10} , the model 304-S rubidium frequency standard has a long term stability of 2 parts in 10^{10} . Optical pumping of rubidium at the 6834-mc ground state stabilizes a quartz crystal oscillator at a subharmonic. A synthesizer converts the output to 0.1, 1, and 5 mc. Other frequencies can be produced on special order. Active elements are solid state. Power requirements are 117 v ac or 26 v dc, 27 w.

Clauser Technology Corp., Dept. ED, 3510 Torrance Blvd., Torrance, Calif.

P&A: \$14,800 each; 90 days.

Precision Resistors 428

Weldable leads are available on 1% deposited carbon resistors rated at 1/8, 1/4, 1/2, 1 and 2 w in all common resistances. The leads are designed for where high-speed welding is employed instead of the usual soldering techniques.

Clarostat Manufacturing Co., Inc., Campbell Industries, Dept. ED, Dover, N. H.

Metal-Cased Thermostat 540

Vibration resistant, with rapid thermal response. Type HS-5300 metal-cased thermostat measures 9/16 in., outside diameter, 37/64 in. high, with normally open or closed contacts. Temperature settings are -65 to +500 F.

Therm-O-Stats Inc., Dept. ED, P. O. Box 303, Chartley, Mass.

CIRCLE 122 ON READER-SERVICE CARD ►

PRODUCTS OF ADVANCED SEMICONDUCTOR TECHNOLOGY

INTERNATIONAL RECTIFIER SILICON CONTROLLED RECTIFIERS

1, 5, 10 AND 15 AMPERE TYPES
RATED TO 400 VOLTS PRV



IR SILICON CONTROLLED RECTIFIERS

are the remarkable solid-state devices that provide complete control of current turn-on at microsecond switching speeds with no moving parts...no contacts. In the field of high-frequency power conversion they offer a totally new concept for versatile, contemporary circuitry highly efficient in operation...dramatically smaller in size.

THE TABLE BELOW lists the devices now in full production at International Rectifier that feature

- Low Gate Currents that Control High Load Currents
- Fast Switching Speeds
- Low Forward Voltage Drop
- Low Forward and Reverse Leakage

Part Type No.	Max. Avg. Fwd. Curr. (Amps)	Max. Average Forward Current @ 25°C, Amps	Gate Power, Watts		Max. Forward Drop @ 25°C, Volts
			Peak	Average	
1 AMPERE RATED SERIES - 8 TYPES - TEMP. RANGE: -30°C to +100°C					
100C2 thru 100C40	25 thru 400	3	5	0.5	1.25
5 AMPERE RATED SERIES - 8 TYPES - TEMP. RANGE: -30°C to +100°C					
500C2 thru 500C40	25 thru 400	4.7	5	0.5	1.0
10 AMPERE RATED SERIES - 8 TYPES - TEMP. RANGE: -30°C to +100°C					
1000C2 thru 1000C40	25 thru 400	10	5	0.5	1.25
15 AMPERE RATED SERIES - 8 TYPES - TEMP. RANGE: -30°C to +100°C					
1500C2 thru 1500C40	25 thru 400	15	5	0.5	0.68

For detailed data on all types, request Bulletin SR-350 thru 354.

Circle Reader Card Number _____

Beyond the advanced design opportunities they present, International Rectifier Silicon Controlled Rectifiers possess significant technical advantages: ELECTRICAL CHARACTERISTICS representative of the highest state of the art. MECHANICAL CHARACTERISTICS that provide rugged packages in configurations that have become industry standards...directly interchangeable with other makes. RELIABILITY that stems from two and a half years of continuous refinement of production techniques, test procedures

and rigid military quality control programs including the U.S. Army Signal Corps RIQAP plan, a distinguishing mark of quality assurance awarded to International Rectifier for six consecutive years. As a source of supply, International Rectifier extends these benefits: APPLICATION ASSISTANCE without delay from three strategically located engineering groups. DELIVERY from stock on most types...from the factory or from 65 industrial distributors. PRICE AND DELIVERY attractively competitive on both counts...TRY US!

WRITE FOR DETAILS ON HOW YOU MAY OBTAIN SAMPLE SCR'S AT NO COST ON THE NEW IR COOPERATIVE SAMPLING PROGRAM!

INTERNATIONAL RECTIFIER CORPORATION:
EL SEGUNDO, CALIF. - PHONE OREGON 8-8881 - CABLE RECTUSA

REGIONAL OFFICES IN NEW YORK CITY, CHICKERING 4-0748 • FORT LEE, NEW JERSEY, WINDSOR 7-3311 • SYRACUSE, NEW YORK, HEMPSTEAD 7-8495 • CAMBRIDGE, MASSACHUSETTS, UNIVERSITY 4-6520 • ARDMORE, PENNSYLVANIA, MIDWAY 9-1428 • SILVER SPRING, MARYLAND, JUNIPER 9-3305 • CHICAGO, ILLINOIS, JUNIPER 3-3085 • BEEKLEY, MICHIGAN, LINCOLN 8-1144 • LOS ANGELES, CALIFORNIA, OREGON 8-6281 • IN CANADA: TORONTO, ONTARIO, PLAZA 9-2291

IMMEDIATE OFF-THE-SHELF DELIVERY FROM
65 INDUSTRIAL DISTRIBUTORS THROUGHOUT THE U.S.

INTERNATIONAL RECTIFIER



SYMBOL OF QUALITY IN SEMICONDUCTORS

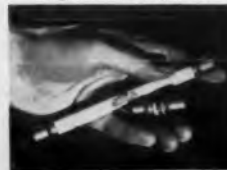
FOR YOUR REVIEW
Four of the Twenty
Product lines that
comprise

THE INDUSTRY'S
WIDEST
SEMICONDUCTOR
LINE!

SILICON ZENER DIODES - 1063 TYPES
Ratings: 250mw to 10w/2.6 to 30 volts



HIGH VOLTAGE RECTIFIERS - 157 TYPES
Ratings: to 440ma to 16,000 PRV



SILICON POWER RECTIFIERS - 187 TYPES
Ratings: to 250 amps, to 600 PRV

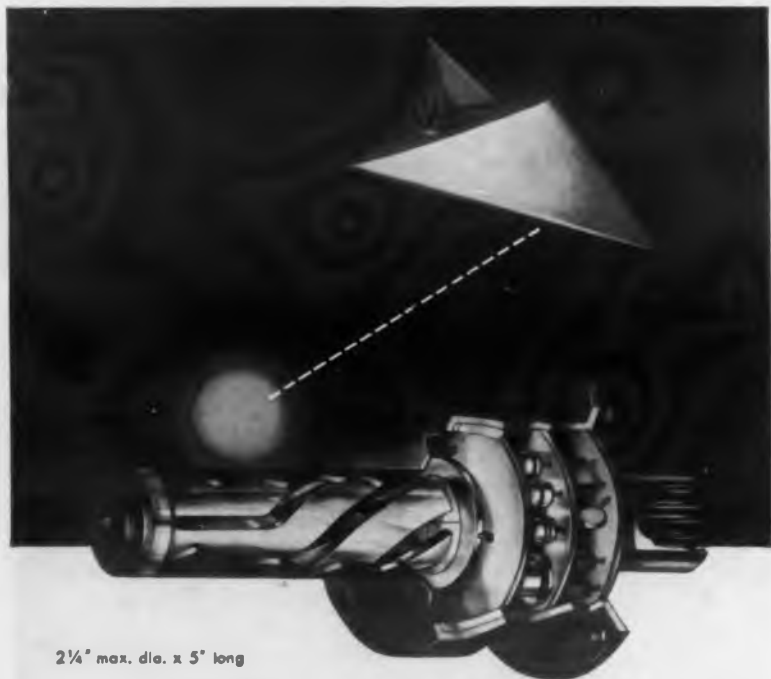


SUBMINIATURE GLASS DIODES - 40 TYPES
Ratings: to 200ma to 380 PRV





ENGINEERING
REPORT
ON BENDIX COMPONENTS



2 1/4" max. dia. x 5" long

BENDIX SUN SENSOR— RELIABLE REFERENCE FOR SPACE VEHICLE CONTROL

An important current E-P program is to develop components with high accuracy to meet spacecraft control system requirements.

The Bendix Sun Sensor combines a unique optical system with a simple four-section photo detector element. Result: a versatile instrument for many spacecraft control reference problems.

The sensor's signals are approximately proportional over a 2π steradian field of view to the sun's displacement angle with respect to the sensor boresight axis. The signals are also proportional, with a linearity of $\pm 1^\circ$ over a field of view of 15° about the boresight axis. Resolution and tracking accuracy are $\pm 0.05^\circ$, with a detector output signal gradient of $7.5 \text{ MV}/0.1^\circ$.

Of significant advantage to null seeking control systems is the capability of deriving rate signals from the preamplifier output over the entire hemispherical field of view. Because of its highly linear, stable output gradient about null, the unit is also ideal for control systems requiring calibrated displacement signals.

Ask about the Sun Sensor's applications to specific control system functional, environmental and packaging requirements.

Eclipse-Pioneer Division

Teterboro, N. J.



District Offices: Burbank, and San Francisco, Calif.; Seattle, Wash.; Dayton, Ohio; and Washington, D. C.
Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

CIRCLE 123 ON READER-SERVICE CARD

NEW PRODUCTS

Transistor Socket and Dissipater 365



For printed circuits, this combination transistor socket and heat dissipater measures 9/16 in. in diameter and 9/16 in. high. Unit can be mounted in larger sinks or soldered to the printed-circuit board. Dissipater is electrically insulated from the transistor base. Pin, turret, and solder-pot terminal styles are available.

Omega Precision, Inc., Dept. ED, 757 N. Coney Ave., Azusa, Calif.

P&A: \$0.75 to \$1.25; from stock.

Insulated Wire 552

Aluminum-oxide film insulation is used with aluminum wire and strip conductors. The flexible thin-film insulation has a melting point of almost 2,000 C, which allows the use of the material at temperatures up to the melting point of the conductor. Standard wire is available in gauges from 10 to 46 AWG; rectangular wire and strip comes in thicknesses from 0.0008 to 0.060 in.

Permaluster, Inc., Dept. ED, 2012 Burbank Blvd., Burbank, Calif.

Automatic Circuit Tester 369



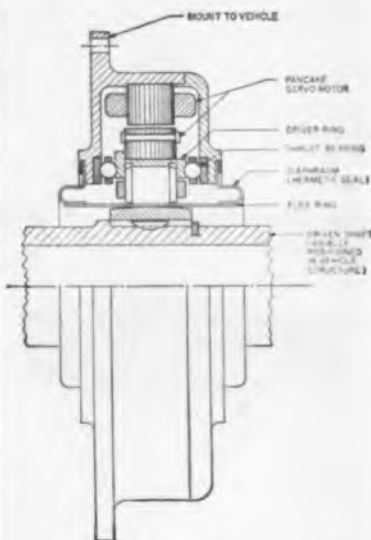
Random access, card-programed automatic circuit tester is used for checking wiring harnesses and electrical assemblies for current continuity and high potential. Unit, designated FACT-RC, has a capacity of 1,200 wire terminations. One IBM card is required for each circuit. The tester can process 72 cards per minute.

Hughes Aircraft Co., El Segundo Div., Dept., ED, P.O. Box 90426, Airport Station, Los Angeles 45, Calif.

P&A: \$34,500; 90 days.

ENGINEERING REPORT

ON OTHER BENDIX
COMPONENT PACKAGES



CYCLO-SINE

Hermetically-sealed drive
for space applications

The Bendix® Cyclo-Sine Drive provides an absolute, hermetically-sealed actuator for varied space applications. Operating through a flexible ring, the drive offers infinite resolution and irreversibility for general-purpose and precision servo devices.

OUTSTANDING CHARACTERISTICS:

5:1 weight advantage over conventional drives • Up to 20,000:1 speed differential • No backlash • Infinite resolution

Manufacturers of

GYROS • ROTATING COMPONENTS
RADAR DEVICES • INSTRUMENTATION
PACKAGED COMPONENTS

Eclipse-Pioneer Division



Teterboro, N. J.

CIRCLE 124 ON READER-SERVICE CARD
ELECTRONIC DESIGN • September 27, 1961

only **iei** gives you this choice:

50%
MORE
CAPACITY



50%
GREATER
ENGINEERING
MARGIN

...in a Tantalum Foil Capacitor

Improved materials and design make **iei** miniature Tantalum Foil capacitors 50% better than equivalent MIL-C-3965 designations. These features combine to give designers a choice of either 50% higher capacity or 50% greater engineering margin in a given case size.

iei capacitors have higher capacity per case size because of more active electrolyte, superior foil etching techniques and tighter packed foil.

iei capacitors have high reliability. Improved

welds and seals, clean-cut foil edges and tightly packed foil give greater vibration resistance.

iei 85° Tantalum Foil capacitors are available in 5 MIL case sizes—and 5 smaller case sizes with equal capacity to permit miniaturization without sacrificing reliability. **iei** packs each size case with working materials for highest CE values.

iei 85° Tantalum Foil and Tantalum Solid capacitors are manufactured to meet or exceed all applicable military specifications. Send for technical bulletins. Forms 2745 and 2773.

iei for many years has been the only company specializing in low-voltage, miniature electrolytic capacitors for transistor applications. **iei** offers full polar, partial polar and non-polar construction in 85° and 125° tantalum foil, from 3 to 150 WVDC, from 2 to 5200 mfd. Also a full line of aluminum foil, tantalum wet slug and solid tantalum types.

CIRCLE 126 ON READER-SERVICE CARD

International Electronic Industries, Inc.
BOX 9036-12 NASHVILLE, TENNESSEE

AN **SPS** COMPANY

where reliability replaces probability

NEW PRODUCTS

Beacon Transmitter

372



Made to locate objects at sea, this beacon transmitter has a 2-w output. Unit is tunable from 2,250 to 2,800 kc, uses a crystal oscillator. Transistorized, the device requires 24-v dc power. Pulse or frequency-shift data transmission is possible. Transmitting antenna may be submerged or shorted to ground for five minutes without damage to transmitter.

HRB-Singer Inc., Dept. ED, Science Park, State College, Pa.

P&A: \$150 to 200; 8 weeks.

Linkage System

547

Bi-directional linkage system, called the Ad-davertor, samples analog channels, converts to digital and delivers data to the digital-computer memory. It subsequently converts the digital results to analog values and presents this data to the analog computer. It is for use with the Electronics Associates analog computer and the Bendix G-15 digital computer.

EPSCO, Inc., EPSCO Systems Div., Dept. ED, Cambridge, Mass.

Microminiature Shift Register

367



Made for space vehicles, this modular shift register occupies 1/16 cu in. per bit and weighs 2 g. Units, operating at shift rates up to 250 kc, provide 5-v flat-topped output pulses at switching ratios better than 8 to 1. Devices operate from a single missile battery with low current drain. Units are made for information conversion, buffer storage, and counting. Compatible semiconductor modules are available.

Magnetics Research Co., Inc., Dept. ED, 179 Westmoreland Ave., White Plains, N. Y.

P&A: \$12 to \$16; 30 to 45 days.

Digital Comparators

359



Data from digital measuring instruments is converted into go no-go form by these digital comparators. Model 54 has four digits; model 55 has five. Bipolar data from 0.0001 up to 1,000 are handled by each instrument. Go no-go indication is issued within 10 msec after preset digital limits are exceeded. Units have plug-in board modular construction.

Non-Linear Systems, Inc., Dept. ED, Del Mar, Calif.

P&A: \$2,000 to \$2,900; from stock.

Tantalum Foil Capacitors

421

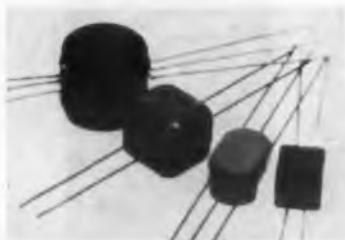
Rectangular tantalum-foil capacitors type CM are made to customer requirements in a wide variety of models. Typical values for 125 C polar types are 3 to 250 v and 38 to 250,000 μ f. For non-polar types at 125 C, capacitances can be from 19 to 200,000 μ f. A 1-f unit is housed in a container measuring 4 x 6 x 6-1/2 in.

Tansitor Electronics, Inc., Dept. ED, West Road, Bennington, Vt.

Availability: made to order.

Pulse Transformers

383



Epoxy transfer molded miniature pulse transformers are available with oriented-grain silicon steel ribbon core units, ferrite toroid cores and ferrite cup cores. Transformer cases have an accuracy of shape to within 10 mils. All units are available in flame-retardant or self-extinguishing epoxies and with weldable leads.

Pulse Engineering Inc., Dept. ED, 560 Robert Ave., Santa Clara, Calif.

P&A: \$5.50 ea; stock to 21 days.

LOWER
*** Qs**
FOR FASTER SWITCHING CIRCUITRY

WITH MOTOROLA SILICON EPITAXIAL MESA TRANSISTORS

* Total Base Control Charge = base stored charge, collector stored charge and linear control charge

The smaller the speed-up capacitor . . . the faster usable clock rate!

Since the Motorola 2N834 has a lower Total Base Control Charge (Q_s) than previous switching transistors, smaller capacitors are required for a momentary overdrive. The result: a faster overall switching circuit.

Key to this low Q_s factor is Motorola's highly-refined epitaxial technique . . . now employed in the fabrication of all Motorola Silicon Mesa transistors. The Motorola epitaxial process results in a lower Total Base Control Charge for all devices . . . permitting improved switching circuitry even with older EIA devices such as the now-epitaxial Motorola 2N706.

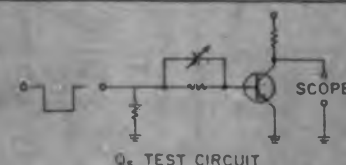
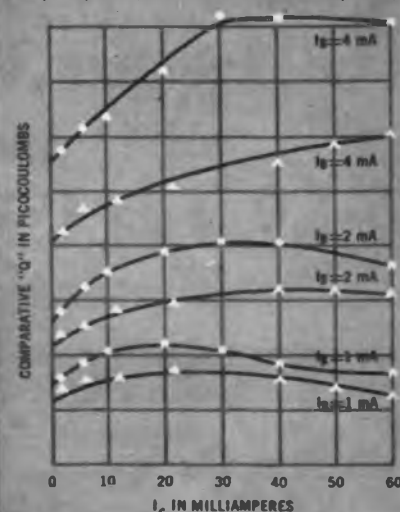
The low Q_s factor is only one of many improved switching characteristics offered by all Motorola Mesa transistors . . . including higher f_t , lower $V_{CE(sat)}$, and higher breakdown voltages.

So, if you are working with switching/computer circuits, investigate the performance and price advantages of Motorola's Silicon Epitaxial, Germanium Epitaxial and Germanium Mesas.

FOR MORE COMPLETE INFORMATION on Total Base Control Charge for Motorola silicon epitaxial Mesa transistors write Motorola Semiconductor Products Inc., Technical Information Center, 5005 East McDowell, Phoenix 8, Arizona. For information on individual devices, request by "type number".

TOTAL BASE CONTROL CHARGE @ 25°C

- 2N706 Silicon Non-Epitaxial
- Motorola Silicon Epitaxial 2N834 and 2N706 (All Motorola Silicon Mesa Transistors are Epitaxial)



MOTOROLA MESA SWITCHING TRANSISTORS

EPITAXIAL SILICON SWITCHES	V _{ce} max volts	h _{FE} @ I _c		V _{CE(sat)} typical volts	f _T typical mc
		typical	mA		
2N706*	25	40	10	.3	300
2N706	25	40	10	.18	450
2N706B	25	40	10	.18	450
2N753	25	75	10	.18	450
2N835	25	35	10	.18	450
2N834	40	40	10	.15	500

*Non-epitaxial unit shown for comparison

MOTOROLA DISTRICT OFFICES:

BELMONT, MASS., Ivanhoe 4-5070 / BURLINGAME, CAL., Diamond 2-3228
CHICAGO, ILL., Avenue 2-4300 / CLIFTON, N. J., Gregory 2-5300
DALLAS, TEX., Lakeside 6-8931 / DAYTON, OHIO, Axminster 3-4164
DETROIT, MICH., Broadway 3-7171 / GLENSIDE, PA., Turner 7-7020
HOLLYWOOD, CAL., Hollywood 2-0821 / MINNEAPOLIS, MINN., Liberty 5-2198
NEW YORK, N. Y., Wisconsin 7-2980 / PHILADELPHIA, PA., Waverly 7-6144
PHOENIX, ARIZ., 273-6364 / SILVER SPRING, MD., Juniper 5-4485
SYRACUSE, N. Y., Granite 4-3321 / WINTER PARK, FLA., Midway 7-2507
TORONTO, ONT., Plymouth 9-2222



MOTOROLA
Semiconductor Products Inc.

A SUBSIDIARY OF MOTOROLA, INC.

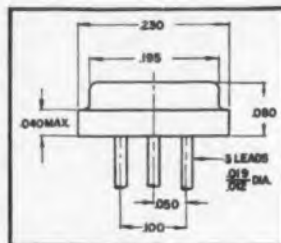
5005 EAST McDOWELL ROAD • PHOENIX 8, ARIZONA

LOOK TO MOTOROLA FOR ALL YOUR SEMICONDUCTOR REQUIREMENTS
POWER TRANSISTORS • MESA SWITCHING & AMPLIFIER TRANSISTORS • MILLIWATT TRANSISTORS • SILICON RECTIFIERS • ZENER DIODES

CIRCLE 127 ON READER-SERVICE CARD


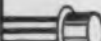

NPN SMALL SIGNAL SILICON TRANSISTORS

TO-46



the Smaller, PRACTICAL Package—
from NSC, the Small Signal Source!

The NS475 series — newest addition to NSC's growing line of quality Small Signal transistors — in the smaller TO-46 "pancake package." Utilizing a glass-to-metal hermetic seal, the TO-46 is one-third the height of the TO-18 — simplifying circuit design — yet has the same diameter, for direct replacement of TO-18 package.

PARAMETER	NS475	NS476	NS477	NS478	NS479	NS480
min. V_{CB0}	30v	30v	30v	60v	60v	60v
min. V_{CE0}						
min. V_{EBO}	6v	6v	6v	8v	8v	8v
h_{fe} *	20-50	40-100	80-300	20-50	40-100	80-300
max. I_{CBO} †	.2 μ A	.2 μ A	.2 μ A	.2 μ A	.2 μ A	.2 μ A
max. V_{CE} ††	1v	1v	1v	1v	1v	1v
max. C_{ob}	8pf	8pf	8pf	8pf	8pf	8pf
min. FT	80mc	80mc	80mc	80mc	80mc	80mc
PHYS. PACKAGE	can be used to replace	can be used to replace	can be used to replace	can be used to replace	can be used to replace	can be used to replace
TO-18 	2N761	2N762		2N734 2N754 2N756 2N756A 2N757 2N757A	2N735 2N759 2N759A	2N736 2N760 2N760A
TO-5 	2N332 2N332A 2N337 2N473 2N474 2N475	2N335 2N335A 2N338 2N470 2N471 2N472 2N478 2N479 2N480	2N336 2N336A 2N541 2N542	2N1564	2N335 2N335A 2N1565	2N336 2N336A 2N543 2N1566
TO-22 	2N1149 2N1150 2N117	2N1152 2N118	2N1153 2N119	2N1147 2N1150 2N117	2N1152 2N118	2N1153 2N119

* $V_{CE} = 5v, I_E = 10mA$ † $V_{CB} = 50\% V_{CB0}$ †† $I_C = 10mA, I_B = 1mA$

For complete technical data on all Small Signal transistors, call, write or wire:

National Semiconductor CORPORATION

Danbury, Conn. • Pioneer 3-7624 • TWX DANB 452-U

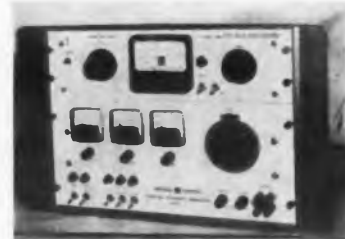
CIRCLE 128 ON READER-SERVICE CARD

81-7

NEW PRODUCTS

Mass Spectrometer

373



For vacuum analysis, the tube and magnet assembly of this mass spectrometer is made to be baked out at 450 C. Individual mass peaks up to mass 150 can be distinguished. System operates over a total pressure range of 10^{-5} to 10^{-10} mm Hg, and detects partial pressures on the order of 10^{-12} mm Hg. Instrument is portable, weighs less than 40 lb.

General Electric Co., Dept. ED, Schenectady 5, N. Y.

P&A: less than \$6,000; 60 days.

Tape Head

420

For monaural recording. Type RH-2 tape head is designed for monaural half-track recording on 1/4-in. tape. Frequency response at a tape speed of 7.5 in. per sec is -10 db at 10,000 cps with an output of 3 mv at 1,000 cps. It can be used at 3-3/4 in. per sec with the frequency response at -15 db at 10,000 cps with an output of 1 mv at 1,000 cps. An erase head is also available.

Sonotone Corp., Dept. ED, Elmsford, N. Y.
P&A: \$10; to OEM.

Coupling Device

417



For missile and aircraft uses. The coupling device is a quick-connect/disconnect type with environmental protection. A 0.7-lb force can extract the pins. Connection can be made with an angular misalignment of 5 deg between the two surfaces of the coupling. A lateral misalignment of 1/16 in. still permits perfect electrical mating.

Kellett Aircraft Corp., Dept. ED, Willow Grove, Pa.

Push-Type Posts

549

Made of nickel-plated brass. Series 29-100 push-type posts are offered in these three mounting sizes: No. 29-100 for 11/64-in. mounting hole, No. 29-101 for standard banana plug, No. 29-104 for 25/64-in. mounting hole. Teflon insulating washers and special button caps can be furnished for high-temperature applications.

Grayhill Inc., Dept. ED, 575 W. Hillgrove Ave., La Grange, Ill.

P&A: \$0.35 to \$0.50; from stock.

Pressure Transducer

393



Strain-gage pressure transducer model 206 is for sensing and measurement of dynamic pressures as in jet or turbine engines; model 206-1 is for corrosive media pressures; model 206-2 is for measuring air water and other fluids. Output voltage is proportional to pressure applied within $\pm 0.25\%$.

Taber Instrument Corp., Dept. ED, 107 Goundry St., North Tonawanda, N. Y.

Static Power Transfer

551

Fast response, low noise level and long life are features of the static power bus transfer, which transfers from one 60-cps bus to another in a few milliseconds. It performs the function of bus transfer switches per MIL-S-17773-A. Operation is not affected by relative phase between busses, power factor of load or non-linear loads.

Vickers, Inc., Electric Products Div., Dept. ED, 1815 Locust St., St. Louis 3, Mo.

Subminiature Solenoids

423

Respond in 1,500 to 2,000 μsec . Subminiature solenoids actuate 1 lb over 0.015 in. with a power input of 20 to 25 w at 3 to 6 v. Units can be furnished for greater power inputs and long periods of pulse-type duty. Applications include clutch actuation, electromechanical control, card sorting and valve actuation.

Marshall Industries, Wahlgren Magnetics, Solenoid Dept., Dept. ED, 1900 Walker Ave., Monrovia, Calif.

Never before could you

DIAL THE RIPPLE AND REGULATION!

Try this new twist: a built-in Adjustable Parameter control that actually lets you dial precisely the regulation and ripple characteristics you need in a power supply—quickly, economically! NJE's entirely new concept in power supply design—the Vari-Reg*—enables the engineer to eliminate overspecification of costly regulation and ripple. You arrive at the combination of characteristics that best suits your application, without wasting time or money—then you

order production models accordingly.

Regulation may be smoothly adjusted between $\pm 0.005\%$ and $\pm 10\%$. Ripple is accurately and smoothly adjustable between 3 and 200 millivolts peak to peak.

All NJE CR and QR Transistor-Regulated Power Supplies now feature the Adjustable Parameter Vari-Reg as an optional extra (\$75). All are available for immediate delivery. Write today for complete technical specifications and prices!

*Patent Applied For



NJE CORPORATION

20 Boright Avenue • Kenilworth, New Jersey
BR. 2-6000 • TWX Cranford, NJ 51 • FAX-FFP

CIRCLE 129 ON READER-SERVICE CARD

simple, low-cost
way to increase
equipment

MTBF




Patented

retrofit with IERC TR Series Heat-dissipating Electronic Tube Shields for increased tube life and equipment reliability!

The easiest low cost answer for increasing electronic equipment Mean Time Between Failures is to recognize that 70% of equipment downtime is caused by tube failures!

IERC TR shields effectively safeguard tube life up to twelve times longer — automatically eliminate equipment downtime and replacement costs due to tube failures caused by heat. The easy way to meet your MTBF reliability contract requirements is to start with the tubes — it costs so little to make them "TR safe"!

WRITE TODAY FOR IERC TR TECH BULLETIN NO. 1121.

IERC  **DIVISION**

International Electronic Research Corporation
135 West Magnolia Boulevard, Burbank, California

Foreign Manufacturers: Europelec, Paris, France. Garrard Mfg. & Eng. Co., Ltd., Swindon, England

CIRCLE 130 ON READER-SERVICE CARD

NEW PRODUCTS

Industrial Batch Ovens

391



Provide 356 or 600 F maximum temperatures. Having capacities from 16 to 96 cu ft, these industrial batch ovens are for general aging, drying, preheat-tempering, and similar uses. They are equipped with an indicating thermostat. Construction is heavy steel.

Blue M Electric Co., Dept. ED, 138th & Chatham St., Blue Island, Ill.

Computer Diode

556

Therma Bond, a heat-pressure method for permanently affixing the silicon disk adds stability to a new computer diode. The unit provides ultra-fast forward and reverse recovery time for high-speed pulse applications, including computer logic, pulse clamping, gating and locking.

U.S. Semiconductor Products, Dept. ED, Phoenix, Ariz.

Availability: engineering samples.

Tape Punch

407



For 5 to 8-channel paper or Mylar-aluminum tape. Model P76 tape punch operates at the rate of 20 characters per sec. A soundproof enclosure of 3/16-in. cast aluminum reduces noise level of punch operation. The tape supply has a capacity of 1,000 ft of tape and tape reels provide for 400 ft.

General Instrument Corp., Systematics Div., Dept. ED, 3216 W. El Segundo Blvd., Hawthorne, Calif.

Availability: 30 days.

*Why Die Stamped
Circuits by
Dytronics?*

EXACT CIRCUIT DUPLICATION

... 25,000 or
5,000,000 units

One of the major problems in printed circuitry is exact duplication of the circuit pattern from unit to unit. The Dytronics die stamped process eliminates this headache by utilizing a metal-cutting die to delineate the conductor pattern exactly whether 25,000 or 5,000,000 circuits are produced.

A new booklet, "Designing with Dytronics Die Stamped Circuits," gives other important reasons for specifying these quality circuits and provides information that will help you design them. Write for a free copy.



Dytronics
INCORPORATED

ROCHESTER 48, MICH.

A subsidiary of Taylor Fibre Co.,
Norristown, Pa.

Rectifiers 440

High-voltage rectifiers and full-wave bridge rectifiers. High-voltage types PS2501 through PS2515 cover from 2,000 to 25,000 piv and measure 0.25 x 0.15 in. Bridge types PS2470 through PS2486 cover 2,500 to 20,000 piv; dimensions are from 0.5 x 0.5 x 0.35 to 1.94 x 1.94 x 0.35 in.

Pacific Semiconductors, Inc., Dept. ED, 12955 Chadron Ave., Hawthorne, Calif.

P&A: \$15.30 up and \$85 up in quantities of 100; stock.

Humidity Controller 543

Accuracy is 1% RH throughout the entire relative humidity range at temperatures up to 180 F. The Hygrocon-1 humidity reader and controller incorporates the PCRC electro-humidity transducer as its sensing element. It has five RH ranges. Recorder terminals are available.

Phys-Chemical Research Corp., Dept. ED, 40 E. 12th St., New York 3, N. Y.

P&A: \$750; 4 to 6 weeks.

Vacuum System 539

Bell-jar vacuum system series 2100 model VSC-20 can be exhausted to 2×10^{-5} mm Hg in 30 min and has ultimate pressures in the range of 10^{-6} . It is a self-contained, 32-in., desk-high console for lab use and small-parts production coating in optical, infrared, electronic and semiconductor fields. The operator can view the work and the instruments and manipulate all controls.

Vacuum Specialties, Inc., Dept. ED, 34 Linden St., Somerville, Mass.

Remote Readouts 436

For digital voltmeters. Any number of these remote readouts can be used with a digital voltmeter or other digital-data source. The assembly measures 3-1/2 x 19 x 17-1/2 in. It accepts binary-coded-decimal 8-4-2-1, gives decimal visual readout and supplies binary-coded-decimal and decimal data outputs.

Electronic Associates, Inc., Dept. ED, Long Branch, N. J.



How would you choose between these two coaxial connectors?

The answer depends on your circuit requirements. The *ipc*® connector on the right was specially designed for a customer who needed a BNC-type connector for high voltage operation. We designed this connector for use up to 5000 vdc. It looks like the AMPHENOL® connector on the left, a standard BNC rated at the usual 500v.

This is typical of the differences between *ipc* and AMPHENOL connectors. Approximately 60 per cent of the *ipc* connectors we market each year are special designs to



meet individual customer's requirements.

The AMPHENOL connector line, on the other hand, offers you the most complete selection of uc-types available from a single manufacturer as well as *Push-On*®, *Quick-Crimp*®, and *Subminax*® connectors.

So, you see, you really don't have to choose between the two. RF Products offers you industry's most complete line of standard coaxial connectors—AMPHENOL—as well as the custom engi-

neered line—*ipc*. Together, they can solve all your connector problems.

You can get full details by writing for Catalog D3 which presents the AMPHENOL line in detail, and Catalog 11 which describes the *ipc* connector line. If you don't find the connector you want in these catalogs, call your nearest RF Products representative. He'll be happy to work with you to develop exactly the connector you need. *Registered Trademark*

RF PRODUCTS

Division of Amphenol-Borg Electronics Corporation • 33 East Franklin St., Danbury, Conn.



NEW PRODUCTS

Servo Drive

379



For digital system application, step servo drive model 622A reverses instantly at speeds up to 200 pps, when used with the company's standard step-servo controllers and pulse sources. Unit requires 28 v dc, 1 amp maximum. Stall torque at 25 C, is 5 in.-oz.

Automation Development Corp., Dept. ED, 11824 W. Jefferson Blvd., Culver City, Calif.

P&A: \$142; from stock to six weeks.

Decimal Indicators

371



From 3 to 6 decimal digits are projected in-line by these decimal indicators. Displays are said to be visible at wide angles. Input is binary-coded decimal for series 500, binary for series 1000, either parallel or serial. Units are transistorized, self-contained.

Howard Instrument Co., Dept. ED, Red Bank, N. J.

Temperature Transducer

354



Range is 0 to 2,000 F for surface resistance-temperature transducer model 2508. The platinum element resistance is 100 ohms $\pm 1\%$ at 77 F. Unit can be installed with response times in the msec range. Size is 1-9/16 x 9/16 x 0.014 in. thick. Unit can be cemented or welded to the surface under test.

Winsco Instruments & Controls Co., Dept. ED, 11789 W. Pico Blvd., Los Angeles 64, Calif.

The Porter Alloyist delivers the right alloy IN THE SPOTS THAT COUNT





There can be no compromise for instant, reliable communication when disaster strikes. That's why the Porter Alloyist recommends phosphor bronze and other special alloys for telephone and switchboard components. Contact springs and other vital parts made from these alloys deliver high electrical conductivity and resist deformation after repeated use.

THE PORTER ALLOYIST IS A SPECIALIST IN A WIDE RANGE OF SPECIAL METALS

Porter's Riverside-Alloy Metal Division is your single reliable source for specialty alloys in 8 basic groups of wire, rod and strip . . . phosphor bronze, nickel silver, cupro nickel, brass, stainless steel, nickel, Monel and Inconel.

Ask for a free copy of "Alloys for Industry" describing our wide range of specialty alloys. Write H. K. Porter Company, Inc., Riverside-Alloy Metal Division, Riverside, N. J. Or contact our sales offices in Hartford, Chicago, East Orange, Atlanta, Cleveland, Detroit, Cincinnati, Los Angeles, and Rochester.



PORTER supplies stainless steel, "K" Monel and Inconel "X" wire for many types of springs.

PORTER carbon steel wire reinforces and lengthens the life of a wide range of industrial hose.

PORTER

RIVERSIDE-ALLOY METAL DIVISION
H. K. PORTER COMPANY, INC.
CIRCLE 134 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

Oscilloscope Cart

380



Collapsible for storage, this oscilloscope cart has a 25-deg tilt. Cart is 29-in. high, 15-in. wide and 27-in. long, with 4-in. caster wheels. Frame is 1-in. steel tubing; trays are 20-gage rolled steel.

Atlantis Electronics Corp., Dept. ED, P. O. Box 451, Garland, Tex.

Price: \$29.95 fob Garland.

Ceramic Capacitors

357



For transistor circuits, these layer-built ceramic capacitors, series N030, have a nominal temperature coefficient of 30 ppm/C. Standard units are available with ratings from 51 to 5-100 pf at 200 v dc at 85 C, or 50 v dc at 125 C. Standard tolerances are $\pm 10\%$, $\pm 5\%$ and $\pm 2\%$. Tolerances of $\pm 1\%$ are available on special order.

Sprague Electric Co., Dept. ED, 347 Marshall St., North Adams, Mass.

Recording Voltmeter

376



Monitors voltage fluctuations while unattended for extended periods of time. Instrument, designated model 1122B-60, responds fully to a 0.1-sec pulse. Unit detects voltage changes as small as 0.25 v in a 120-v system. It is capable of functioning on line without attention for weeks at a time. Unit comes with a recorder.

Brenner-Fiedler & Associates, Inc., Dept. ED, 7563 Melrose Ave., Los Angeles 46, Calif.

DRAFTING

TRENDS



New, improved Rotolite Expediter conveniently makes sepia reproduces and diazo films in addition to low cost whiteprints.

Make your own whiteprints in two minutes or less

Here's a new, fast, economy whiteprinter that fills a real need in small drafting rooms or large engineering departments.

Workprints for architects, consulting engineers, surveyors, contractors. The Rotolite Expediter can handle *all* copying needs for the two- or three-man drafting operation, is always ready to cope with rush jobs, even after hours. With Post Super Vapo Papers, print production can be doubled.

Quick checkprints for larger manufacturers. Even huge, multi-department engineering divisions with their own reproduction departments or outside sources praise Expediter's practical, on-the-spot convenience for quick copies of preliminary sketches, checkprints, conference data, visual presentations. Hundreds of companies have placed Rotolites advantageously in each of their several engineering and drafting rooms for "self-service" whiteprints in a hurry.

No preheating or other delays—Rotolite makes prints immediately. There's a choice of three models to take 18", 27" or 42" wide tracings of any length. Furnished with dry-developing ammonia tube. Rotolite is easily hung on wall or placed flat on a table top, plugs into any standard convenience outlet. With new dial speed control, you can make cloth and film reproductions immediately, as well as paper prints. Provides clean, sharp prints every time through simple design, durable construction. Single lamp simplicity is entirely adequate for every "quick print" need.

Recommended print materials. Use Post diazotype sensitized products—Vapo paper, sepia vellum, cloth or film—for best results. Get full information on Expediter and standard Rotolite whiteprinters from your Post dealer or write Frederick Post Company, 3644 N. Avondale Avenue, Chicago 18, Ill.



SENSITIZED PAPERS & CLOTHS • TRACING & DRAWING MEDIUMS • DRAWING INSTRUMENTS & SLIDE RULES
ENGINEERING EQUIPMENT & DRAFTING SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE

CIRCLE 135 ON READER-SERVICE CARD

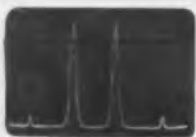
now... analyze **both SSB & AM** transmitters & receivers faster, with uniform sensitivity over entire **100 cps-40 mc** range **AT MINIMUM COST**



new — improved

PANORAMIC SSB-3a SPECTRUM ANALYZER

Panoram adds important NEW design features to the time-proven Model SSB-3! Now, in one convenient, compact package, you get the comprehensive unit you need to set up, adjust, monitor and trouble shoot SSB and AM transmitters and receivers.



TWO TONE TEST*

Fixed sweep width 2000 cps. Full scale log sideband tones 1.5 kc and 2.1 kc from carrier (not shown). Odd order 1. M. distortion products down 37 db.



HUM TEST*

Indication of one sideband in above photo increased 20 db. Sweep width set to 150 cps reveals hum sidebands down 53 db and 60 db.

*See Panoram Analyzer No. 3 describing testing techniques, etc., for single sidebands. A copy is yours for the asking.

GREATER FREQUENCY RANGE New Optional REC-1 Range Converter extends SSB-3a 2 mc-40 mc range down to 100 cps . . . speeds distortion analysis of receiver AF and IF outputs, transmitter bass band. **NEW 2-TONE AF GENERATOR MODEL TTG-2** 2 generator frequencies, each selectable from 100 cps-10 kc • Resettable to 3 significant digits • Accuracy: $\pm 1\%$ • Output Levels: each adjustable from 2 to 4 volts into matched 600 ohm load • Output DB Meter • Spurious, hum, etc, less than -60 db. • 100 db precision attenuation in 1 db steps.

FASTER-NEW TUNING HEAD FEATURES RAPID "SIGNAL SEARCH" PLUS PRECISE FINE TUNING.

ALL THESE NEW FEATURES . . . PLUS A SENSITIVE SPECTRUM ANALYZER

Panoram's Model SB-12aS Analyzer. Pre-set sweep widths of 150, 500, 2000, 10,000 and 30,000 cps with automatic optimum resolution for fast, easy operation. Continuously variable sweep width up to 100 kc for additional flexibility. 60 db dynamic range. 60 cps hum sidebands measurable to -60 db. High order sweep stability thru AFC network. Precisely calibrated lin & log amplitude scales. Standard 5" CRT with camera mount bezel. Two auxiliary outputs for chart recorder or large screen CRT.

INTERNAL CALIBRATING CIRCUITRY Two RF signal sources simulate two-tone test and check internal distortion and hum of analyzer. Center frequency marker with external AM provisions for sweep width calibrations. Write, wire, phone RIGHT NOW for technical bulletin and prices on the new SSB-3a. Send for our new CATALOG DIGEST and ask to be put on our regular mailing list for The PANORAMIC ANALYZER featuring application data.



Formerly Panoram Radio Products, Inc.

SEE US AT E.I.M.E.

SYRACUSE, N.Y. • SHERATON INN • SEPT. 21 • NORWALK, CONN. • TREADWAY INN • SEPT. 25 • ROOSEVELT FIELD, I.I., N.Y. • SAGAMORE ROOM • SEPT. 27, 28

PANORAMIC ELECTRONICS, INC.

524 So. Fulton Ave., Mount Vernon, N. Y. • Phone: OWens 9-4600
TWX: MT-V-NY-5229 • Cable: Panoram, Mount Vernon N. Y. State



Sec. 2900

CIRCLE 136 ON READER-SERVICE CARD

NEW PRODUCTS

Component Sorter

416



Automatic component sorter, called the Test-Amatic, sorts axial-lead components according to electronic value. Sorting resistors in standard, sequenced operation, it handles 3,396 units per hr. It comprises an input hopper, a testing station and three or more receptacle bins.

Develop-Amatic Engineering, Dept. ED, 923 Industrial Ave., Palo Alto, Calif.
P&A: \$1,475; 90 days.

Electric Soldering Pots

400



Stripping and tinning of plastic insulated wire and leads on small parts can be done simultaneously with electric soldering pots type 875, rated at 150 w, and type 875T, rated at 300 w. Type 875T can be furnished with an adjustable thermostat.

Electric Soldering Iron Co., Inc., Dept. ED, Deep River, Conn.

Static Teletypewriter Relay

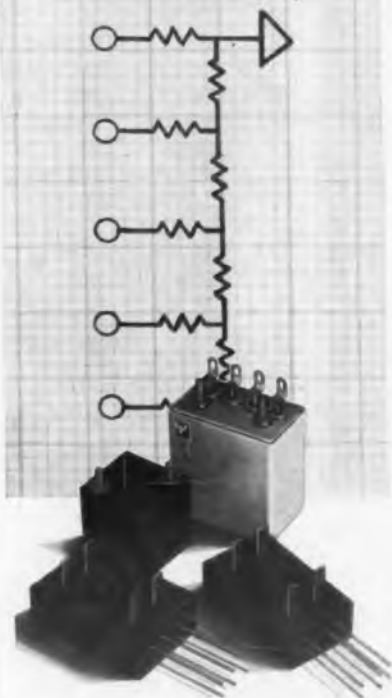
361



For a specific application in a teletypewriter repeater, this static relay gives 0.02 or 0.05 amp output for 120 or 155 to 180 v input. Relay is activated by square waves from a vacuum-tube circuit. A lifetime of 10,000 hours of 200 cps operation is expected.

Kidde Electronics Laboratories, Dept. ED, Brighton Road, Clifton, N. J.

Precision Resistive Networks



Ortho's complete line of precision resistive networks are ultra-stable, accurate and reliable—and are available to meet all applicable MIL specifications. Typical applications include digital analog conversion, summing, voltage and current division and reference, phase shift, time constant, bridged T, decade, integration, differentiation, and temperature sensitive uses. All networks are designed and packaged to custom requirements.

TYPICAL NETWORK CHARACTERISTICS

Type	D/A Converter
Input	13 Bit
Overall Accuracy	Better than $\pm 0.003\%$ (total voltage error less than $\frac{1}{4}$ voltage contribution of 13th bit)
Temp. Coefficient	Absolute ± 5 PPM/ $^{\circ}$ C. Relative ± 0.5 PPM/ $^{\circ}$ C.
Stability	Better than 10 PPM/Y

Write today for full details!

Opr ortho
precision
resistors inc.

A Subsidiary of ORTHO INDUSTRIES INC. 

7 Paterson St. • Paterson 1, N. J. • MU 4-5858

CIRCLE 137 ON READER-SERVICE CARD
ELECTRONIC DESIGN • September 27, 1961

LAZAR

Combination of electrical characteristics never before possible!

RECOVERY 4ns • CAP 4pf @ ZERO V • I_r 100mA @ 1V
LEAKAGE .025 μ A @ 25°C 25 μ A @ 150°C

Ask for detailed specifications!

CIRCLE 138 ON READER-SERVICE CARD

**High
Conductance
Logic Diode**

1N3258

Pacific Semiconductors, Inc.



A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE INC.
12955 CHADRON AVE., HAWTHORNE, CALIFORNIA

Oscilloscope

394



For severe environments, model 945 oscilloscope with model MC preamplifier permit measurements from dc to 24 mc. Operating environmental limits are: temperature, -40 to +71 C; vibration, 5 g at 55 cps and 0.03 in. peak to peak; shock, 400-lb hammer drop; altitude, 20,000 ft.

Tektronix, Inc., Dept. ED, P. O. Box 500, Beaverton, Ore.

Differential DC Amplifier

395



Gain is 1 to 1,000, adjustable. Model 611-B chopper-input amplifier has an output of ± 10 v at an impedance of less than 0.5 ohm. Zero stability is better than 0.02% per day. Rise time is 20 msec to 99.9% of full value. Miles of cables at input or output do not effect performance.

Video Instrument Co., Inc., Dept. ED, 3002 Pennsylvania Ave., Santa Monica, Calif.

Ceramic-to-Metal Terminals

389



Alumina ceramic-to-metal terminals, for hermetically sealed electronic equipment, can be used at temperatures to 1,700 F. The Advac line consists of 20 standard sizes from 5/16 to 1-1/2 in. in diameter. Made to MIL-T-27, they withstand over 27-kv flashover voltage.

Advanced Vacuum Products, Inc., Dept. ED, 430 Fairfield Ave., Stamford, Conn.
P&A: \$2 to \$26; stock.

CIRCLE 139 ON READER-SERVICE CARD

ROBINSON

All-Metal Mounting Systems

**Isolate
VIBRATION**

**Reduce
SHOCK**

**Increase
RELIABILITY**

Uncontrolled vibration is the mortal enemy of performance. It impairs the reliability of electronic and other equipment — shortens service life — increases costly maintenance.

Robinson has specialized in the engineered control of vibration and shock for over twenty-five years. Robinson mounting systems have been thoroughly proven in practice in virtually every field of application — aircraft, missile, shipboard, mobile, industrial and commercial. 100% all-metal construction (even the MET-L-FLEX cushions) makes Robinson mounts deterioration resistant — able to meet and exceed exacting space-age specifications.

Send for **FREE** brochure.



Radial type mounts were developed by Robinson for the resilient support and protection of individual instruments used in many aircraft and missiles.



All-metal, high temperature resistant engine mounting systems make possible smooth, vibration-free, noise-free flight for the latest jet aircraft.



Robinson has designed and produced in quantity low frequency mounting systems for many types of Naval shipboard equipment (exclusive with Robinson) now in service throughout the fleet.



Typical base type mounting system assures high vibration isolation for the protection of many types of electronic and electro-mechanical equipment.



ROBINSON VIBRASHOCK DIVISION

Vibration and Shock Control

ROBINSON Technical Products, Inc. TETERBORO, NEW JERSEY

WEST COAST ENGINEERING OFFICE • SANTA MONICA, CALIF.

BIG ACCELEROMETER PERFORMANCE IN A SUBMINIATURE PACKAGE!

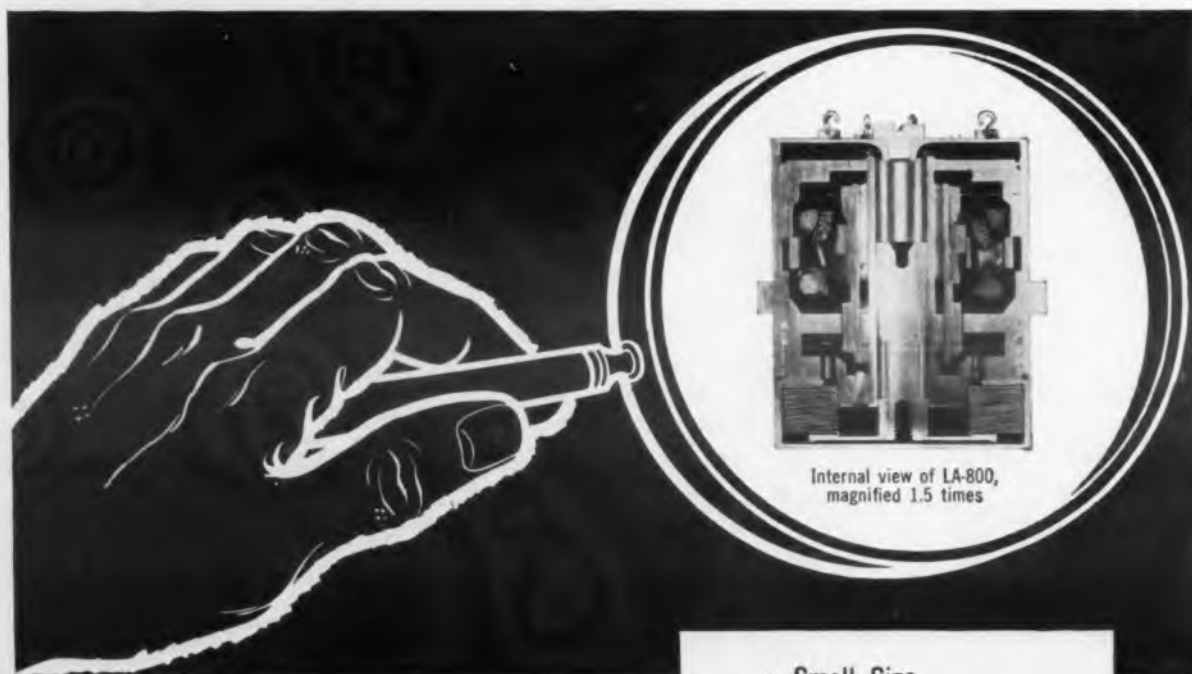
The LA-800 Series is the smallest non-pendulous linear accelerometer available today featuring a variable reluctance pickoff and essentially constant damping over the temperature range of -65°F to $+250^{\circ}\text{F}$. It is the smallest instrument of its type that can measure acceleration forces up to 80 G.

Reliability through overall simplicity was the primary goal of the LA-800 design. An example is the seismic mass support which eliminates sleeve bearings and their inherent friction. The result of this basic design objective is an accelerometer which can be relied upon

to operate instantaneously and for long periods, even after months of storage.

The combination of miniaturization, ruggedness, and high performance makes this instrument ideally suited for advanced aircraft and missile applications where space and weight considerations are critical.

Write for Technical Bulletin BM-SLA8-1 to Minneapolis-Honeywell, Boston Division, Dept. 10, 1400 Soldiers Field Road, Boston 35, Mass., or call your local Military Products Group Office. Sales and Service offices in all principal cities of the world.



Internal view of LA-800,
magnified 1.5 times


PERFORMANCE DATA

- **SIZE:** 1 inch in diameter by less than 1.5 inches (over terminals)
- **WEIGHT:** Approximately 3 ounces
- **DAMPING RATIO:** Any nominal $\pm 20\%$ from -65°F to $+250^{\circ}\text{F}$
- **RANGE:** Up to 80 G
- **PICKOFF:** Variable Reluctance design provides infinite resolution and high signal-to-noise ratio
- **LOW THRESHOLD, EXCELLENT RESOLUTION:** 10^{-4}G
- **EXCELLENT LINEARITY:** $\pm 0.5\%$ to half-scale; $\pm 2\%$ to full-scale
- **LOW HYSTERESIS:** Less than 0.15% full scale
- **LINEAR ACCELERATION:** 10 G's or 3 times full-scale, whichever is greater.
- **LINEAR VIBRATION:** 15 G's to 2 kc for low G units; 30 G's to 2 kc for high G units

Consult Honeywell for your specific linear accelerometer requirements

- Small Size
- Simple Construction
- Reliable
- Self-Test Available

Honeywell

 Military Products Group



Subminiature Accelerometer LA-800, shown $\frac{3}{4}$ size

CIRCLE 140 ON READER-SERVICE CARD

NEW PRODUCTS

Angular Accelerometer

384



For missile applications, the model 4575 angular accelerometer has full scale ranges from ± 500 to $\pm 1,500$ rad per sec². Nominal output is ± 7.5 v, linear within 0.05%. Unit measures 2 x 1-1/4 x 1-1/2 in., weighs less than 4 oz.

Donner Scientific Co., Dept. ED, Concord, Calif.

P&A: \$710; 30 days.

Trimmer Potentiometers

396



Rated at 100 ohms to 20 K, model 224 trimmer potentiometers are designed for high-reliability system applications. Resolution is 1% for the 100-ohm types, 0.2% for types rated at 20 K. Power rating is 0.5 w at 70 C. Quality-control records can be furnished.

Bourns, Inc., Trimpot Div., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.

Availability: stock.

Military Relay

406



Withstands 50-g vibration at 3,000 cps and 500-g shock. Hermetically sealed, 4pdt dc relay has a dry circuit to 5-amp contact rating. Insulation resistance is 1,000 meg, dielectric strength is 1,000 v rms. The relay is capable of switching high and low power levels interchangeably.

Couch Ordnance, Inc., Dept. ED, 3 Arlington St., North Quincy 71, Mass.



Are stable to ± 0.5 or ± 2 C. The DFO-900 crystal and component ovens operate in the temperature range of -55 to $+100$ C, on inputs of 6.3 to 117 v ac or dc with heater power of 5 to 30 w. The crystal ovens hold one or two HC/18, HC/6 or HC/13 crystals; the component oven has a cavity of $1 \times 2\text{-}11/32$ in. with a 9-pin socket for module plug-in.

Delta-F, Inc., Dept. ED, 113 E. State St., Geneva, Ill.

P&A: \$5.50 to \$14.25; stock to 3 weeks.

AC Voltage Standard

411



Accuracy is $\pm 0.01\%$ from 1.5 to 1,125 v from 20 to 50,000 cps. Model FLH portable ac voltage standard directly measures the influence of frequency on the indication of voltmeters, calibrators and other transfer standards. Resolution is 0.005% min.

Sensitive Research Instrument Corp., Dept. ED, 310 Main St., New Rochelle, N. Y.

Price: \$1,685.

DC Relays

402



Withstand 35-g vibration at 3,000 cps and 150-g shock for 11 msec. Series VR miniature dc relays are built for missile applications. They have 0.2-in. grid-spaced terminals for printed-circuit use. Contacts are dpdt, rated at 3 amp, resistive, at 28 v dc. Life is 100,000 operations or more.

Elgin National Watch Co., Dept. ED, 2435 N. Naomi St., Burbank, Calif.

Availability: stock or made to order.

FRONT END PLUG IN VERSATILITY

THE ONLY SOLID STATE
10 MC COUNTER-TIMERS
THAT PROVIDE COMPLETE
FRONT END FLEXIBILITY.
ALL MODELS ARE READILY
CONVERTIBLE TO UNIVERSAL COUNTER-
TIMERS BY USE OF PLUG-IN UNITS.



The 1039 Series equipment represents a significant engineering design contribution to user convenience; ease of operation, performance, flexibility and modular solid state reliability are achieved.

PICK A PLUG-IN FOR YOUR SIGNAL

Universal Amplifier AC-DC Coupled

Sensitivity: 0.1vrms 0 to 11 mc
Impedance: $1m\Omega$ 50 pf
Attenuator: 1, 3, 10, 30, 100
with Trigger Level Control

Low Impedance Unit — DC Coupled

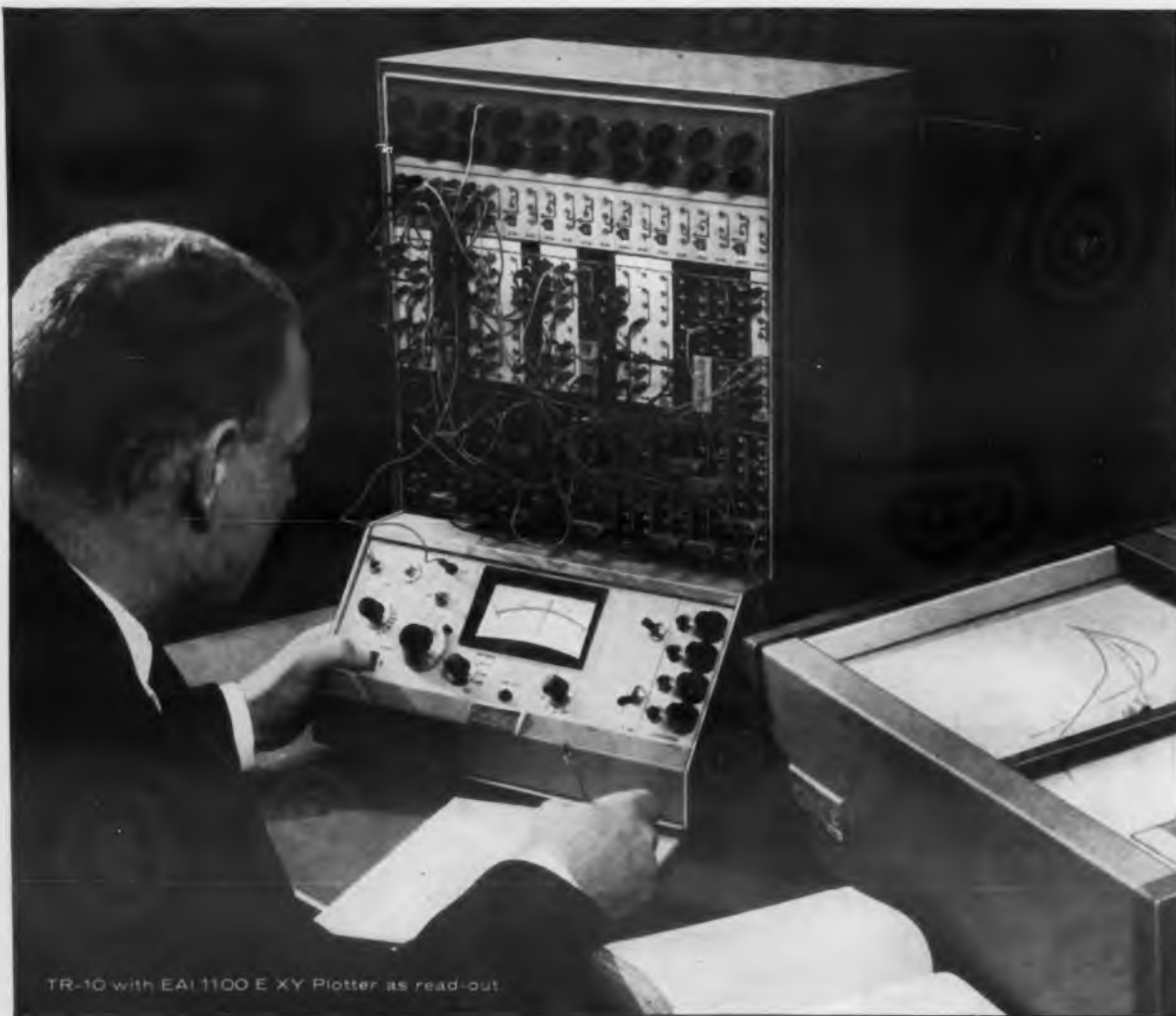
Sensitivity: 0.25vrms at 10 mc
Impedance: 93Ω or 50Ω
Trigger Level: ± 1 volt

These instruments, depending upon the model desired, are priced between \$2,325.00 and \$2,750.00

Let us send you complete specifications of the Model 1039 Series.

- 1039TL
Time Interval Meter \$2,325.00
- 1039T
Time Interval Meter \$2,475.00
- 1039FL
Frequency Counter \$2,475.00
- 1039UL
Universal Counter-Timer \$2,525.00
- 1039F
Frequency Counter \$2,550.00
- 1039U
Universal Counter-Timer \$2,750.00

SYSTRON
DIVISION OF **SYSTRON-DONNER**
Corporation
950 GALINDO STREET
CONCORD, CALIFORNIA



TR-10 with EAI 1100 E XY Plotter as read-out.

THE *FIRST* ALL TRANSISTORIZED ANALOG COMPUTER

—basic model less than \$4000

PACE[®] TR-10 Eliminates Drudgery—Gives New Insight Into Engineering Problems

This compact unit, 15" x 16" by 24" high, is powered by 115 volts AC and can provide day-in day-out instant solution of your most vexing engineering problems. Even if you have never seen a computer before, you can learn to operate the TR-10 as easily as you learned to use a slide rule.

Simply turn a dial to feed in design parameters, and the computer provides an instant by instant, dynamic picture of the effect of each change. You can study the inter-related effects of heat, pressure, flow, vibration, torque or any variable, and visually compare one with the other. Engineering data comes alive—insight into how new designs will work is obtained easier, faster.

Because of its minimum size and low price, the TR-10 can become your own personal analog computer. You gain first-hand experience with the power of analog techniques, and convert more of your time to *creative engineering*. New ideas that were too costly to try before are now practical.

You can design virtually to perfection and have a permanent, visual record of performance before building pilot models or prototypes. As a result, "cut and try" expense is reduced.

The same quality workmanship and design that has made Electronic Associates the world's leading producer of precision general purpose analog computers will be found in this new unit. Accuracy to ± 1 per cent. Modular construction allows you to select varying quantities of the following computing functions: summation, integration, multiplication or division, function generation, parameter adjustment, logical comparison.

For complete engineering data, write for Bulletin TR-10 .

EAI

ELECTRONIC ASSOCIATES, INC.
Long Branch, New Jersey

CIRCLE 142 ON READER-SERVICE CARD

NEW PRODUCTS

Latching Relays

401



General-purpose latching relays type LFA, rated at 5 amp, and LFB, rated at 10 amp, are available in a variety of ac and dc coil voltages. Contact arrangements are spdt, dpdt or 3pdt. Operating power is 2 to 3 w dc and 3 to 4 w ac. Mechanical life expectancy is 500,000 operations.

Elgin National Watch Co., Electronics Div., Dept. ED, 2435 N. Naomi St., Burbank, Calif.
Availability: 4 to 8 weeks.

Liquid-Level Control

397



For cryogenics. Called the Cryolevel, the liquid-level control can be used with liquid helium, hydrogen, nitrogen and other cryogenic liquids. It maintains the liquid to within $\pm 1/4$ to 6 in. of a preset level. It can be adapted to any standard cryogenic container or storage tank. Manual operation is possible.

Cryotronics, Inc., Dept. ED, Mountainside, N. J.

Galvanometer Protector

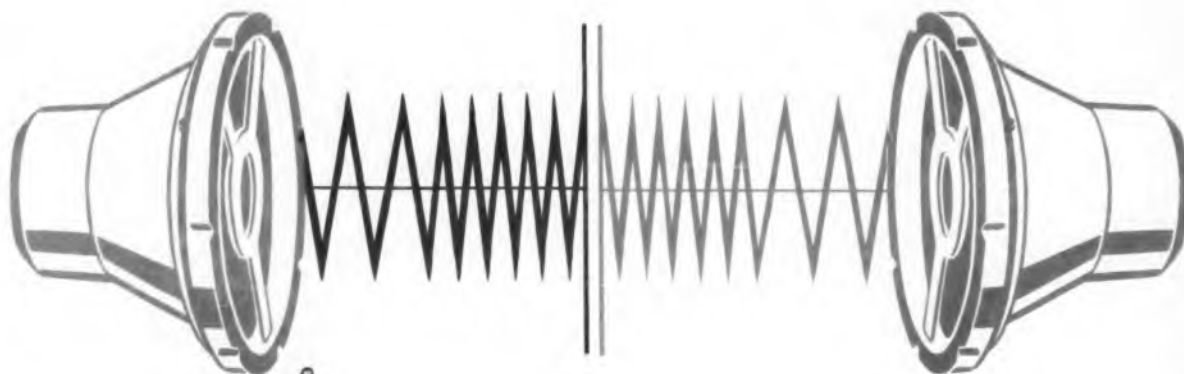
390



Prevents coil burnout of the firm's magnetically damped galvanometers. The galvanometer protector has an insertion resistance of 4 ohms at 75 F. Parallel resistance is greater than 7.5 K for inputs of ± 100 mv or less. Phase shift is 1 deg max from 0 to 10 kc.

Bell & Howell Co., Data Recorders Div. of Consolidated Electrodynamics Corp., Dept. ED, 360 Sierra Madre Villa, Pasadena, Calif.

ELECTRON TUBE NEWS from SYLVANIA



New!  **Sylvania-6JK8** especially designed for

FM Tuners for Stereo Multiplex

Features strap frame grid! Provides high signal-to-noise!

Sylvania-6JK8, double triode, opens new design possibilities for high gain, low noise performance in a low-cost, compact FM tuner. 6JK8 combines a strap frame grid RF amplifier and an oscillator-mixer in a T-6½ envelope with miniature 9-pin circle. It enables the design of a simplified circuit capable of better than 40db quieting with less than 10 μ Volts signal input for superb multiplex performance. Equally significant, 6JK8 and its associated family — 8JK8, 17JK8—cost less than two single triodes of comparable performance.

TYPICAL CHARACTERISTICS—6JK8			
Ef — 6.3V		If — 400mA	
	Triode # 1	Triode # 2*	Units
Eb	150	135	V
Ec ₁	-1	-1.2	V
Ib	5.3	11.5	mA
Gm	6800	14,500	μ mhos
Mu	50	70	

*Utilizes Strap Frame Grid

For further information, contact your Sylvania Sales Engineering Office. For technical data on specific types, write Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y.

SYLVANIA 10-PIN TYPES FOR 1-TUBE FM TUNER FRONT ENDS

Sylvania-6/17C9 combines two high performance sharp-cutoff tetrodes in a T-6½ envelope. Tenth pin enables separate connections for cathodes and the use of effective shielding to reduce undesirable oscillator signal radiation. They are designed for VHF service as an RF amplifier and autodyne mixer.

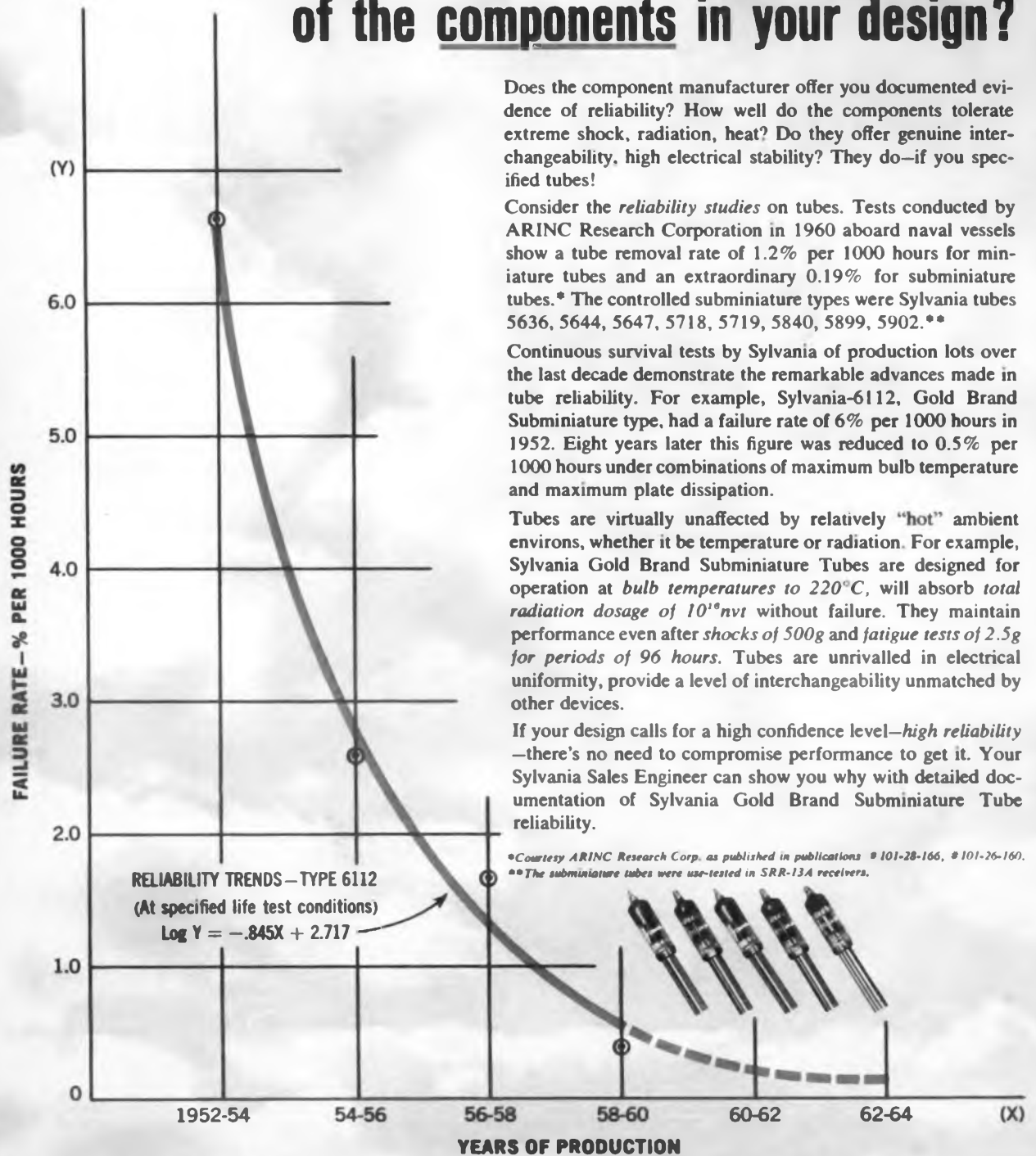
Sylvania SR-2946A, triple triode in a T-6½ bulb. Ten-pin base provides excellent isolation, heater from cathodes, facilitating circuit design for series string operation. SR-2946A provides the combined functions of RF amplifier, oscillator-mixer, AFC control.

IMPROVED SYLVANIA TYPES FOR SUB-CARRIER GENERATORS

Sylvania-12AT7, 12AU7A, 12AX7A are improved versions of these popular types featuring low hum, noise and microphonics and offering amplification factors of 62, 20, 100 respectively.



How high is the confidence level of the components in your design?



Does the component manufacturer offer you documented evidence of reliability? How well do the components tolerate extreme shock, radiation, heat? Do they offer genuine interchangeability, high electrical stability? They do—if you specified tubes!

Consider the *reliability studies* on tubes. Tests conducted by ARINC Research Corporation in 1960 aboard naval vessels show a tube removal rate of 1.2% per 1000 hours for miniature tubes and an extraordinary 0.19% for subminiature tubes.* The controlled subminiature types were Sylvania tubes 5636, 5644, 5647, 5718, 5719, 5840, 5899, 5902.**

Continuous survival tests by Sylvania of production lots over the last decade demonstrate the remarkable advances made in tube reliability. For example, Sylvania-6112, Gold Brand Subminiature type, had a failure rate of 6% per 1000 hours in 1952. Eight years later this figure was reduced to 0.5% per 1000 hours under combinations of maximum bulb temperature and maximum plate dissipation.

Tubes are virtually unaffected by relatively "hot" ambient environs, whether it be temperature or radiation. For example, Sylvania Gold Brand Subminiature Tubes are designed for operation at *bulb temperatures to 220°C*, will absorb *total radiation dosage of 10¹⁶nvt* without failure. They maintain performance even after *shocks of 500g* and *fatigue tests of 2.5g for periods of 96 hours*. Tubes are unrivalled in electrical uniformity, provide a level of interchangeability unmatched by other devices.

If your design calls for a high confidence level—*high reliability*—there's no need to compromise performance to get it. Your Sylvania Sales Engineer can show you why with detailed documentation of Sylvania Gold Brand Subminiature Tube reliability.

EQUIPMENT SALES OFFICES

CHICAGO: 200 W. Canal Ave., Meigs and Park, Ill., Elmhurst 9-2525. CINCINNATI: 411 Oak St., Plaza 1-8454. DALLAS: 100 Fidelity St., Riverside 1-4836. DAYTON: 333 W. First St., Belden 3-6227. DRY BRIDGE, IND.: 4740 Caldwell Rd., 73-1148, 186 AMBERLEY 6505 E. Gayhart St., Richmond 3-5371. NEW YORK CITY: 1000 Hayler St., Teaneck, N. J., ATten 8-2884. N. Y. METRO: Seneca Falls, 10pm 8-5884. OMAHA: Santa C, 1520 Edgewater Dr., P.O. Box 7248 Omaha, Neb., CEdon 4-6244. SAN FRANCISCO: 1811 Adson Rd., 8 at 11-gone. Calif., ORter 7-3569. WASHINGTON, D. C.: 1120 Connecticut, N.W., FEderal 7-6600. WILMINGTON, DEL.: 201 Main St., DEver 8-3367.

SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS



Telemetering Equipment

414



Frequency-type telemetering equipment, called Tele-Dac, consists of a 15 to 35 cps transmitter-receiver combination able to communicate any quantity that can be converted to a proportional dc mv signal. Over-all accuracy is $\pm 1\%$. The equipment is suitable for rack mounting.

Westinghouse Electric Corp., Dept. ED, P. O. Box 2099, Pittsburgh 30, Pa.

Miniature Fan

418



Moves 17.5 cfm under free-delivery conditions. The 60-cps Propimax 2 fan measures slightly over 3 in. in diameter, 1-1/2 in. deep and weighs 6-1/2 oz. It is physically and aerodynamically symmetrical, permitting reversal of air flow by turning end-for-end.

Rotron Manufacturing Co., Inc., Dept. ED, Woodstock, N. Y.

Static Inverter

382



Rated 100-v_a, 3-phase, the model K33 static inverter provides sine wave output from 28-v dc input. Output is regulated, contains no radio noise, has 2% max harmonic distortion, and meets MIL-E-7894 specifications. Components are solid-state, temperature-compensated. Unit is potted and hermetically sealed, and meets MIL-E-5272C specs. Device measures 4 x 7-3/4 x 2-1/2 in.

Arnold Magnetics Corp., Dept. ED, 6050 W. Jefferson Blvd., Los Angeles 16, Calif.

P&A: \$600; 30 days.



What
will
ISOPLYS®
lead
to
next?

Isoplys (isolated power supplies) were first introduced by Elcor, Inc., now a Welex Subsidiary, back in 1957. Since that time many of our customers have introduced imaginative applications for Isoplys that are new to even its inventors.

The Isoply is more than just new equipment. It represents a totally new concept, for Isoplys are used ungrounded. Unique construction provides extremely low shunt capacitance and low noise. It offers new flexible designs for direct-coupled amplifier circuits that are relatively insensitive to power line fluctuations. They give excellent frequency response.

Bridge, cathode follower, and other type circuits can be improved significantly. Less design and assembly time is needed. Interaction between circuits is substantially reduced which helps not only in design problems but also in simplifying maintenance. Learn how ISOPLYS can help reduce costs and improve performance in circuits you design.



Write for full information: **ELCOR Incorporated**

Subsidiary of Welex Electronics Corporation
Sales / R & D Laboratory / Manufacturing
1225 W. Broad Street / Falls Church, Virginia
JEfferson 2-8850

6EJ7 6F104 RF PENTODE



ANOTHER MULLARD FRAME GRID TUBE

Increased gain, reduced microphonics, and better controlled characteristics—these are the advantages you get when you specify Mullard frame-grid television tubes.

Frame-grid sharp cut-off pentode for use as an amplifier in television receivers.

CHARACTERISTICS

V_a	170	200	V
V_{g2}	170	200	V
V_{g3}	0	0	V
I_a	10	10	mA
I_{g2}	4.1	4.1	mA
V_{g1}	-2.0	-2.5	V
g_m	15.6	15	mA/V
r_a	330	380	k Ω
μ_{g1-g2}	60	60	
r_{q1} (f 40Mc s)	9.5	11	k Ω

SUPPLIES AVAILABLE FROM:

IN THE U.S.A.
International Electronics Corporation
81 Spring Street, New York 12, N.Y.
Worth 6-0780

IN CANADA
Rogers Electronic Tubes & Components
116 Vanderhoof Avenue, Toronto 17, Ontario.
Hudson 5-8821

Mullard is the trademark of Mullard Limited



Mullard

ELECTRONIC TUBES

BRITAIN'S FIRST CHOICE FOR FIRST EQUIPMENTS
MULLARD OVERSEAS LTD, MULLARD HOUSE, TORRINGTON PLACE, LONDON, ENGLAND



MEV 3818

NEW PRODUCTS

Clear Cement 429

High dielectric strength for adhering wires to all types of surfaces is provided by Dekophane clear, acrylic resin-base cement. It forms an air-tight, moisture-proof seal, does not become brittle, and withstands temperatures to 120 C.

The Crystal Essence Corp., Dept. ED, P. O. Box 108, Bound Brook, N. J.

Data Plotter 437

Magnetic-tape X-Y data plotter series 3440 automatically reduces digital data to graphic form on 30 x 30-in. or smaller sheets. Plotting speeds are to 4,500 line segments per min. Data may be read from punched cards or punched paper tape as well as magnetic tape.

Electronic Associates, Inc., Dept. ED, Long Branch, N. J.

Coating Test Device 544

Nondestructive test device Type EC gages nonconductive coatings on aluminum and its alloys. It also measures thickness of nonferrous metal on a nonferrous base, thickness of a nonferrous coating on a nonconductor and the conductivity of nonferrous materials.

Twin City Testing Corp., Dept. ED, 533 S. Niagara St., Tonawanda, N. Y.

Computer Tape 427

Two types are offered. Series 832 computer tape exceeds 300,000 error-free passes on the firm's FR-300 digital-tape transport at a packing density of 556 bits per in. Also offered, series 834 exceeds 25,000 error-free passes at the same packing density.

Ampex Corp., Magnetic Tape Products, Dept. ED, Opelika, Ala. *Availability: through distributors.*

Battery Substitute 425

Output is 1.015 to 1.045 v dc at a load current of 10, 6, 5 or 1 amp. The Batt-Sub battery substitute operates from a 177-v ac supply. The output is regulated by a two-stage Zener diode network. Model BS-1 replaces dry

◀ CIRCLE 145 ON READER-SERVICE CARD

NEW PRODUCTS

cells in potentiometer instruments and model BS(TC)-1 replaces the dry cell, standardizing mechanism, and standard cell.

Dynage, Inc., Dept. ED, 390 Capitol Ave., Hartford, Conn.

Core-Memory Tester 431

For industrial computer and business-type data processing systems. Called the Core Memory Exerciser, the core-memory tester checks systems of up to 4,096 words with 26 bits per word. It checks systems before or after installation in computers.

Radio Corp. of America, Dept. ED, 30 Rockefeller Plaza, New York 20, N. Y.

Clean Room 424

Packaged, mobile clean rooms include air conditioning, filtration systems, lighting, electrical outlets and other facilities. The standard 500-ft size can be expanded by attaching additional mobile units by means of air-shower interlocks.

Controlled Atmosphere Enclosures Manufacturing Co., Dept. ED, P. O. Box 5864, Jacksonville 7, Fla.
Availability: on a rental basis.

Potting Compounds 426

A wide variety of compounds for potting, impregnating and encapsulating can be furnished. Mixtures 2000 and 2008, for example, meet MIL-I-16923C for embedding compounds in type C applications. Mixture 2008, for use at 180 C in commercial applications, also meets MIL-I-16923C for 155 C use in type D applications.

Acme Wire Co., National Aniline Div., Dept. ED, 40 Rector St., New York 6, N. Y.

Frequency Standards 434

Range is 360 cps to 4 kc for both frequency standards. Type SMA high-precision unit measures 1-5/8 x 1-5/8 x 1-5/8 in., weighs about 2 oz, and fits flat into printed-circuit boards. Type SM has a vertical design. Both provide complete frequency stabilization in 30 sec after application of power.

Accurate Instrument Co., Dept. ED, 2418 Alabama, Houston 6, Tex.

ANOTHER MULLARD FRAME-GRID TUBE

Increased gain, reduced microphonics, and better controlled characteristics - these are the advantages you get when you specify Mullard frame-grid television tubes.

6EH7

VARIABLE MU
RF PENTODE

6EH7



Frame-grid variable-mu r.f. pentode for use as an automatic gain controlled i.f. amplifier in television receivers.

CHARACTERISTICS

V_a	170	200	230	V
V_{g2}	90	90	90	V
V_{g3}	0	0	0	V
I_a	14	12	10.5	mA
I_{g2}	5.3	4.5	3.6	mA
V_{g1}	-1.8	-2.0	-2.1	V
g_m	14	12.5	10.6	mA/V
r_a	350	500	650	k Ω
r_{g1} (f = 40Mc s)	11.6	13	15.3	k Ω

SUPPLIES AVAILABLE FROM:

IN THE U.S.A.
International Electronics Corporation
81 Spring Street, New York 12, N.Y.
Worth 6-0790

IN CANADA
Rogers Electronic Tubes & Components
118 Vanderhoof Avenue, Toronto 17, Ontario.
Hudson 5-8821



"Mullard" is the trade mark of Mullard Limited
Mullard
ELECTRONIC TUBES

BRITAIN'S FIRST CHOICE FOR FIRST EQUIPMENTS

MULLARD OVERSEAS LTD, MULLARD HOUSE, TORRINGTON PLACE, LONDON, ENGLAND



THE VOICE OF EXPERIENCE SAYS —



"Use
Castell
9030
Lead"



The most valuable lesson an upcoming engineer, architect or draftsman learns is "Use the best tools!" This means CASTELL #9030 Black Gold graphite-saturated lead that stays black without flaking, feathering or "burning out." Gives you crisp, opaque lines on all surfaces, including Cronar and Mylar base films. CASTELL #9030 never hesitates because of gritty spots. Remarkably uniform in all degrees, 7B to 10H, each as precise as a machine tool. Erases without leaving ghosts. Plastic tube with gold cap.

FITS ALL STANDARD HOLDERS. Pick up a tube from your supplier today.

A.W. FABER-CASTELL Pencil Co., Inc., Newark 3, N. J.

New celebrating its 200th birthday

CIRCLE 147 ON READER-SERVICE CARD

148

NEW PRODUCTS

Electronic Timers

362



Hermetically sealed crystal case timer package weighs 0.8 oz and measures 1.0 x 0.8 x 0.4 in. Temperature range is from -55 to $+125^{\circ}\text{C}$. Minimum adjustment range available is from 0.05 to 1 sec. Maximum adjustment range is from 3 to 60 sec. Accuracy rating is $\pm 10\%$ of nominal time delay. Units are for 28 v dc input.

Tempo Instrument Inc., Dept. ED, Hicksville, N. Y.

Frequency-to-DC Converter

413



For telemetering flow and tachometer data. The FR-84 airborne frequency-to-dc converter provides an output of 0 to 5 v dc with $\pm 0.25\%$ linearity, over-range limiting at 6.8 v and a power consumption of 45 ma at 27.5 v. Consisting of solid-state circuitry on printed-circuit cards, it withstands 100-g shock and 20-g vibration. Weight is less than 1 lb.

Waugh Engineering Div., The Foxboro Co., Dept. ED, 7740 Lemona Ave., Van Nuys, Calif.

Digital Ohmmeter

352



Range is 0.1 ohm to 10 meg for digital ohmmeter model NLS 784. Unit is fully automatic, with automatic range changing, positioning of the decimal point, and built-in controls for automatic readout to data printers. It can read at an average rate of 1 reading per sec, with an accuracy of $\pm 0.05\%$ of reading plus one digit.

Non-Linear Systems, Inc., Dept. ED, Del Mar, Calif.

P&A: \$1,650; from stock.



**NOW WITH
SPDT™**

**MODEL
4005**



**CONSTANT VOLTAGE
CURRENT**

**FROM THE SAME TERMINALS
with AUTOMATIC TRANSFER
TO EITHER MODE**

0-40 volt, 500 ma, regulated
DC power supply featuring
AMBITROL, a transistorized
regulator providing
continuous control of voltage
or current to .05%.

\$143⁵⁰

F.O.B. FACTORY
Write For
Catalog

*S P D T : Silicon Planar Diffused
Transistor High Stability Amplifier

Power Designs inc.

1700 SHAMES DRIVE
WESTBURY, L. I., N. Y.
EDgewood 3-6200 Area Code 516

CIRCLE 148 ON READER-SERVICE CARD

BUILD-YOUR-OWN ELECTRONIC ORGAN

STEP UP TO AN

Artisan
GREATEST
NAME IN
ORGAN KITS



20th CENTURY
SUCCESSOR TO THE
PIPE ORGAN

PAY-AS-YOU
BUILD

STEP-BY-STEP
INSTRUCTIONS

HOME, CHURCH
AND CONCERT
MODELS
2-3-4 MANUALS
FROM
\$1,750 to \$12,500



PIPE-LIKE TONE AND
APPEARANCE

DIRECT FACTORY
TO OWNER
SAVES 50%



WORLD'S LARGEST SELECTION OF ORGAN KITS,
ACCESSORIES AND CUSTOM-BUILT ORGANS
Send for FREE literature **DORSETT ELECTRONICS, INC.**
ELECTRONIC ORGAN DIVISION
4949Y YORK BLVD., LOS ANGELES 42, CALIF.

CIRCLE 149 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

TOROIDAL COIL WINDING

-- you name it, we make it

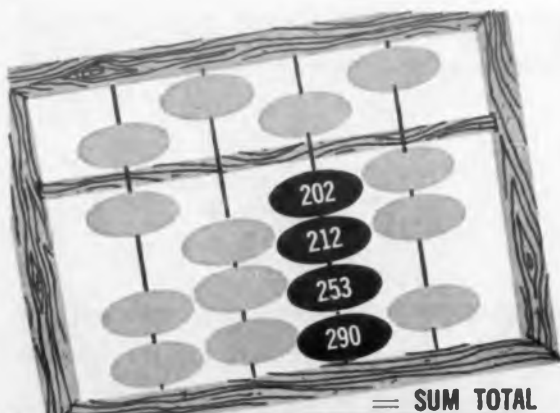


We produce a full line of coils from $\frac{1}{8}$ " Fin. I.D. to 30" O.D., wire range #2- #50 AWG.

Toroidal coils • magnetic amplifiers • potentiometer windings • DC-AC and DC-DC converters • differential transformers • filters • current transformers • variable inductors • power transformers • pulse transformers, or any toroidally wound device.



CIRCLE 150 ON READER-SERVICE CARD



an EPOCAST EPOXY RESIN FORMULA for any ELECTRICAL INSULATION PROBLEM!

More than 30 different formulas are now in stock to solve your electrical insulation problems. Whether it be an extreme environmental condition or a normal impregnation, encapsulation or coating project, there's a Furane epoxy resin to fit your requirements.

WRITE NOW FOR FREE ELECTRICAL PROPERTIES CHART!

furane plastics
INCORPORATED



WEST COAST / 4516 Brazil Street, Los Angeles, California CHapman 5-1151
EAST COAST / 42 Chasner St., Hempstead, Long Island, N.Y. IVanhoe 3-6246

CIRCLE 151 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

Microminiature Components

409



A sample kit, type A, contains all the microminiature components necessary to build 10-kc flip-flop with set and reset capabilities and occupying 0.179 cu in. Type B kit contains the same components and accessories, plus interconnecting materials, terminals and encapsulating materials for building a variety of other circuits.

P. R. Mallory & Co., Inc., Microcomponents Dept., Dept. ED, Indianapolis 6, Ind.

Price: A, \$44.95; B, \$139.95.

Coaxial Switch

405



For use to 200 mc. Model CU 723 spdt coaxial switch has a vswr of less than 1.15, isolation of better than 33 db, insertion loss of less than 0.1 db, power capability of 150 w and switching time of 7 msec. Life is 100,000 actuations. Other types of connectors can be furnished.

Bay-Roy Electronics, Inc., Dept. ED, P. O. Box 7503, Cleveland 30, Ohio.

Zero-Bias Power Triodes

375



Used as class-B linear amplifiers in audio or rf applications, these power tubes require no bias. Typical power gain is 20 in grounded-grid circuits. Triodes provide 0.5 to 20 kw pep. Types 3-400Z, 3-1000Z, and 3X3000F7 are of glass and metal construction; types 3CX10.000A7 and 3CV20.000A3 are ceramic and metal.

Eitel-McCullough, Inc., Dept. ED, San Carlos, Calif.

Illustrated literature and technical data are available upon request.

Methode Electronics, Inc.
7447 West Wilson Avenue
Chicago 31, Illinois

METHODE RELI-ACON CONNECTORS VS. COMPARABLE COMPETITORS' CONNECTORS		CONNECTOR "A"	CONNECTOR "B"	CONNECTOR "C"	CONNECTOR "D"
TESTS PERFORMED MIL-C-21007 (SHIPS)	METHODE	2,000 V DC Sea Level 585 V DC 70,000 FT.	1,900 V DC Sea Level 500 V DC 70,000 FT.	2,000 V DC Sea Level 500 V DC 70,000 FT.	1,900 V DC Sea Level 500 V DC 70,000 FT.
Paragraph 4.4.3 High potential	24.3 MV	31.9 MV	46.0 MV	96.6 MV	34.5 MV
Paragraph 4.4.4.1 Resistance of contacts in ten contacts tested at 4 V DC and 7.5 Amps	500,000 Meg Ohms	500,000 Meg Ohms	500,000 Meg Ohms	500,000 Meg Ohms	500,000 Meg Ohms
Paragraph 4.4.2 Insulation resistance	No loss of contact thru out entire vibration sweep or at resonance in any of the 3 planes after 3 hours test.	First loss of contact after 25 minutes, with continued intermittent loss up to 49 minutes when test was discontinued.	Failed intermittently after one minute with increased loss of contact after 12 minutes test discontinued.	Intermittent loss of contact thru out vibration sweep at resonance. Complete contact loss.	No loss of contact up to 21 minutes, then intermittent contact loss throughout balance of 2 hours.
Paragraph 4.4.5 Vibration 10 to 55 cps, plus additional test as required per MIL-E-5272 Procedure for intervals of 12 minutes to 3 hours.	Average 8 ounces; Maximum pair 9 ounces.	Average 9 ozs; Maximum pair 14 ounces.	Average 1 oz; Maximum pair 3 ounces.	Average 2 ozs; Maximum pair 5 ounces.	Average 6 ozs; Max pair 13 ounces.
Paragraph 4.4.6.1 Contact insertion (Average of ten pair of contacts)	Will hold 3 success All contacts	Will hold 3 ounces on only 4 pair of contacts	Will not hold 3 ounces on any contacts	Will not hold 3 ounces on any contacts	Will hold 3 ounces on 8 contacts
Paragraph 4.4.6 Contact retention	Passed insertion average 5 ozs. Will hold all hold 3 ozs. Max hold 9.9 average 32 millivolts.	Failed	Failed	Failed	Failed
Paragraph 4.4.8 Durability (Average of 10 contacts tested)	Method	Method	Method	Method	Method

COMPARE!

Methode

"RELI-ACON" CONNECTORS are the Finest!

One large and complete source for the finest RELI-ACON card receptacles and sockets which are designed for switch gear, computers, instruments, telephone panels, airborne communications equipment, guidance systems, telemetering equipment and other automatic control devices using printed circuitry for military and commercial applications.

CIRCLE 152 ON READER-SERVICE CARD

**Another FIRST for
UNIVERSAL!**
**a TRUE
BANK WINDER
for
Variable
Auto-Transformers**



Universal is the first American machine manufacturer to market a true Bank Winding Machine for manufacturing "variable autotransformers". TRUE BANK WINDING is accomplished by precisely and tightly winding turns of wire adjacently on the outside diameter of a core. To accom-

plish this unique type winding, the wires must accurately overlap on the inside diameter of the core. On completion the transformer has an even "brush surface" over which a "wiper" will pass. Wire sizes are #20 to #30 AWG.

Send your requirements.

OTHER NEW UNIVERSAL TOROIDAL WINDERS

NEW MODEL S—the first with fully transistorized In-Line Digital "Read-Out" Counter, and 11 interchangeable winding heads

NEW MODEL TVW—for toroidally winding New Vertical Deflection Coil being adopted by Television Industry!

NEW MODEL LS-1 LABORATORY SLIDER-TYPE WINDER—with Model "S" interchangeable winding heads. #20-46 AWG. Fig. 1. D. .065".

Send for further information.

UNIVERSAL MANUFACTURING COMPANY, Inc.

1168ED Grove Street, Irvington 11, N. J. ESsex 4-9800
The most COMPLETE line of TOROIDAL equipment in the world.

CIRCLE 153 ON READER-SERVICE CARD

Timely

**TEFLON
SPAGHETTI TUBING**

with special color coding
for easy identification

AVAILABLE IN
SPECIAL SHAPES
FOR
CUSTOM FIT
INSTALLATIONS

Top-quality Teflon® spaghetti tubing is available from Timely Tech in a wide range of sizes and types.

STANDARD WALL SPAGHETTI:
Sizes AWG 0 to 24. Wall: .020 to .012

THIN WALL SPAGHETTI:
Sizes AWG 0 to 30 Wall: .015 to .008

Normally supplied in natural opaque white color. Available with impregnated color stripes for coding and identification as well as in special shapes for contour installation.

Immediate Delivery from Stock

Write for sample card No. 2



Timely
TECHNICAL
PRODUCTS, INC.
100 PINE STREET
VERONA, NEW JERSEY
CEnter 9-2900

*Du Pont TM.

CIRCLE 154 ON READER-SERVICE CARD

NEW PRODUCTS

Alloying Furnace 474

Temperatures to 1,000 C can be reached with this vertical alloying furnace. Vertical stacking zone is 2 in. in diameter and 8 in. high. Unit has an inconel muffle and pedestal. Furnace is three-zone type, with working and end zone reactors controlled. Other arrangements are available on special order.

Research Instrument Co., Inc., Dept. ED, 558 Main St., Westbury, N. Y.

P&A: \$5,000 and up; 2 to 4 months.

Breadboard Kit 358



Rapid assembly of prototype electronic equipment is possible with the 3-D breadboarding kit. Designer is able to complete prototypes without using any power tools except a soldering iron. Kit comprises an assortment of pre-punched laminated phenolic panels, terminal strips, volume-control strips, punched chassis-frames, rack-mounting plates and assorted hardware.

Precision Metal Products Co., Dept. ED, 41 Elm St., Stoneham, Mass.

Price: \$13.95.

Refrigeration Chamber 548

For metallurgical chilling. Model ST-120-15 refrigeration chamber measures 36 x 24 x 30 in. and has a capacity of 4,000 BTU per hr at -120 F. It can chill 200 lb of steel per hr from ambient to -120 F. Construction is of 14-gage steel.

Cincinnati Sub Zero Products, Dept. ED, 3932 Reading Road, Cincinnati 29, Ohio.

Fixed Resistors 553

Ceramic-metal fixed resistors, Ceradot, are stable at temperatures to 600 C. Resistances are from 50 ohms to 100 K. Power rating is 0.1 w at 125 C, derated linearly to zero at 200 C. Temperature coefficient is 300 ppm. Units are 0.05 in. in diameter and 0.03 in. thick.

CTS Corp., Dept. ED, Elkhart, Ind.
P&A: \$1 to \$3; samples, 2 weeks; quantities, 4 weeks.

BINARY OPERATED READOUT

New!

Operates Direct—No Buffers
or Translators Required

ALL
DIGITS
CAN BE
READ
FROM
ANY
ANGLE



Self-Decoding
Alpha-Numeric Readout

Price Complete from \$50.00

Applications... May be connected directly into computers, teletype, other electronic equipment.

Features... Electro-magnetic operation, low power (10 milliwatts), accepts BCD code to 6 bits, does own translating and displays proper character.

Specifications... Speed: 20 characters per sec. Character Size: 1 3/8" high. Dimensions: 1 3/4" x 3 1/4" x 6 3/4".

WRITE TODAY FOR COMPLETE DETAILED INFORMATION.

Representatives in principal cities.



INDUSTRIAL ELECTRONIC ENGINEERS, Inc.

5528 Vineland Avenue, North Hollywood, California

CIRCLE 155 ON READER-SERVICE CARD

BEFORE 1.25 cubic inch



NOW .66 cubic inch



POWERTRIM™ ADJUSTABLE POWER RESISTOR

- Make precise adjustment with circuit ON—no cool-down time necessary—no burn or shock hazards.
- Power rating—up to 20 watts.

Ask your local distributor today!



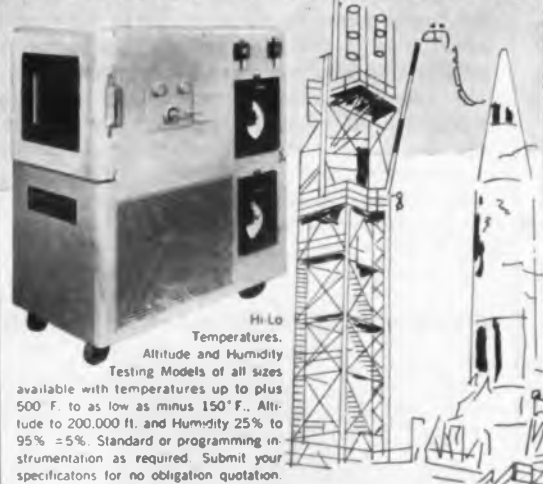
INVAR ELECTRONICS CORP.

1723 Cloverfield Blvd. • Santa Monica, Calif. • EX 3 9611

CIRCLE 156 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

RELIABILITY starts Behind the Scene



Hi-Low
Temperatures,
Altitude and Humidity
Testing Models of all sizes
available with temperatures up to plus
500° F. to as low as minus 150° F., Altitude
to 200,000 ft. and Humidity 25% to
95% ± 5%. Standard or programming in-
strumentation as required. Submit your
specifications for no obligation quotation.

Over 20 yrs. Experience in the Field of Temperatures

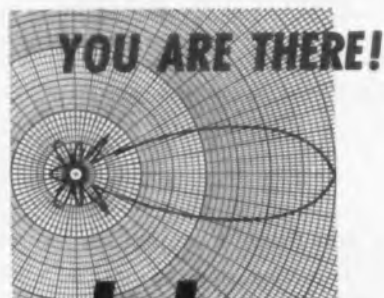
CINCINNATI

SUB-ZERO PRODUCTS

General Offices & Plant

3930-D4 Reading Road • Cincinnati 29, Ohio

CIRCLE 157 ON READER-SERVICE CARD



with **telrex**

"BEAMED-POWER" ANTENNAS

NOW MAILING! PL88 — technical
data, pricing bulletin describing
Advanced-design commercial and
citizen-band base-station antennas
and accessories. Includes Tower,
Rotator, "Baluns," Mast and
Transmission line data, plus nice-
to-have-around "info." Request
your copy, today; no obligation.

WORLD RENOWNED AND RESPECTED
PERFORMANCE — 8 to 1500 MC.

ANTENNAS **telrex**
SINCE 1921
Communication
and TV Antennas
LABORATORIES

ASBURY PARK 41, NEW JERSEY, U.S.A.

CIRCLE 158 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

Tape Head

392



For stereo recording. Type RH-4 tape head
operates with four-track stereo tape systems.
Frequency response at 3-3/4 in. per sec is -10
db at 10,000 cps with an output of 3 mv at
1,000 cps. It also plays at 7.5 in. per sec with a
frequency response of -5 db at 10,000 cps and
an output of 3 mv at 1,000 cps. A matching
erase head is available.

Sonotone Corp., Dept. ED, Elmsford, N. Y.
P&A: \$28.50; to OEM.

Cable-Continuity Tester

410



For instantaneous checking of individual
circuits in multi-conductor assemblies. Model
NT-103 cable-continuity tester can be used for
checkout of 57 conductors at one time and is
suitable for missile-systems cable checkout. It
is portable, measures 13 x 17 x 23 in. and op-
erates on 110 v ac.

Noble-Tanksley Corp., Dept. ED, 1650 Col-
lamer Road, Cleveland 10, Ohio.

Semiconductor Mount

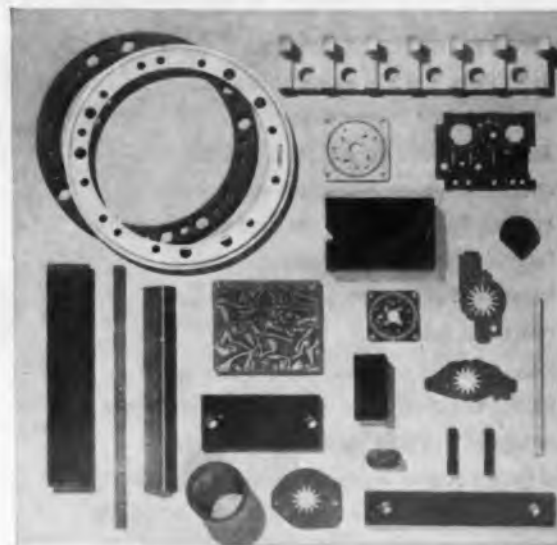
404



For JEDEC TO-3 power transistors, diodes
and rectifiers. Type CFG mount is black phe-
nolic as per MIL-N-14; type MME, melamine
per MIL-M-14; type SDG, diallyl phthalate per
MIL-M-18794. Contacts are spring-temper
phosphor bronze, electrotin plated, accepting
0.04 or 0.05-in. pins.

Augat, Inc., Dept. ED, 33 Perry Ave., Attle-
boro, Mass.

RELIABLE Laminated Plastics for Electrical & Electronic Parts



An Example of

Synthane You-shaped Versatility

Here, from one reliable source, you can satisfy all
your requirements for laminated plastic materials
or fabricated parts. High temperature laminates,
flame-retardant laminates, copper-clad laminates
as well as all the widely-accepted electrical grades.
Complete facilities for quality-controlling desired
properties and for environmental testing. For
parts fabricated to your specifications we are
equipped with a complete tool room for special-
ized dies and fixtures.

You-shaped Versatility makes Synthane a Better Buy in Laminates.

SYNTHANE

CORPORATION **S** OAKS, PENNA.

Synthane Corporation, 42 River Rd., Oaks, Pa.

Gentlemen:

Please send me information relating to Synthane as a source
for laminated plastic materials and parts.

Name _____

Address _____

City _____ Zone _____ State _____

CIRCLE 159 ON READER-SERVICE CARD

THIS SWITCH OPERATES ON CHEMICAL ENERGY

Here's a really rugged, powerful, dependable, one-shot switch so compact you can hold it in your fingertips.

Actuated by Atlas squibs, these switches operate on powerful chemical energy released by electrical signal. They are used in space vehicles, test sleds, missiles, and rockets, replacing larger, heavier, and more complicated relays and breakers.

These switches withstand temperatures up to 500°F., vibrations up to 2000 cycles/sec., shocks as high as 35000 Gs., and fit a wide range of remote control switching applications. Certain types incorporate pyrotechnic time delays for sequencing operations or delayed action.

Atlas Research and Development teams—backed by years of practical experience in the field—are constantly finding new applications and developing new designs. Technical literature is available on Atlas squib switches, actuators, electric matches, and other explosives or squib devices in the Atlas product line. Write today regarding products or projects.



OM SERIES SWITCHES



1MT114 MINIATURE
PISTON ACTUATOR



1MT111 TELESCOPIC
PISTON ACTUATOR



IGNITERS

MEETING RELIABILITY CHALLENGES BY ELECTRO-CHEMI-MECHANICAL RESEARCH

ATLAS

CHEMICAL INDUSTRIES, INC.
ORDNANCE MATERIEL DEPT.
WILMINGTON 99, DELAWARE

CIRCLE 160 ON READER-SERVICE CARD

NEW PRODUCTS

Cooling-Heating Module 557

Thermoelectric modules use 10 per cent of the power normally required to do an equivalent job of heating or cooling. Units can be used to cool electronic components and laboratory instrumentation devices. They may find application in consumer products by eliminating the noise and bulk of motor-compressor refrigerator units.

Jepson Thermoelectrics, Inc., Dept. ED, 139 Nevada St. El Segundo, Calif.

Missile and Space Timers 408



Accuracy is 0.1% for time bases from hundredths of a second to 100 sec over the temperature range of -65 to +165 F. Based on magnetic-core oscillation techniques, the missile and space timers are miniature in design and are able to withstand shock of 4,000 g. Power consumption is low.

Minneapolis-Honeywell Regulator Co., Ordnance Div., Dept. ED, 600 Second St., N. Hopkins, Minn.

Rack and Panel Connectors 385

For switching and re-routing applications these rack and panel connectors have polarizing pins that provide positive mating. Receptacle series 2P-SD-600 have low voltage drop after repeated insertions. Plugs are designated series 2P-MD-600. Contacts are spring tempered, gold-plated phosphor bronze.

Methode Electronics, Inc., Dept. ED, 7447 W. Wilson Ave., Chicago 31, Ill.

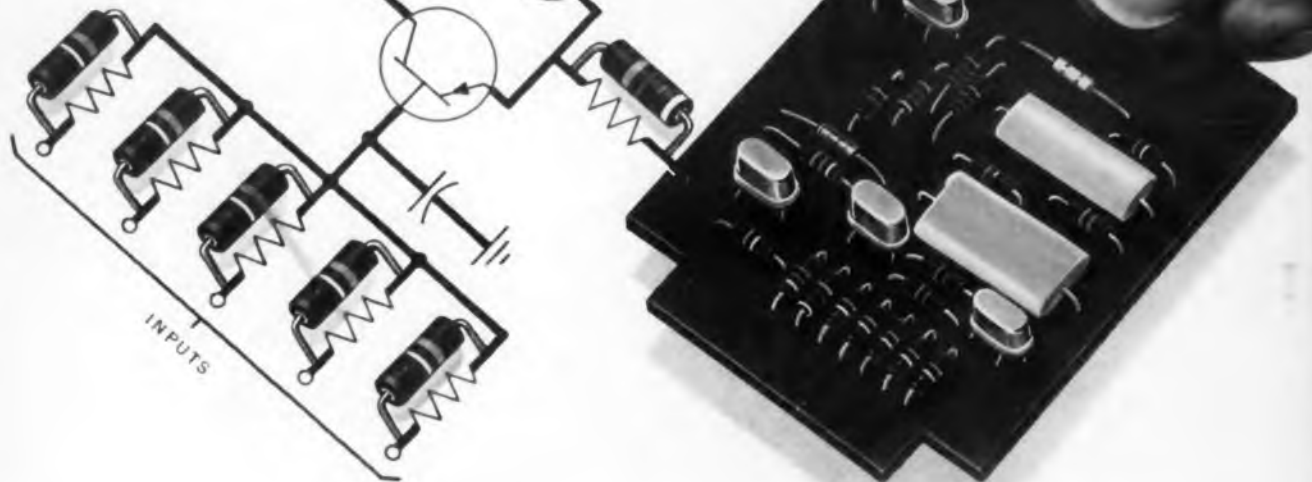
Metal and Plastic Compound 555

For tool and die processes, the new metal and plastic compound can be used in industries such as aircraft, missiles, plastic and metal forming. It comes in dry powder form, can be poured into a mold and liquified by heat and hardens to the shape of the mold as it cools. Tolerance can be as close as 0.001 in.

The Boeing Co., Dept. ED, Seattle 24, Wash.

CIRCLE 161 ON READER-SERVICE CARD >

Electronic Nerve Cell



Illustrated above is a section of the schematic diagram for the artificial neuron (nerve cell).

Goal of New Research Project MORE EFFICIENT COMMUNICATION SYSTEMS

Research to explore the information processing in nervous systems is now underway at Bell Telephone Laboratories. Here, scientists are experimenting with newly developed electronic elements which are designed to imitate the actions of a living nerve cell. Too little is yet known about living cells to permit exact electronic duplication. However, experiments with groups of artificial neurons have roughly duplicated some of the eye's basic reaction to light. This new approach to studying basic nerve network functions can provide clues for stimulating further exploration into the fundamentals of the transmission of intelligence.

Allen-Bradley is very happy that the quality of their hot molded resistors caused them to be selected for these exacting experiments. With their uniform properties and conservative ratings—A-B resistors will provide the same superior performance in your electronic circuits. Be certain you specify A-B hot molded resistors—especially for your critical jobs. Send for Publication 6024.

A-B Hot Molded Composition Resistors

SHOWN ACTUAL SIZE

Hot molded composition resistors are available in all standard EIA and MIL-R-11 resistance values and tolerances.

*Pending MIL Spec Assignment

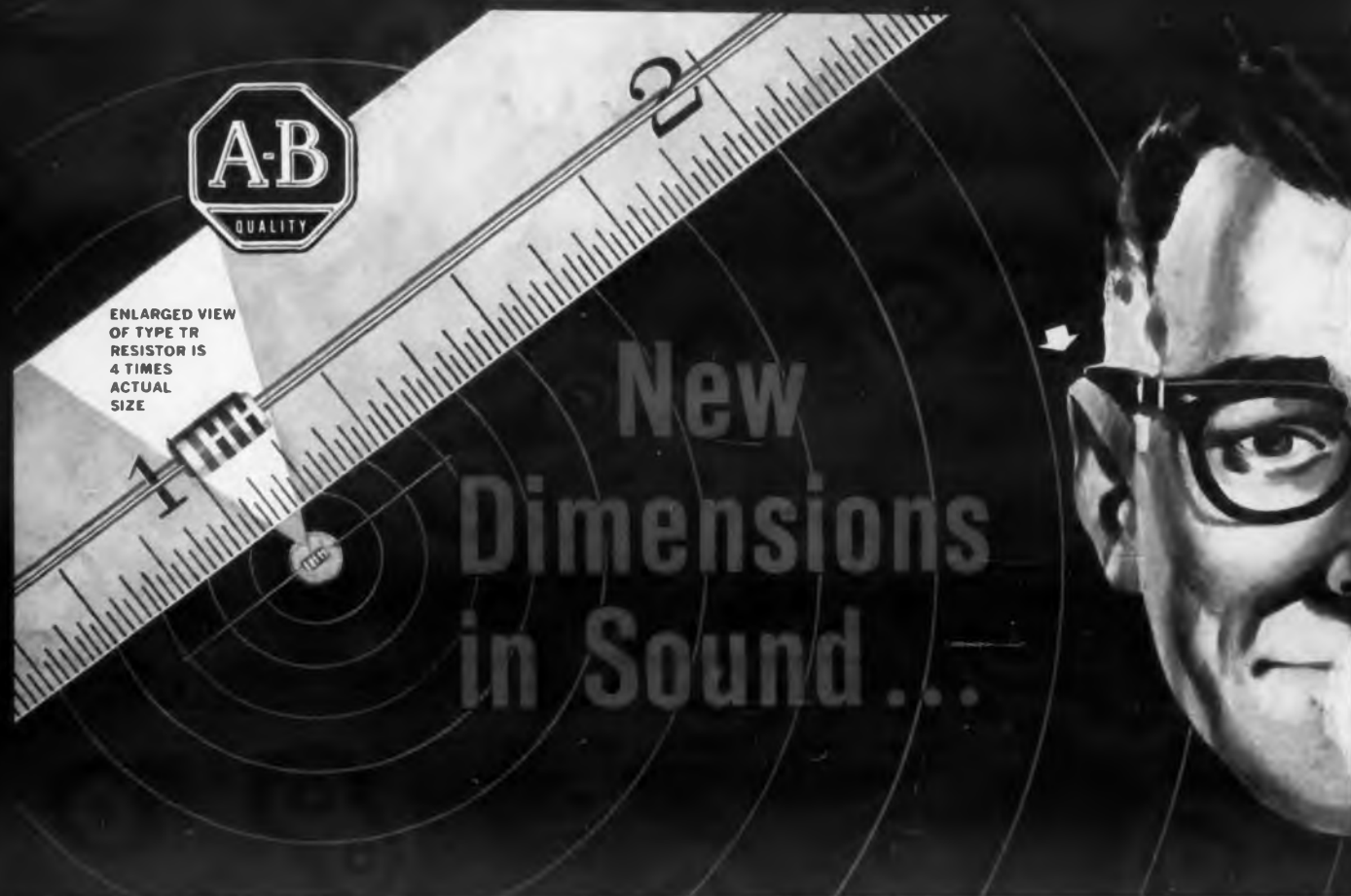
Type TR 1/10 Watt	MIL Type RC 05*
Type CB 1/4 Watt	MIL Type RC 07
Type EB 1/2 Watt	MIL Type RC 20
Type GB 1 Watt	MIL Type RC 32
Type HB 2 Watt	MIL Type RC 42

8-61-E

ALLEN-BRADLEY

Quality
Electronic Components

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ontario



ALLEN-BRADLEY TYPE TR RESISTORS are STANDARD for today's miniaturized hearing aids

Because of the engineering ingenuity of the manufacturers, hearing aids have become so tiny they are hardly noticeable—since the principal objection to wearing a hearing aid has been overcome, ever increasing thousands are enjoying this remarkable contribution to the joy of hearing.

Allen-Bradley is proud to play a part in this important development. The extremely tiny Type TR fixed resistor (actually smaller than a grain of rice) is used by virtually every hearing aid manufacturer to help achieve today's amazing miniaturization—without sacrificing reliability!

Tiny as they are, these miniature resistors—made by Allen-Bradley's exclusive hot molding process—*have never experienced catastrophic failure in service.* They are remarkably "uniform" to their resistance rating. Therefore, you are only fair to yourself—and your customers—when you insist on the reliability of the A-B Type TR resistors.

For complete details, please send for Technical Bulletin 5001, and Publication 6024 which also includes information on other A-B space-saving electronic components.

SOME OF THE MANUFACTURERS OF HEARING AIDS WHO RELY ON A-B TYPE TR RESISTORS

American Sound Products, Inc.
 Audivox, Inc.
 Beltone Hearing Aid Company
 Busse Electronics Company
 Dahlberg Company
 Dictograph Products, Inc.
 Electro Acoustic Research Labs., Ltd.
 Gem Ear Phone Co., Inc.
 Halhen Widex, Inc.
 Johnston Hearing Aid & Electronics, Inc.
 Maico Electronics, Inc.
 The Microtone Company
 E. A. Myers & Sons, Inc.
 Otariion Listener Corp.
 Qualitone Company, Inc.
 Sonotone Corp.
 Telex, Inc.
 Unex Laboratories
 Vari Electronics, Inc.

ALLEN - BRADLEY

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
 In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

QUALITY
ELECTRONIC COMPONENTS

Portable Drafting Kit

399



Weights 1.5 lb and measures 9-1/2 x 13 x 1-1/2 in. The portable drafting kit includes a drafting instrument with 3 x 5 or 4 x 6 in. scale and a 180-deg protractor, 50 sheets of paper, and a pencil. It comes in a vinyl, self-locking binder.

Draftette Co., Dept. ED, P. O. Box 794, Beverly Hills, Calif.

Price: \$8 or \$9.

Selenium Rectifiers

353

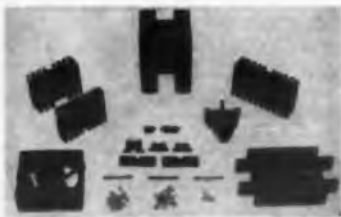


Paper base phenolic cartridge houses thin cell selenium rectifiers. Cells are made of 0.010 in. aluminum stock. Stacks have up to 500 cells. Cells operate at 130 C ambient temperature. A single stack used in a half wave circuit will accommodate 15,000 v and will block a peak reverse voltage of 31,500 v.

General Electric Co., Rectifier Components Dept., Dept. ED, W. Genesee St., Auburn, N. Y.

Heat-Sink Kit

415



Complete heat-sink kit series A contains 17 natural-convection, conduction and forced-convection units as well as three sets of mounting kits. The heat sinks provide a range of thermal resistance to cover all possible transistor applications. Natural convection units range from 0.68 to 1.9 C per w.

Astro Dynamics, Inc., Dept. ED, Northwest Industrial Park, Burlington, Mass.

P&A: \$37.50; stock.

EVEN AT HIGH TEMPERATURES, MYLAR® HELPS MOTORS RUN TROUBLE-FREE LONGER!

Mylar* polyester film resists the three main causes of motor failure—heat, humidity and physical stress. Temperatures in the Class B range have relatively little effect on the electrical characteristics of "Mylar". It's also 35 times more moisture-repellent than rag paper . . . 8 times stronger . . . and can't dry out because it contains no plasticizer. "Mylar" also helps reduce size and weight of motors, and gives them an extra safety margin from shock because it repels moisture so well.

Capacitors benefit from "Mylar", too. Last longer, are more reliable . . . at no greater cost than paper units for similar service. In a wide variety of applications, "Mylar" can improve performance, lower costs. Here are some more reasons: • dielectric strength of 4,000 v/mil.** • thermal stability from -60°C. to over 150°C. • resistance to chemicals, aging, abrasion and tearing. Best of all, you can use less, often pay less . . . because you get all these advantages in thinner gauges. Evaluate "Mylar" for your product. Write for free booklet (SC) detailing properties and applications. Du Pont Co., Film Dept., Wilmington 98, Delaware.



REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
... THROUGH CHEMISTRY



*Registered Du Pont Trademark.
**ASTM D-149.

POWER
SUPPLIES

VALUE

QUALITY



RS305A

@ \$55.50

For original use . . . For incorporation into laboratory equipment . . . In 55- to 400-cycle systems. The Trans Electronics Model RS305A Power Supply provides voltage regulation of .05% load and .05% line over the entire 225- to 325-volt range. Operating current range 0-50 ma, continuous duty, with filament output of 6.3 volts CT AC @ 3 amps. Units feature low ripple and noise (5 mv peak to peak); fast recovery time (25 to 50 microseconds). Three versions of Model RS305A offer, respectively, modular construction in package 5 x 4 1/8 x 6 1/2 inches; rack-mounting; and rack-mounted models with 3 1/4-inch meters, in case with 3 1/2-inch panel height. Input is 105-125 volts AC.

SPECIFICATIONS

model*	voltage range	current ma	filament volts/amps	price
RS-110				\$108.00
RR-110	0-100	0-100	6.3/3	133.00
RM-110				169.00
RS-205	150-225	0-50	6.3/3	55.50
RR-205				80.00
RM-205				115.00
RS-217A	150-225	0-175	6.3/8	87.50
RR-217A				112.50
RM-217A				147.50
RS-305	225-325	0-50	6.3/3	55.50
RR-305				80.00
RM-305				115.00
RS-317	225-325	0-175	6.3/8	87.50
RR-317				112.50
RM-317				147.50
RR-450	+300-400	0-50	6.3/2	155.50
RM-450			6.3/1.5	196.00
DUAL TRACKING	-300-400		6.3/1.5	
RR-473	+300-400	0-25	6.3/2	140.00
RM-473			6.3/1.5	175.00
DUAL TRACKING	-300-400		6.3/1.5	
RS-505	300-500	0-50	6.3/3	81.50
RR-505				106.50
RM-505				141.50
RR-303	0-300	0-500	6.3/15	320.00
RS-303	0-300	0-500	6.3/15	360.00
RR-550	300-500	0-500	6.3/15	310.00
RM-550	300-500	0-500	6.3/15	350.00

TRANS ELECTRONICS, DIV.

Burton Manufacturing Company

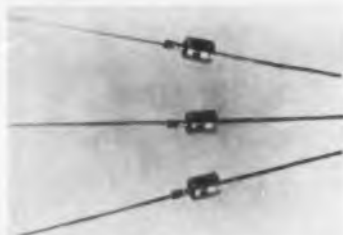
8910 Winnetka Avenue
Northridge, California Diamond 1-4400

CIRCLE 163 ON READER-SERVICE CARD

NEW PRODUCTS

Zener Regulators

508



Rated at 1 w. Zener regulators range from 2.8 to 200 v and can carry up to 150-ma test current. JETEC types are 1N1766 through 1N1802; NAE types are PRS3011 through PRS3017, in voltages from 2.8 to 5 v. They are storage tested at 200 C and are hermetically sealed.

North American Electronics, Inc., Dept. ED,
71 Linden St., West Lynn, Mass.

Transient Voltage Indicator

507



Has two ranges: 0 to 200 v at $\pm 5\%$ full-scale accuracy and 0 to 2,000 v at $\pm 2\%$. Self-contained and portable, the transient voltage indicator detects pulses down to 1 μ sec. Input impedance is 5 pf in shunt with 1 meg, both ranges. Battery power is used.

Vapor Heating Corp., Dept. ED, 6444 W.
Howard St., Chicago 48, Ill.

Availability: through distributors.

Vibration Monitor

628



A transistorized monitor to detect and measure vibration amplitudes is modular in construction and portable. Frequency range is 10 to 1,000 cps and displacement range is 1.5, 5, and 15 mils. Dimensions are 8-3/4 x 3-5/8 x 7-1/2 in.; weight is 4 lb without filters.

Lehigh Valley Electronics, Inc., Dept. ED,
Allentown, Pa.

SO WHAT'S A WEE LINE?



For the answer, join the Wee Line Club. Free monthly cartoons, free membership scroll in a fascinating language and technical data on the new modular delay line. Membership is limited to the first 8 1/2 million. Write to Dept. WL-8 1/2

NAVIGATOR, INC.

ESSEX ELECTRONICS DIVISION

550 SPRINGFIELD AVENUE, BERKELEY HEIGHTS, N. J.

CIRCLE 164 ON READER-SERVICE CARD

20 years of
experience in
the world

- Reduce costs
- Simplify assembly
- Improve appearance with

GRC

DIE CAST ZINC ALLOY
& MOLDED NYLON

FASTENERS

Round Head THUMB NUTS

Open
End



Closed
End



GRC's exclusive wide grip; generous width tops have deep fluted edges for firm, comfortable grip. Corrosion resistant, rustproof. Smart design for added sales appeal.

Head Diameters:
1/8" thru 1 1/8"
Thread Sizes:
#6 to 7/16"

- High in quality
- Uniformly accurate
- Low in cost
- Wide range of stock styles, types, sizes and threads

Produced in one high speed automatic operation. GRC's exclusive methods assure uniformity, smooth rustproof and corrosion resistant surfaces and the lowest possible cost. New kinds of fasteners never before available . . . modifications in stock fasteners for specialized use . . . infinite variety in styles, types and sizes, have been made possible by GRC's special automatic die casting and molding machines.

Write, wire, phone
RIGHT NOW for samples, prices, your copy of GRC's NEW DETAILED FASTENER CATALOG



GRIES

GRIES REPRODUCER CORP.

World's Foremost Producer of Small Die Castings
40 Second St., New Rochelle, N. Y. • New Rochelle 3-8600

CIRCLE 165 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

DIE CAST
ZINC ALLOY



Wing Nuts



Cap Nuts

Thumb
Nuts



Thumb & Wing Screws

MOLDED
NYLON



Screws



Hex Nuts



Washers



Screw Insulators

new edition / free retaining ring engineering manual

shows how Ramco's tOtal 2 solves your toughest problems!



the unique 360° full circle ring offers many design variations.

SINGLE TURN RINGS • MULTI-TURN RINGS • SELF-LOCKING RINGS



It takes two types of rings to answer all retaining ring needs. That's why Ramco's tOtal 2—Spiralox and Circo-

lox—provide the superior solution to your retaining ring problems. Your free Engineering Manual brings you the complete story—write for it now!



... and Circolox

the improved die-formed ring

RAMSEY CORPORATION a subsidiary of Thompson Ramo Wooldridge Inc.
Box 513, Dept. W, St. Louis 66, Missouri

CIRCLE 166 ON READER-SERVICE CARD

IS YOUR JOB COSTING YOU \$84,000.00?

It could be costing you this much—and even more.

The average increase in salary of the Electronics Men placed through Cadillac this year is \$2,800. If these men merely maintain their present increase through 30 additional work-years, then their earning power has increased \$84,000.00.

What about you? Are you earning less these days than your capability dictates? If so, we suggest that you contact Cadillac.

Cadillac is employed by 520 top electronics firms—coast to coast. Our service is completely confidential and absolutely free of charge. The companies pay our costs.

FREE — Opportunities Bulletin

Find out the top positions in electronics every month. Send us your name and home address direct or circle Reader Service Card Number 885



LON D. BARTON
President

CADILLAC
ASSOCIATES, INC.

29 East Madison Bldg.
Chicago 2, Illinois
Financial 6-9400

"Where More Electronic Executives Find Their Positions Than Anywhere Else in The World."

CIRCLE 885 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

Decade Scaler

686



One mc counter module is a count-to-ten device that utilizes the 8-4-2-1 binary code to count random serial pulses at any rate to 1 mc. Any number of these units can be cascaded by means of front panel connectors. Visual display is by neon-lighted decimal digits. An analog voltage equivalent of the final count is available on the front panel.

Harvey-Wells Electronics, Inc., Dept. ED, 14 Huron Drive, Natick, Mass.

P&A: \$141.40; from stock.

Insulating Cloths and Tapes 608

Temperature ranges from 150 to 300 C are offered for the insulating tape designated Mica-Seal. Tape is a pre-stretched fabric coated with mica particles. It is adaptable to potting operations and is useful as slot liners and phase insulation for motors and dielectric for capacitors.

McMillan Industrial Corp., Electronic Components Div., Dept. ED, Brownville Ave., Ipswich, Mass.

Availability: from stock.

Bulb for Pilot Lights 496



Miniature, 6-w bulb for pilot lights produces 36 lumens. Filament design spreads light so that lenses of all colors may be used. Voltage rating is 125 v, giving the bulb a life of 1,500 hr avg. Two 3-w coiled tungsten filaments are connected in series and separate mounts protect each filament.

General Electric Co., Dept. ED, Nela Park, Cleveland 12, Ohio.

P&A: \$0.95; to OEM.

- HARDENED PINIONS
- 125°C AMBIENT
- HIGH TORQUE

BOWMAR

Precision Servo Motors

SIZE

8

SIZE

10

Five basic types—Plain or hardened pinions—Tapped holes on mounting faces—Split, center tapped or plain control phase windings for 26 or 36 volt operation—26 volt fixed phase. All types have .35 in.-Oz. minimum stall torque.

Six types available—26 or 115 volt fixed phase—Split, center tapped or plain control phase for 26 or 36 volt operation. High compression glass molded terminals, extremely shock resistant, meet high altitude specifications. High torque throughout ambient temperature range.



BOWMAR MOTOR  BOWMAR GEARHEAD

You get exclusive "one-stop" capability in Servo Motors and Servo Motor Assemblies from Bowmar. You may obtain motors alone, or wedded with precision Bowmar Gearheads, multispeed "ELECTROSHIFT" Gearchangers and other components. They are also available in complete Bowmar-designed Servo Packages. All Bowmar Servo Motors have slotted shafts at terminal ends to facilitate checking of total lost motion (backlash) AFTER assembly to other components. Electrical and mechanical characteristics of all Bowmar Servo Motors may be changed to meet customer requirements.

SEND FOR "SM" DATA PACKAGE



INSTRUMENT CORPORATION

8000 BLUFFTON ROAD
FORT WAYNE, INDIANA

PRECISION MECHANICAL COMPONENTS, PRECISION COUNTERS AND INDICATORS, PRECISION TIMING AND PROGRAMMING DEVICES, PRECISION ELECTRO-MECHANICAL DEVICES, PRECISION SERVO PACKAGES

CIRCLE 168 ON READER-SERVICE CARD



0.01% total — from this new transistorized power supply

Add up *all* the factors: line and load regulation of 0.0005%; short-term drift of 0.001%; and, hum and noise of 50uv rms. Result: total stability of 0.01%!

Krohn-Hite's new Model UHR-T361 transistorized power supply is an important new bench supply for development, measurement and research. Its phenomenal stability also makes it ideal for component tests, and powering computer circuits.

Voltage range: 0-36 volts. Current: 0-1 ampere. AC output impedance: 250 microhms. Transient response: 25 usec. Line voltage: 115/230; 50-400 cps.

The extremely tight line and load regulation of the Model UHR-T361, plus its remote sensing feature, permit remote operation with better regulation at 100 feet, 0.001%, than most other supplies at their terminals. The supply also features remote voltage control for automatic programming.

Constant voltage or constant current can be obtained from this supply. The voltage is constant under pulsed or steady-state resistive or reactive loads. The current is constant to within 0.01%.

Krohn-Hite's new UHR-T361 is convection-cooled, and fully protected against short-circuit, overvoltage, overtemperature, and on/off voltage surges.

Get full information on the UHR-T361, and the 3, 5, and 10 amp Krohn-Hite transistorized power supplies.



KROHN-HITE CORPORATION

580 Massachusetts Avenue • Cambridge 39, Mass.

Pioneering in Quality Electronic Instruments

CIRCLE 169 ON READER-SERVICE CARD

NEW PRODUCTS

Solid State Timers

684

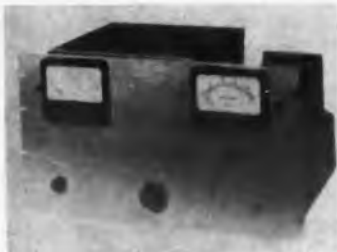


Range is from several seconds to 15 min. Units have wide application as sequencers, time delay relays and automatic cycling switches. Standard operative voltage is 18 to 28 v dc. Other voltages are available on request.

Crane Electronics Co., Dept. ED, 4345 Hollister Ave., Santa Barbara, Calif.

Power Supply

692



Output is 15 to 40 kv at 2 ma, continuously variable, for the power supply model 2M-40. A bar shorts the high voltage output when the unit is not in use. Unit is useful in insulation testing, plastic pinning, electrostatic flocking and painting and other applications.

Spellman High Voltage Co., Dept. ED, 1930 Adeo Ave., Bronx 67, N. Y.

Multiturn Potentiometers

643



Range is 5 to 600 K ohms for the potentiometers series 3600. Units are available in both 3 and 10-turn models. Resolution is down to 0.004% and 135 tap positions are possible. Operating temperature range is from -55 to +105 C. Standard resistance is $\pm 3\%$. Power rating at 40 C derating to 0 at 105 C is 5 w for the 3-turn model and 7 w for the 10-turn model.

Duncan Electronics, Inc., Dept. ED, 2865 Fairview Road, Costa Mesa, Calif.



The Sebit-24B Transmitter-Receiver represents the most recent performance improvement over the Sebit-24A, already recognized as a superior data modem. Design improvements so far have reduced an original 2.25% message error rate to 0.075% (approximately 4 bit errors in 10^7) and it's going lower. For the present, this sets the "state-of-the-art" for 2400 bit/sec. operation over available 3 Kc voice bandwidth, wire line circuits. Reliability of greater than 5000 hours mean time between failure has been established for the Sebit-24. Recent competitive laboratory and operational circuit testing supports this high performance and reliability.

Rixon is also out front in system and system hardware design. Call on our experience which has established Rixon as an authority on data handling and communications systems. Rixon is currently performing subcontract engineering for such programs as "Advent" and 412-L.

WRITE FOR DETAILED BULLETINS

RIXON
ELECTRONICS, INC.

2121 Industrial Parkway
Montgomery Industrial Park
Silver Spring, Md. MAyfair 2-2121

CIRCLE 170 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

- the ultra
new **YOKE!**



Deflectron*
By **Celco**

**MAJOR ADVANCE IN
THE SCIENCE OF
ELECTRON BEAM DEFLECTION!**

SPOT RECOVERY

Fastest! to 1 μ S

SPOT SIZE

Smallest - by 25%

SPOT SWEEP

Straightest.....

*** DEFLECTRONS for DISPLAYS**

Where ordinary precision
yokes **FAIL** to meet your
requirements.

Write for **NEW "DEFLECTRON"**
Data and Standard Yoke
Catalog. 

Celco

*Constantine Engineering
Laboratories Co.*

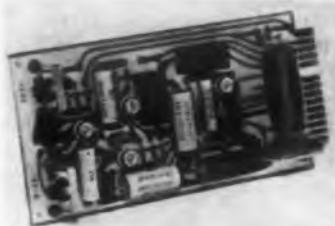
Main Plant: **MANWAN, N. J. DAvis 7-1123**
PACIFIC DIV.-**UPLAND, CALIF. YUkon 2-0215**
CENTRAL DIV.-**LANESBORO, PA. ULYsses 3-3500**

CIRCLE 171 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

Chopper Stabilizing Amplifier

696



A single-ended, non-inverting device, the series 100 chopper stabilizing amplifier utilizes solid-state circuitry and a 10,000-hr mechanical chopper. It has a stable 80 db dc-to-dc gain with ± 5 v output. Terminals provide for either internally filtered or unfiltered output. The unit can be driven from source impedance up to 50 K.

C.E.S. Electronic Products, Dept. ED, 5026 Newport Ave., San Diego 7, Calif.

Blowing Equipment

695



For enclosed rack, cabinet or console use, the Trans-Aire blower line is for use where excessive heat is generated. Units are available in three sizes with air displacement ranges from 100 to 700 cfm. All models have thermal overload protection and automatic reset.

Bud Radio, Inc., Dept. ED, 2118 E. 55th St., Cleveland 5, Ohio.

Follower Amplifier

689



Plug-in follower amplifier model K2-BJ is used as a booster with the company's militarized operational amplifiers. Unit provides for the operational amplifiers an increased steady-state output of 20 ma at ± 100 v, gain about 0.8, and output impedance about 250 ohm before feedback.

Philbrick Researches, Inc., Dept. ED, 127 Clarendon St., Boston 16, Mass.

Price: \$49.

compact
t/d/r
for
compact
control
systems



Miniature AGASTAT
time/delay/relay offers
maximum reliability in minimum space

For control systems where reliability *and* size are important design considerations, specify the Miniature AGASTAT time/delay/relay.

Only 1½ in. square, less than 5 in. high, and weighs as little as 15 oz. Four adjustable models provide delays from .03 sec. to 3 minutes—on pull-in or drop-out. Electrically-operated, pneumatically timed for instant recycling and freedom from voltage-variation drift. Choice of ac and dc operating voltages, with solder lug, octal plug or AN connector terminals.

Since 1931, AGASTAT time/delay/relays have been specified for reliability and accuracy in almost every industry with electrical control requirements. Wouldn't this be a good time to learn what this proven performance can mean in your timing circuit?

We'll gladly send complete details. Just write Dept. M2-49

AGASTAT® TIMING INSTRUMENTS
ELASTIC STOP NUT CORPORATION OF AMERICA
ELIZABETH DIVISION ■ ELIZABETH, NEW JERSEY

IN CANADA: ESNA CANADA, LTD., 12 GOWER ST., TORONTO 16, ONTARIO, CANADA
CIRCLE 172 ON READER-SERVICE CARD

RUGGED RACKS... TO DO A RUGGED JOB!

PREMIER
HEAVY DUTY TRANSMITTER RACKS
18" and 24" DEEP FOR 19", 24" and 30" RACK PANELS

- BLACK OR GREY WRINKLE GREY OR BROWN HAMMERTONE
- REMOVABLE ROUNDED CORNER MOULDINGS
- LOOSE JOINT HINGES and CHROME HANDLE
- 16 GAUGE SHEET STEEL
- #12 GAUGE STEEL BOTTOM
- RED STRIPED CHROME MOULDING
- 3/16 THICK MOUNTING ANGLES
- ANGLES TAPPED 12, 24 ON E.I.A. SPACINGS
- COMPLETELY WELDED THROUGH-OUT
- DUPLIX RECEPTACLE AND OUTLET BOX
- CUT-OUT FOR LEADS, ETC.

RM SERIES

CONTACT YOUR LOCAL DISTRIBUTOR OR SEND FOR COMPLETE CATALOG

PREMIER METAL PRODUCTS COMPANY
337 MANIDA STREET, NEW YORK 59, N. Y.
WESTERN SALES OFFICE: 1667 Laurel St., San Carlos, California
EXPORT DEPARTMENT: EMEC, 127 Grace Street, Plainview, New York
MFD. IN CANADA by PREMIER METAL HOUSINGS Ltd., 5810 Smart Ave., Montreal

CIRCLE 173 ON READER-SERVICE CARD

**FREE • 1962
NEWARK CATALOG No. 72
INDUSTRIAL ELECTRONICS**

FOR INDUSTRY, DEFENSE,
BROADCAST

- In stock . . . ready to go . . . over 70,000 items from more than 500 manufacturers.
- Semiconductor Headquarters for Industry at Quantity Prices Competitive with Manufacturers.

- ★ COMPETITIVE FACTORY PRICES
- ★ COMPLETE ON-HAND STOCK
- ★ IMMEDIATE DELIVERY

NEWARK
ELECTRONICS CORPORATION

Write Dept. DE9

Mail Order Division, Main Office and Warehouse
223 West Madison Street • Chicago 6, Illinois

BRANCH WAREHOUSES AND SALES: INGLEWOOD, CALIF. • DETROIT, MICH. • GRAND RAPIDS, MICH.

CIRCLE 104 ON READER-SERVICE CARD

158

NEW PRODUCTS

Connector Sleeve

646



Entries from 0.156 to 2.375 in. in 1/8 in. increments are available for the connector sleeve assembly G91. Assembly is made watertight through use of an internal grommet and follower at the cable end and an O-ring seal to the connector itself. Underwater tests have qualified fully assembled connector, cable and sleeve to 15 psi for 4 hr.

Glenair, Inc., Dept. ED, 1211 Airway, Glendale, Calif.

Availability: from stock.

Temperature Controllers

610

Range is -20 to +125 C for thermistor type temperature controllers model TCK and model TCC. Sensitivity is ± 0.05 C. Relay is 10 amp spdt type. Extension cables with male or female connectors or continuous cables to 1,000 ft are available.

Tri-R Instruments, Dept. ED, 144-13 Jamaica Ave., Jamaica 35, N. Y.

Price: \$125, model TCK; \$56, model TCC.

Vapor Degreaser

694



Heating capacity is 2,000 w for the ultrasonic vapor degreaser. Unit is powered by a solid state 500-w generator which features Magnatrac automatic tuning. Degreaser contains a boiling compartment to remove gross contaminants from metal parts or assemblies and an ultrasonic compartment for a final clean and rinse. Both compartments are stainless steel.

Westinghouse Electric Corp., Industrial Electronics Dept., Dept. ED, 2519 Wilkens Ave., Baltimore 3, Md.

**UNIQUE
PORTABLE,
PLUG-IN
SWEEP
GENERATOR**



the **NEW**
MICRO-SWEEPER

Here's a small, lightweight sweep generator that attaches directly to your oscilloscope panel. No cables or batteries. Just plug in and operate. MICRO-SWEEPER sweeps speeds up to 2 microseconds/centimeter on your scope. Use it for IF alignment; wideband amplifier testing; filter studies; tv test work; field testing where portability is a must; classroom demonstrations.

And check these performance advantages!

- Choose from 3 models:
Model 200 — .15 to 2mc
Model 201 — 2.0 to 15mc
Model 202 — 15.0 to 115mc
- Output voltage: 0.25 Volts rms into 600 ohms for Model 200.
0.1 Volts rms into 50 ohms for Models 201 and 202.
- Flatness: ± 0.5 db or better on all bands (± 0.25 db on Model 200)
- Over-all flatness, band-to-band: ± 1 db or less (± 0.5 db on Model 200)
- Easy maintenance, fully transistorized

. . . New — check the prices!

Model 200 \$160.00 201 \$160.00 202 \$160.

For complete information, please write

TELTRONICS
23-27 Main Street, Nashua, N.H.
Export Division: EMEC, Inc. Plainville, L.I., N.Y.

CIRCLE 174 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961



HAWK-PROVEN CONNECTORS

LIONEL

Series S-20

Extra Reliability With—

- Shell-Enclosed, Die-Cast Housings
- Diallyl Phthalate Moldings
- Positive Alignment & Polarization
- Minimum Depth in Mated Position
- Beryllium Copper Contacts for Extended Insertion/Withdrawal Life



4 sizes: 13 to 41 high voltage contacts, 2 and 4 coaxial contacts; Meet applicable MIL specs; Materials & specifications modified to meet your special needs.

• Write Dept. 19-HW for Series S-20 Dimensional Data Sheets

 **Lionel
Electronic
Laboratories**

(Formerly Anton Electronic Laboratories)

1226 Flushing Ave.
Brooklyn 37, N. Y.

CIRCLE 175 ON READER-SERVICE CARD
ELECTRONIC DESIGN • September 27, 1961

Flat Capacitor

647



Range is 0.01 to 0.33 μ fd for the capacitor 605. Rating is 50 v. Temperature range is -55 to +125 C at full rated voltage. Tolerances are ± 20 , ± 10 and $\pm 5\%$. Metal case is hermetically sealed and is a flat shape with oval cross section. Units meet all military environmental requirements and vibration specifications of NIL-C-19978A.

Good-All Electric Manufacturing Co., Dept. ED, Ogallala, Neb.

Power Operators

685



For control drive applications, three models of Powertork power operators develop output torques of 30, 60 and 120 ft.-lb. at 1/2 rpm. Gear train is completely immersed in a high dielectric, radioactive-shielding oil which is suitable for service from -30 to +200 F. Drive motor is an 1,800 rpm reversible split capacitor type, also immersed.

Electro-Mech Corp., Reliance Instrument Div., Dept. ED, 500 Livingston St., Norwood, N. J.

Accuracy Is Our Policy

The photograph accompanying the description of the ADC-1B analog-to-digital converter manufactured by Systems Engineering Laboratories, Inc., Fort Lauderdale, Fla., which appeared on p 68 of the June 21 issue of ELECTRONIC DESIGN, showed the five different types of circuit cards used in its construction rather than the converter. Also, the line that reads only five different circuit cards are used . . . , should have read, only five different types of circuit cards are used.

Extra High Purity Gold Plate!



Ordinary Gold Plate

 **TEMPEREX[®] HD^{*}**

TEMPEREX HD electroplate meets or surpasses the most exacting specifications of the electronics industry. Its deposits of 99.99+ purity provide a uniformity of metallurgical characteristics never before attainable in gold electroplate.

Other advantages: 75 Knoop hardness; easy to solder or weld; and an exceptional ductility that permits *cork-screw twisting of electroformed strips without fracturing!*

Write for details.

*Patent applied for



SEL-REX CORPORATION
NUTLEY 10, NEW JERSEY

World's largest selling precious metal plating processes

CIRCLE 176 ON READER-SERVICE CARD

FAST ECONOMICAL
SERVICE ON

short run

BERYLLIUM COPPER
screw machine products

Consult—
I-S
on
prototypes
and sample
quantities

Our modern plant and facilities for turning, grinding, milling, drilling, threading, heat-treating and electroplating are available for small or large volume. Simple or intricate, flanged or tapered designs from .020" to 1.00" diameters. Send drawings and specifications for quotations.

**INSTRUMENT SPECIALTIES
CO • INC**

 "MICRO-PROCESSED"
BERYLLIUM COPPER SPECIALS

270 Bergen Boulevard
Little Falls, New Jersey
Telephone: CLifford 6-3500

CIRCLE 177 ON READER-SERVICE CARD

Rowan Control

1%

Panel Meters



13 basic models of panel meters for both commercial and military use are manufactured by the Rowan Controller Company. Pictured above is Model #145, typical of all models for commercial applications in that it performs with accuracy to 0.50%, sensitivity to 100,000 Ω/V and has ranges 10 μA to 1,000+ amps and 10 MV to 1,000+ Volts. Standard features include mirror scales, spring back sapphire jewels, and screw machine parts.

Expanded scale frequency and volt meters with accuracy to 0.2% are available in both standard and ruggedized MIL Spec models with spans from $\pm 4\%$ to $\pm 20\%$ of center scale and inherent temperature and voltage stability.

See all models at the WESCON Show, booth 221, or write for complete catalog with dimensions, mounting schematics, prices and performances of all models.

FOR MIL SPEC M-10304-B

Models #25 and #35 generally attain an accuracy of $\pm 2.0\%$ but may be had with accuracy of $\pm 1.0\%$ on request. Especially designed for military usage, they meet or exceed the most severe requirements of MIL-M-10304-B under the most critical conditions of shock, vibration, and mechanical stress and strain, retaining all the high degree of accuracy and stability for which the Rowan Controller line is noted.

Sales Representatives in Principal Cities.

METER DIVISION

THE ROWAN CONTROLLER COMPANY

26 BRIDGE AVENUE, RED BANK, NEW JERSEY

CIRCLE 178 ON READER-SERVICE CARD

NEW PRODUCTS

Recording/Reproducing System 649



Ten simultaneous audio transmissions can be recorded on 1/2 in. tape for the multi-channel recording/reproducing system model T-1510. A fail-safe feature instantaneously detects mechanical or electronic failure and automatically starts standby recorder. System is adaptable for language laboratories, airport communications, etc.

Magnasync Corp., Dept. ED, 5546 Satsuma Ave., North Hollywood, Calif.

Matching Transformers 601

Broadband high frequency matching transformers are available with ratings of 1, 5 and 20 kw. Frequency range is 2 to 30 mc. Units can be supplied in any of the following four standard impedance transformations: 50 ohms unbalanced to 70 ohms, 150 ohms, 300 ohms or 600 ohms, balanced. Transformers are for indoor or outdoor use.

Barker & Williamson, Dept. ED, Bristol, Pa.

Temperature Controllers 644



Range is -300 to $2,000$ F for indicating temperature controller series 6000-A. Units utilize a Wheatstone bridge circuit with a choice of four control modes covering the complete range of temperature control from on-off through proportional and 3-position operation. A fail-safe resistance sensing element is used.

Electronic Processing Corp., Dept. ED, 436 Bryant St., San Francisco, Calif.

Price: from \$185 to \$250.



Cleaning and polishing small component parts, instruments and control mechanisms.



Breaking edges, shaping to slight radius, touching up and scores of other operations.



Relieving stress concentration and blending in to reduce danger of fatigue failure.

PREDICTABILITY—

A Key to Reliability

Advanced technologies demand accurate predictions of performance in tools as well as materials. Predictability in tools used is basic to reliability in products made.

CRATEX RUBBERIZED ABRASIVES

can be used with complete confidence. They will perform as expected—engineered for the most delicate and sensitive applications in Deburring, Smoothing, Cleaning and Polishing.

WHEELS	}	Coarse (C)
POINTS		Medium (M)
BLOCKS		Fine (F)
STICKS		Extra-Fine (XF)
CONES		

Sold through leading Industrial Supply Distributors

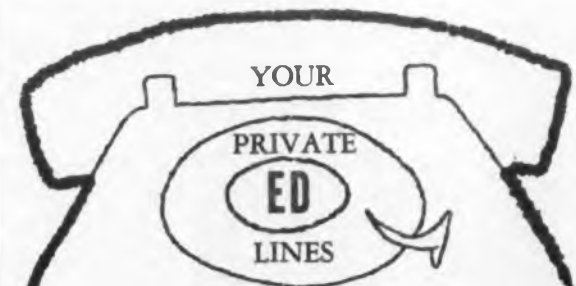
FREE! send for the new, informative 22 page Cratex Application Manual, including a complete illustrated catalog.

CRATEX

MANUFACTURING COMPANY, INC.

1600 Rollins Road Burlington, Vermont

CIRCLE 179 ON READER-SERVICE CARD



When employment information is obtained through *ELECTRONIC DESIGN*, it's sent direct to your home, so that only you and one prospective employer at a time know about it. You can conduct your employment campaign privately—as it should be conducted.

This is why every Reader Service Card reserves a line for your home address, and why circled numbers are detached from Career Inquiry Service Forms sent to companies.

You can apply for many jobs simultaneously . . . only you will know how many.

Use the Career Inquiry Service Form, and the Reader Service Card when job hunting. They're your *private lines* to employment opportunities . . . another service for you from

ELECTRONIC DESIGN.



YOUR HIDDEN HELPER

—eliminates the old bugaboo of cable entanglement which damages tubes and components in lower chassis each time the one above is withdrawn for service and returned to position.

Our new Cable Retractor's double action maintains constant tension and correct suspension of cable at all times—permits ample cable length for full extension and tilting of chassis without hazard of snagging.

For use with all types of chassis or drawer slides, adjustable to fit varying chassis lengths, simple to install, inexpensive, proven thoroughly reliable in operation.

Mounts on rear support rails on standard 1 3/4" hole increments. Cadmium plated CRS.

Write for Bulletin CR-100E ORegon 8-7827

WESTERN DEVICES, Inc.
600 W. FLORENCE AVE., INGLEWOOD 1, CALIF.
CIRCLE 181 ON READER-SERVICE CARD



PRECISION METERS

Catalog Available

If your operation demands accuracy to 1/10 of 1% you need this AMF Catalog, which includes specifications, sizes and weights of Frequency and Volt Meters for test, research, industrial, military and government use.

AMF Meters are rugged. They compensate for practically any temperature and environment. They can be tailored to your requirements—or are available immediately from stock. Send today for your Catalog! Address Department D.



American Machine & Foundry Company

1101 N. Royal Street, Alexandria, Virginia

CIRCLE 180 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

Relay Socket

492



Microminiature relay socket model 2999, designed to fit the firm's four-pole relay, has a fiber-glass filled diallyl FS5 body and terminals of heat-treated beryllium copper with gold over silver plate. Dielectric strength is 1,500 v rms between terminals. The 14 socket holes have 0.1-in. spacing.

Branson Corp., Dept. ED, P. O. Box 234, Whippany, N. Y.

Gold Salts

638

A **stress-free**, pure, ductile, and tight-grained deposit is claimed for Orotemp 24, a new 24-karat neutral gold salt. The salt contains no brighteners or free cyanide. Discoloration under heat is prevented by the salt's purity. Orotemp 24 fuses with gold-silicon eutectic alloy without discoloration and plates directly on stainless steel, monel, kovar, and other alloys.

Technic, Inc., Dept. ED, Box 965, Providence, R. I.

Prices: \$45 to \$42 per troy oz.

Overvoltage Protector

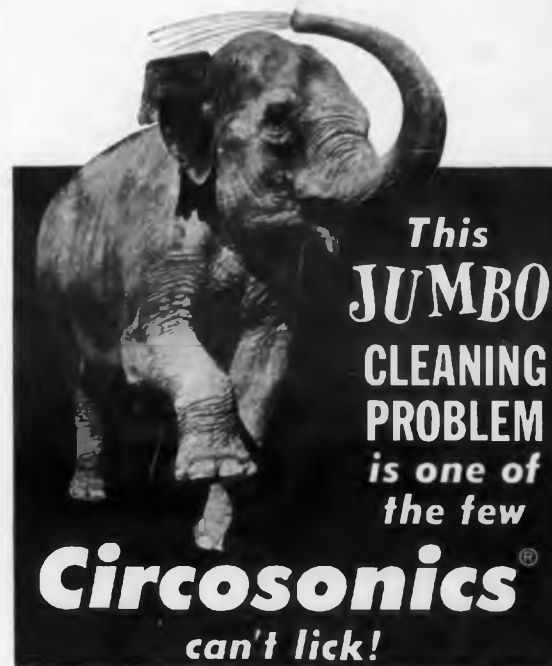
480



Responds in 2 μ sec. Designed for permanent mounting in transistorized equipment, the overvoltage protector places a short across the power input terminals to the semiconductor circuit and discharges capacitors. It can be furnished for up to 400 v. Overvoltage pulses of 1% with a duration of 1/3 μ sec will trigger the protector.

The Victoreen Instrument Co., Jordan Electronics, Dept. ED, 121 S. Palm Ave., P. O. Box 2047, Alhambra, Calif.

P&A: \$32.50; 30 days.



This **JUMBO** CLEANING PROBLEM is one of the few

Circosonics can't lick!

Frankly, pachyderms pose a problem in dirt with which Circo ultrasonic cleaning units can't cope. These amazing machines are, however, the masters of almost any other cleaning job you can name. Here's why.

By bombarding dirt with ultrasonic sound, these revolutionary units actually blast contaminants loose. They clean absolutely in mere seconds—without harming your product in any way!

Circo ultrasonics have already proven themselves in an amazing number of exacting applications where absolute cleanliness is a must. They star, too, by dramatically speeding up cleaning operations while they reduce labor requirements and drastically lower operational costs. Circo ultrasonics achieve precision cleaning of housings and hypodermics, gears and gyro parts, meters and missile parts, clocks, and electrical circuits.

Why don't you clean up with Circo—in precision cleaning, economy, speed and quality? Call for complete information today. We have representation in all major cities.



Double Tunnel Washer

Ordinary cleaning methods aren't good enough at Regina Corporation. To swiftly and completely clean parts for electric sweepers, brooms and floor polishers, Regina chose this Circo Double Tunnel Washer. Result? Precision cleaning of all parts in just seconds. And—at least cost!

Ultrasonic Agitator 1 PA-US

Cleans better 2 ways! Circo Ultrasonic Agitator, Model 1 PA-US, uniquely combines ultrasonic vibrations with agitator action to swiftly, efficiently clean extremely agglutinous materials. Result? Dramatic savings in time and labor.

Clean Up with **CIRCO**
CIRCO CORPORATION

ULTRASONICS • WASHERS • DEGREASERS
Solvents

51 TERMINAL AVENUE

CLARK, NEW JERSEY

A subsidiary of Branson Instruments, Inc.

CIRCLE 182 ON READER-SERVICE CARD

solid
state
airborne
TELEMETRY
system

Applied Electronics Corporation of N. J. are producers of the most reliable solid state telemetry systems available today.

Supplied for use on Titan, Minute Man, Sub Roc and other major missile programs with an outstanding record of operational performance. In addition to the company's standard line of PAM, PDM and PCM systems, a new family of satellite telemeters is being produced and supplied for

QUALIFIED

use on several satellite projects. These equipments are characterized by low power dissipation, small size and high accuracy. Technical Specialization has enabled us to produce the most advanced and reliable completely solid state telemetry systems. Several of these are briefly described opposite.

Appplied
Electronics
Corporation
OF NEW JERSEY



METUCHEN, N. J.
TWX — METU 708
Liberty 9-9200

45 x 20 PDM MULTICODER
MODEL MDH — 4 SERIES



PDM Multicoders solid state designed with utmost compactness, highest accuracy with low power dissipation. This equipment contains power supply, commutator and pulse duration modulator. The equipment is also available for low level applications

HIGH SPEED SOLID STATE
PCM MULTICODER MCH SERIES



PCM System or digital Telemeter includes a high resolution electronic commutator which accurately samples up to 120 channels, coder and power supply in a package size of 6" x 6" x 9"—the smallest working digital telemeter available today

PDM, PCM, PAM

30 CHANNEL LOW LEVEL PAM
MULTICODER MAL-3 SERIES



PAM are available in all standard IRIG sampling and channel configurations, Solid State, high reliability, long life and low power dissipation —also available for low level applications

30 CHANNEL TWO POLE
SOLID STATE PAM MULTICODER
MODEL MAH-3-2 SERIES



Engineering Specifications are available on all available AEC Designed Equipment, our Engineering and Research, and Design Departments are always available to discuss your specific telemetry problems

OFFICES

WASHINGTON — EX 3-0451
SANTA MONICA, CALIF.
— GL 1-2214

CIRCLE 103 ON READER-SERVICE CARD

NEW PRODUCTS

Conductive Molding Compound 439

Corrosion resistance and physical strength are properties of Grade X-1011-F conductive compound of fiber glass reinforced polyester. It can be molded into blowers for explosion-proof equipment. Impact strength is 5 ft-lb per in., flexural strength is 16,000 psi and tensile strength is 5,000 psi.

The Glastic Corp., Dept. ED, 4321 Glenridge Road, Cleveland 21, Ohio.

Price: \$0.63 to \$0.69 per lb.

Recording Voltmeter 533



For maintaining and troubleshooting electrical systems, the

Amprobe Recorder Voltmeter offers a miniature recording device. The unit is inkless, uses smudgeless, pressure-sensitive paper. The internal-core meter movement, motor and chart-drive mechanism are shielded by Mylar.

Amprobe Instrument Corp., Dept. ED, 630 Merrick Road, Lynbrook, L. I., N. Y.

P&A: \$79.85, regular-scale model; \$84.85, expanded-scale model; from stock.

Explosion-Proof Motor 532



For Class I, Group D and Class II, Groups F and G environments. Explosion-proof motors are avail-

PARAFORMED

SHARP
SQUARE
INSIDE
CORNERS

FLAT
SIDE
WALLS

SMALL
OUTSIDE
CORNER
RADIUS

SPIRAL WOUND
Not Die Formed

Spiral Wound

PAPER TUBES

Speed and Improve
COIL WINDING

ANY SIZE—SQUARE OR RECTANGULAR

PARAFORMED paper tubes simplify coil winding operations and speed production, *yet cost no more*. In the exclusive PARAFORM method of tube making, no artificial heat or pressure is used—*Paraforming* takes place at the time of spiral winding. Hi-Dielectric. Hi-Strength. Kraft, Fish Paper, Acetate, Red Rope or any combination wound on automatic machines. *Produced from stock arbors or special sizes engineered for you.* Can also be supplied in regular or with slight bow.

- No sharp outside edges to cut wire
- No need for wedges to tighten wire
- Permits winding coils to closer tolerances
- Has full rigidity and physical strength
- Allows faster stacking of wound coils

Write on company
letterhead for
**STOCK ARBOR LIST
OF OVER 2000 SIZES**

Paramount PAPER TUBE CORP.

608 LAFAYETTE STREET, FORT WAYNE 2, INDIANA
Manufacturers of Paper Tubing for the Electrical Industry Since 1931

CIRCLE 184 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

able in 1- to 3-phase induction or synchronous types, 1/150 to 1/20 hp. Torque or dynamic brake types also are available.

Holtzer-Cabot Motor Div., National Pneumatic Co., Inc., Dept. ED, 125 Armory St., Boston 19, Mass.

try and five selective ranges of sensitivity.

KeXplore Electronics, Inc., Dept. ED, Houston, Tex.
P&A: \$379; less than 60 days.

Squib Testing Device 523



0.01 C temperature rise in a squib wire can be detected by this squib testing device. Unit is for testing missile and rocket systems for dangerous rf energy. Self-contained and battery operated, it has all transistor circuitry

DC-to-DC Dynamotor 525



Output is 500 w at 25 C for 5,000 hr and 500 w at 85 C for 1,000 hr for any output voltage between 100 and 2,000 v dc and 250 w at 25 C for 5,000 hr and 250 w at 85 C for 1,000 hr for any output voltage between 12 and 100 v dc. Input is 24 to 30 v dc with transient capabilities up to 34 v dc.

NJE Corporation, Dept. ED, 20 Boright Ave., Kenilworth, N. J.

NEW FROM

Langevin

FOR THE FIRST TIME

UP TO 20 DECKS WITH 160 POLES

In Precision Instrument Switches — Through accurate, automatic alignment with low drag

CHANGEABLE DECKS—Captive Rotor gives integrated deck assembly—Switch can be disassembled, wired, decks exchanged, reassembled—quickly, easily, with common socket wrench.

LOW RESISTANCE—Fine Silver brushes and contacts—Lowest contact resistance of 1.3 milliohms—ideal for dry circuits.

LONG LIFE—Rugged, Low Contact Pressure with self equalizing brush design withstands up to 50G shock with 50% longer life.

SMOOTH ACTION—Equal Torque—Exclusive vertical rise detent gives uniform action.

FREE—Write today for 24 page Guide to Choosing Precision Instrument Switches

This switch
20 1/2" long

Langevin



A Division of
Sonotec
Incorporated

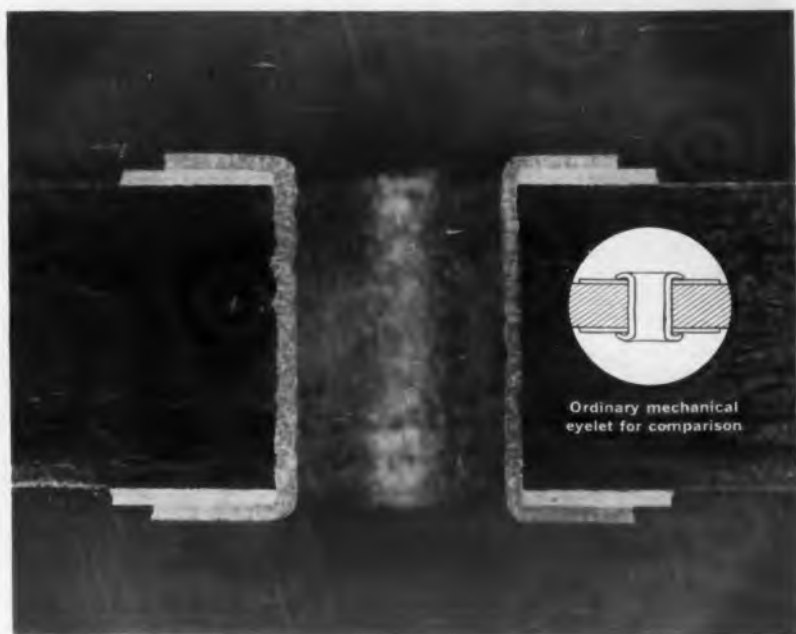


503 SOUTH GRAND AVENUE • SANTA ANA, CALIFORNIA

CIRCLE 185 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

A NEW IMPORTANT EXCLUSIVE IMPROVEMENT IN THRU CONNECTIONS



The Electroformed Eyelet

Here's a welcome answer to your printed circuitry problems—the **Electroformed Eyelet**, new from Graphik Circuits. This remarkable thru connection is as strong as an eyelet, as reliable as the finest plated thru-hole. A new GC technique eliminates failures due to gas entrapment as well as other common eyelet troubles caused by vibration, intermittancy, or high electrical resistance at mechanical connections. Economical, too—if a precious metal finish, such as gold, is desired in the thru-hole, use of the **Electroformed Eyelet** eliminates the need to gold-plate the entire pattern and conductor paths. Extremely close line width and spacing tolerances are possible, as are heavy wall deposits of .005 or greater without danger of excessive build-up on surface conductors.

The **Electroformed Eyelet** is just one more example of the superb craftsmanship you always find in Graphik Circuits printed circuitry.

Write us, or call your nearby Cinch Manufacturing office.



Graphik Circuits

Division of Cinch Manufacturing Company, 200 So. Turnbull Canyon Road, City of Industry (Los Angeles), Calif.
Offices in 49 Principal Cities throughout United States listed under Cinch Mfg. Co. or United-Carr Fastener Corp.

CIRCLE 186 ON READER-SERVICE CARD

Another
reliable
GENERAL
MAGNETICS
"MAG MOD"
Miniature



Continuous Accuracy
within $\pm 5\%$ of Theo-
retical Product over
the entire Ambient
Temperature Range

NEW MAGNETIC *multiplying* MODULATOR

Specifically designed to deliver an analog output voltage which is the continuous product of two variable input voltages. One of these is an excitation voltage which varies over a pre-determined range; in this case, 0 to 1 VRMS 400 cycles per second. The other signal is a DC current which varies between 0 and $\pm 400 \mu\text{a}$. The output voltage is 400 cycles AC, and is always in phase or 180° out of phase with the variable excitation or fixed reference, i.e., in phase when the variable amplitude DC signal is positive, and 180° out of phase when the DC signal is negative.

TYPE MCM 515-1 SHOWN ACTUAL SIZE. COMPLETELY RUGGEDIZED, VIRTUALLY SHOCK AND VIBRATION PROOF. WEIGHS ONLY ONE OZ.

THERE IS NO SUBSTITUTE FOR RELIABILITY!

Specify "MAG MOD" miniature components for infinite life, faster response time, negligible hysteresis and extreme stability. Call or write for new Brochure 102 on "MAG MOD" Miniaturized Magnetic Modulators and Magnetic Multiplying Modulators.



General Magnetics • Inc



135 BLOOMFIELD AVENUE
BLOOMFIELD, NEW JERSEY
Telephone: Pilgrim 8-2400

CIRCLE 187 ON READER-SERVICE CARD

REMOTE DATA RETRIEVERS, EVENT AND DATA RECORDERS

117.50

121.00

122.99

127.99

PRINT AND PLOT SIMULTANEOUSLY

HOGAN FAXimile recorders are available with up to 2000 individual styli for simultaneous recording. A wide range of stylus spacings is offered—up to 100 to the inch for high-speed facsimile, television and radar recorders and high resolution printers and plotters. Chart widths to 30" and feed rates to 50" per second.

Hogan specializes in electrolytic techniques for event, spectrum analysis, oscillograph and facsimile recording, frequency time analysis and special purpose binary and gray scale record applications. Hogan electrolytic recording papers provide a permanent high contrast black on white record which is reproducible on most conventional office duplicators.

Whatever your recording problem may be—contact HOGAN FAXimile, a subsidiary of TELautograph Corporation, 635 Greenwich Street, New York 14, N. Y.

HOGAN FAXimile Corporation • 635 Greenwich St., New York 14, N. Y.
A SUBSIDIARY OF TELAUTOGRAPH CORPORATION

CIRCLE 188 ON READER-SERVICE CARD

OPERATION MONITOR • PRINTERS • PLOTTERS • TIME QUANTIZERS

SPECTRUM ANALYSIS, DENSITOMETERS, FACSIMILE RECORDERS

NEW PRODUCTS

Vacuum Tube Voltmeter

690



Frequency range is 10 cycles to 2 mc for the ac vtm model 58. Unit has a frequency and temperature compensated decade attenuator, calibrated both in voltage and 10 db steps, consisting of 0.5% film resistors. Allowing for 10% variation of line voltage, accuracy is still 1% of full scale from 30 cps to 100 kc, and 2% from 10 to 30 cps and from 100 kc to 2 mc.

Precision Apparatus Co., Inc., Dept. ED, 70-31 84th St., Glendale 27, N. Y.

Loop Antenna

639

This balanced, self-supporting, electrostatically shielded loop antenna (L-1) has been designed for outdoor installation in any environment. The unit is designed for low and very-low frequencies where electrostatic shielding is needed for reception. The loop is for calibrated measurement as well as for normal reception.

Aerospace Research, Inc., Dept. ED, 94 Massachusetts Ave., Cambridge 39, Mass.

P&A: \$98.50; from stock.

Recording System

620



Analog voltage inputs, corresponding to differential and absolute temperatures and thermal radiation levels, are measured, integrated and recorded by this recording system. The system has a capacity of 36 channels. Input data are sampled for value and sign, stored and integrated for a one hr period, then recorded via a tape punch. Sampling rate is 100 samples per channel per hr.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

RTV Silicone Rubber

NOW IN 1-LB. SIZE!

General Electric's liquid silicone rubber that cures at room temperature to form a flexible solid now comes in a new 1-lb. minimum order size.

New 1-lb. jar makes it easy to mix up small batches — less waste for infrequent users, more economy for smaller users.

Ideal for potting, sealing, caulking, encapsulating, and flexible molds, G-E RTV silicone rubber has excellent electrical properties. Usable over temperature range of -65°F to 600°F .

New 1-lb. size is available in 6 viscosities, from easily pourable to thick paste.



For full information, contact the distributor nearest you:

San Francisco

Electrical Specialty Co.
158 Eleventh St.

Chicago

Federal Insulation Co.
549 W. Randolph St.

Detroit

Insulation & Copper Sales
15605 Woodrow Wilson

Jersey City

Smooth-On Mfg. Co.
572 Communipaw Ave.

Floral Park, Long Island, N. Y.

Punt, Incorporated
160 Woodbine Ct.

Philadelphia

Smith of Philadelphia
1024 Race St.

Chagrin Falls, Ohio

Electrolock, Inc.
28 North Main St.

or write: General Electric Company, Silicone Products Dept., Section L958, Waterford, N. Y.

GENERAL  ELECTRIC

CIRCLE 189 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961



Richard B. Doorley, Mgr., New Products Div., Railway Maintenance Corp., Pittsburgh, Pa.

“Norbatrol helped us cut R&D time by 1 year with this Bistable Amplifier”

“Norbatrol’s Bistable Amplifiers solved many control problems in redesigning our McWilliams Jack-and-Production Tamper from manual to reliable, automatic operation. Now this RMC railroad surface machine operates electronically—improves grade and cross level to accuracies never previously accomplished. And we got a bonus,” Mr. Doorley continues, “these rugged, reliable static relays cost less than alternate systems.”

You, too, can speed development and production time with the ultrasensitive Bistable Amplifier—it replaces mechanical relays in critical control and regulating applications. The Bistable incorporates silicon controlled rectifiers, magnetic amplifiers and attendant circuitry to give multiple inputs as low as 5×10^{-8} watts, fast response, high gain and a current output of 1 Amp at an 85° C. ambient.

GET THE FACTS on design and application data—write for technical bulletin CS60.

NE-1



NORBATROL
Electronics Corp.

DEPT. C 358 Collins Avenue
Pittsburgh 6, Pennsylvania

CIRCLE 190 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

Accelerometer Switch

687



Air damping and flexure suspension are features of the accelerometer switch type AS24-0201-1. Unit is useful in testing where the actual accelerations are not known. When the desired acceleration level is determined the switch can be furnished in production quantities with exactly the same dynamic characteristics with pre-set range.

Humphrey, Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

Index Mechanism

600

Rotary switch index mechanism will achieve a minimum of 50,000 cycles. Designation is Tri-Spring, Tri-Ball mechanism. The mechanism can be specified for the company’s 20 deg throw, 18 position switches and for 15 deg throw, 24 position switches.

Oak Manufacturing Co., Dept. ED, Crystal Lake, Ill.

Radio Navigation System

554

Pulsed, hyperbolic radio navigation system, Loran C, provides continuous position-fixing information for land, sea and air navigation. Transmission frequency is 100 kc. Applications include in submarines, underwater cable laying, mapping and surveying.

Collins Radio Co., Dept. ED, P. O. Box 1891, Dallas 21, Tex.

Epoxy Material

626



One-component, epoxy-based material, in dry powder form is designed for easy handling in potting applications. Low shrinkage and low coefficient of thermal expansion approach inorganic materials in value. Exceptionally high thermal conductivity is claimed for the material.

Hysol Corp., Dept. ED, Olean, N. Y.

Engineers! Designers!

THERE IS NO SUBSTITUTE FOR RELIABILITY!

Specify—

**PERFORMANCE
PROVEN "MAG MOD"**

MAGNETIC MODULATORS

Actual Size



For complete specifications and application data on "Mag Mod" Miniature and Standard Components, call or write.

Miniaturized design permits engineers to employ these new components in transistorized printed circuit assemblies and wafer type structures. All models offer maximum reliability, fully ruggedized construction and conform to MIL-T-27A specifications.

- COMPLETE RELIABILITY
- INFINITE LIFE
- FASTER RESPONSE TIME
- NEGLIGIBLE HYSTERESIS
- EXTREME STABILITY (Ambient Temp. Range from -75° to $+135^{\circ}\text{C}$)
- COMPACT SIZE
- LIGHTWEIGHT

Typical circuit applications for Magnetic Modulators are algebraic addition, subtraction, multiplying, raising to a power, controlling amplifier gains, mechanical chopper replacement in DC to fundamental frequency conversion, filtering and low signal level amplification.

GENERAL MAGNETICS • INC

135 BLOOMFIELD AVENUE
BLOOMFIELD, NEW JERSEY
Telephone: Pilgrim 8-2400

CIRCLE 191 ON READER-SERVICE CARD

.. HIGH VOLTAGE TESTING of Electronic Cables, Components, Materials and Completed Assemblies



Mobile D-C HYPOT[®]

Rugged . . . Mobile . . . for Production,
Installation and Maintenance Testing

Output . . . 120 kv models provide up to 5000 microamperes d-c. 75 and 45 kv models offer up to 10 ma. d-c.

115v A-C Line . . . Input through three-conductor power cord with standard two prong plug and grounding clip.

Self-Contained, Fully Portable . . . Single mobile housing with rubber tired wheels and push handle contains metering circuitry and high voltage supply (oil immersed above 45 kv).

Safe, Simple Operation . . . Direct reading of insulation leakage current. Fully interlocked, cabinet grounded, output cable shielded . . . to protect operator and equipment.

.. for Every Application

Heavy Duty HYPOTS[®]
A-C or D-C, to 150 kv.

Bench Type HYPOTS[®]
A-C to 35 kv, 2 kv
D-C to 45 kv, 25 ma

Mobile HYPOTS[®]
A-C to 30 kv, 10 kva
D-C to 120 kv, 10 ma

Portable HYPOTS[®]
A-C to 10 kv, 230 va
D-C to 5 kv, 2 ma

Write for Manual J-67

Methods for Insulation Testing
.. Engineering .. Production
.. Maintenance



ASSOCIATED RESEARCH, Incorporated
"Electrical Testing Instruments Since 1934"

3769 W. Belmont Ave., Chicago 18, Illinois

CIRCLE 192 ON READER-SERVICE CARD



test . . . test . . . test . . .

If you feel you *must* make your own pots to get exactly what you need, don't overlook quality control along the way! And this can be a messy business, what with special, elaborate techniques to quality-check *every* production stage! Oh, you'll get involved in maddening bouts with visual comparitors, ratiometers, environmental testing labs — and when you've finished — *and* made a few hundred revisions — you *might* have the quality you want!

So, before you go fly a kite — consider Ace. We've been all through this before, and have what is regarded to be the finest quality control system in the industry. It enables us to keep our final costs down, by rejecting sub-standards at each stage, without waiting for the final inspection. Although it's more work this way, we can offer a higher degree of resolution and linearity at a lower price. So, for precision-at-price, see your ACErep!



Here's 0.3% linearity in a 1/2" pot: the Series 500 ACEPOT®. Single-turn, -55° to 125°C range. As with all Ace components, tested in every stage of its manufacture!

ACE ELECTRONICS ASSOCIATES, INC.
99 Dover Street, Somerville 44, Mass.
SOMerial 6-5130 TMM SMVL 181 West. Union WJX

Acepot® Acefilm® Acestat® Aceohm® *Reg. Appl. for
CIRCLE 193 ON READER-SERVICE CARD

NEW PRODUCTS

Multiple Function Meter

630



Model VM-235 phase angle voltmeter combines the functions of an ac voltmeter, phase sensitive null indicator, power factor meter and measures separately the in-phase and quadrature components of a signal. Twelve ranges cover from 1 mv to 300 v full scale. Accuracy as a phase angle is $\pm 3\%$ full scale, and $\pm 2\%$ of full scale as an ac voltmeter. Null sensitivity is $2 \mu\text{v}$ and harmonic rejection is greater than 55 db in the phase sensitive operating mode.

North Atlantic Industries, Inc., Dept. ED, Terminal Drive, Plainview, L. I., N. Y.

Silicon Transistors

419

Switch up to 120 w without heat sinks. Having a volume of 0.028 cu in., types 2N2033, 2N2034 and 2N2035 silicon transistors are intended for use at collector currents of 500 ma, 1 amp and 1.5 amp, respectively. Types 2N2033 and 2N2034 are in the TO-5 package; type 2N2035, the TO-8 package.

Silicon Transistor Corp., Dept. ED, Carle Place, N. Y.

Bi-directional Counter

619



Fully transistorized bi-directional counter is applicable for numerical information readout, recording or process control. The counter indicates true position while going through zero in either direction, eliminating the need for external reset to establish a reference. Specifications are: weight, 30 lb; counting rate, 45,000 counts per sec; readout, 5 standard decades and polarity indicator; signal output, up to 100 v on 53 pins.

Crane Co., Hydro-Aire Div., Dept. ED, 300 Winona Blvd., Burbank, Calif.

SAMS

BOOKS OF WORTH
YOU'LL ALWAYS WANT AT HAND



Handbook of Electronic Charts & Nomographs

Important time-saver—contains 58 electronic charts and nomographs to provide solutions to hundreds of formulas and ratios—in just the time it takes to rule a line. Shows how to use each nomograph. Bound in clear vinyl overlay sheet positions over any nomograph, permits ruling in erasable pencil lines connecting proper points on graph scales; can be used repeatedly. Special chapter on how to use nomographs effectively and how to develop your own. 128 pages. $8\frac{1}{2} \times 11"$. No. NOM-1. Only \$4.95

Industrial Transistor & Semiconductor Handbook

Latest, most complete data on industrial semiconductors, their characteristics, circuit-design procedures, typical applications. Covers semiconductor physics, general characteristics, circuit fundamentals, ratings and measurements. Discusses applications: diodes, industrial control, power converters, communications, unusual devices, thermo-electricity in solar-energy conversion. Special chapters describe advanced semiconductor manufacturing techniques and new developments, such as thin-film and integrated circuits, high-density packaging, micro-miniaturization, etc. Includes transistor parameter symbols and definitions, plus methods for determining thermal stability of transistor circuits. 256 pages. $5\frac{1}{2} \times 8\frac{1}{4}"$. No. TTT-1. Only \$4.95



Using the Scope in Industrial Electronics

Explains how to use scope to test industrial equipment such as thyatron controls, ignitrons and controls, saturable reactors and magnetic amplifiers, radar equipment, automotive ignition systems, transistorized controls. Covers basic scope information capability, operating features, characteristics, general use in industrial electronics. Discusses waveform photography, lab applications, scope maintenance and calibration, etc. Includes handy scope specifications charts plus numerous waveforms showing normal and abnormal conditions. 256 pages. $5\frac{1}{2} \times 8\frac{1}{4}"$. No. OSM-1. Only \$4.95

First-Class Radiotelephone License Handbook

The most up-to-date reference on broadcasting and the 1st-Class FCC Exam; provides everything you need to know to progress from a 2nd-class to a 1st-class license holder; a valuable reference for station engineers and technicians. Includes latest data on frequency assignments, duty and license requirements, studio and control-room facilities, AM and FM transmitter and antenna systems, laws and test procedures, and typical questions and answers based on Element IV of the FCC exam. 304 pages. $5\frac{1}{2} \times 8\frac{1}{4}"$. No. BON-1. Only \$4.95

Tube Substitution Handbook, 3rd Edition

Latest edition of this valuable book. Contains only DIRECT substitutions. Now includes 5,234 substitutions (1808 more than in prior volume). Lists 2,759 substitutions for 1,687 receiving tube types. Shows 224 industrial and 602 European substitutes for American receiving types; 513 American for European receiving types, etc. 96 pages; $5\frac{1}{2} \times 8\frac{1}{4}"$. No. TUB-3. Only \$1.50

FREE

Send for the Howard W. Sams Technical Book List—over 130 authoritative titles. Send coupon below.

HOWARD W. SAMS & CO., INC.

Order from any Electronic Parts Distributor, or mail to Howard W. Sams & Co., Inc., Dept. J-101 1720 E. 38th St., Indianapolis 6, Ind.

Send the following: NOM-1 TTT-1 OSM-1
 BON-1 TUB-3

\$.....enclosed. Send on FREE 10-Day Approval

Send FREE Sams Book List

Name _____

Address _____

City _____ Zone _____ State _____

CIRCLE 194 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961



NOT AFFECTED by magnetic fields.

**BIG
LOOK** panel meters

SELF-SHIELDED DC MECHANISMS FOR GREATER RELIABILITY

SELF-SHIELDED DC MECHANISM is one of the big built-in features you get with General Electric d-c BIG LOOK panel meters. Self-shielding eliminates special calibration problems . . . allows more flexibility in locating meters on panelboards through minimizing interaction.

Here's why: Unlike many other designs, the BIG LOOK's core is around the magnet . . . where it belongs . . . and shields the entire d-c mechanism. This means that interaction is eliminated, even when meters are cluster-mounted. Also, stray magnetic effect is minimized!

For the complete AC and DC BIG LOOK panel meter story, just contact your nearby General Electric Apparatus Sales Office or distributor; or write for bulletin GEA-7034 direct to General Electric Company, Section 597-02, Schenectady 5, New York.

INSTRUMENT DEPARTMENT

GENERAL  ELECTRIC

CIRCLE 195 ON READER-SERVICE CARD
ELECTRONIC DESIGN • September 27, 1961

Tape Punch

648



Motorless direct-drive paper tape punch that will perforate a 5-, 6-, 7- or 8-hole tape at rates up to 20 characters per sec is designated model P-100. Unit is available in a cabinet for bench or desk use, without a back cover for oem mounting, and with a 19-in. front panel for rack mounting. Punches are actuated directly by solenoids.

Invac Corp., Dept. ED, 14 Huron Drive, Natick, Mass.

P&A: \$495; 90 days.

Strip Conductor

599

Aluminum coil strip conductor with smooth precontoured edges is available in 0.16 to 0.51 in. thicknesses.

Reynolds Metals Co., Dept. ED, Richmond 18, Va.

Printing Tube

614

Rate is 10,000 lines per minute for the 8-1/2 in. electrostatic charge printing tube type SC-3075. Tube uses magnetic deflection and focus. Uses include reproduction of charts, photographs, numbers and words.

Sylvania Electric Products, Inc., Dept. ED, 730 Third Ave., New York 17, N. Y.

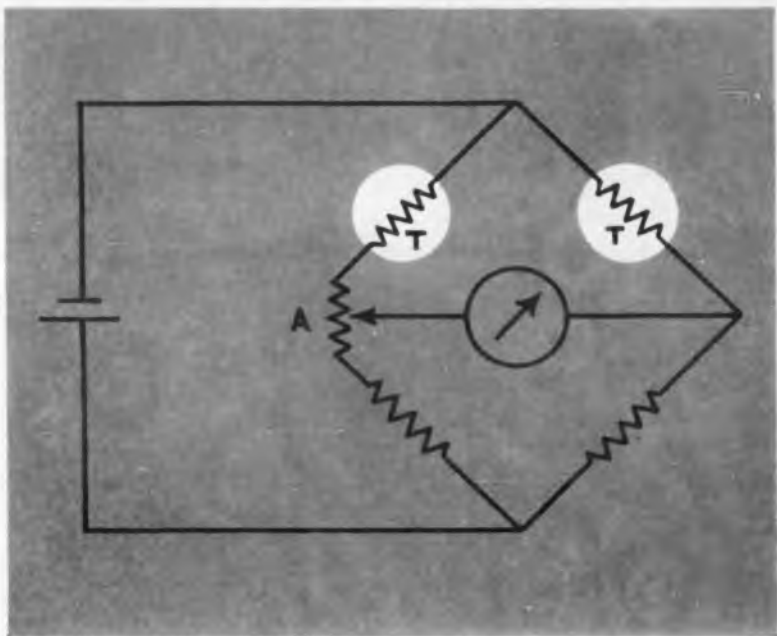
Recording System

497



Sweeping-image recording system model 339B is for the study of transient events with velocities to 200,000 ft per sec and duration as short as 5×10^{-6} sec. Applications include flash-tube and spark-discharge phenomena, simultaneity of plane-wave generation and simulated nose-cone re-entry studies.

Beckman & Whitley, Inc., Dept. ED, San Carlos, Calif.



A little thermistor makes a big difference in many thermal conductivity instruments

Place two small bead thermistors in a bridge circuit where enough current flows to heat them to 150° C, and you'll find you have an instrument for the measurement of many different physical phenomena. *For example:*

GAS ANALYZER — Place the thermistors in small cavities filled with identical gases, and balance the bridge by varying the setting of "A". A change in the gas in one of the cavities will either raise or lower the resistance of the thermistor because of a change in the thermal conductivity. This will unbalance the bridge and give a reading on a meter.

FLOW METER — Seal a thermistor in a cavity, and place the other thermistor in a pipe. Balance the bridge when there is no flow through the pipe. When the flow starts, the resistance of the thermistor changes, and the bridge becomes unbalanced.

ANEMOMETER — Design the instrument with a sensing thermistor held in free air, and it will be capable of measuring air velocity from the slightest breeze to a gale.

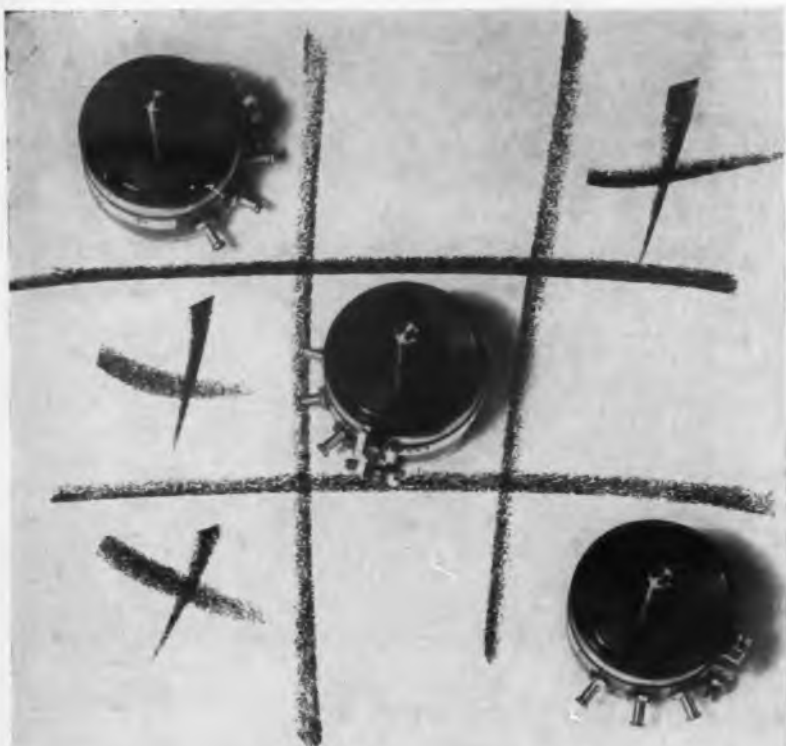
VACUUM GAUGE — Place one of the thermistors in an evacuated bulb and the other in a chamber connected to a vacuum pump. Pump the chamber down to a high vacuum, and balance the bridge. A reading can be obtained when the chamber is not a high vacuum because the presence of air will cool the thermistor and raise its resistance.

Thermistors can be used in many other circuits to great advantage. For details, application assistance and new Thermistor Catalog EMC 4, write:

Fenwal Electronics' new, modern production facility and offices mean better service and better products for you.



63 FOUNTAIN STREET
FRAMINGHAM, MASS.



WINNER!

It's not the game, it's winning that counts—and Duncan potentiometers score right down the line. Precision, quality and reliability (three in a row) offer a combination that thwarts competition. Simple? Only because Duncan has improved design and manufacturing techniques—become expert in potentiometer oneupmanship.

Our pots can fill that blank spot on your board. The next move is yours. Put your x on this advertisement (name and address will further clarify) and return it to us. We'll be pleased to send you a complete list of the Duncan winners.

Exceptional vibration and shock performance (30g to 2,000 cps vibration and 50g shock) make Duncan's miniature $\frac{1}{8}$ " single turn Model 1201 above, particularly suitable for military servo packages. Diallyl phthalate housing withstands shock and protects against fungus, acid and alkali attack. Operating temperatures to 150°C are available.

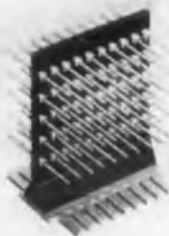
DUNCAN ELECTRONICS, INC.
2865 FAIRVIEW ROAD • COSTA MESA, CALIFORNIA

CIRCLE 197 ON READER-SERVICE CARD

NEW PRODUCTS

Wire Wrap Terminal Block

629



For use with a variety of commercially available wire wrap tools, this series of terminal blocks is available with standard assemblies of 10 and 20 terminals per row. Terminals are 0.045 in. sq on 0.220 x 0.375 in. centers. They are locked in place with nylon bushings in a block of anodized aluminum. Base is fiber glass reinforced plastic with slots for wire fanning.

Magnetic Controls Co., ADC Products Div., Dept. ED, Minneapolis, Minn.

Epoxy System

609

Temperatures to 500 F can be withstood for continuous operation at extended periods of time. Mereco 43-21 is a low viscosity epoxy impregnating and casting system. Heat distortion temperature is 148 C. System has a working life of at least four weeks. It is useful in vacuum impregnating operations and laminating applications.

Mereco Products, Div. of Metachem Resins Corp., Dept. ED, 530 Wellington Ave., Cranston, 10, R. I.

Wirewound Resistors

650



Range is 1 ohm to 1 meg for wirewound resistors types 447-P and 446-P. Rating is 1/8 w from -65 to +125 C, derated 5% per deg C over 125 C. Standard tolerances available to 0.01%. Temperature coefficient is 2 ppm per C. Size of resistor type 447-P is 1/4 x 1/4 x 1/8 in. with printed circuit type leads. Size of type 446-P is 1/2 x 1/4 x 1/8 in.

Kelvin Electric Co., Dept. ED, 5907 Noble Ave., Van Nuys, Calif.



RELIABILITY
DELIVERED



NEW SUBMINIATURE COAXIAL R F CONNECTORS

**SMALLEST, LIGHTEST, MATCHED
IMPEDANCE SUBMINIATURE
CONNECTOR AVAILABLE**

MICON, new as a company, old in experience, makes available the industry's most extensive line of uniquely designed bulkhead, chassis, line and printed wiring board connectors of the 50 ohm screw-on type.

The following are Micon 1000 Series exclusive features:

25% smaller than other matched connectors

1000 volt minimum flashover up to 70,000 feet

Cable pullout resistance — 30 pounds minimum

No rubber or plastic boots — the only all metal-to-metal contact available

Field inspection requires no tools or spare parts

Coupling nut pullout resistance — 100 pounds minimum

Extended temperature range of -100°C to +200°C

25% lighter than any other matched line cable connector



We, at MICON, have prepared an evaluation kit which is available on request.



MICON ELECTRONICS, INC.

ROOSEVELT FIELD,
GARDEN CITY, L. I., NEW YORK
a wholly owned subsidiary of Metalcraft, Inc.

CIRCLE 198 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961



"DRESSES-UP" your panels, switchboards, other products.

BIG LOOK panel meters

MODERN DESIGN IMPROVES END PRODUCT APPEARANCE

Now, General Electric's **BIG LOOK** panel meter styling can help improve the appearance of your switchboards, panels and other equipment. **BIG LOOK styling** is the result of careful planning, development and field testing. It represents more than 28 years of General Electric leadership in creative panel meter design.

Now, **BIG LOOK** panel meters are available in your choice of seven attractive color windows to complement the appearance of your products or equipment.

For the complete AC and DC **BIG LOOK** panel meter story just contact your nearby General Electric Apparatus Sales Office or distributor; or write for bulletin GEA-7034 direct to General Electric Company, Section 597-04, Schenectady, New York.

INSTRUMENT DEPARTMENT

GENERAL  ELECTRIC

CIRCLE 199 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

Brushless DC Fan

499



Moves 100 cfm at free delivery. Model 3201 brushless dc motor-fan, rated for 28-v operation, measures 1-3/4 in. deep by 4-11/16 in. sq. A variety of speeds, directly proportional to inputs of 20 to 40 v dc, are possible. Frame and impeller are of aluminum.

Astro Dynamics, Inc., Dept. ED, Northwest Industrial Park, Burlington, Mass.

Beryllia Oxide

606

Ceramic-to-metal seals of beryllia oxide are inorganic and have the characteristic pure oxide properties of high resistivity and low dielectric loss at elevated temperatures. Vacuum tightness has been tested with a mass spectrometer to 2×10^{-10} cc/sec of helium.

Electronic Materials Corp., Dept. ED, 131 Lexington St., Waltham 54, Mass.

Aluminum Oxide

550

Purity is 99.8%. Aluminum oxide can be furnished in particle sizes ranging from 0.3 to 0.7 microns. This high-density powder is suitable for applications such as ceramics, insulators and high-temperature coatings.

Republic Foil, Inc., Dept. ED, 55 Triangle St., Danbury, Conn.

Availability: in samples.

Connector Kit

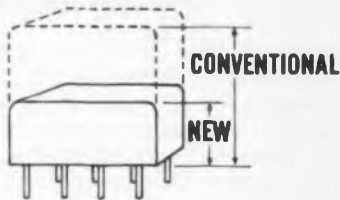
622



A designer's kit that provides wide flexibility in the use of ribbon cable includes everything needed to fabricate special cable assemblies. The Tape-Term connectors are for use in terminating or connecting ribbon cable to almost any type of electrical connection, including wire type connectors.

Digital Sensors, Inc., Dept. ED, 6443 N. Figueroa St., Los Angeles 42, Calif.

NEW LEACH HALF-SIZE CRYSTAL CAN RELAY



REVOLUTIONIZES PRINTED CIRCUIT PACKAGING

It's only .400 inches high. Weighs only .250 ounces. New Leach M-250 is so tiny it uses less than half the space needed by standard subminiature crystal can relays!

Space is saved on printed circuit boards because three M-250s will replace one ordinary, horizontally-mounted crystal can relay. And with its 0.2-inch terminal spacing and internal terminal connections, it is interchangeable with conventional crystal can relays.

Simplified design, mechanized production with minimum human contact, rotary balanced armature design and small space requirement—four reasons why you should specify Leach Half-Size Crystal Can Relays for your printed circuits (and that's just half the story!)

Available now:

Contact Ratings Low level to 2 amps.

Normal Coil Operating Voltages 6 to 26.5 VDC

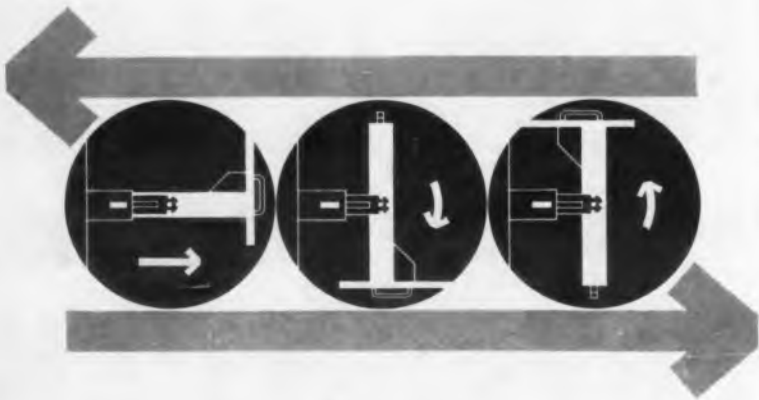
Meets or exceeds all requirements of Mil-R-5757D.

Get the whole story. Write for complete technical specifications and application information.

LEACH CORPORATION

18435 SUSANA ROAD, COMPTON, CALIFORNIA
EXPORT: Leach International, S. A.

CIRCLE 200 ON READER-SERVICE CARD



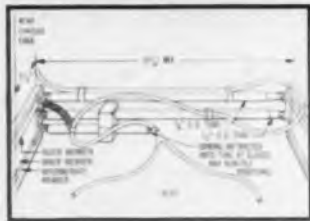
The Ins and Outs of System Packaging

Development of the common cabinet drawer was as important a contribution to **storage** as the wheel to mobility. Use of ball-bearings appreciably improves the action of both. Advanced drawer design has been applied by Jonathan to electronic chassis storage in the form of close tolerance, extruded aluminum ball-bearing slides for precision packaging. Now chassis are instantly accessible for maintenance and replacement. Gear of any weight may be accommodated without restriction of length and travel, and with tilting and locking features.

First Precision-Designed **Cable Carrier**

The new Power Track Cable Carrier facilitates servicing rack mounted electronic chassis without disconnecting the power source. It is the first cable carrier with uniform telescopic action in the carrier and the slides. Telescopic supporting arms are mounted to opposing sides of 3-member Jonathan Thinline telescoping chassis slides, forming a carrier along which the cable is supported. This transfers cable weight to the strong, smooth-running arms and ball-bearing slides, effectively preventing damaging vibration and shock.

The telescoping action allows full drawer extension and 90° tilting up and down. Since the cables are unable to sag or bind, there is no longer risk to other stored electronic chassis. Cable is compactly stored in minimum depth. The carrier system meets all applicable military standards.



Write for new 16 page descriptive brochure.

JONATHAN
MANUFACTURING COMPANY



720 East Walnut Avenue
Fullerton, California

Eastern District Offices
1209 Teaneck Road
Teaneck, New Jersey

CIRCLE 201 ON READER-SERVICE CARD

NEW PRODUCTS

Potentiometer Recorder

627



Self-balancing potentiometer recorder, the Recordette-4 measures 6-3/4 x 8-1/2 x 10 in. Specifications include: accuracy, 1/2%; full scale balancing time, 3/4 sec; maximum permissible source resistance, 50 K; chart width, 4 in.; chart speeds, 1/4 in. per hr to 12 in. per min. Input circuit is floating with separate chassis ground.

Instrument Corp. of America, Dept. ED, 516 Glenwood Ave., Baltimore 12, Md.

P&A: \$380; one month.

Receptacle Jack

637

For printed circuit or wiring applications that incorporate test points at various circuitry positions. The SKT-111PC jack is only 0.381 in. in height before spin-over of mounting stud. It accepts a standard 0.080 in. D probe x 0.250 in. L maximum. Overall diameter of the Teflon body is 0.218 in.

Sealectro Corp., Dept. ED, 139 Hoyt St., Mamaroneck, L.I., N. Y.

DC Recording Amplifiers

607

Frequency response is dc to 5 kc ± 1 db for the amplifier RA-1665 that consists of an input chopper-modulator, stabilized band-pass amplifier and an output chopper demodulator. Sensitivity is ± 20 mv for ± 0.45 ma to the record head. A RA-1666 chopper oscillator supplies the high-frequency square wave signals for up to 13 amplifiers.

Wextrex Recording Equipment, Dept. ED, 335 N. Maple Drive, Beverly Hills, Calif.

Receiving System

621



Six-channel vlf receiving system covers the 10 to 30 kc frequency range. Sensitivity is better than 1 μ v per meter for 0 db signal to

NEED AC-OPERATED MILITARY RELAYS?



For reliable switching ... try "Diamond H" Series RA and SA relays with a-c coils

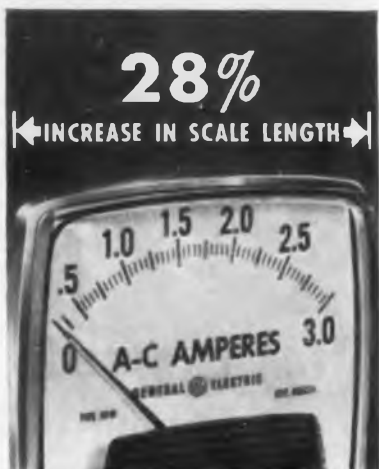
These relays for 400 cps and 60 cps operation are identical in size and weight to Hart's widely specified Series R and S d-c relays and meet the same specifications*. They provide the same shock resistance (to 50G), the same vibration resistance (to 20G-2000 cps), and the same performance under temperatures ranging from -65°C to $+125^{\circ}\text{C}$. Contact ratings from dry circuit to 10 amps, 115 volts a-c resistive and 30 volts d-c resistive.

The "Diamond H" line includes hundreds of standard models and special variations are possible. Ask for literature and specification list.

*Like the R and S series, they meet the requirements of MIL-R-5757C. Models are also available to fill the requirements of MIL-I-6181.



THE
HART
MANUFACTURING COMPANY
210 Bartholomew Avenue
Hartford 2, Conn.
Phone Jackson 5-3491



UP TO 28 PERCENT increase in scale length improves meter readability.

BIG LOOK panel meters

DESIGNED FOR AT-A-GLANCE READABILITY

In designing the BIG LOOK panel meter, engineers placed particular emphasis on achieving an important balance between distinctive appearance and excellent readability.

This balance of aesthetic and functional design values makes BIG LOOK panel meters *easier to read*, relieves eye tension and stress—and reduces reading error.

Accurate, at-a-glance readability is a prime requisite for panel meters. To achieve it, G-E first eliminated the problem of shadows by designing a cover to admit light from top, sides and bottom. The color area of the window completely hides the distraction of the moving internal mechanism. This gives you exactly what you want . . . a clear uncluttered view of the scale and an accurate reading.

For the complete AC-DC BIG LOOK story just contact your nearby G-E Apparatus Sales Office or distributor; or write for bulletin GEA-7034 direct to General Electric Company, Section 597-05, Schenectady 5, New York.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

CIRCLE 203 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

noise ratio in 100 cps if noise bandwidth. All circuits are solid-state, each channel is fixed-tuned with plug-in filters. Channel filters may be changed by replacing the plug-in rf filter and changing the local oscillator frequency.

Develco, Inc., Dept. ED, 440 Pepper St., Palo Alto, Calif.

P&A: six channel system, without local oscillator synthesizer, \$3,600; stock to 60 days.

Magnetic Amplifier

498



Proportional-power magnetic amplifier type 300 SRMA D 73312 is designed for precise control applications. A linear change in the system input produces a percentage change in process power. It operates from a 110 v, single-phase, 60-cps line with a 0 to 5 ma input; the output is 0 to 85 v dc.

Hevi-Duty Electric Co., Dept. ED, 304 Hart St., Watertown, Wis.

Phase-Angle Counter

500



Range is 0.005 to 500 cps. Model 1002 phase-angle counter measures instantaneous value of phase angle between two signal voltages. No amplitude adjustment is needed from 2 to 100 v rms. Direct reading in degrees is expressed in four digits with a resolution of 0.1 deg.

Ad-Yu Electronics Laboratory, Inc., Dept. ED, 249-259 Terhune Ave., Passaic, N. J.

Price: \$948.

Accuracy Is Our Policy

The photograph accompanying the description of the model V-46 digital voltmeter manufactured by Cubic Corp., San Diego, Calif., which appeared on p 115 of the Aug. 2 issue of ELECTRONIC DESIGN, shows the S-46 data acquisition system rather than the V-46 voltmeter. The model V-46 digital voltmeter is a smaller unit measuring 19 x 5-1/4 x 14 in. deep.



The CAMBION® Teflon* Line E-X-P-A-N-D-S More Types... More Advantages

Now you have 138 basic types of CAMBION Teflon-insulated terminals to choose from . . . including all the popular sizes and mounts!

Thanks to their excellent electrical stability, environmental endurance and mechanical strength, CAMBION Teflon terminals bring new solutions to old design problems. For example, they can be easily inserted directly into chassis with a positive grip. This cuts production time and costs. Also, these terminals can be readily removed and replaced for design changes. Meeting applicable government specifications they function over broad temperature and humidity ranges and withstand severe shock, vibration and other hazards. Learn how CAMBION Teflon terminals can benefit you. Write Cambridge Thermionic Corporation, 457 Concord Avenue, Cambridge 38, Mass.

*Reg. Dupont T.M.

CAMBRIDGE THERMIONIC CORPORATION
CAMBION®
The guaranteed electronic components



STOCKING DISTRIBUTORS

ALABAMA, Birmingham
MG Electronics and Equipment Co.
203 South 18th St.
(FA 2-0449)

ARIZONA, Phoenix
Midland Specialty Co.
1930 N. 22nd Ave.
(AL 8-8254)

CALIFORNIA, Gardena
Dini Electronic Corp.
305 E. Alexandra Blvd.
(FA 1-5802)

CALIFORNIA, Inglewood
Newark Electronics Co., Inc.
4747 W. Century Blvd.
(OR 8-0441)

CALIFORNIA, Monte Park
Bell Electronic Corp.
1070 O'Brien Drive
(DA 3-9431)

CALIFORNIA, Paramount
Elwyn W. Lay Co.
16514 So. Garfield Ave.
(NE 6-8339)

CALIFORNIA, San Diego
Bell Electronic Corp.
8072 Engineer Rd.

CALIFORNIA, San Jose
Peninsula Electronic Supply
656 So. First St.
(CY 4-8781)

COLORADO, Denver
Ward Terry & Co.
90 Rio Grande Blvd.
(AM 6-3181)

CONNECTICUT, Danbury
North East Electronics Dist., Inc.
48 Main St.

DISTRICT OF COLUMBIA,
Washington
Electronic Wholesalers, Inc.
2345 Sherman Ave., N. W.
(NU 3-5200)

FLORIDA, Melbourne
Electronic Wholesalers, Inc.
1301 Hibiscus Blvd.
(PA 3-1441)

FLORIDA, Miami
Electronic Wholesalers, Inc.
8390 N. W. 27th Ave.
*OX 6-1626

GEORGIA, Atlanta
Specialty Distributing Co., Inc.
763 Juniper St., N. E.
(TR 3-2521)

ILLINOIS, Chicago
Allied Radio Corp.
111 No. Campbell
(NA 1-6800)

INDIANA, Indianapolis
Newark Electronics Corp.
223 W. Madison St.
(ST 2-2944)

INDIANA, Indianapolis
Graham Electronics Supply, Inc.
122 S. Senate St.
(ME 4-8406)

INDIANA, Indianapolis
Radio Distributing Co.
814 N. Senate Ave.
(NE 7-5571)

MARYLAND, Baltimore
Kann-Elert Electronics, Inc.
2050 Rock Rose Ave.
(TU 9-4242)

MASSACHUSETTS, Boston
DeMambo Radio Supply Co., Inc.
1095 Commonwealth Ave.
(AL 4-9000)

MICHIGAN, Detroit
Ferguson Electronics, Inc.
2306 Puritan St.
(UN 1-8700)

MINNESOTA, Minneapolis
Northwest Electronics Corp.
52 South 12th St.
(FE 8-7551)

MISSOURI, St. Louis
Ferguson Electronics, Inc.
2501-D3 So. Jefferson
(PR 1-2900)

NEW JERSEY, Camden
General Radio Supply Co., Inc.
600 Penn St.
(WO 4-8560)

NEW JERSEY, Mountainside
Federated Purchaser, Inc.
1021 U. St. 22
(ND 2-8200)

NEW MEXICO, Alamogordo
Radio Specialties Co., Inc.
209 Penn Ave.
(NE 7-8370)

NEW YORK, Bellmore, L. I.
Car-Lac Electronic Industrial
Sales, Inc.
2357 Bedford Ave.
(CA 1-1441)

NEW YORK, Binghamton
Stock Industrial
Electronics, Inc.
45 Washington St.
(BA 3-6326)

NEW YORK, Buffalo
Standard Electronics, Inc.
1487 Main St.
(TT 3-5000)

NEW YORK, Jamaica
Lafayette Radio Corp.
165-58 Liberty Ave.
(AN 3-7000)

NEW YORK, New York
Electronics Center, Inc.
160 Fifth Ave.
(AL 5-4600)

NEW YORK, New York
Terminal-Hudson
Electronics, Inc.
236 W. 17th St.
(CH 3-5200)

NORTH CAROLINA,
Winston-Salem
Dalton Wago, Inc.
930 Burke St.
(PA 5-8711)

OHIO, Akron
The Sun Radio Co.
310 E. Market St.
(NE 4-2171)

OHIO, Cincinnati
United Radio, Inc.
1314 Vins St.
(CH 1-6530)

OHIO, Cleveland
Pioneer Electronic Supply Co.
5403 Prospect Ave.
(432-0010)

OHIO, Columbus
Hughes Peters, Inc.
481 East 11th Ave.
(AX 4-5351)

OHIO, Dayton
The John A. Becker Co.
14 Brown St.
(BA 4-1071)

OKLAHOMA, Tulsa
Engineering Supply Co.
1124 E. Fourth St.
(LU 3-8121)

PENNA., Philadelphia
Philadelphia Electronics, Inc.
1225 Vine St.
(LO 8-7444)

PENNA., Pittsburgh
Cameradio Co.
1221 Penn Ave.
(EX 1-4000)

TENNESSEE, Knoxville
Chemistry Radio & Electric Co.
P. O. Box 5076
2211 Dutch Valley Rd.
(NU 7-3530)

TENNESSEE, Nashville
Electric Distributing Co.
1914 West End Ave.
(AL 5-8444)

TEXAS, Dallas
Engineering Supply Co.
6000 Denton Drive
(FA 7-4121)

TEXAS, El Paso
Midland Specialty Co.
500 W. Paisano Dr.
(NE 3-9555)

TEXAS, Houston
Busacher Electronic
Equip. Co., Inc.
1216 West Clay St.
(JA 6-4661)

UTAH, Salt Lake City
S. R. Ross, Inc.
1212 So. State St.
(DA 8-0591)

WASHINGTON, Seattle
Pacific Electronic Sales Co.
1209 First St.
(NU 2-5390)

CANADA

ONTARIO, Toronto
Electro-Sonic Supply Co., Ltd.
543 Yeans St.
(WA 4-9301)

QUEBEC, Montreal
Canadian Electrical
Supply Co., Ltd.
275 Craie St.
(UN 1-2411)

CIRCLE 204 ON READER-SERVICE CARD

PURITY as high as 99.9975% with 'LINDE' RARE GASES

MONATOMIC
DIATOMIC
RADIOACTIVE
SPECIAL MIXTURES
COMBINATIONS

All LINDE atmospheric gases are produced under continuous Mass Spectrometer Control—insuring *highest possible purity.*

Huge production facilities and a widespread distribution system make it possible for LINDE to supply large quantities of these gases and mixtures throughout the country—in bulbs or in cylinders of various sizes. These unique capabilities are the result of 50 years of pioneering research and development work in rare gases and their behavior.

LINDE gases serve the electronics industry in a wide range of uses, such as electron tubes including thyratrons, Geiger-Muller, and high-voltage regulator tubes; x-ray fluorescence analyzers, electric displays, and insulation for high-voltage terminals; standard and miniature incandescent lamps and high-speed photographic lamps. Many *new* uses are constantly being developed.

For complete data on gases, write for a copy of F-1002C, "Linde High Purity Gases." Address Dept. ED-094, Linde Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited, Toronto 7.

LINDE
COMPANY

UNION
CARBIDE

LINDE and UNION CARBIDE are registered trade marks.

CIRCLE 205 ON READER-SERVICE CARD

NEW PRODUCTS

Semiconductor Bases

693



Brazed base assemblies for semiconductors come with virtually all brazing and plating operations completed. Pre-assembly includes the joining of such parts as glass-sealed pin terminals, weld ring, base plate and threaded copper heat sink. Molybdenum or silver-tungsten pedestals with suitable coating are also available.

Standard Pressed Steel Co., Dept. ED, Jenkintown, Pa.

Conductive Adhesive

558

For increased versatility, CONAP 1225 conductive epoxy comes with three hardeners: one for curing at room temperature, one to provide long pot life, and one for operation at elevated temperatures. When cured, CONAP 1225 yields a volume resistivity of 0.01 ohm-cm at 25 C.

CONAP, Inc., Dept. ED, 184 E. Union St., Allegheny, N. Y.

P&A: \$15 for 1-lb kit and hardener.

Voltage References

605

Stability range is ± 0.01 to $\pm 0.002\%$ for a series of 6.3 v voltage references. Each device is certified as to its stability after 1,000 hr of operation. Each certified reference is sold with a complete history of readings taken on the device during the 1,000 hr operation period.

Transitron Electronic Corp., Dept. ED, 168 Albion St., Wakefield, Mass.

Linear Pulse Amplifier

645



200,000 random pulses per sec can be amplified by the linear pulse amplifier model 15-A-002. Regular pulse train to 1 mc can also be amplified. Voltage gain is 300 min and frequency response is 0.5 to 5 mc. Paired pulse

TELEMETRY BY TELE-DYNAMICS

1 and 2-watt

Transistorized FM Transmitters



If you've a need for light—17 ounces—extremely compact—20 cu. in.—215 to 260 telemetry transmitters, specify Tele-Dynamic's Type 1053A and Type 1055A.

Providing one- or two-watt true FM output respectively, they employ dependable silicon transistors for high efficiency and offer better than 0.01% frequency stability. Type 1055A uses germanium transistors in the output stage. Each will operate reliably at any altitude and under any environment. Pressurized aluminum cases seal out the effects of altitude, humidity, salt spray, sand and dust.

These units, representative of Tele-Dynamic's latest creative effort in the complete telemetry field, are capable of being combined into various custom systems and are low in cost.

For detailed technical bulletins, call the American Bosch Arma marketing offices in Washington, Dayton or Los Angeles. Or write or call Tele-Dynamics Division, American Bosch Arma Corporation, 5000 Parkside Avenue, Philadelphia 31, Pa. Telephone TRinity 8-3000.

0612

TELE-DYNAMICS

DIVISION

**AMERICAN BOSCH ARMA
CORPORATION**

5000 Parkside Ave., Philadelphia 31, Pa.

CIRCLE 206 ON READER-SERVICE CARD

GE ELECTRONICS



FULL LINEAR SCALE for a-c measurements

BIG LOOK panel meters **NOW INCLUDE RELIABLE, NEW RECTIFIER TYPES**

New General Electric rectifier-type BIG LOOK panel meters feature the high sensitivity of permanent-magnet moving-coil mechanisms for a-c measurements. Linear relation of current to deflection results in even-scale distribution, improves readability . . . even at low end of the scale. Other advantages: self-shielding eliminates special calibrations; sensitivities of 1000 ohms per volt or more; operation possible at frequencies up to 10 kilocycles with little additional error; performs a-c measurements with minimum power consumption.

Available in a complete range of ratings, rectifier voltmeters and ammeters include every BIG LOOK advantage—distinctive appearance, excellent readability, reliable operation, low cost and fast delivery. For the full AC-DC BIG LOOK story, contact your nearby G-E salesman or distributor; or write direct to General Electric Co., Section 597-12, Schenectady 5, N. Y.

INSTRUMENT DEPARTMENT

GENERAL  ELECTRIC

CIRCLE 207 ON READER-SERVICE CARD
ELECTRONIC DESIGN • September 27, 1961

resolution is 1 μ sec with minimum output pulse width of 300 nsec. Both input and output impedance is 1 K for pulses.

Franklin Systems, Inc., Dept. ED, 2734 Hillsboro Road, West Palm Beach, Fla.

Price: from \$100 to \$150.

Expanded-Scale Voltmeters 487



In ac and dc types, the expanded-scale voltmeters can be used in applications such as recording line, bus and feeder voltage on power systems, motor overload studies and checking computer circuits. A permanent-magnet moving coil measuring system is used.

Esterline Angus Instrument Co., Inc., Dept. ED, P. O. Box 596, Indianapolis 6, Ind.

P&A: \$490; stock.

Shielded-Grid Triode 483



Air-cooled shielded grid triode type 6544, rated at megawatt, is for use in radar-pulse modulators. It features a beamed oxide coated cathode structure, a squirrel-cage control grid and a shield grid internally connected to the cathode. It is 10 in. high and 5-1/4 in. in diameter.

Nuclear Corp. of America, Central Electronic Manufacturer's Div., Dept. ED, 2 Richwood Place, Denville, N. J.

Receiving Tubes 602

All-glass base novar receiving tubes have a maximum piv of 5,500 v. Maximum dc plate current is 180 ma. Maximum peak plate current rating is 1,100 ma. Tube types 6BC3, 17BH3 and 22BH3 are half-wave vacuum rectifier tubes for use as damper diodes in horizontal deflection circuits of TV receivers.

Radio Corp. of America, Dept. ED, 30 Rockefeller Plaza, New York 20, N. Y.

now



STYLE 1001
SPDT



STYLE 1005
SPDT

MIDGET RELAYS for AC or DC Operation

Price Electric Series 1000 Relays Now Feature . . .

- AC or DC Operation
- Solder or Printed Circuit Terminals
- Open or Hermetically Sealed Styles

These versatile, midget, general-purpose relays, formerly available only for DC operation, are now being offered for operation directly on AC. The AC relays, of course, have the same basic features, including small size, light weight, and low cost that made the DC relays pace setters in their fields of application.

Typical Applications

Remote TV tuning, control circuits for commercial appliances, radiosonde, auto headlight dimming, etc.

General Characteristics

Standard Operating Voltages:

3 to 32 VDC; 6 to 120 VAC 60 Cycle.

Maximum Coil Resistance: 13,000 ohms

Sensitivity:

0.05 watt at standard contact rating; 0.3 watt at maximum contact rating for DC relays; 1.2 volt-amperes for AC relays.

Contact Combination: SPDT

Contact Ratings:

Standard 1 amp.; optional ratings, with special construction, to 3 amps. Ratings apply to resistive loads to 26.5 VDC or 115 VAC.

Mechanical Life Expectancy:

10,000,000 operations, minimum

Dielectric Strength: 500 VRMS, minimum

PRICE ELECTRIC CORPORATION

302 Church Street • Frederick, Maryland
MONument 3-5141 • TWX: Fred 565-U

CIRCLE 208 ON READER-SERVICE CARD

Replace bulky
expensive lab type units
with ERA's

TRANSPAC®

Miniaturized
HIGH CURRENT
power packs



Why pay for outputs and bulky cumbersome equipment you don't use. SPECIFY Transpac High Current Power Packs to replace battery sources for incorporation into equipment as well as for laboratory test purposes. Miniaturized Transpacs supply a rugged, reliable source of DC power for all types of electronic devices.

- New High Current Solid State Designs
- Battery Voltage Outputs
- Closely Regulated
- Low Ripple Content... less than 2 mv
- Short Circuit Proof... Automatic Recovery

SPECIFICATIONS

Input 105-125, 60-400 cps. Line or load regulation better than 0.05% or 5 millivolts. Models listed are specified for operating temperatures up to 55°C. but may be derated for extended temperatures.

4 AMPERE SERIES Current Output 0-4 Amps		
Model	Output (V)	Net Price*
TR64R**	6	\$255.00
TR124R**	12	255.00
TR184R	18	260.00
TR244R	24	260.00
TR284R	28	265.00
TR324R	32	265.00

Case Sizes: **5 3/4" H x 7 1/4" D x 5 3/4" W
6 1/2" H x 7 1/2" D x 6 1/4" W

8 AMPERE SERIES Current Output 0-8 Amps		
Model	Output (V)	Net Price*
TR68R**	6	\$325.00
TR128R**	12	325.00
TR188R	18	335.00
TR248R	24	335.00
TR288R	28	345.00
TR328R	32	345.00

Case Sizes: **6 1/2" H x 8 1/4" D x 7 3/4" W
6 1/2" H x 7 1/2" D x 10 1/2" W

1 AND 2 AMPERE SERIES

Available in all standard outputs

* F.O.B. Cedar Grove, N. J. ® Reg. U. S. Pat. Off.

Write for complete Technical Specifications

ELECTRONIC RESEARCH ASSOCIATES, INC.
Laboratories & Factory: 67 Factory Place,
Cedar Grove, New Jersey - CEnter 9-3000

CIRCLE 209 ON READER-SERVICE CARD

NEW PRODUCTS

Terminal Swaging Tools

501



Self-aligning swaging tools hold the two mating dies that secure the terminal to the board. Designed for field or production use, it is furnished in two models: ST-300 and ST-600 with 3- and 6-in. throats. In production, they can be secured to the bed of a hand or air-operated arbor press developing 500 psi.

Pacific Coast Electronics Corp., Dept. ED, 2457 Chico Blvd., South El Monte, Calif.

Electronic Counter

615

Impulse counting device, designated 8001 universal counter, provides a pre-settable, count-controlled output impulse on each tenth input pulse. The count can be changed to a nine, eight, etc., down to a two or one-count. Modular units can be coupled directly in tandem for number or word structure. Frequency is 10-30,000 cps.

Vector Manufacturing Co., Inc., Commercial and Industrial Div., Dept. ED, Southampton, Pa.

Mylar Film Punch

655



Hole diameters from 0.016 to 0.125 in. are possible with the mylar film punch MP-100. Unit is solenoid actuated (60 cps, 110 v) by a foot-operated switch. Standard punch and dies are available with 0.016, 0.021, 0.028, 0.035, 0.040, 0.062 and 0.125 in. diameters. Punches are ground, hardened steel. Unit has a built-in base light.

Wems, Inc., Dept. ED, 4807 W. 118th Pl., Hawthorne, Calif.

P&A: \$390; from stock.

REGULATED HIGH VOLTAGE POWER SUPPLIES



TRANSISTORIZED SERIES TRHV

1 KV DC-5 MA To 20 KV DC-1 MA
INPUT: 115V-60 cycles

FEATURES

- All solid state
- Fast response time
- Excellent line and load regulation
- Small size, light weight
- Excellent thermal and time stability
- Sealed construction

MODEL NO.	OUTPUT	SIZE
1RS-1	1 KV-5 MA	4 1/4" x 3 3/4" x 5 1/2"
2SR4-1	2.5 KV-4 MA	4 1/4" x 3 3/4" x 5 1/2"
5R2-1	5 KV-2 MA	4 1/4" x 3 3/4" x 5 1/2"
7.5R1-5-1	7.5 KV-1.5 MA	4 3/4" x 4" x 6"
10R1-1	10 KV-1 MA	4 3/4" x 4" x 6"
10R2-1	10 KV-2 MA	6 1/4" x 4 1/4" x 7 1/2"
15R1-5-1	15 KV-1.5 MA	6 3/4" x 4 1/4" x 7 1/2"
20R1-1	20 KV-1 MA	6 3/4" x 4 1/4" x 7 1/2"

For additional information write to Dept. ED



DEL ELECTRONICS CORPORATION
521 HOMESTEAD AVE. • MOUNT VERNON, N. Y.

OWENS 9-2000

Choice sales territories for Mig. Reps. available.

CIRCLE 210 ON READER-SERVICE CARD

NEW solder discovery!



Two outgassed solders.

Left, standard solder. (Note degree of oxides present.) Right, ALPHA Vaculoy solder is bright, clean, oxide free!

ALPHA Vaculoy® bar solder cuts printed circuit joint rejects from 1-in-50 to 1-in-5,000. No other solder does this because no other is made this way!

Above is an unretouched photograph of two solder specimens—both outgassed. Left, is a standard printed circuit solder. Note presence of impurities on surface—a sure sign of undesirable oxides. Right, is ALPHA Vaculoy.® Its bright, clear surface indicates freedom from oxide-forming elements. Result? ALPHA Vaculoy bar solder cuts dross, improves wetting, produces brighter connections, increases bath life, reduces inherent inclusions and insures reliable electrical connections. Meets Fed. Specs. QQS-571C. Get all the facts. Write for data today!

*Formerly called "ALPHA AAA"

When dependability counts!

alpha metals, inc.

58A Water St., Jersey City 4, N. J.

In Los Angeles, Calif.: 2343 Saybrook Ave.

In Chicago, Ill.: ALPHALLOY Corp., 2250 S. Lumber St.

Other ALPHA products: Fluxes • Solder Preforms • High Purity Metals

CIRCLE 211 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

General Control Push Button Switches



STANDARD MPB SWITCH



RIGHT-ANGLE MPB SWITCH



MPB GROUP — INTERCOUPLED

• First of their type; and still the leader.

• A flexible, streamlined, thoroughly practical approach to circuit switching is available in this newly re-designed long-life Push Button Switch.

• Operating combinations: Accumulative Lock; No Two Interlock; Lock Release; and Non-Lock. Both 1 and 5 ampere types available. From 2 to 12 positions.

• Right-Angle Type saves behind-panel space.

• Stacked and Intercoupled they provide single-switch operation of 2 or 3 switch banks.

• Specials also available
• Write for Bulletin PB-300

FOOT LEVER PUSH BUTTON and LIMIT SWITCHES
ELECTRONIC and SYNCHRONOUS-MOTOR TIMERS

GENERAL CONTROL COMPANY

1207 Soldiers Field Road • Boston 24, Massachusetts

CIRCLE 212 ON READER-SERVICE CARD

EICO

PUTS THE BEST IN
CREATIVE ELECTRONICS
INTO YOUR HANDS



Send for
FREE
Catalog

28
PAGES OF
PROFESSIONAL
ELECTRONIC
EQUIPMENT
IN KIT AND WIRED
FORM — FOR LAB
LINE... HOME

EICO, 3300 N Blvd., L.I.C. 1, N.Y. ED-9
 Send free 32-page catalog & dealer's name.
 Send new 36-page Guidebook to NI-PI for which I enclose 25¢ for postage & handling.

Name _____
Address _____
City _____ Zone _____ State _____

EICO

3300 Northern Boulevard, Long Island City 1, New York
Export Dept., Roburn Agencies Inc., 431 Greenwich St., New York 13, N.Y.

CIRCLE 213 ON READER-SERVICE CARD

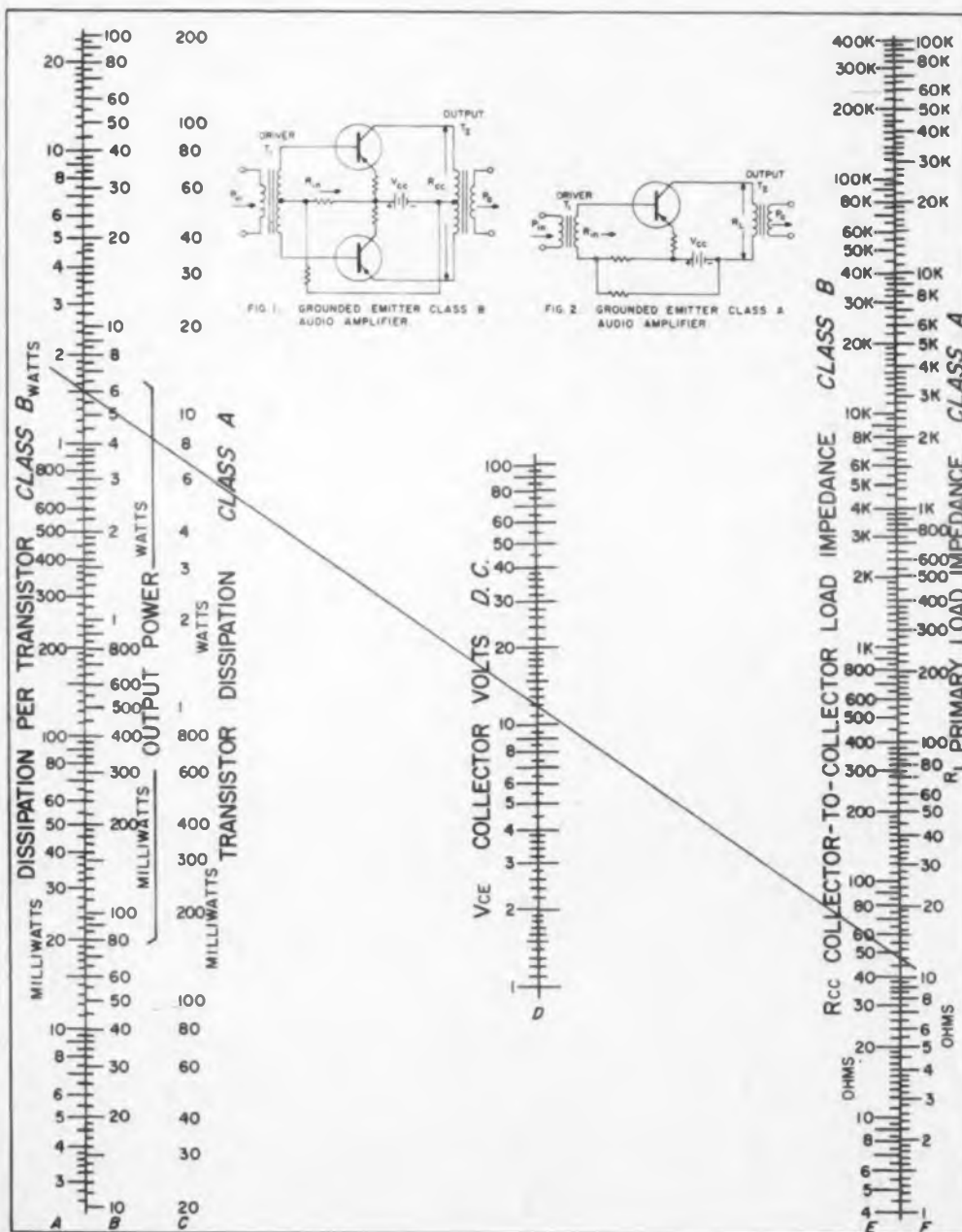
ELECTRONIC DESIGN • September 27, 1961

DESIGN

ENGINEERING DATA

Transistor Load Impedance And Dissipation Nomogram

Albert J. Eisenberg
Microtran Co., Inc.
Valley Stream, N. Y.



(Text on following page)

Transistor Load Impedance and Dissipation Nomogram

(Nomogram on preceding page)

CALCULATIONS involved in the design of class A and B audio and servo amplifiers can be tedious and time-consuming. With the nomogram presented, the primary and secondary impedance of driver and output transformers can be quickly found. Transistor dissipation and driving power can also be read from the nomogram.

Typical Examples Illustrating Use of the Nomogram

Problem 1: To determine required primary impedance of output transformer T_2 and transistor dissipation, see Fig. 1.

Given: $V_{CE} = 12 \text{ v} \approx V_{cc}$ (power supply voltage)

$P_o = 5 \text{ w}$ to speaker load

Solution: Assume transformer efficiency of 80 per cent. Then the transistor output power required = $5/0.8 = 6 \text{ w}$.

- A) Using nomogram, draw a straight line from output power of 6 w on scale B through collector volts, V_{ce} of 12 on scale D. Extend line and read primary impedance R_{cc} of 48 ohms C. T. for class B operation on scale E, or R_L of 12 ohms for class A on scale F.
- B) Read transistor dissipation of 1.5 w each for class B operation on scale A, or 12 w for class A on scale C. Verify that transistor power dissipation ratings are not exceeded.

Problem 2: To determine primary and secondary impedances of driver transformer (T_1) to match transistor input impedance (R_{in}). Also determine the required driving power (P_{in}).

Use the following equations:

For class B output stage (Fig. 1)

$$R_{in} \approx 4 h_{ie}$$

$$P_{in} \approx \frac{4 h_{ie} PO_{pp}}{(h_{fe})^2 R_{cc}}$$

For class A output stage (Fig. 2)

$$R_{in} \approx h_{ie}$$

$$P_{in} \approx \frac{h_{ie} PO_A}{(h_{fe})^2 R_L}$$

Given: Assume 2N656A's or 2N1481's in class B output stage of Fig. 1. Transistor output power $PO_{pp} = 6 \text{ w}$. $V_{CE} = 12 \text{ v}$. Primary impedance R_{cc} of $T_2 = 48 \text{ ohms C.T.}$

Solution: A) Transistor handbook ratings for 2N656A are: $h_{fe} \approx 40$ and $h_{ie} \approx 200$.
B) $R_{in} \approx 4h_{ie} = 4 \times 200 = 800 \text{ ohms C.T. secondary impedance of } T_1$.

$$\begin{aligned} \text{C) } P_{in} &\approx \frac{4h_{ie} PO_{pp}}{(h_{fe})^2 R_{cc}} \\ &= \frac{4 \times 200 \times 6}{(40)^2 \times 48} = 62.5 \text{ mw.} \end{aligned}$$

Allowing for typical transformer efficiency of 75 per cent, input power to T_1 should be $62.5/0.75 = 83.3 \text{ mw}$.

D) Use nomogram to determine primary impedance of driver transformer T_1 by drawing line from 83.3 mw on scale B through 12 v dc on scale D. Read class A primary impedance of 850 ohms on scale F.

Reference Information

Class A Formulas

$$\text{Transistor power output, } PO_A = \frac{V_{CE}}{2R_L}$$

$$\text{Power gain, } G_{eA} \approx \frac{(h_{fe})^2 R_L}{h_{ie}}$$

$$\text{Power in, } P_{in} = \frac{PO_A}{G_{eA}} = \frac{h_{ie} PO_A}{(h_{fe})^2 R_L}$$

(Assumes > 10 mw power level)

Class B Formulas

$$\text{Transistor power output } PO_{pp} = \frac{V_{CE}}{2R_L}$$

$$\text{Power gain } G_{eB} \approx \frac{(h_{fe})^2 R_{cc}}{4h_{ie}}$$

$$\text{Power in, } P_{in} = \frac{PO_{pp}}{G_{eB}} \approx \frac{4h_{ie} PO_{pp}}{(h_{fe})^2 R_{cc}}$$

(Assumes > 50 mw power level)

References

Motorola 1960 Power Transistor Handbook, pp 64-81.
G.E. Transistor Manual 5th edition, pp 44-47.

BROADBAND POWER DENSITY METER Model NF-157

For fast, accurate determination of RF power density and location of areas presenting RF hazards to personnel



Description: A broadband device providing direct reading of RF power densities from 1 mw/cm² to 1000 mw/cm² (mid-scale readings), over the continuous frequency range from 200 to 10,000 MC.

Features:

- Direct reading of power density insures immediate awareness of hazardous areas.
- Broad frequency range and high accuracy permit universal application to mapping of high level RF fields from VHF to X-Band.
- Accurate built-in step attenuator provides capability of handling power densities over a dynamic range of 10,000 to 1.
- Three constant-gain calibrated probes permit direct reading in mw/cm² over the continuous frequency range from 200 to 10,000 MC.
- Physical separation of probes from main unit vastly increases flexibility of applications.
- Battery-powered, light-weight design permits complete portability.
- Convenient carrying case simplifies transportation of instrument.
- Efficient shielding prevents stray RF pick-up.
- Conservative design insures resistance to over-load.
- Main unit may be used independently as an accurate, rugged RF power meter over a wide power range.



Send for our Catalog No. 614

**EMPIRE DEVICES
PRODUCTS CORPORATION**

AMSTERDAM, N. Y.

Victor 2-8400

MANUFACTURERS OF FIELD INTENSITY METERS
DISTORTION ANALYZERS • IMPULSE GENERATORS
COAXIAL ATTENUATORS • CRYSTAL MIXERS

CIRCLE 214 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961





VA-800C - 2.16 to 2.40 kMc - 10 kW CW

HOW THE WORD GETS AROUND... Problem: Build a 4,000-mile military communications network for 15 NATO countries. Bounce microwave messages off the troposphere, hurdle mountain ranges, reach over the curvature of the earth to span a continent from the Arctic Circle to Turkey. Tall order! But NATO is doing it, with Project Ace High: an international forward-scatter communications system.

The first link in Ace High, a four-station system called Hot Line, was installed in Norway in 1958. Varian's VA-800C amplifier klystrons are the heart of the system. Tube life to date is averaging over 5,000 hours. What's more, the average improves every day; two-thirds of the tubes are still operational. In fact, two tubes are over 13,000 hours.

Do you require such exemplary tube performance? Technical data? Just write Tube Division.

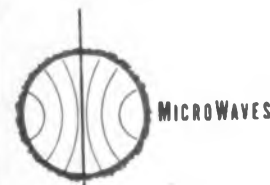


VARIAN associates

PALO ALTO 21, CALIFORNIA

BOMAC LABORATORIES, INC.
VARIAN ASSOCIATES OF CANADA, LTD.
S-F-D LABORATORIES, INC.
SEMICON ASSOCIATES, INC.
SEMICON OF CALIFORNIA, INC.
VARIAN A.G. (SWITZERLAND)

CIRCLE 215 ON READER-SERVICE CARD



MICROWAVES

The (Strip) Line Forms on the Right

The venerable strip transmission line has been with us long enough for development of the necessary applications know-how. Much of this knowledge is distilled into the article by Jesse Taub beginning on p 182 of this issue. With the technique's novelty largely worn off, the time has come for intelligent applications.

The same is true of parametric frequency generators, slated for increased use in microwave systems as described in the article on the opposite page.

The transition from laboratory to practical hardware involves a certain time lag. Here are two instances where the process is more or less completed. So step right up and take advantage of these useful, proved techniques in the design of your own equipment.

Efficient circuits and increased power capabilities underlie the current emphasis on solid-state microwave generators reported in

Systems Applications Due for Parametric Frequency Multipliers . . . p 179

The many strip transmission lines now on the market and their best use in microwave design are described in

When to Use Strip Transmission Line p 182

A time-saving design tool is presented in

Cavity Nomogram Speeds Design of Symmetrical Band Pass Filters . p 188

Millimeter-wave Fresnel-zone-plate antennas, a line of polyrod antennas, a receiver for precision attenuation measurements, and a miniature high-speed coaxial switch head the

Microwave Products p 190

Systems Applications Due for Parametric Frequency Multipliers

Manfred Meisels
Technical Editor

A RAPIDLY expanding market is anticipated by manufacturers of parametric frequency multipliers. The emergence of efficient multiplier circuits has opened many microwave-system applications calling for an all-solid-state, stable-frequency source of low to moderate power.

Such uses include:

- Local oscillators
- Transmitter exciters
- Parametric amplifier pumps
- Telemetry transmitters
- Test equipment

Parametric multipliers have found limited but important use in all these areas, and design plans call for their continued application in larger quantities.

NASA, for example, has specified these devices for telemetry transmission in its Surveyor probe and Orbiting Astronomical Observatory. Surveyor will carry a 2-w, 2.2-Gc unit, while a 20-w, 400-mc transmitter will be carried aboard the observatory. Both transmitters are being manufactured by the Hughes Aircraft Co.

Other frequency multipliers slated for use as transmitters, exciters or local oscillators in classified military equipment are being developed by Microwave Associates, Convair-Pomona, Space Technology Laboratories and Micromega.

Commercial applications still are restricted by the relatively high cost of these devices. One instance of commercial interest, however, is evidenced by Canadian Marconi's unsuccessful bid to buy American parametric local oscillators at about \$1,000 per copy for the company's microwave—re-

lay equipment. It is reported that the Canadian firm now plans to manufacture these units itself.

Test-equipment applications, especially on production lines, where a reliable, preset and twiddle-proof frequency source is often needed, are stressed by the apparatus division of Texas Instruments. The company has been marketing a fairly extensive line of such instruments since late 1960. An indication of Texas Instruments' ambitions in this area is its unwillingness to disclose sales figures or future marketing plans.

"There are still only a few outfits really active here, and we don't want to encourage any new entries," a company spokesman declared.

Firms Report Brisk Response To Parametric Multipliers

Other companies are relatively satisfied with their business in parametric frequency multipliers. Micromega, Calif., admits to

having delivered 25 units during the past year and reports that new inquiries are coming at an average of three per week.

Microwave Associates has delivered some 50 units to date and is similarly encouraged by the rate of inquiries.

The key to this recent interest in parametric frequency multipliers has been the development of considerably more efficient circuitry. At frequencies below 1 Gc, conversion efficiencies of up to 90 per cent are said to be possible. At X-band, efficiencies drop off to between 10 and 30 per cent, but performance is nevertheless adequate for many low-power applications.

Microwave Associates is in the midst of an Air Force-sponsored program calling for development of a 9-Gc source delivering 200 mw. This is to be achieved by a tripler circuit driven with a 3-Gc signal, likewise developed by a parametric multiplier chain.

Space Technology Laboratories is reported to have operated a similar 9-Gc unit deliv-



Complete parametric multiplier package developed by Pacific Semiconductors, Inc. and Space Technology Laboratories delivers 2.5 w at 2.25 Gc. From left to right: crystal-controlled 94-mc oscillator and preamp; transistorized amplifier with 13-w output; tripler and two successive doubler stages delivering 4 w at 1.1 Gc; final doubler stage.

**NOW . . . X BAND
NONDEGENERATE
PARAMETRIC AMPLIFIERS**
with a tuning range of 1.1 Gc!



Parametric amplifiers with wide tuning capability for applications at L, S, C, and X-band are now available from Texas Instruments. The X-band nondegenerate model, designed with a TI gallium arsenide diode, gives bandwidths up to 30 mc at 15 db gain over a tuning range of 1.1Gc. Noise figure, including circulator loss and normal second stage is 4.5 db. Broadband signal frequency response and fixed pump frequency provide minimum tuning adjustments and ease of operation.

**TYPICAL MODEL X-22
SERIES SPECIFICATIONS**

Mode of Operation	Nondegenerate
Tuning Range	8.5 to 9.6 Gc
Bandwidth	30 mc
Gain	15 db
Noise Figure (Including circulator loss and normal second stage)	4.5 db
Pump Frequency	24.0 Gc
Diode	Texas Instruments Gallium Arsenide Diode
Pump Power	50 mw

For details on TI's X-band parametric amplifiers, write for Bulletin DLA-1231. For information on specific applications at all frequencies, contact RADAR AND MICROWAVE PRODUCTS DEPARTMENT.



APPARATUS DIVISION
TEXAS INSTRUMENTS
INCORPORATED
4000 LEMMON AVENUE
P. O. BOX 9015 DALLAS 22, TEXAS

CIRCLE 216 ON READER-SERVICE CARD



MICROWAVES

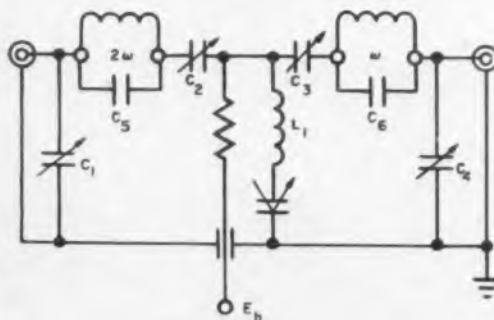
ering 130 mw with 1/2 w input to the final tripler stage. The latter company's work is generally supported by its affiliate—Pacific Semiconductors, Inc. The two companies jointly demonstrated at WESCON a 2.25-Gc telemetry transmitter developing 2.5 w.

There seems to be no clear-cut preference among designers in the use of doublers, triplers or quadruplers. Some believe that quadruplers will have greater efficiency at low frequencies than an equivalent combination of two cascaded doublers. One advantage of using quadruplers and possibly triplers, especially at low frequencies, is the ability to "leap-frog" over the awkward region between 500 and 1,000 mc where both distributed and lumped circuit elements come into play.

Much of the performance attainable by the circuits depends on the choice of varactor. Square-law-response diodes typified by the silicon-alloy junction type are thought by some to be best suited to tripler circuits and to be more efficient generators of the higher harmonics.

Cube-law diodes, typified by the silicon-mesa type, are favored by others as being less temperature-sensitive than the alloy junction diode.

Commonly agreed upon power limits now feasible—at various frequencies range from approximately 5 w at S-band down to 1 w at X-band. These limits assume, however, the use of a single diode per stage. Designers at Micromega and Hughes, however, have explored the paralleling of several varactors per stage. Micromega spokesmen are parti-



High-efficiency frequency doubler with common inductance developed by Pacific Semiconductors, Inc. in its parametric multiplier units. Measured over-all efficiency of this circuit at 125 mc input was 70 per cent.

cularly optimistic about such techniques and claim to be well along in developing procedures for matching and compensating the several diodes in each stage.

In any event, design of parametric multiplier circuits is by no means a stagnating art. David Leeson, of Stanford University and Hughes Aircraft, is among those working to establish a theoretical foundation for the design of multipliers. "At present," he notes, "hardware development has outstripped the theory." A designer at Convair-Pomona comments: "The multiplier circuits that I've seen don't begin to exploit the characteristics of currently available diodes."

A useful contribution in this area may be the charts and nomograms derived by Bliss Diamond of the Lincoln Laboratory that completely predict the performance of multipliers given the pertinent varactor characteristic. Mr. Diamond indicates that the validity of his data was confirmed by the performance of several amplifiers designed according to his charts.

While the interest in parametric multipliers has been heightened by the promise of reasonably high power, some designers believe the real future for these devices lies in the already achieved low-power circuits. This view is exemplified by Thomas Hylton of Texas Instruments, whose company has effectively declared itself out of the watt-power race. "If a customer wants high power, he's better off with a hybrid device with a vacuum tube or twt output stage," Mr. Hylton told ELECTRONIC DESIGN.

"For a klystron local oscillator replacement, an all-solid-stage generator is ideal, but the race for higher and higher power is not where these converters belong.

"When you drive varactors to their power limits you're destroying much of the reliability that makes them attractive in the first place," Mr. Hylton added.

**Parametric Multiplier Boasts
Low Power Drain, Stability**

Mr. Hylton emphasized that the real advantage of the crystal-controlled parametric multiplier is its low power drain and stability. In this respect, many designers believe that it will supplant the stabilized klystron local oscillator, with price an important advantage as quantity production develops.



Typical harmonic generator built by Microwave Associates. This model 799C employs 500-mw 11-Gc input to deliver 33 Gc output with 20 db conversion loss. Device incorporates input and output filters.

For many applications, broad-band performance is required. The efficiencies and outputs cited for the multipliers generally assume single-frequency operation. Designers now are trying to achieve similar performance in broad-band devices. A bandwidth of about 10 per cent generally is required in many of the oscillator, exciter and transmitter applications for which parametric multipliers are considered. Microwave Associates, Micromega and Convair-Pomona are particularly active in this aspect of circuit design.

In efforts to reach higher frequencies, diode manufacturers are attempting fabrication of ever-smaller structures. One development, reported by Semiconductor Devices, Newport Beach, Calif., is manufacture of an epitaxial silicon mesa structure only 0.0005 in. across. Zero bias capacitances down to 0.3 μf are possible, according to the company officials.

Silicon appears to be the favored varactor material for multiplier diodes. Texas Instruments, however, employs gallium arsenide diodes of its own design at higher frequencies.

Spurious harmonic output of the parametric frequency multipliers is generally held to at least 30 db below the signal by proper filtering. Noise is said to be below that generated by equivalent vacuum-tube circuits if the varactors are not driven hard. At higher powers, the multipliers tend to be somewhat noisier than vacuum tubes, it is reported. ■ ■

FERRITE ISOLATORS

by D-B
-for exceptionally high performance... a full range of sizes... 30-day deliveries



DE MORNAY



BONARDI

D-B supplies ferrite isolators covering a range from 2.6 to 18.0 kmc. Units will soon be available to 140 kmc. All units in the line have the following high-performance features:

High isolation—a minimum of 30 db at X Band, and 24 db at Ku Band.

Low insertion loss—a maximum of 1.0 db in all sizes.

DeMornay-Bonardi isolators are resonance absorption type units, employing a low-loss ferrite developed especially for this application.

Low VSWR—a maximum of 1.15 in either direction.

Short insertion lengths—only $5\frac{7}{8}$ " in X Band size.

Complete data in Bulletin DB-480.

Other ferrite units manufactured by DeMornay-Bonardi include: Frequency Converters, Circulators, and Harmonic Rectifiers using unique D-B ferrite compounds.

D-B

- a reliable supplier

As the oldest manufacturer of microwave equipment, we have the talents to design reliable instruments... the skills to manufacture them, and the complete equipment for checking and calibration. You'll find deliveries prompt now at D-B, and, as always, every instrument backed by a firm replacement guarantee.

DE MORNAY-BONARDI 780 South Arroyo Parkway, Pasadena, California

CIRCLE 217 ON READER-SERVICE CARD

When to Use Strip Transmission Line



Microwave designers are learning the hard way that strip transmission line circuits do not always save size and weight when reasonably high performance is required. On a cost basis, however, strip lines are often quite attractive in comparison with waveguide and coaxial line. Author Jesse Taub here examines the several types of strip line on the market and points out how they can be profitably applied in the design of microwave components and systems.



Jesse Taub
Airborne Instruments Laboratory
Div. of Cutler Hammer, Inc.
Deer Park, N. Y.

WITH THE ADVENT of strip transmission line development it was commonly believed that the apparent cost, size and weight advantages of strip lines would render waveguide and coaxial cable obsolete in many areas of microwave design.

Experience has shown, however, that devices made of strip transmission line are often larger than those made of waveguide, especially where reasonably good electrical performance is required. The major reason for consideration of strip line remains economy, and here, the technique has indeed fulfilled expectations.

The alert microwave designer should, nevertheless, appreciate that for many specialized applications, strip line offers an economical and versatile alternative to rigid waveguide.

The five types of strip transmission line in use are:

- Microstrip
- Solid strip transmission line
- Stripline*
- Triplate*
- High-power strip transmission line.

Construction of these lines is illustrated in Figs. 1 through 5.

Microstrip, developed by ITT Laboratories, employs a single ground plane (Fig. 1). Radiation losses are minimized by keeping the strip close to the ground plane. Although Microstrip is the least expensive type of strip line, it has a higher attenuation constant^{1, 2, 3} than strip lines using two ground planes. Applications described in this article require lower attenuation constants than are available with Microstrip.

Solid strip transmission line consists of a single strip conductor located symmetrically between two ground planes (see Fig. 2);

the dielectric medium is air. Loss characteristics of this line are comparable to coaxial line⁴ of the same cross-sectional area. Since the double set of ground planes minimizes radiation losses, attenuation is due mainly to conductor losses.

To achieve low attenuation, strip symmetry must be maintained by regularly placed dielectric supports. The swr effect of these supports is similar to that of bead supports on coaxial lines. With careful design, a low swr can be achieved.

Stripline, developed by Airborne Instruments Laboratory, is slightly more lossy than solid strip transmission line, but is more easily supported. The main strip (see Fig. 3) is formed by a pair of thin copper strips bonded to a dielectric sheet. If the total thickness of the main strip is t , the line's properties will be similar to those of a strip transmission line having a solid strip of thickness t .

The dielectric separating the two strips has little effect on the line's characteristic impedance and attenuation because the electric field penetration is small.⁴ Dielectric loss due to the fringe field is minimized by using thin dielectric sheets. A sheet thickness of 0.020 in. is typical.

Stripline is readily supported by metal pins spaced about one ground plane from the edges of the strip.

Triplate, developed by Sanders Associates, has a cross section similar to that of solid strip transmission line, but employs a solid dielectric (See Fig. 4).

The main advantage of this dielectric sandwich line is that it is self-supporting. Sandwich lines can be made in much smaller sizes than the other double-ground-plane types; components having ground-plane spacings of 1/32 in. are typical. Because of

Table 1. Characteristics of strip transmission lines.

Type of Strip Transmission Line	Advantages	Disadvantages
Microstrip	Compact Light Inexpensive Self-supporting	High losses
Solid strip transmission line	Very low losses (mainly I ² R losses) Light	Bulky Not self-supporting
Stripline	Low losses Sturdy	Bulky
Triplate	Compact Self-supporting	Comparably higher losses Heavy
High-power strip transmission line	Megawatt power handling	Bulky Expensive (but may be cheaper than high-power waveguide) Not self-supporting

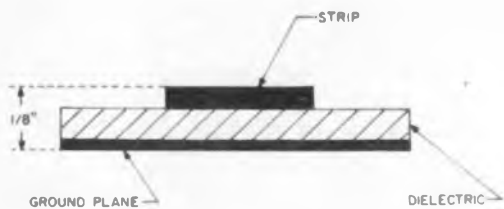


Fig. 1. Microstrip line consists of a single strip and single ground plane separated by a dielectric. This line is relatively inexpensive but has higher attenuation than lines with two ground planes.

construction problems, other double-ground-plane types rarely use spacings of less than 1/4 in.

The sandwich line has a higher attenuation than other double-ground-plane types because of its small size and because of dissipation in the dielectric. Sandwich lines are best suited to applications where some attenuation loss can be tolerated.

High Power Line Operates At Megawatt Power Levels

High-power strip transmission line can be operated at megawatt peak-power levels. To reduce corona effects, the strips are thicker than in other lines (1/8 in. or greater) and are rounded at the edges (see Fig. 5). The dielectric is air. As in solid strip transmission line, strip symmetry is necessary and is maintained by regularly placed stub supports. Although the high-power line is the most expensive of the five strip lines discussed here, it is nevertheless more economical than many waveguide high-power components.

Characteristics of the five-strip transmission lines are summarized in Table 1. Impedance and attenuation properties of strip transmission line have been derived by S. B. Cohn.⁵ His curves are reproduced here as Figs. 6 and 7. They give the characteristics of the transmission line as a function of ground-plane spacing, strip width, strip thickness, and the dielectric constant of the medium.

These curves are directly applicable to solid strip transmission line and to Triplate.

The characteristic impedance curves are about 4 per cent too high for Stripline but somewhat low in their estimate of Stripline attenuation. The exact attenuation correction depends on the frequency. For most appli-

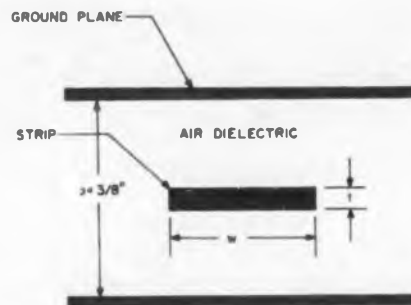


Fig. 2. Solid strip transmission line uses two ground planes and an air dielectric. Losses are comparable to coaxial line of similar cross-sectional area.

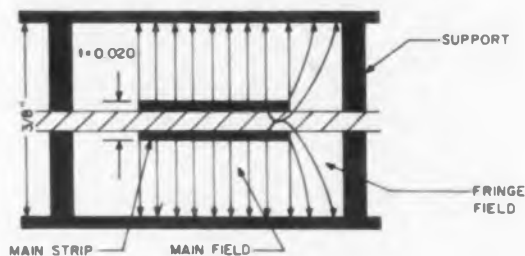


Fig. 3. Stripline employs two conducting strips separated by a dielectric and two ground planes with an air dielectric. This construction permits convenient support of conducting strip despite use of an air dielectric.



Fig. 4. Triplate line is self-supporting and is available in considerably smaller sizes than other strip lines. Attenuation is increased, however, because of dissipation in the dielectric.

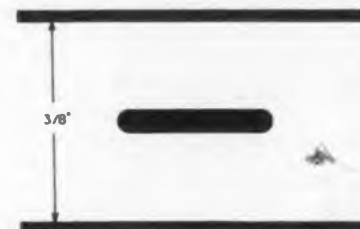


Fig. 5. High-power strip line uses thick, rounded strips to reduce corona effects. Megawatt powers can be handled and line is less expensive than many waveguide high-power components.

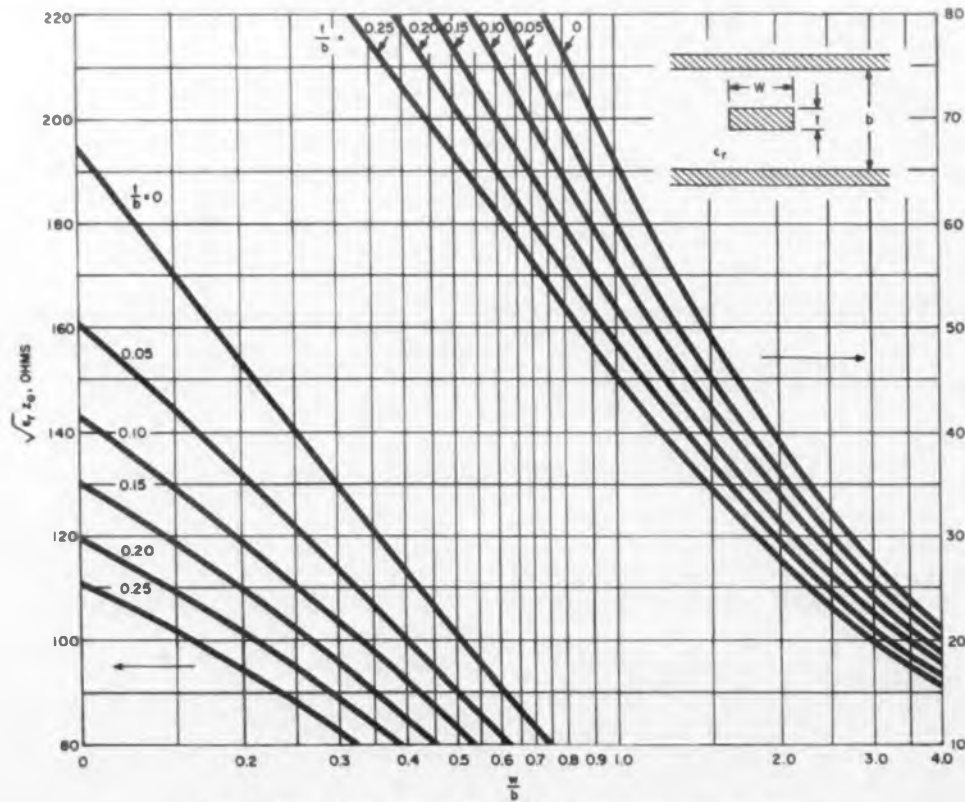


Fig. 6. Impedance curves for design of strip transmission lines.

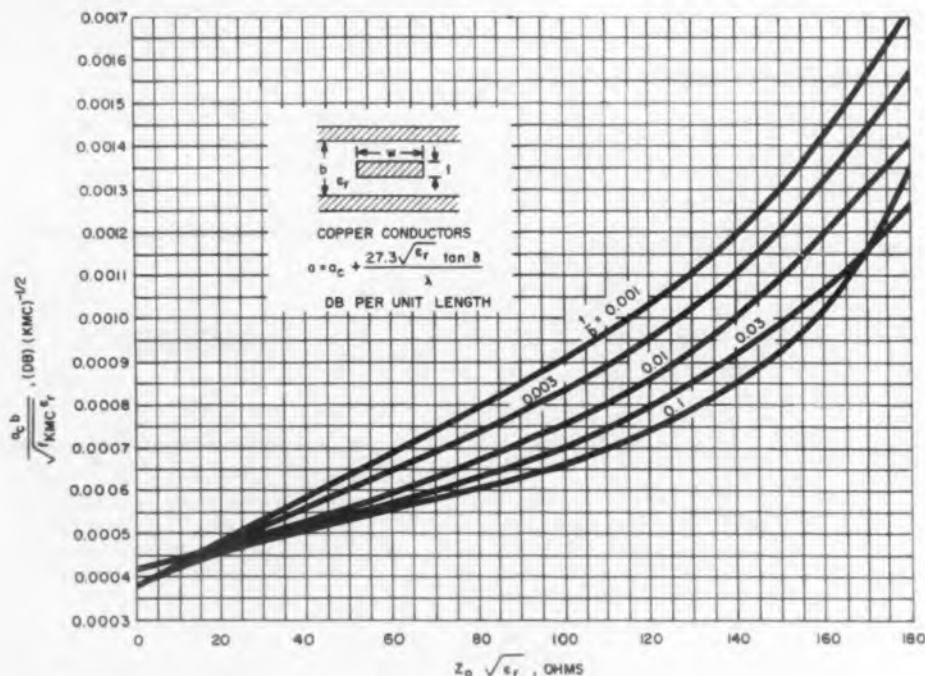


Fig. 7. Theoretical attenuation of copper-shielded solid strip transmission line in a dielectric medium ϵ_r .

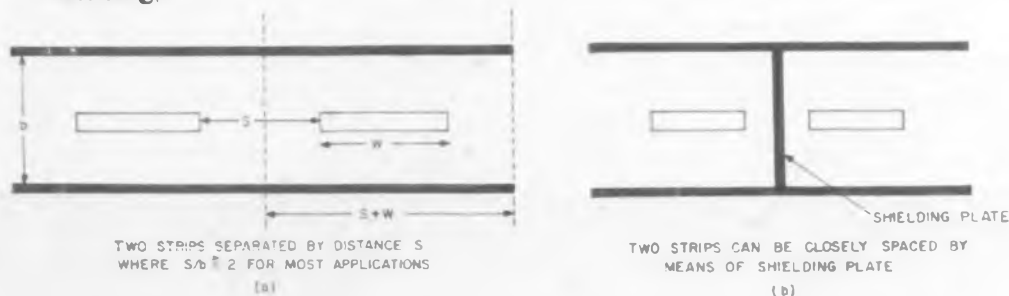


Fig. 8. Separation of two adjacent strip transmission lines to minimize coupling.

cations below 5 Gc, the accuracy is within 10 per cent.

The curves can be used for the high-power strip line by taking the width of the strip as w .

Design Examples for Strip Line Using Curves Are Given

To illustrate the use of these curves in designing strip lines, consider two typical examples:

Example 1. A solid strip transmission line

operating at 5 Gc with 1/4 in. ground-plane spacing (b) is to be designed for 50 ohms impedance using 0.025 in. thick (t) strips. Find the width (w) and the attenuation per unit length (α).

Using Fig. 6, set

$$t/b = \frac{0.025}{0.250} = 0.1 \text{ and } \sqrt{\epsilon_r Z_0} = 50$$

($\sqrt{\epsilon_r} = 1$ for an air dielectric). We obtain $w/b = 1.15$, or $w = 0.2875$ in. Fig. 7 gives a value of $\alpha_c b / \sqrt{f_{kmc} \epsilon_r}$ of 0.00053 for

$t/b = 0.1$ and $Z_0 = 50$ ohms. At 5 Gc the resultant α is 0.057 db per ft.

Example 2. A Triplate line filled with a dielectric having $\epsilon_r = 2.5$ and loss tangent ($\tan \delta$) of 0.0001 (typical of Rexolite 1422) is to be designed for 50 ohms at 5 Gc; $b = 1/8$ in. and $t = 0.005$ in. Find w and α .

Using Fig. 6 for

$$t/b = 0.005/0.125 = 0.04 \text{ and}$$

$$\sqrt{\epsilon_r Z_0} = \sqrt{2.5} 50 = 79, \text{ gives } w/b = 0.65, \text{ or } w = 0.081 \text{ in.}$$

The attenuation constant due to the copper losses (α_c) obtained from $\alpha_c b / \sqrt{f_{kmc} \epsilon_r} = 0.00063$, is 0.214 db per ft. To obtain the total attenuation loss, use the relation

$$\alpha = \alpha_c + \frac{27.3 \sqrt{\epsilon_r} \tan \delta}{\lambda}. \text{ The second term}$$

is 0.218 db per ft. resulting in a total attenuation constant of 0.432 db per ft.

Strip transmission lines do not always effect savings in size and weight. In using them as low-loss transmission lines, certain restrictions on the minimum ground-plane spacing (b) and strip width (w) must be recognized.⁵

If two or more lines are to be packaged close together, the minimum spacing between strips (s) is limited by mutual coupling. Separating two adjacent strips by one ground plane spacing results in a decoupling of about 27 db.⁶ For most applications at least two ground plane spacings between adjacent strips are required, as shown in Fig. 8. This restriction can be eliminated if a shielding bar is placed between the strips, but this adds to the cost and is therefore considered undesirable.

The restriction on minimum strip separation gives an over-all cross-sectional area of $b(s+w)$. For the typical case of $s = 2b$ and $w = b$, the cross-sectional area is $3b^2$.

When minimum circuit size is desired, the designer should compare strip lines and waveguides of the same attenuation before making a decision. Consider, for example, a strip transmission line (Fig. 2) operating at 9 Gc in which $w = b = 0.375$ in. and $t/b = 0.05$ (all conductors are silver-plated). The attenuation constant of this line is 0.064 db per ft.

Silver-plated rectangular waveguide, operating in the TE_{10} mode and having dimensions of 0.195 in. by 0.900 in., for an area of 0.175 in.², has the same attenuation constant. The equivalent strip transmission line cross section is 0.375 in. by 1.125 in. (assuming $s = 2b$) for an area of 0.495 in.²

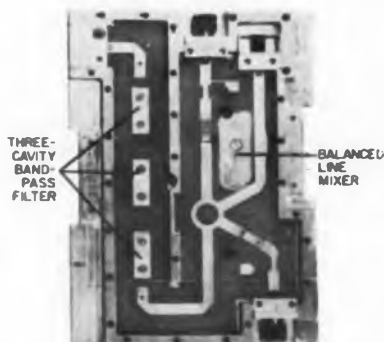


Fig. 9. Three-cavity band-pass filter coupled to a strip line balanced mixer. Device has a 20-mc, 3-db bandwidth at a center frequency of 9 Gc.

Thus, for equal attenuation constants, waveguide may actually be smaller than strip line.

The use of strip transmission line rarely results in unacceptable increases in size. Comparative weights of waveguide and strip line construction are not discussed here because the circuit occupying the smallest volume probably will be the lightest.

Low Cost, Rather Than Size, Is Chief Advantage of Strip Lines

Experience has shown that strip transmission line usually yields the most inexpensive microwave circuits but does not necessarily offer advantages in size, weight and electrical performance over waveguide.

The microwave designer should consider strip transmission line when he is able to compromise slightly on size, weight and performance. If so, considerable economy can result—particularly when large numbers of components are involved.

System designers, on the other hand, often must select the type of transmission line to be used for a group of microwave components. The correct choice may often involve structures that utilize strip transmission line in conjunction with waveguide or coaxial line. For example, a filter-mixer front end may benefit from the combination of a waveguide filter for low-loss and a strip transmission line mixer for simplicity. Strip-to-waveguide or strip-to-coaxial transition designs are available that make such composite structures practical.

Some useful strip transmission line components illustrating advantageous use of the

MICROWAVE ASSOCIATES PROGRESS REPORT



Microwave Power from Varactor Diodes

Efficient conversion of microwave power has been accomplished with a variety of new varactor frequency multipliers developed at the Waveguide Systems Division of Microwave Associates, Inc.

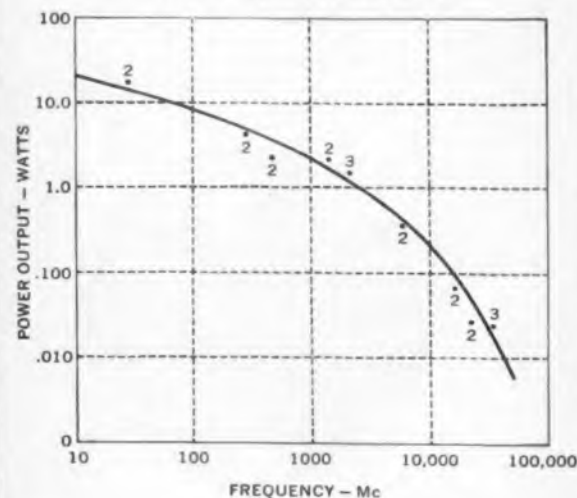
We have produced microwave power of several watts at UHF frequencies, several hundred milliwatts at X-band frequencies, and tens of milliwatts at Ka-band frequencies. The curve above indicates more accurately the power levels achieved by these Microwave Associates units. They employed doublers and triplers.

Efficiencies of these units range from 80–90% in the UHF region and from 20–30% at X-band. At present, the highest efficiencies are achieved at relatively narrow bandwidths (1%–2%). However, our capabilities are rapidly improving efficiencies for broader band operation. An example of a fixed-tuned broadband unit is a "tripler" which provides an output of 10 milliwatts over a 14% range at X-band.

Because of their efficiency and simplicity, these frequency multipliers are of considerable interest to systems engineers designing radar exciter circuits, low-power transmitters, stable local oscillator and param pump sources, and other circuits which require high frequency stability and exceptionally long life. These varactor multiplier circuits are generally passive, requiring neither tuning nor external bias voltage.

Our progress in producing efficient microwave

ALL SOLID-STATE FREQUENCY MULTIPLIERS Power Output (vs) Frequency



power with all-solid-state techniques is related to performance of the most advanced high-power epitaxial varactors with significantly lower losses. The capabilities of Microwave Associates' Semiconductor Division in producing such varactors is a most positive asset. As this article is being printed, the multiplier performances shown here have already been exceeded.

We are also developing chains of these frequency multipliers to provide moderate amounts of power when driven by transistor oscillators. Efficiencies of these multiplier chains (RF output/DC input) are as good or better than equivalent klystron sources. Compactness and all-solid-state reliability are equally important benefits.

If you have an application for efficient varactor frequency multiplication or would like to discuss the very latest capabilities of these units, please write to Mr. Herbert Cox, Waveguide Systems Division. We'll be pleased to send you a new article on Varactor Frequency Multiplication by Mr. M. E. Hines.



MICROWAVE ASSOCIATES, INC.
WAVEGUIDE SYSTEMS DIVISION

Burlington, Massachusetts • BRowning 2-3000
Western Union Fax • TWX: Burlington, Mass. 942

Export Sales: MICROWAVE INTERNATIONAL CORP.
36 W. 44th Street, N.Y.C., N.Y., U.S.A., Cable MICROKEN

CIRCLE 218 ON READER-SERVICE CARD

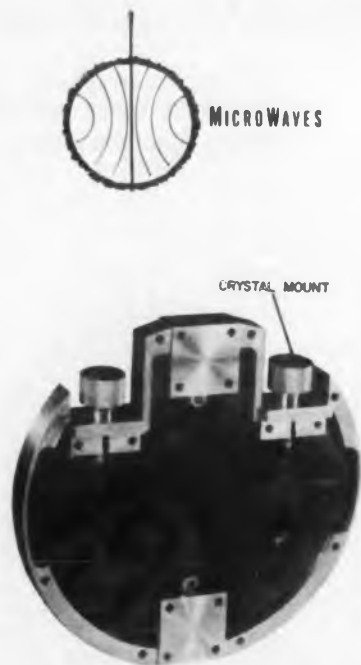


Fig. 10. Balanced mixer constructed of Stripline. The unit operates at a local-oscillator frequency of 9 Gc. Mixer has an 8-db noise figure—0.5 db more than similar waveguide component.



Fig. 11. Seven channel Stripline mixer using power divider for local oscillator distribution. Attenuation in the strips is less than 2 db.



Fig. 12. Front end of missile receiver uses single-layer strip transmission line packaging. Mixers and preselectors are incorporated in this unit.

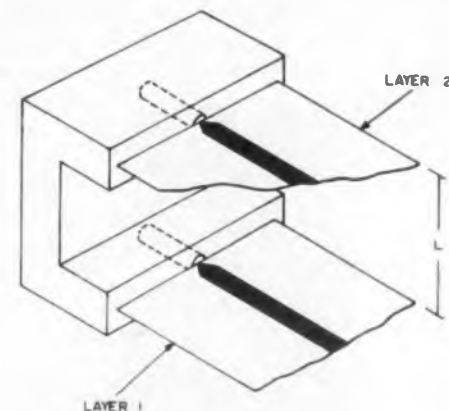


Fig. 13. Double waveguide to strip transition for multi-layer strip assemblies.

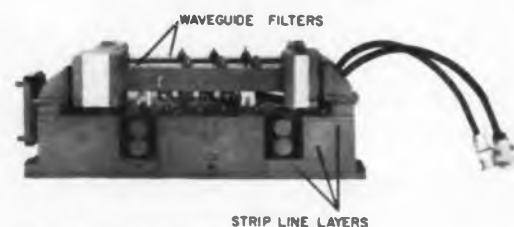


Fig. 14. Three-layer version of the assembly shown in Fig. 12. Connection between layers is via the waveguide-to-strip transition shown in Fig. 13.

technique are described here. Since design data on Triplate components are readily available,⁶ only components using Stripline and solid strip transmission line are discussed here.

A three-cavity band-pass filter (coupled to a balanced mixer) having a 20-mc 3-db bandwidth at a center frequency of 9 Gc is shown in Fig. 9. This component was built for a surface-to-surface missile. Strip transmission line was chosen for this application because it was the most inexpensive transmission medium available, yet gave adequate performance.

A requirement for minimum frequency shift with temperature would have necessitated that a waveguide filter be constructed from Invar. The solid strip transmission line utilized Invar for the strips and aluminum for the ground planes. The strip line was built in limited quantity for about \$100 per copy—half the cost of an equivalent waveguide filter.

A Stripline balanced mixer used in a proximity fuse application is shown in Fig. 10. This mixer operates at a local oscillator frequency of 9 Gc. It has an 8-db noise figure

compared with 7.5 db for a waveguide type. Since the crystal mounts represent a significant portion of the fabrication cost, and Stripline is used in the ring-type hybrid junction, a slight reduction in over-all cost is achieved.

Stripline has proved useful in microwave power dividers, such as the seven-channel, C-band mixer shown in Fig. 11. Local oscillator power is fed to seven mixers through a power-dividing network.

The entire power divider is photoetched on the same sheet as the mixers. Attenuation in the strips is under 2 db—a tolerable value in this application. This divider was built for use in a multichannel shipboard receiver.

Power dividers also have been used in high-power applications. Rotary joints with multiple point feeding of the coaxial center section⁷ have recently been designed to handle up to three megawatts in air at atmospheric pressure. Such rotary joints, built for multi-beam L- and S-band radars, use high-power strip transmission line power dividers and yield considerable economy over waveguide power dividers. High-power strip transmis-

sion line also should be useful in distributing power to complex transmitting antenna arrays, an application that has not yet been sufficiently exploited.

Combination of Strip Line With Other Techniques Proving Useful

In evolving the over-all layout of a microwave subsystem using strip transmission line, flexibility is important in adapting the form factor to the available space. A typical microwave package may combine strip transmission line with waveguide or coaxial line. Most of the early strip transmission line packaging was of the two-dimensional type. The front end of a missile receiver shown in Fig. 12 is typical of this construction. With the development of low-swr transitions from strip to coaxial line and strip to waveguide transitions (Fig. 13), more use has been made of multi-layer packaging.

Thus, a multi-layer version of the receiver front end shown in Fig. 12 was designed (see Fig. 14). The circuit consists of a group of Stripline mixers and a pair of Invar waveguide filters. It was originally assembled in two dimensions and then repackaged using

MICROWAVES

three stacked layers of strip transmission line circuitry.

Similar electrical performance was achieved for both arrangements. Microwave power was transmitted from one layer to the next through a pair of strip-to-waveguide transitions of the type illustrated in Fig. 13.

The strip transmission line couples first to a short coaxial line and then to waveguide by means of a coaxial-to-waveguide transition. Power is transmitted up the waveguide to the next layer and coupled to the strip transmission line through a second waveguide-to-coaxial line adapter and a second coaxial-to-strip transition. The separation (l) between each layer is almost equal to the ground plane spacing. These transitions can be matched to swr's under 1.1 over 30 per cent frequency bands—quite adequate for many applications.

The designer should utilize transitions from strip transmission line to other lines as an aid in achieving a desired form factor. Transitions also are helpful in designing circuits that use strip transmission line in conjunction with waveguide or coaxial line.

Contrary to a former belief, strip transmission line circuits do not always save size and weight when reasonably high-quality electrical performance is required. Strip transmission line circuitry, however, can often be manufactured at a lower cost than waveguide and coaxial line. This is the main reason for its consideration.

Designers should encourage the use of structures using strip transmission line in conjunction with other transmission lines. High-power strip transmission line, for example, can be used to a greater extent than previously believed. It is particularly useful for transmitting antenna arrays using complex waveguide distribution networks. ■ ■

References

1. D. D. Grieg and H. F. Englemann, "Microstrip—A New Transmission Technique for the Kilomegacycle Range", Proc. IRE, Vol 40, pp 1644-1650, Dec. 1952.
2. J. A. Kostriza, "Microstrip Components", Proc. IRE, Vol 40, pp 1658-1663, Dec. 1952.
3. M. Arditi, "Characteristics and Application of Microstrip for Microwave Wiring", Trans. IRE PGMTT, Vol MTT-3, pp 31-56, March 1955.
4. W. E. Fromm, "Characteristics and Some Application of Stripline Components", Trans. IRE PGMTT, Vol MTT-3, pp 13-20, March 1955.
5. S. B. Cohn, "Problems in Strip Transmission Lines", Trans. IRE PGMTT, Vol MTT-3, pp 119-126, March 1955.
6. Sanders Associates Staff, "Handbook of Triplate Microwave Components", Sanders Associates, 1956.
7. E. Fubini, W. Fromm, and H. Keen, "A New Type of Rotary Joint", IRE Conv. Rec., Part 1, pp 78-82, 1958.



AT

Douglas Aircraft Co.,
EL SEGUNDO

— the day in, day out reliability
of Scientific-Atlanta
antenna test equipment



The first reliability report is in on the complete new antenna test facility at Douglas Aircraft Company's plant in El Segundo, California. All operational equipment was furnished by Scientific-Atlanta, Inc. During the first eight months of operation, the facility was operated 10 hours a day, six days a week for the developmental testing of antennas and radomes.

At Douglas, as well as at test facilities around the country, Scientific-Atlanta instrumentation has been proven to operate dependably. Whenever service or technical assistance is needed, Scientific-Atlanta engineers are there in a hurry.

WIDE FREQUENCY COVERAGE

One installation at El Segundo consists of a 20' model range tower and a 5' heavy duty positioner atop a specially constructed 48' supporting tower, a centralized control console containing a wide range receiver, remote tuned signal sources, positioner control and indicator units, rectangular recorders, polar recorders, and a pattern integrator.

With the remote tuned signal sources, the operator changes frequency at the console—it's not necessary to climb the tower.

MANY MEASUREMENTS POSSIBLE

The Douglas installation again demonstrates the versatility of Scientific-Atlanta instrumentation. Complete frequency coverage from 100 mc to 16 kmc is provided with recordings proportional to voltage, power, or db in either rectangular or polar coordinates. Other laboratory measurements performed, using Scientific-Atlanta equipment, include calibration of microwave attenuators, isolation between operational antennas, and insertion loss or gain.

More Data Available—For more details on the Douglas facility, and how Scientific-Atlanta can design, construct, and install an antenna test facility that suits your needs, write to:



**SCIENTIFIC
ATLANTA, INC.**

2162 Piedmont Road, N.E.
Atlanta 9, Georgia
Phone: 875-7291

Excellent employment opportunities for electronic, microwave, and mechanical engineers. An equal opportunity employer.

CIRCLE 219 ON READER-SERVICE CARD



SWEEP SIGNAL SOURCES



MODEL NO. X775A

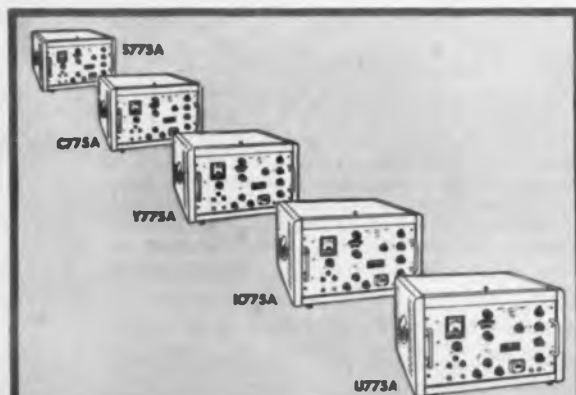
for fast, visual
reflectometer tests
ranges from 2 to 40 KMC

- Direct Reading Frequency Dials for Setting Upper and Lower Band Ends
- Integral AGC Circuit Keeps Output Flat to ± 0.5 db
- AGC Provision Eliminates Need for Slow Response Radiometer Set-ups
- Convenient, Portable, Versatile

Another breakthrough in measuring convenience has been achieved by the newly expanded FXR family of self-contained, direct reading sweep signal sources. Coverage is now provided as high as 40 KMC. Each unit utilizes a permanent magnet BWO as the tunable RF source. Output power can be equalized at any detection point relative to the response of the detection element through use of FXR's

exclusive built-in AGC circuit. This circuit provides a flat (± 0.5 db level) on modulated signal throughout the swept frequency range when used with matched bolometers and directional couplers. This AGC provision eliminates the need for using slow response radiometers, and allows for visual VSWR or Reflection Coefficient tests.

FXR FAMILY OF ALL ELECTRONIC SWEEP SIGNAL SOURCES



GENERAL SPECIFICATIONS

SWEEP RATE (Resolution): 0.3 to 300 KMC/sec linear with time
SWEEP WIDTH: approximately 200 KC to full frequency range
OUTPUT SIGNAL: CW, square wave (inherent limit to 1200 cps)
FREQUENCY DIAL ACCURACY: $\pm 1\%$ for fixed frequency operation
 $\pm 2\%$ for sweep frequency operation
POWER REQUIREMENTS: 115/230 v, 50/60 cycles, 200 w.
DIMENSIONS: 12 1/2" high x 21 1/4" wide x 16" deep
WEIGHT: 70 lbs.

Model Number	Frequency Range (KMC)	Approx. Minimum Power Out.	OUTPUT		Price
			Waveguide Type	Connector	
S775A	2.0-4.0	70 mw	(%) Coax Type N		-
C775A	4.0-8.0	20 mw	(%) Coax Type N		-
X775A	8.2-12.4	20 mw	WR-90	UG-39/U	\$2900.
Y775A	12.4-18.0	10 mw	WR-62	UG-419/U	\$3300.
K775A	18.0-27.0	5 mw	WR-42	UG-595/U	-
U775A	27.0-40.0	5 mw	WR-28	UG-599/U	-

Characteristics and prices subject to change without notice.

*UNDER DEVELOPMENT

FXR OFFICES IN NEW YORK • BOSTON • LOS ANGELES
REPRESENTATIVES IN ALL MAJOR CITIES THROUGHOUT THE WORLD



FXR
a division of
Amphenol-Borg Electronics Corporation
25-26 50th STREET • RA, 1-9000
WOODSIDE 77, N. Y. • TWX: NY 43745



MICROWAVES

Cavity Nomogram

Peter Ravenhill, Harold Smith
Weapon Control Department
Westinghouse Electric Corp.
Baltimore, Md.

THE nomogram is based on the formula

$$\log_{10} \left(\frac{F_2 - F_0}{F_1 - F_0} \right)^{2N} + \log_{10} (0.2589 R) = 0 \quad (1)$$

where

N = number of cavities

R = required rejection

and F_0 , F_1 and F_2 are center and pass band frequencies as shown in Fig. 1.

To use the nomogram of Fig. 2 first determine Y , the ratio of the stop band to the pass band.

$$Y = \frac{F_2 - F_0}{F_1 - F_0} \quad (2)$$

Extend a line from the computed value of Y to the desired rejection value on the R scale of the nomogram. Its intersection with the N scale denotes the required number of cavities.

For example: determine the number of cavities required for a filter having a pass band between 4.040 and 4.240 Gc with 40-db rejection at 3.820 and 4.440 Gc.

From Eq. 2,

$$Y = \frac{4.44 - 4.14}{4.24 - 4.14} = 3.$$

The line between $Y = 3$ and $R = 4$ intersects the N scale at 4.8. Thus, the filter would require 5 cavities.

PRECISION MICROWAVE EQUIPMENT • HIGH-POWER PULSE MODULATORS • HIGH-VOLTAGE POWER SUPPLIES • ELECTRONIC TEST EQUIPMENT

CIRCLE 220 ON READER-SERVICE CARD

Speeds Design of Symmetrical Band-Pass Filters

This nomogram solves the time-consuming first step in the design of uhf and microwave band pass filters—determining the number of cavities. Authors Ravenhill (left) and Smith developed the nomogram while designing filters for radar equipment requiring signals with very low spurious content.



Performance of a 5-cavity filter designed with the aid of the nomogram is illustrated in Fig. 3. Also shown is the computed response of a 4-cavity filter. Note that the 4-cavity filter will not provide the required 40-db rejection at the extreme limits of the pass band. Insertion loss of the 5-cavity filter within its narrower pass band is less than 2 db.

A developmental 5-cavity filter is shown in Fig. 4. This pre-production model consists of slotted rigid coaxial line. The length and position of the cavities can be adjusted by sliding the blocks along the line. The pointed supporting screws permit the designer to quickly measure the length of the cavities merely by pressing the whole assembly against a sheet of metal and thereby measuring the distances between the resulting indentations. ■ ■

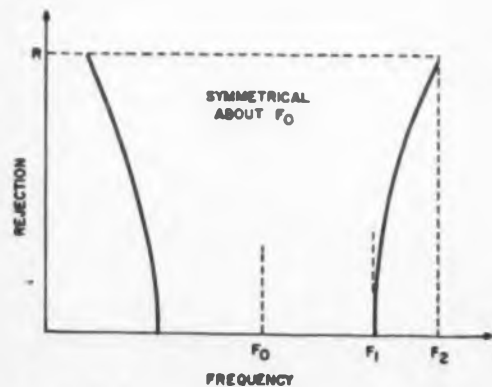


Fig. 1. Definition of terms in nomogram equation.



Fig. 2. Cavity nomogram for symmetrical band-pass filters.

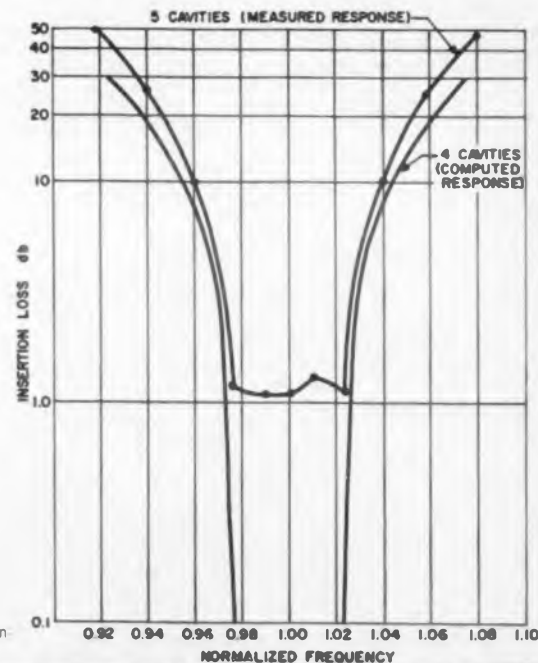


Fig. 3. Measured response of five-cavity filter and computed response of four-cavity filter.

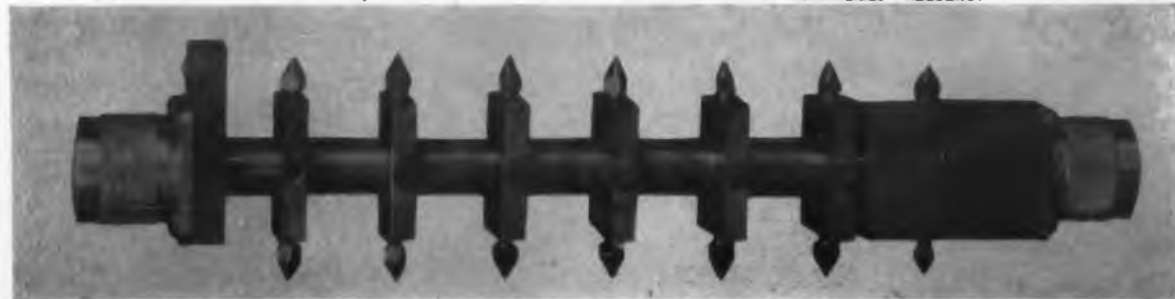


Fig. 4. Developmental five-cavity filter using slotted coaxial line. Blocks are movable for adjusting length and position of the cavities.



Entirely self contained, this new Transco antenna operates efficiently under continuous extreme environmental conditions. Dual radiation pattern coverage is remotely controlled by an integral coaxial switch.

With switch de-energized, the radiation is omni-directional in the azimuthal plane; energized, the radiation pattern is cardioid shape with a front to back ratio of - 17 db or greater over a range of 225 to 400 MC. For further information, or to apply Transco antenna capability to your new project, please write Transco Products, Inc., 12210 Nebraska Ave., Los Angeles 25, California.

**UNITIZED
DUAL-
PATTERN
UHF DATA
LINK
ANTENNA**



COAXIAL SWITCHES • WAVEGUIDE SWITCHES • ANTENNAS • MICROWAVE COMPONENTS • VALVES • ACTUATORS

CIRCLE 221 ON READER-SERVICE CARD

MORE FROM PRD!



BROADBAND DIRECT-READING ATTENUATORS

now available through K bands . . . up to 40 kmc. Compact, precision instruments feature 60 DB Attenuation Range, VSWR 1.15 Maximum, Accuracy to ± 0.1 DB, Insertion Loss as low as 0.5 DB, Spectrum Coverage from 3.95 to 40.0 kmc/s (nine models). Direct Reading. Send for data.

PRD ELECTRONICS, INC.

202 Tillary St., Brooklyn 1, N. Y., ULster 2-6800;
1698 Centinela Ave., Inglewood, Calif., ORegon
8-9048 • A Subsidiary of Harris-Intertype Corp.



CIRCLE 222 ON READER-SERVICE CARD



MICROWAVES

MICROWAVE PRODUCTS

Dielectric Antenna

473

A gun of sorts, it's really a dielectric antenna. Ball-joint mounted and boresighted, the antenna can be quickly set up and directed at remote units a few miles distant. There is little problem of windloading. The antenna has a nominal gain of 15 db with a 3-db beamwidth of about 28 deg, and covers frequencies from 2.7 to 3 Gc. Called a polyrod antenna, model STP-1, the device is made for site surveys and data communication links. Antenna is about 30 in. long.

Applied Technology Inc., Dept. ED, 930 Industrial Ave., Palo Alto, Calif.

P&A: \$450; 60 days.



Fresnel-Zone Plates

472

Bull's eye for millimeter waves, these Fresnel-zone plates are made for transmitting and receiving antennas. Acting as lenses, they focus 70-Gc-and-up millimeter waves into a plane-wave beam. At the receiving antenna, another zone plate focuses the beam to a point. Plates normally have diameters of 3 to 15 in., although special 4-ft plates for high-power transmissions have been produced. Plates are polystyrene, ground to different thicknesses at the proper diameters to produce the desired phase delay. Speeds faster than $f/1$ have been achieved.

Electronic Communications, Inc., Dept ED, 1830 York Road, Timonium, Md.

P&A: \$200 up; 2 weeks in small quantities.



Microwave Receiver System 470

Precision attenuation measurements over dynamic ranges of 100 db are possible with the model 61A1 microwave receiver. Attenuator accuracy of 0.00005% and readout resolution of 0.02 db are attained. The test signal is compared with an internal reference signal by a solid-state input switch, and output is fed to a null detector. No preamplifier or plug-in heads are required. Over-all noise figure is 3 db. Accessory mixers and local oscillator couplers for 2.6 through 40 Gc are available.

Sperry Microwave Electronics Co., Dept. ED, Clearwater, Fla.

P&A: \$1,750; from stock.



Solid-State Switch 471

Handling from 0.1 to 400 mc, the model 201 spdt solid-state switch operates at 50-nsec speeds. The unit measures 3/4 x 1-3/4 x 3-3/4 in. and weighs less than 2-1/2 oz. Power rating is from 20 to 200 mw; vswr is 1.1. At 200 to 400 mc, isolation is 30 to 60 db, and insertion loss is less than 1 db. Temperature range is -65 to +70 C. Shock of 30 g for 11 msec and vibration of 20 g are survived.

Sanders Associates, Inc., Dept. ED, 95 Canal St., Nashua, N. H.

P&A: \$65 each in production quantities; 45 days.

FOR POWER MEASUREMENT

New model extends
Sierra coaxial
load coverage to
3000 watts!

Model 160-1200 Load extends the range of Sierra 160 Series Coaxial Terminations all the way to 3000 watts, with optional accessories to convert it to a forced-air-cooled and water-cooled instrument. Model 160-1200 provides power capacity to 1200 watts in standard form, to 2000 watts with accessory air cooler, to 3000 watts with easily installed water cooler. You can order the power capacity you need now, expand it later. DC to 1 gc (kmc), low VSWR, may be ordered with Type N, HN or LC female connectors.

Sierra 160 Series Coaxial Loads provide wide frequency coverage and wide power capacity, plus extremely low VSWR (see chart). The terminations are highly stable at full-rated power, even at 104° F., and derating permits operation at still higher ambient temperatures. Complete shielding and internal expansion chambers provide safety for operating personnel, and the loads require no adjustments or maintenance. Type N connectors, others available on special order.

Model	Full Power at 40° C, still air	VSWR Less Than	Frequency Range	Price
160-1	1 watt	1.10	DC-4 gc	\$ 25.00
		1.15	DC-6 gc	
		1.25	DC-11 gc	
160-5	5 watts	1.10	DC-4 gc	\$ 30.00
		1.20	DC-6 gc	
		1.50	DC-11 gc	
160-20	20 watts	1.10	DC-1 gc	\$ 40.00
		1.15	DC-4 gc	
		1.50	DC-6 gc	
160-100	100 watts	1.10	DC-500 mc	\$140.00
		1.20	DC-4 gc	
		1.50	DC-5 gc	
160-500	500 watts	1.10	DC-500 mc	\$200.00
		1.20	DC-3.4 gc	
		1.50	DC-5 gc	

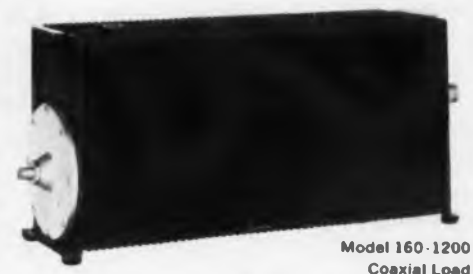
Write today for complete information on these superior instruments for power measurements.

sierra

SIERRA ELECTRONIC CORPORATION

A Division of Philco Corporation
7311K BOHANNON DRIVE • DAVENPORT 9-2060 • AREA CODE 415 • MENLO PARK, CALIF., U. S. A.
Sales representatives in all major areas
Canada: Atlas Instrument Corporation, Ltd., Montreal, Ottawa, Toronto, Vancouver
Export: Fraxar & Hansen, Ltd., San Francisco

CIRCLE 223 ON READER-SERVICE CARD



Model 160-1200
Coaxial Load



Model 160-20



Model 160-100



Model 160-1

PLUS THIS WIDE-RANGE POWER MEASUREMENT INSTRUMENTATION:

Sierra 184 Bi-Directional Power Monitor, nine plug-in elements, 2 to 1000 mc, 1 to 1000 watts. Basic Unit, \$110; plug-ins, \$75.00 to \$170.00.

Sierra Directional Couplers for VSWR, reflection coefficient, power measurements, 1 to 1200 mc. \$120.00 to \$150.00.

Sierra 184 Series Low Pass Filters, to 400 mc cut-off, power range 250 watts in pass band, 25 watts in rejection band. \$100.00 each.

Sierra 185 Series Termination Wattmeters, two models, 0 to 30/100 and 0 to 150/500 watts, 20 to 1000 mc. Model 185A-100, \$260.00; Model 185A-500, \$375.00.



MICROWAVES PRODUCTS

Amplifier for 7 to 11 Gc 449



A gain of 30 db and noise figure of 11 db are claimed for the type SHA-1b amplifier. The device operates from 7 to 11 Gc, and is built to withstand severe environments. Unit, with a self-contained thermostatically-controlled heater, operates from -40 to +55 C. Vibration to 2,000 cps at 10 g and shock at 20 g are survived. Unit uses a ppm traveling wave tube.

Applied Technology Inc., Dept. ED, 930 Industrial Ave., Palo Alto, Calif.

P&A: \$5,680; 60 days.

Low Pass Filters 459

Cutoff from 200 to 2,000 mc at increments of 5 mc is provided by the series TLP low pass filters. Cutoff frequencies are said to be exceptionally sharp and band-pass attenuation low. Center frequency, bandwidth, and cutoff points may be specified for individual requirements. Units can be adapted for most connectors, and can be hermetically sealed.

Telonic Engineering Corp., Dept. ED, Laguna Beach, Calif.

Coaxial Variable Attenuator 451



Measuring 4-1/16 x 1 x 1 in., the model A-4 coaxial variable attenuator is a miniature device. Frequency range is 5 to 7.5 Gc, with screw-driver or micrometer control. Insertion loss is less than 0.5 db, and vswr is under 1.35. Attenuation range is 5 db min.

Merrimac Research and Development, Inc., Dept. ED, 517 Lyons Ave., Irvington, N. J.



ONLY POLARAD CAN A 4,000 mc BANDWIDTH VISUAL MICROWAVE

Polarad takes another giant stride in advancing the state of the art for microwave research and development—you can now observe a complete 4,000 mc bandwidth on one scope, at one time, with the new Model WSA Wide Band Spectrum Analyzer.

Here's the value to microwave engineers. To see the entire tuning range of transmitters, generators and all other broadband devices, just push one appropriate band selection button—no tracking, no further tuning.

Here's the value in RFI work. Because you can view a wide band of frequencies at one time, you can see interfering signals instantly. And by switching over to narrow band analysis, the exact nature of the signal can be determined—an aid in compiling a "spectrum signature."

Model WSA joins the most comprehensive line of visual microwave analysis equipment available today.

SPECIFICATIONS MODEL WSA

Frequency Range
10 mc to 40,000 mc in 20 Bands

Band Selection
Automatic; with illuminated pushbuttons

Dispersion
Narrow Band: 1 mc to 25 mc.
Wide Band: 50 mc to 4,000 mc.
Resolution..... Narrow Band: 20 kc
Wide Band: 1.5 mc

I-F Frequencies
8,200 mc, 3,600 mc, 1,000 mc, 160 mc, depending on band selection.

High Intermediate Frequency
Assures image rejection and prevents video detection.

DISPLAY FOR ANALYSIS

Which of these Polarad Microwave Spectrum Analyzers solves your problem?

From 10 to 100,000 mc, Polarad offers spectrum analyzers for every aspect of microwave research and development. Thousands of the instruments shown here are in use today throughout the electronics industry—in laboratories, on the production line, in systems, out in the field and at research centers.

Ask your Polarad representative to work with you in selecting the equipment that will most efficiently accomplish your objectives.

ALL POLARAD SPECTRUM ANALYZERS FEATURE:

- 1 to 30 cps adjustable sweep rate
- Direct-reading UNIDIAL® tuning control, with no klystron modes to set
- High accuracy, resolution and sensitivity
- Non-contacting klystron cavity chokes for noiseless tuning
- Provision for use with Multi-pulse Spectrum Decoder (Model SB-1)

UNIVERSAL OPERATION?

Self-Contained Units Cover 10 to 40,000 mc

- MODEL SA-84**
- Dispersion: 10 to 99 mc: 500 kc to 5 mc, adjustable
 - 35 to 40,000 mc: 500 kc to 25 mc, adjustable
 - Resolution: 20 kc
 - Internal Marker: variable

MODEL SA-84W

- Wide Dispersion: 10 mc to 240 mc: 10 mc
- 240 mc to 40,000 mc: 80 mc
- Resolution: 2 kc to 80 kc variable
- Crystal controlled markers from 10 to 40,000 mc
- Log-linear display
- Accurately calibrated IF attenuator

TRANSISTORIZED MOBILITY?

MODEL SA-84T Single Unit Covers 10 to 40,000 mc

- Dispersion: 500 kc to 25 mc, adjustable
- Resolution: 20 kc at all frequencies
- Internal Marker: ± 13 mc
- Power Consumption: when battery operated, 110 watts, 12 vdc
- Sensitivity: —50 to —105 dbm, depending on frequency
- Weight: 70 lbs. One half the weight of conventional vacuum-tube equivalent
- Meets MIL-1-26600 for r-f interference

STANDARD OPERATION?

MODEL TSA 10 to 44,000 mc in 5 Plug-In Tuning Units

- Dispersion: 400 kc to 25 mc
- Resolution: 2 to 80 kc variable
- Attenuation: Continually variable
- Sensitivity: —50 to —95 dbm, depending on frequency
- Internal Marker: ± 14 mc

TIME AND FREQUENCY DISPLAY?

MODEL TSA-S SYNCHROSCOPE ANALYZER

- 10 to 44,000 mc in 5 Plug-In Tuning Units
- Bandwidth: 5 kc, 50 kc, 500 kc, 5 mc
 - Synchroscope sweep rate: 2, 10, 100, 1,000, 10,000, and 100,000 μ sec per screen diameter.
 - Dispersion, Sensitivity and Internal Marker same as TSA.

WIDE DISPERSION?

MODEL TSA-W Narrow And Wide Pulse Analysis

- 10 to 44,000 mc in 5 Plug-In Tuning Units
- Dispersion: 200 kc to 80 mc (2 ranges)
 - 80 mc dispersion displays pulses narrow as 0.1 μ sec. For wide pulses, dispersion may be adjusted down to 200 kc.
 - Resolution: 2 to 80 kc variable
 - Internal Marker: ± 40 mc
 - Screen Display: Linear or log

ULTRA-BROAD BAND?

MODEL WSA Self-Contained Unit Covers 10 to 40,000 mc in 20 Bands

- Dispersion: 1 mc to 25 mc in narrow band, 50 mc to 4000 mc in wide band
- Resolution: 20 kc in narrow band; 1.5 mc in wide band
- Rapid band selection by means of illuminated push-button switches.
- Frequency difference marker up to 4000 mc.
- Sensitivity: —50 to —80 dbm, depending on frequency

EXTENDED FREQUENCY?

MODEL DA-70 50,000 mc to 100,000 mc in Three Bands

- Dispersion: Continuously adjustable from 50 mc to 1000 mc. Permits narrow pulse inspection.
- Resolution: 1 mc
- High intermediate frequency assures image rejection and prevents video detection.
- Dial Frequency Accuracy: $\pm 1.0\%$
- Nominal Sensitivity: —50 dbm for entire frequency range.

SPECTRUM SELECTOR?

MODEL SD-1 MULTI-PULSE SPECTRUM SELECTOR

- Permits spectrum analysis of individual microwave pulses in a pulse group when used with any Polarad Spectrum Analyzer. Any pulse in a complex coded signal may be isolated for examination.



MICROWAVES

Circulator

588



High-power broad band three-port circulator may be converted into a microwave switch by replacing the permanent magnet with an electromagnet. Models are available with power handling capabilities of more than 50 kw. Frequency range is 8.0 to 10.5 Gc; isolation is 20 db min; insertion loss, 0.4 db max, vswr. 1.20 max; power, 25 w average. Connectors mate with UG/39/U.

Kearfott Div. of General Precision, Inc., Dept. ED, 14844 Oxnard St., Van Nuys, Calif.

Traveling-Wave Tube

675

Traveling-wave tube; model WJ-217, 10 w, operates from 2 to 4 Gc. Small signal gain is 40 db min, ± 3 db, and vswr is 1.5. Device is ppm-focused, is 13 in. long and 1-3/8 in. in diameter, and weighs 3 lb.

Watkins Johnson Co., Dept. ED, 3333 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif.

Availability: 90 days.

Radar Test Set

674



Portable radar test set, model 121, provides on-the-ramp testing of weather, navigation, and anti-collision radar systems, and radio altimeters. Does not require physical connection to aircraft. Set simulates aircraft moving at 120 to 600 knots. Peak power can be measured, accurate to ± 1.5 db. Transmitted output signal, 1 mw, is variable over 50 db, and has a 1- μ sec pulse width.

Republic Electronic Industries Corp., Dept. ED, 111 Gazza Blvd., Farmingdale, N. Y.

Availability: immediate.

POLARAD

ELECTRONICS CORPORATION

43-20 34th Street • Long Island City 1, New York

FREE LIFETIME
SERVICE

CIRCLE 224 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

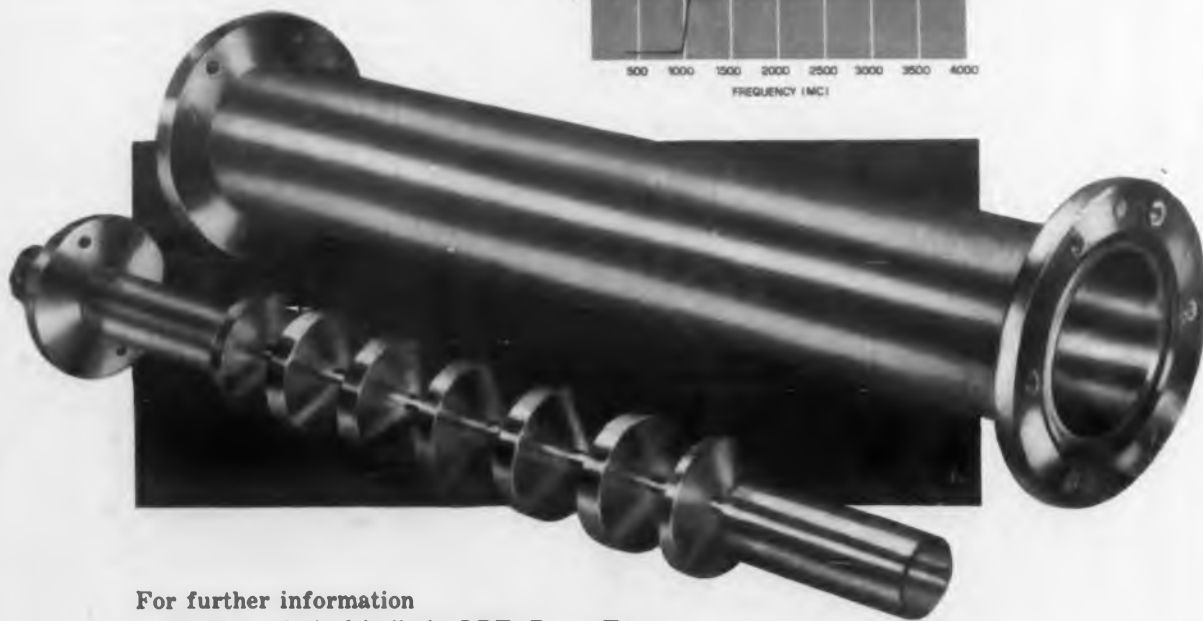
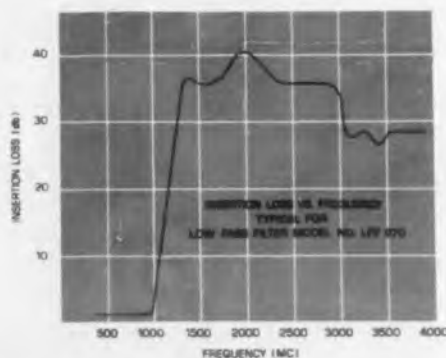
193

THE COAXIAL FILTER WITH POWER HANDLING CAPACITY UP TO 10KW

THE GB ELECTRONICS LOW PASS FILTER SERIES DESIGNED FOR USE WITH HIGH POWER TRANSMITTERS SUPPRESSES 2nd AND 3rd HARMONICS

These coaxial filters employ a succession of high and low impedance transmission lines designed as a constant k type filter with M derived end sections. The stop band characteristics, low pass band insertion loss, low input and output VSWR, and high power handling capability of this design make these filters ideal for the suppression of 2nd and 3rd harmonics in high power transmitters.

GB Electronics Low Pass Filters are custom-designed for specific applications. Numerous models have been manufactured in production quantities and are presently in use in many foreign and domestic installations. All models are available on short notice. GB Electronics will be pleased to quote on your specific requirements.



For further information
write for technical bulletin LPF, Dept. E.

GENERAL BRONZE CORPORATION

GB ELECTRONICS DIVISION

Garden City, Long Island, N. Y.

CAREER OPPORTUNITIES FOR QUALIFIED SCIENTISTS AND ENGINEERS.



CIRCLE 225 ON READER-SERVICE CARD



MICROWAVES PRODUCTS

Attenuation Measurement System 672



Covering 100 mc to 12.4 Gc frequencies, the model VM-1 standard attenuator comparator measures attenuation of 40 mv to 0.2 μ v, corresponding to -15 to -121 dbm in a 50-ohm system. Standards laboratory accuracy can be obtained over a 60-db dynamic range. Unit is direct-reading in decibels; no correction charts or calibrations are needed.

Weinschel Engineering Co., Dept. ED, Kensington, Md.

Miniature Ferrite Isolators 461



For aircraft and missiles, these coaxial ferrite isolators operate at any frequency from 4 to 11 Gc. The X-band isolator, illustrated, is 2-11/16 in. long and weighs 4 oz. It has a 20 to 1 isolation to insertion-loss ratio and a 10% bandwidth. Environmental specifications are said to match those of larger devices.

Sylvania Electric Products, Inc., Dept. ED, 1100 Main St., Buffalo 9, N. Y.

Availability: four weeks.

Synchronizer Measures Frequencies to 12.4 Gc 465



Accuracy of 3 parts in 10^6 is possible with the model DY-5796 transfer oscillator synchronizer. The instrument is used with a transfer oscillator and an electronic counter to provide

MICROWAVES

frequency measurements from 0.2 to 12.4 Gc. Synchronizer automatically locks the transfer oscillator to signal frequency. Accuracy depends on counter time base; an external time base can be even more accurate.

Dymec Div., Hewlett-Packard Co., Dept. ED, 395 Page Mill Road, Palo Alto, Calif.

P&A: \$685; immediate.

Insulation Adhesive 464

Applicable by brush or spatula, Rexolite 12517 adhesive is made to bond the firm's uhf insulating material to itself. Curing requires two hr at 175 C.

William Brand-Rex Div., American Enka Corp., 31 Sudbury Road, Concord, Mass.

Parabolic Antennas for 806 to 960 Mc 467



Spun and mesh reflector parabolic antennas come in 4- to 12-ft sizes. Antennas are made for 806 to 960 mc operation. Feeds, mounted on either front or back, are adjustable throughout 360 deg, in 90-deg steps on mesh models, continuously on spun models.

Technical Appliance Corp., Dept. ED, Sherburne, N. Y.

Radar Test Set 462



Beacon checkout test set model RBT-202 measures beacon transmit frequencies, power levels and beacon coding ability. Unit is for L- to X-band use. It can be rack or bench mounted and can be used for field tests, full-scale production tests and lab evaluation of high sensitivity code-interrogated beacons.

Remanco, Inc., Dept. ED, 1805 Colorado Ave., Santa Monica, Calif.

60 MILLIWATTS OF *Versatility*

with the NEW

SPERRY *Microline* SWEPT OSCILLATOR



Features which make this oscillator superior for any microwave measurement:

- Sweep: End points independently adjustable over entire frequency range. Sweep may be from low to high, or high to low frequency. Sweep rates continuously variable in four ranges from .01 to 100 seconds. There is provision for external sweep, dc coupled, to permit frequency programming. Manual recurrent or triggered sweep and front panel indication, with meter and lamp, when sweeping.
- Markers: Five separate markers at the start and stop frequencies and any three intermediate points. Markers can be set directly from front panel meter, or readily with an external wavemeter using the unique spot frequency selection feature.
- Spot Frequency Selection: Five spot frequencies are available, which are independently selected by the start, stop and three marker settings. The Microline oscillator is a five-frequency, preset signal generator as well as a swept oscillator.

The new Sperry Microline swept oscillator is offered in three output frequency ranges.

MICROWAVE SWEPT OSCILLATOR SPECIFICATIONS

Microline Number	Output frequency GC	Minimum Power mw	Sweep Rate seconds
64S1	2.0 - 4.0	60	.01 to 100
64C1	4.0 - 8.0	20	.01 to 100
64X1	8.2 - 12.4	20	.01 to 100

Modulation: Internal grid modulation, 1000 cps. or provision for external modulation.

Levelling: Output level controlled from front panel. Provision for external level control for programming output level.

Frequency Scale: Slide rule dial accurate to 1 percent.

Sweep: Linear, with time to 1 percent.

Size: 12 1/4" x 19 1/4" x 17 1/4".

Power: 105 - 125 / 210 - 230 volts; 50 - 60 cps.

DIVISION OF SPERRY RAND CORPORATION

SPERRY

MICROWAVE ELECTRONICS COMPANY,
CLEARWATER, FLORIDA

Microline Instruments • Radar Test Sets • Systems Instrumentation
Solid State Devices and Materials • Microwaves Components and Antennas



"ANSWERING SERVICE" IN SPACE

ACF TRANSISTORIZED RADAR BEACONS greatly extend the range to which ground radar can track satellites and missiles accurately and effectively. As a pioneer in the development of long-range Radar Beacons, ACF designs, manufactures and tests its own components and sub-assemblies. This "in-plant" capability eliminates long-lead procurement time for critical components and assures reliable, controlled performance of flight-ready units off the ACF shelf.

THE TYPE 149 RADAR BEACON is designed as an airborne, pulse-type tracking aid for long-range space or missile application in both S and C Bands. These "miniature sending stations" have exceptionally high reliability and long life, respond to coded or uncoded interrogations and provide "echo boost" at low power consumption. ACF Beacons have qualified for more major satellite and missile programs than any other beacon.

ACF ELECTRONICS
DIVISION

ACF INDUSTRIES



MICROWAVES PRODUCTS

Crystal Holder

583



Tunable detector mount allows any crystal to be matched to the line. Holders can be used as balanced pairs in mixer circuits, and seals allow use in pressurized systems. Crystals can be matched to less than 2.0 vswr, and selected crystals to less than 1.5 vswr.

Technical Research Group, Antenna and Microwave Dept., Dept. ED, 9 Union Square, Somerville, Mass.

Tuned Attenuators

374



Low vswr attenuators for systems applications are fixed-tuned to a desired frequency from 1 to 4 Gc. Attenuation values are from 1 to 20 db. The vswr is 1.05 max at center frequency and 1.10 over a $\pm 10\%$ bandwidth. Attenuation accuracy is ± 0.3 db, 1 to 10 db, and ± 0.5 db, 11 to 20 db. Attenuators are bi-directional and have type N or C connectors.

Maury and Associates, Dept. ED, 10373 Mills Ave., Montclair, Calif.

P&A: \$70 to \$75; 3 to 4 weeks.

Polyurethane Foam

481



Dielectric constant is 1.2 to 3.0. Foam plastic with ferrous or nonferrous mixture has controlled dielectric properties. Density can be varied from 2 to 25 lb per cu ft. Material has high strength-to-weight ratio and is not affected by environmental conditions.

PolyStructures, Inc., Dept. ED, 41 Montvale Ave., Stoneham, Mass.

MEC Reports on....

Low Noise TWT's with PPM Focusing

■ *S, C and X-Band,
Metal-Ceramic, PPM Focused,
Magnetically Shielded,
10 mw Output and 30 db Gain
with Maximum Broadband
Noise Figure of 10 db.*

Typical of MEC's advanced family of metal ceramic low noise traveling-wave tubes is the new M2105. Rugged and reliable, this tube is the result of engineering skill and manufacturing care appropriately combined to form a production tube with truly reproducible characteristics.

Shielding of the tube and its focusing structure, an advantage of the PPM format, eliminates the effect of stray magnetic fields and permits use of tubes in close proximity to magnetic materials or to each other. Elimination of the focusing solenoid and power supply reduces power consumption to less than 3 watts, including heaters, and does away with auxiliary cooling.

Reliability— A Built-in Feature of MEC Tubes

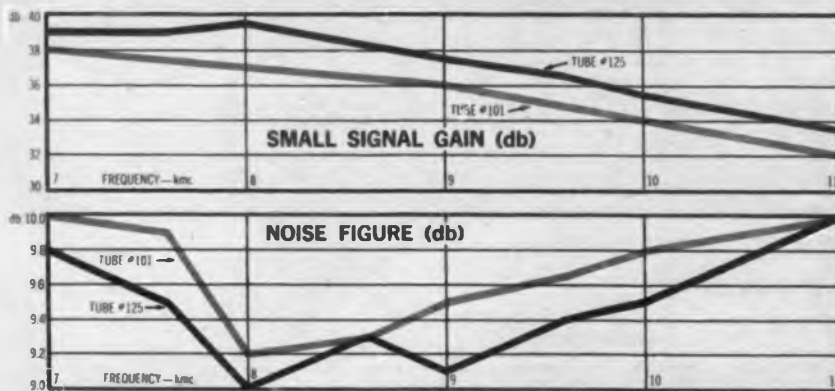
Metal-ceramic construction gives MEC tubes a headstart on reliability. They are evacuated at higher temperatures (650°C), producing a higher vacuum and cleaner environment for long cathode life.

Inherently rugged, they provide superior performance over environmental extremes. (The M2105 withstands 15 g shock and 15 g vibration between 5 and 2000 cycles with no degradation in performance. Temperature compensation work is now being completed.)

MEC construction features also include a stacked ceramic gun and a helix rigidly supported by three ceramic rods. Critical turn spacing is accurately maintained to assure uniform gain characteristics from tube-to-tube. The tube can be operated in any position without change in characteristics.

MEC's new short form catalog with complete information on our production engineered line of traveling-wave tubes is available now. In addition to low noise types, the catalog covers medium and low power, serrodyne, and special purpose tubes. For your free copy, call your nearest MEC engineering representative or write to us.

*Ask for your
copy of our
new catalog....*



REPEATABILITY MEANS RELIABILITY
Notice how closely the small signal gain and noise figure characteristics for the first M2105 (#101) compare with those of the last member in the first lot (#125).

TYPICAL LOW NOISE TWT TUBES IN PRODUCTION

PPM FOCUSED TUBES	Frequency Range	Small Signal Gain	Saturation Power	Noise Figure
M2103 Series (Family)	2 - 4 kmc	30 db	10 mw	10 db
	(over 0.5 kmc portion of the band)	30	10	8
	2.3 - 4.4	30	10	10
	2 - 4	30	10	15
M2112 Series	4 - 8	30	10	10
	4.3 - 7.4	30	10	10
	4 - 8	30	10	15
M2105 Series	7 - 11	30	10	10
	7 - 11	30	10	15
	8 - 12.4	30	10	15
M2114	12.4 - 18	30	5	14
SOLENOID FOCUSED TUBES				
M2103 Series	2.0 - 4.0 kmc	30 db	5 mw	8 db
	(over 0.5 kmc portion of the band)	30	5	6
M2107	4.0 - 8.0	30	5	10
M2101 Series	7.0 - 11.0	30	10	9
M2114	12.4 - 18.0	30	5	12



Model M2105 Low Noise TWT weighs 5 pounds and is 12 1/8" long.

MEC

**MICROWAVE
ELECTRONICS
CORPORATION**

4061 Transport Street
Palo Alto, California
DAvenport 1-1770

SOLID STATE ISOLATORS

● PRODUCTS OF SPERRY RESEARCH

Specifications to meet every requirement within the UHF, communications and radar bands, and for commercial, laboratory and bench test applications.

*New Lower Prices
on Standard Models!*



MICROWAVES PRODUCTS

Ferrites

386



Single crystals of yttrium iron garnet (YIG) and lithium ferrite are available as polished or rough-ground spheres, cubes, disks, special shapes, or unfinished. YIG resonance linewidth is 0.4 to 0.45 oersted; lithium ferrite linewidth is less than 10 oersteds. Optimum frequency ranges of the materials are, respectively, 2 to 4 Gc and 5 to 10 Gc. YIG crystals of 95 g have been grown.

Airtron Div., Litton Industries, Dept. ED, 200 E. Hanover Ave., Morris Plains, N. J.

Standard-Gain Horn Antennas

466

To determine gain of uncalibrated antennas, this waveguide horn can be used as a standard. Units are calibrated for a gain of 15 ± 0.3 db at the specified frequency. Frequencies from 2.6 to 40 Gc are available. Beam width is about 30 deg; vswr averages 1.2. Horns serve as either transmitters or receivers.

Waveline, Inc., Dept. ED, Caldwell, N. J.
Price: \$45 to \$115.

Feed Horns

422



Linear-circular polarized feed horns, series 897, are designed for parabolic reflectors having a 0.3 f/d ratio. Models for use at 3.2, 4, and 8.6 mm wavelengths are available. Rotation of a portion of the feed through 45 deg switches polarization from circular to linear. The vswr is less than 1.3. Axial ratio is 0.7 db max over a 4% frequency band.

Technical Research Group, Inc., Antenna and Microwave Dept., Dept. ED, 9 Union Square Somerville, Mass.

MINIATURIZED SOLID STATE DEVICES



ALL NEW!

Model No.	Frequency (GC)	Max. Power		Insertion Loss (db) Max.	Isolation (db) Min.	Max. VSWR	Transmission Line	Connectors		Dimensions (in.)		Weight (oz.) Approx.
		Peak (Kw)	*Avg. (w)					Input	Output	L	D	
D44L7	1.25-1.35	5	5	0.9	15.0	1.20	3/8" coax.	N Ma	N Fe	6 39/64	25/32	6 1/4
D44L7-4	1.435-1.535	5	5	0.6	16.0	1.15	3/8" coax.	N Ma	N Fe	6 39/64	25/32	6 1/4
D44L33-25	1.7-2.3	5	10	1.0	13.0	1.20	3/8" coax.	N Ma	N Fe	9 15/16	25/32	8
D44L33-23	2.12-2.305	5	5	0.7	13.0	1.15	3/8" coax.	N Ma	N Ma	5 1/4	25/32	5
D44S7	2.7-3.1	5	5	0.9	15.0	1.20	3/8" coax.	N Ma	N Fe	4 11/32	25/32	5
D44C7	5.4-5.9	5	5	0.9	15.0	1.20	3/8" coax.	N Ma	N Fe	4 11/32	25/32	5

*Assume 2:1 Max. Load VSWR

BROADBAND LOW POWER



ALL NEW!

Model No.	Frequency (GC)	Max. Power		Insertion Loss (db) Max.	Isolation (db) Min.	Max. VSWR	Transmission Line	Connectors		Dimensions (in.)			Weight (lbs.) Approx.
		Peak (Kw)	*Avg. (w)					Input	Output	L	W	H	
D44S(72L3)	1-2	10	10	1.0	10.0	1.25	3/8" coax.	N Ma	N Fe	1 1/2	1 1/2	1 45/64	2 lb. 2 oz.
D44S(72S3)	2-4	10	10	1.0	10.0	1.20	3/8" coax.	N Ma	N Fe	11 11/64	1 1/2	1 45/64	1 lb. 7 oz.
D44C(72C3)	4-7	10	10	1.0	10.0	1.20	3/8" coax.	N Ma	N Fe	6 7/16	1 41/64	1 23/32	1 lb. 4 oz.
D44E(72E3)	7-11	10	10	1.0	10.0	1.25	3/8" coax.	N Ma	N Fe	6 7/16	2 1/4	2 3/8	1 lb. 6 oz.

*Assume 2:1 Max. Load VSWR

BROADBAND HIGH POWER



ALL NEW!

Model No.	Frequency (GC)	Max. Power		Insertion Loss (db) Max.	Isolation (db) Min.	Max. VSWR	Transmission Line	Connectors		Dimensions (in.)			Weight (lbs.) Approx.
		Peak (Kw)	*Avg. (w)					Input	Output	L	W	H	
D44L7	95-235	10	200	1.0	10.0	1.25	7/8" coax.	L-T Ma	L-T Fe	15 1/2	2 1/16	3 9/16	5 1/2
D44L6	1.25-1.365	20	200	0.7	15.0	1.20	7/8" coax.	N Ma	N Fe	11 1/2	2 1/16	3 9/16	5 1/2
D44S2	2.0-4.0	20	200	1.0	10.0	1.20	7/8" coax.	UG-46/U	UG-45/U	12 1/4	2 1/16	3 9/16	4 1/2
D44S3-8	2.35-5.0	10	200	1.0	10.0	1.25	7/8" coax.	L-T Ma	L-T Fe	13	2 1/16	3 9/16	4 1/2

*Assume 2:1 Max. Load VSWR

†Insertion Length

STRIP TRANSMISSION LINE



ALL NEW!

Model No.	Frequency (GC)	Max. Power		Insertion Loss (db) Max.	Isolation (db) Min.	Max. VSWR	Transmission Line	Connectors		Dimensions (in.)			Weight Approx.
		Peak (Kw)	*Avg. (w)					Input	Output	L	W	H	
D44Z7	400-450	5	5	1.0	10.0	1.20	Strip	N Ma	N Fe	7 37/64	3	1 1/2	3 lbs. 7 oz.
D44P1-8	870-990	5	5	1.2	20.0	1.20	Strip	N Ma	N Fe	7 37/64	3	1 1/2	3 lbs. 7 oz.

*Assume 2:1 Max. Load VSWR

BROADBAND WAVEGUIDE

ALL NEW!

Model No.	Frequency (GC)	Max. Power		Insertion Loss (db) Max.	Isolation (db) Min.	Max. VSWR	Transmission Line	Connectors		Dimensions (length - inches)		Weight (lbs.) Approx.
		Peak (Kw)	*Avg. (w)					Input & Output	Length	Width		
D41S3	2.6-3.95	10	10	1.0	15	1.10	RG 48/U	UG 53/U	11	11	12 1/2	
D41C3	3.95-5.85	10	10	1.0	20	1.15	RG 49/U	UG 149 A/U	8	8	6 1/4	
D41G3	5.85-8.2	10	10	1.0	25	1.15	RG 50/U	UG 344/U	6 1/2	6 1/2	3	
D41Z3	8.2-12.4	10	10	1.0	30	1.15	RG 52/U	UG 39/U	6 1/4	6 1/4	2	
D41U3	12.4-18.0	10	10	1.0	30	1.15	RG 91/U	UG 419/U	*6	*6	2	

*Assume 2:1 Max. Load VSWR

*Tentative

Most of these units available from stock. We will welcome your inquiries for more complete information.

SPERRY

DIVISION OF SPERRY RAND CORPORATION

MICROWAVE ELECTRONICS COMPANY,
CLEARWATER, FLORIDA

Microline Instruments • Radar Test Sets • Systems Instrumentation • Solid State Devices and Materials • Microwave Components and Antennas

CIRCLE 229 ON READER-SERVICE CARD

Working from 18,000 to 90,000 mc?

**Don't
settle
for
less
than
narda
precision
Impedance
Meters!**



**MILLIMETER
IMPEDANCE METERS**

Model:	Price:
K218	\$ 500.
V217	600.
Q217	1100.
M217	995.
E217	1650.

Just because you're working in millimeter bands is no reason to "make do" with lesser specs than you get from L to KU Bands. It's true that it's more difficult to maintain top specs at 90,000 mc than at X Band, for example, but in most cases Narda does it! And especially, in our slotted lines!

Precision instruments in every way, Narda millimeter Impedance Meters give you these important benefits: Smooth, stable carriage travel, absolutely parallel to the transmission line axis, with complete freedom from backlash. Imperceptible slope (0.01 max.), thanks to precision milling of tellurium copper

main transmission line, followed by a silver plate of molecular thickness and a rhodium flash.

Residual VSWR is under 1.01 for K and V Bands; 1.02 for Q, M and E. Position of the built-in probe is measured with a precision dial indicator having a least count of 0.001". And as an added advantage, the probe is usable with any waveguide detector.

All in all, an exceptionally fine instrument — and yet, typical of all Narda millimeter products. For complete information on the entire line, write for a free catalog. Address: Dept. ED-6.

Rely on narda for these other precision millimeter products:

Direct Reading **VARIABLE ATTENUATORS**
HARMONIC GENERATORS
High-Directivity **DIRECTIONAL COUPLERS**
FREQUENCY METERS

STANDARD GAIN HORNS

SLIDING TERMINATIONS
FIXED TERMINATIONS
TUNABLE SHORTS
CRYSTAL DETECTORS

**UHF
to 90 Gc!**



**NARDA '61
Microwave
Catalog
puts all this
at your
fingertips:**

- Complete specs and prices on attenuators, bolometers, coax couplers, ferrite devices and magnetron modulators, plus over 600 microwave instruments and components!
- Standard waveguide data chart
- Single and double ridged waveguide standards
- 17 additional pages of technical data and charts

MAIL COUPON TODAY

Gentlemen: Please send me your 1961 Catalog.

Name _____

Title _____

Company _____

Address _____

City _____ Zone _____ State _____



the **narda** microwave corporation

PLAINVIEW, LONG ISLAND, N. Y.

GE 3-9000

ANOTHER
ADVANCED
MICROWAVE
TUBE
DEVELOPMENT



COMPACT C-BAND TWT, QKW 928, utilizes PPM focusing for lightweight construction. VSWR is 1.1 over any 50 Mc channel. Tube is also available with coaxial fittings for full octave (4-8 kMc) coverage.

Raytheon introduces low-cost 12-watt TWT for long-life microwave relay operation

Rugged all metal-ceramic tube for 5,925 to 7,125 Mc range designed for power amplifier service in unattended stations.

The QKW 928 offers a combination of advantages never before available in a traveling wave tube for communications applications.

This 12-watt tube's periodic permanent magnet focusing permits a new, simpler, more compact construction that assures long life and permits a lower cost. The new design reduces external magnetic fields so that two tubes can be mounted in close proximity to each other.

Write today for detailed technical data or application service to Microwave and Power Tube Division, Raytheon Company, Waltham 54, Massachusetts. In Canada: Waterloo, Ontario.

QKW 928 TYPICAL OPERATING CHARACTERISTICS

Frequency Range	5,925-7,125 Mc
Power Output (saturated)	12 Watts minimum
Small Signal Gain	36 db
Helix Voltage	2,600 Vdc
Collector Voltage	2,600 Vdc*
Anode Voltage	2,650 Vdc
Filament Voltage	6.3 Volts

*Can be depressed to 1,400 volts for improved efficiency.

RAYTHEON COMPANY

MICROWAVE AND POWER TUBE DIVISION

RAYTHEON



MICROWAVES PRODUCTS

DC Blocks

669



For counter-measures systems, these dc blocks operate from 1 to 7 Gc. Model 875 has a range of 1 to 1 Gc with an insertion loss of 0.3 db max and a vswr of 1.25 max. Model 876 has a range of 2 to 7 Gc with an insertion loss of 0.4 db max and vswr of 1.3 max. Units dissipate 4 w at 100 v. Bodies, black anodized aluminum, measure 1-15/16 in. long and 5/8 in. in diameter.

Weinschel Engineering Co., Dept. ED, Kensington, Md.
P&A: \$60.00; 10 weeks.

Standard Coaxial Switches

460

More than 80% of the coaxial switch functions can be handled by this standard line of switches, the firm says. They operate from 1 to 4,000 mc at power ratings of 100 to 1,000 w. The vswr is 1.3. Both manual and electromagnetically operated switches are available in a variety of switch functions up to 12 throws, single and double pole. Design includes shorted, non-shorted, and resistor terminations.

RF Products Div., Amphenol-Borg Corp., Dept. ED, 33 E. Franklin St., Danbury, Conn.
Price: \$18 each for 100 or more.

C-Band Circulator

453



Light-weight, compact C-band circulator operates over a wide temperature range. Designated model CC03, the circulator operates from 5.4 to 5.9 Gc with inser-

◀ CIRCLE 231 ON READER-SERVICE CARD

MICROWAVES

tion losses less than 1.2 db. Isolation is greater than 12 db. Temperature range is -55 to $+105$ C. Device permits use of antennas for simultaneous transmission and reception.

Motorola, Inc., Solid State Electronics Dept., Dept. ED, P. O. Box 5409, Phoenix, Ariz.

Coaxial Shutter 454



For fail-safe protection from rf overloads, the model S-70 coaxial shutter provides 40-db isolation up to 4 Gc upon failure or removal of actuator power. Operating time is 6 msec. Shutters measure 2.9 x 0.9 x 1.5 in., weigh 1.5 oz, operate from -65 to $+160$ F, and meet MIL-E-5272 specs.

Don-Lan Electronics Inc., Dept. ED, 2520 Colorado Ave., Santa Monica, Calif.

Waveguide Shutter Switch 450



Miniature waveguide shutter switch, model 890444, weighs less than 3-1/2 oz and occupies 1.65 cu in. Unit operates in the X-band with a vswr of 1.1. Over a 10% bandwidth, the vane-closed attenuation is 30 db min. Vane-open attenuation is 0.2 db max. Switch is made to protect radar receiver crystals resulting from strong local signals when receiver is turned off.

Litton Industries, Dept. ED, 200 E. Hanover Ave., Morris Plains, N. J.



McCoy Electronics Co., Mount Holly Springs, Pa., uses the G-R 1130-A Counter to measure the temperature stability of crystals in production testing. The crystal is placed in an air stream whose temperature can be controlled over a range from -10° C to $+10^{\circ}$ C. Frequency is measured directly with the Counter.

G-R COUNTER RUNS 4100 HOURS* WITHOUT DOWNTIME

... and still going strong!

A G-R 1130-A Counter at McCoy Electronics Company has been in continuous service for 4157 hours without replacement, adjustment, or maintenance of any kind! This is not an isolated instance — similar records are being run up daily by other G-R Counters in service.

THIS RECORD OF RELIABILITY IS NOT SURPRISING:

This instrument uses a simplified decade code not found in any other counter. Unreliable multiple feedback loops required by other codes have been completely avoided. This counter will not "go soft" or give erroneous readings without warning.

The Counter's circuits have been designed to operate properly under the worst possible combination of cumulative tolerances imposed by tubes, component values and voltage levels. In fact, this Counter will perform properly even when its tubes approach the half-dead state.

The Counter uses proven "hard bottoming" multivibrator dividers for exceptional stability, eliminating periodic adjustments of time-base circuits.

There are many, many other built-in reasons that make the G-R 1130 Digital Time and Frequency Meter the most reliable Counter ever built. For a complete description of this remarkable new instrument write for our Counter Bulletin.

*As of August 3, 1961

SPECIFICATIONS

Display: 8 digits intermittent; 4 digits continuous readout (previous count displayed continuously during counting interval; changes to new value when count is completed).

Measurement Ranges:
Frequency: dc to 10 Mc
Period: 10 μ sec to 10⁷ sec
Time Interval: 1 μ sec to 10⁷ sec
Also measures 10 periods, frequency ratios, phase shifts, pulse characteristics, and counts random events.

Sensitivity: 0.25v rms

Accuracy: ± 1 count \pm time-base stability. A variety of time-base generators are available with short-term stabilities ranging from 1 part in 10⁴/min to 1 part in 10⁵/min.

Price: From \$2,595 to \$2,950 depending on time-base generator desired.

Accessories Available: Digital-to-Analog Converter, Data Printer, Frequency Converter to extend measurements to 500 Mc under development.

GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

NEW YORK, WOrth 4-2722
District Office in Ridgefield, N. J.
Whitney 3-3140

CHICAGO
Oak Park
Village 8-9400

PHILADELPHIA
Abington
HAncock 4-7419

WASHINGTON, D.C.
Silver Spring
JUniper 5-1088

SAN FRANCISCO
Los Altos
WHitecliff 8-8233

LOS ANGELES
Los Angeles
HOLlywood 9-6201

IN CANADA
Toronto
CHerry 6-2171

the common denominator behind each success:

SERVOSCOPE®

servo system analyzer

The *Atlas*... the *Minuteman*... take virtually any major missile program
... The *B-52-H*... the *F-104*... all the important aircraft developments
... The *M-60* or any other tank... Plants and projects throughout the world—
most likely including your own...

From missiles to manufacturing—wherever servo systems must be tested
and evaluated quickly, accurately, dependably—there is one common
denominator: the **SERVOSCOPE®** servo system analyzer. **SERVOSCOPE** stands
in the shadow of each success.

To the engineer working with missiles, weapons systems, airborne gear, ground
support equipment, instrumentation, navigation equipment, computers,
controls... **SERVOSCOPE** is an accepted part of the program. Understandably so.

From the simplest to the most complex electronic, electrohydraulic,
electromechanical, and electropneumatic servo system, they find, **SERVOSCOPE**
provides them with reliable answers in a hurry. By measuring the changes
in phase, gain, and transient response which occur when signals of various
frequencies are fed to the design, the investigator can safely evaluate
the behavior pattern of the system to meet ultimate operating conditions.

SERVOSCOPE is always set to take on new problems immediately.
And it's so easy to operate, that even a new man will be plotting Nyquist,
Bode, and Nichols diagrams after only a few minutes' familiarization.
(You'll even see **SERVOSCOPE** being operated right on the production line.)

If you've never tried the **SERVOSCOPE**, never seen what it can do,
prove it to yourself. Ask for a demonstration. There's a Servo office or
representative in your area.

- A free set of **SERVOSCOPE** WORKSHEETS or a Servo calculator, as well as technical literature will be sent you on request.



SERVO CORPORATION OF AMERICA

111 New South Road • Hicksville, L. I., N. Y. • WElls 8-9700

Sales and service offices coast to coast

NEW LITERATURE

Temperature Recording 261

Operation of a platinum resistance temperature detector is outlined in this 12-page booklet. Bridge circuits and calibration tables are shown. Brush Instruments, 37th and Perkins, Cleveland 14, Ohio.

Torque Measurements 262

Methods of measuring torque characteristics and speed of motors, gear trains, servo mechanisms, and potentiometers are described in this 12-page brochure. Torques from 1/4 to 200 lb-in. are included. Power Instruments, Inc., 7352 N. Lawndale Ave., Skokie, Ill.

Precision Resistors 263

The firm's line of precision deposited carbon-film resistors for commercial, sub-miniature, MIL-type, high-resistance, high-voltage, and microwave resistor applications is described in this eight-page catalog. Pyrofilm Resistor Co., Inc., U. S. Highway 46, Parsippany, N. J.

Weight and Thrust Measurements 264

Typical instrumentation systems for jet engine test facilities and electronic methods of weight and thrust measurements and calibrations as used in ICBM facilities are discussed in 32-page technical bulletin No. TD-106. Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland 20, Ohio.

Tables and Formulas 265

Tables of weights and measures, math symbols and constants, the Greek alphabet, temperature conversions, binary numbers, powers of numbers, electrical formulas, the fundamentals of Boolean algebra, and similar information is available in this 32-page booklet, "Tables and Formulae." Automatic Electric Sales, Industrial Products Div., Control Equipment Sales, Northlake, Ill.

Graphical Symbols

Seventy-eight recommended graphical symbols for machines, transformers, primary cells, and batteries are given in 30-page publication No. 117-2 of the International Electrotechnical Commission. Send \$2.40 to American Standards Association, Dept. P-209, Dept. ED, 10 E. 40 St., New York 16, N. Y.

Flexible Laminates 266

Flexible laminates for temperature classes A and B are described in this eight-page brochure. Typical properties and applications of varnished cambric and polyester film laminations combined with various other laminating materials are listed. Minnesota Mining and Manufacturing Co., Irvington Div., Dept. W1-193, 900 Bush Ave., St. Paul 6, Minn.

Regulated Power Supplies 267

The firm's line of regulated transistorized power supplies is listed in this 44-page long-form catalog. Descriptions, illustrations, specifications, output curves, and prices are given for over 20 instruments. Harrison Laboratories, Inc., 45 Industrial Road, Berkeley Heights, N. J.

Instrument Tubes

Characteristics and applications of instrument tubes, including frame-grid and secondary emission tubes, are given in eight-page bulletin No. PA-391. Write on company letterhead to CBS Electronics, Dept. ED, 100 Endicott St., Danvers, Mass.

Microminiature Flip-Flops 268

A series of microminiature flip-flops, called Micrologic elements, are described in this eight-page brochure. Logic design and applications of the devices are described. Fairchild Semiconductor Corp., 545 Whisman Road, Mountain View, Calif.

Epitaxial Devices 269

Germanium and silicon epitaxial transistors and diodes are described in this eight-page booklet entitled "A Case History in Progress." Mechanical and electrical characteristics of six units are given and compared with those of some conventional types. Sylvania Electric Products, Inc., 1100 Main St., Buffalo 9, N. Y.

Microwave Components

The firm's microwave instruments and components are described and illustrated in 32-page catalog No. SH-61. Electrical and mechanical specifications of the devices are given. Some general microwave theory, including methods of impedance measurement, is presented in text. Write on company letterhead to Alford Manufacturing Co., Dept. ED, 299 Atlantic Ave., Boston 10, Mass.

New Bourns Precision Potentiometer Resolves the Quality-Price Dilemma!

Here is military reliability in a competitively priced industrial potentiometer. Bourns wirewound 10-turn Model 3500 measures just $\frac{7}{8}$ " in diameter by 1" long—shorter by $\frac{1}{2}$ " than units available elsewhere—yet has a resistance element 20% longer than that of comparable potentiometers.

Fully meeting military requirements for steady state humidity, Model 3500 can also be provided at a 10% premium to meet the cycling humidity specs of MIL-STD-202, Method 106. It's the only $\frac{7}{8}$ " 10-turn potentiometer guaranteed to meet this spec. Its published characteristics incorporate wide safety margins.

Reliability insurance is provided by the exclusive Bourns Silverweld[®] bond between terminal and resistance wire. Virtually indestructible under thermal or mechanical stress, this termination

eliminates a chief cause of potentiometer failure. In addition, a special close-tolerance rotor almost completely does away with backlash.

Model 3500 is also subjected to the rigorous double-check of Bourns' exclusive Reliability Assurance Program. In short, every possible step is taken to ensure that the performance you specify is the performance you get. Write for complete data.

Resistances	500 Ω to 125K. $\pm 3\%$ std. (to 250K spl.)
Linearity	$\pm 0.25\%$ std.
Power rating	2w at 70°C
Operating temp.	-65° to +125°C
Mech. life	2,000,000 shaft revolutions



BOURNS
 BOURNS, INC. TRIMPOT DIVISION
 8135 MAGNOLIA AVE. RIVERSIDE, CALIF.
 PHONE OVERLAND 4-1700 - TWX R29222
 CABLE: BOURNSINC

Manufacturer: Trimpot[®] potentiometers; transducers for position, pressure, acceleration. Plants: Riverside, California; Ames, Iowa; and Toronto, Canada

CIRCLE 234 ON READER-SERVICE CARD



TRANSISTOR HEAT SINKS

FOR TO-5, TO-9 AND TO-18 CASES!

Stud-mounted
types for TO-5
and TO-9 packages.
1101A — insulated
1101 — uninsulated

- approaching 25°C case temperature ratings!
- positive contact — not a friction fit!
- electrical insulation for "hot" cans!



Stud-mounted
types for
TO-18 package
1107—insulated
1106—uninsulated



Finned types for
TO-5 and TO-9
printed board
applications
2209—insulated
2208—uninsulated

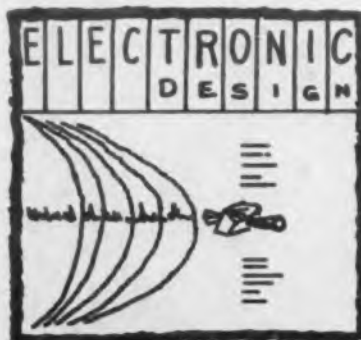
for Complete Details Send for Technical Bulletin No. 6100-A



Thermolloy Company

2130 IRVING BOULEVARD
BOX 4341 • DALLAS 8, TEXAS

CIRCLE 235 ON READER-SERVICE CARD



most
effective
on
the
job



A recent circulation estimate revealed that 95% of *ELECTRONIC DESIGN*'s readers receive the magazine at their plants—on the job where it is most effective as a design workbook.

By receiving *ELECTRONIC DESIGN* at work, you're getting extra values from it. These extra values—known to marketing people as time and place utilities—add to the usefulness of any item. Only in-plant distribution gives you: Time Value—because *ELECTRONIC DESIGN* arrives precisely when you can use it best . . . while you're working; Place Value—because it arrives where it can really be put to work . . . on the job, at the point of design.

If you don't receive your copies where you work, write to our Circulation Department and request that your subscription be addressed to you at your plant. By putting *ELECTRONIC DESIGN* on the job you'll be getting the most value from it.

Arriving at the plant, *ELECTRONIC DESIGN* brings new ideas to be applied to your current projects. You and your fellow designers can discuss timely topics together—expressing your views and comments while the news is fresh in your minds. And, when searching for sources, for products, for new techniques, you need look no further than the copies of *ELECTRONIC DESIGN* right on your desk.

NEW LITERATURE

Electron Tubes 270

Called "Electron Tube Application Notes," this 58-page illustrated brochure reviews many of the "do's and don'ts" of electron tube applications. Sylvania Electric Products, Inc., 1100 Main St., Buffalo 9, N. Y.

Power Supplies 271

A line of isolated power supplies and transformers, current sources, integrators and indicators, and dc amplifiers are described in this series of catalogs. A price list is also available. Elcor, Inc., 1225 W. Broad St., Falls Church, Va.

Space Re-Entry Vehicles 272

The development of re-entry vehicles in the U.S. space programs is surveyed in this 33-page, illustrated booklet entitled "Progress in Re-Entry and Recovery Vehicle Development" General Electric Co., Missile and Space Vehicle Dept., 3198 Chestnut St., Philadelphia 1, Pa.

Microwave Antennas 273

Plane and dual polarized parabolic microwave antennas operating from 0.8 to 13 Gc are described in this 14-page catalog, No. 100. Electrical and physical specifications are included. Technical Appliance Corp., Sherburne, N. Y.

Coaxial Lines 274

Aluminum and copper coaxial transmission lines are described in 40-page catalog No. 595. Installation procedures and recommendations and electrical characteristics are given. Prodelin, Inc., 307 Bergen Ave., Kearney, N. J.

Thermocouple References 275

The firm's line of thermocouple reference junctions is described in this eight-page booklet. Materials used, specifications and operating characteristics are given. Genistron, Inc., 6320 W. Arizona Circle, Los Angeles 45, Calif.

Transistor Testers 276

Go-no-go and absolute-readout transistor testers are described in this 12-page brochure. Specifications for several models are given, and theory of operation is discussed. Fairchild Semiconductor Corp., 545 Whisman Road, Mountain View, Calif.

Wire Products

277

Over 6,000 electronic wire, cable, and tubing products are described in 52-page catalog No. 62. Included are military hook-up wire, Teflon and magnet wire, cables, tubing products are described in 52-page *pha Wire Corp.*, 200 Varick St., New York 14, N. Y.

Microwave Instruments

278

Microwave signal sources, levelers, amplifiers, low-noise amplifiers, and power supplies are described in this eight-page short-form catalog entitled "Microwave Tube Instrumentation." Illustrations, descriptions, and specifications are included. Wave Particle, 150 S. Second St., Richmond, Calif.

Tachometers

279

The firm's line of ac and dc tachometer generators and indicators are described in 12-page bulletin No. GEZ-3251. Information on application, calibration, accuracy, and selection is given. Specifications, schematics, and photos of the systems are included. General Electric Co., Schenectady 5, N. Y.

Selenium Rectifiers

280

A line of selenium rectifiers, including high-voltage, high-current, arc-suppressing, and encapsulated units, is described and illustrated in eight-page bulletin 101. Electrical ratings are included. Edal Industries, Inc., 4 Short Beach Road, East Haven, Conn.

Pilot Lights

281

Subminiature indicator lights, pilot lights with resistors for neon lamps, enclosed assemblies for neon and incandescent lamps, oil-tight lights, dimmers, press-to-tests lamps, lens holders, and similar lights and lamps are described and illustrated in 24-page catalog L-161C. Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.

Portable Meters

282

A line of ac and dc voltmeters, ammeters, ohmmeters, industrial meters and circuit testers, current transformers, ac clamp meters, light meters, and similar instruments are described and illustrated in eight-page catalog Z-54. Specifications and prices are given. Daystrom, Inc., Weston Instruments Div., 614 Frelinghuysen Ave., Newark, N. J.

The amplifier that beats temperature



NEW DONNER OPERATIONAL AMPLIFIER features exceptionally low drift with temperature variation. (See specs below.) Single channel Model 3811 shown here was tested between -55°C and $+55^{\circ}\text{C}$ in temperature chamber—standard procedure for all Donner amplifiers before delivery.

Drift is *not* a function of temperature in Donner solid state operational amplifiers. Donner's design assures reliable performance at non-constant temperature—as you actually encounter. For only \$150, Donner offers a single channel, chopper stabilized amplifier that meets these drift specs (significantly lower per 10°C than any competing model):

DRIFT REFERRED TO INPUT

- (a) at constant temperature: $100\ \mu\text{v}/8\ \text{hours}$
- (b) between -20°C and $+45^{\circ}\text{C}$: $150\ \mu\text{v}/10^{\circ}\text{C}$
- (c) between -55°C and $+55^{\circ}\text{C}$: $200\ \mu\text{v}/10^{\circ}\text{C}$

Donner's operational amplifiers may be used for integration, summation, inversion, differentiation or low-level preamplification. Dual channel units (Model 3811-2) are available on printed cards, priced at \$300. Both single and dual channel models use germanium transistors. They are also available with silicon transistors.

OTHER KEY SPECIFICATIONS

Input Impedance, 500k at dc; Frequency Response, $-3\ \text{db}$ at 150 kc (unity closed loop gain); Open Loop Gain, 10^6 at dc; Output Range, 40 volts. Note: chopper section also solid state.

ORDER NOW IF YOU DESIRE — Donner guarantees all specs and data in this ad. To order, specify Model 3811 Single Channel Operational Amplifier (\$150) or Model 3811-2 Dual Channel Amplifier (\$300). *Quantity discounts on orders of 10 or more.* Prices are for germanium models, f.o.b. Concord, California. Delivery 45 days.



ADDITIONAL INFORMATION

Technical bulletin gives complete specifications. Also available is new brochure on unique quarter-square multiplier. Please call your Donner rep or write us directly.

DONNER

 SCIENTIFIC DIVISION

SYSTRON-DONNER
Corporation

888 Galindo Street • Concord, California • MUlberry 2-6161

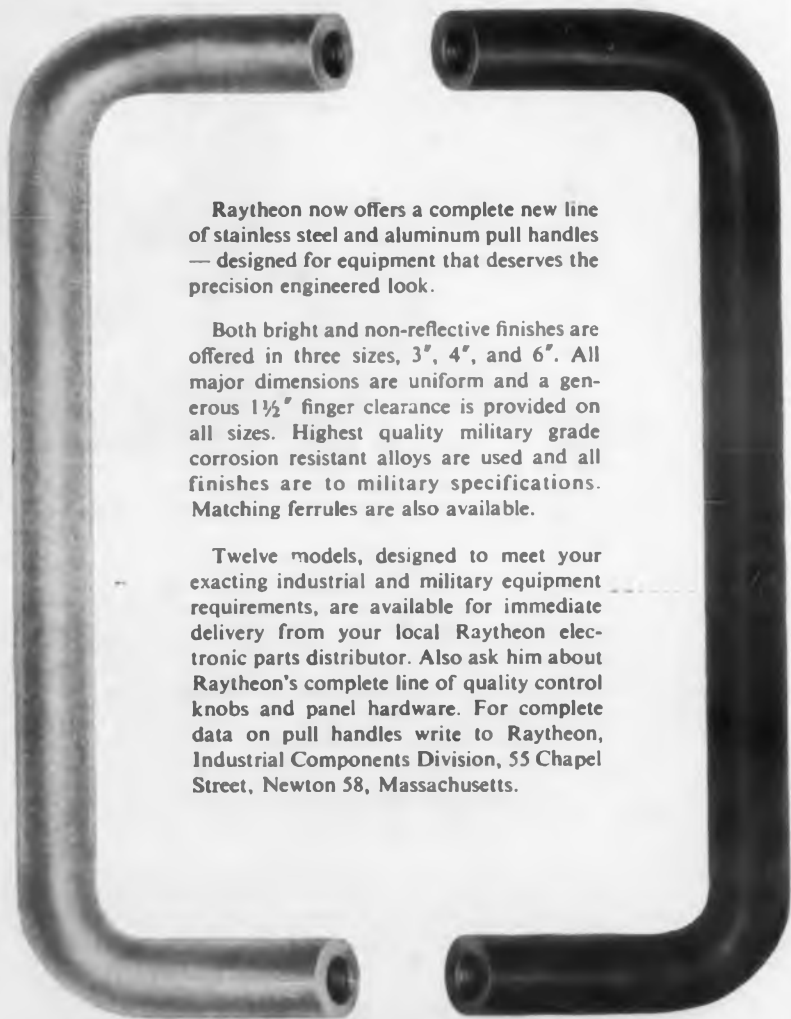
CIRCLE 236 ON READER-SERVICE CARD

New from Raytheon . . .

QUALITY PULL HANDLES

in STAINLESS or ALUMINUM

**from Factory Stock or
Raytheon's 350 Distributors**



Raytheon now offers a complete new line of stainless steel and aluminum pull handles — designed for equipment that deserves the precision engineered look.

Both bright and non-reflective finishes are offered in three sizes, 3", 4", and 6". All major dimensions are uniform and a generous 1½" finger clearance is provided on all sizes. Highest quality military grade corrosion resistant alloys are used and all finishes are to military specifications. Matching ferrules are also available.

Twelve models, designed to meet your exacting industrial and military equipment requirements, are available for immediate delivery from your local Raytheon electronic parts distributor. Also ask him about Raytheon's complete line of quality control knobs and panel hardware. For complete data on pull handles write to Raytheon, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts.

RAYTHEON

RAYTHEON COMPANY

INDUSTRIAL COMPONENTS DIVISION

CIRCLE 237 ON READER-SERVICE CARD

NEW LITERATURE

Materials Test Instruments 283

Optical and physical properties of materials can be investigated with the equipment described in this 28-page general catalog. Among the devices included are abrasion testers, color differentiators, scratch-thickness gages, glossmeters, reflectometers, and viscosity cups. Illustrations, descriptions, general specifications, and prices are given. Gardner Laboratory, Inc., P. O. Box 5728, Bethesda 14, Md.

Potentiometers 284

Loading, trimming, linearity, and life expectancy of potentiometers is discussed in this bulletin. Load and quadrature compensated potentiometers, single-turn precision potentiometers, and rotation-to-voltage transducers are described and illustrated. Analogue Controls, Inc., 200 Frand Road, Hicksville, N. Y.

Terminal Selection 285

The proper size terminal or splice barrel for any given size of solid, stranded, rectangular, or square wire can be selected with this catalog. Tables and a nomogram aid in estimation of circular mil area of wire, from which the proper terminal can be selected. A stud hole chart is included. AMP Inc., Eisenhower Blvd., Harrisburg, Pa.

Conductive Cements 286

Thermosetting silver and gold cements suitable for use in place of solder are described in 4-page bulletin No. CP-7-361. Application and curing of cements and use in laminations are considered. Testing procedures are outlined. Thinners are described, and methods of storage are suggested. Physical properties are briefly tabulated. E. I. DuPont de Nemours and Co., Wilmington 98, Del.

TWT's OPTIMIZED for NARROW BAND USE

GREATER POWER OUTPUT
INCREASED SMALL SIGNAL GAIN

L 1.1 - 1.4 kmc The PPM focused type HA-53, normally operated from 1-2 kmc, when optimized is capable of > 35 DBM power output and 40 db small-signal gain

S 2.4 - 3.8 kmc Cataloged as a 2-4 kmc amplifier, the PPM focused HA-30 exhibits > 40 db small-signal gain, with 33 DBM minimum power output over the narrow band.

C 5.3 - 6.0 kmc The HA-35, a 4-8 kmc solenoid focused amplifier, displays narrow-band performance of 32 DBM minimum power output, and > 45 db small-signal gain.

X 8.5 - 9.5 kmc Normally operated from 8-11 kmc, the PPM focused type HA-21 is capable of > 45 db small-signal gain, and 31 DBM minimum power output when optimized.

If your system application requires a high-performance, narrow-band traveling wave tube amplifier, contact Huggins Laboratories. We may have a TWT with the exact characteristics for your system.

HUGGINS LABORATORIES INC.
999 East Arques Ave. • Sunnyvale, Calif. • RE 6-9330

HUGGINS LABORATORIES
manufacture
development
engineering
design
research

CIRCLE 238 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

Power Supplies 287

Solid-state and vacuum-tube power supplies, regulated and unregulated, are listed in this 16-page catalog. Illustrations, descriptions, specifications, and prices are included. NJE Corp., 20 Boright Ave., Kenilworth, N. J.

Chemicals 288

Bright dips, carbon removers, cleaners, scale removers, wire strippers, ultrasonic descalers, and other chemicals for use in electronic parts manufacture are listed in this catalog. Fidelity Chemical Products Corp., Electronic Chemicals Div., 470-474 Frelinghuysen Ave., Newark 14, N. J.

Germanium Transistors 289

The firm's line of germanium transistors is cataloged in bulletin AO-3. Over 452 types are listed with electrical specifications in eight pages. Electronic Transistors Corp., 9226 Hudson Blvd., North Bergen, N. J.

Transformers

Data on miniature transformers are contained in this looseleaf handbook. Called the "Transformer Handbook Manual", this publication includes a transistor load impedance nomogram, MIL designation information, terminal connection sheets, environmental guides, and a cross-reference index. Technical data on the firm's line is given. Write on company letterhead to Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N. Y.

Wave Tube Catalog 290

Data and outline drawings of many types of millimeter wave tubes are given in this 52-page catalog. Included are monitor diodes, noise tubes, high power floating drift tube klystrons, reflex klystrons and others. Also included are noise tube mounts and adjustable waveguide mounts. Litton Industries, Electron Tube Div., 960 Industrial Road, San Carlos, Calif.



TERMINAL BOARDS

Kulka Military Terminal Boards were designed by the Bureau of Ships according to MIL-T-16784B. They are made to BUSHIPS 9000-S6505-73214 drawings, with latest revisions, and BUORD S64101.

Kulka Military Boards are available as single row, double row, or through connected type units, and are molded of Type MAI-60 glass-filled alkyd resin according to the latest revision of M-14 specifications.

Kulka offers the complete line of these Military Boards, along with a wide selection of hardware accessories...

The complete catalog on Military Terminal Boards... Write for your FREE copy...



KULKA ELECTRIC CORP.

633-643 SO. FULTON AVENUE, MOUNT VERNON, N. Y.

CIRCLE 239 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

up to 3300pf
capacitance
packed into
.0023 cubic inch

NEW ERIE WEECON

sub-miniature ceramic plate capacitors conserve valuable printed board space

High capacitance in limited board space is made possible by WEECON Ceramicons[®], designed by Erie to offer the ultimate in miniaturization of ceramic capacitors.

Sub-miniature size and rectangular design permit a higher component density on printed circuit boards and in applications where space is a critical factor. Available in MIL lead spacing for printed wiring boards or conventional spacing for point-to-point wiring.

WEECON Ceramicons are conservatively rated at the following specifications:

Temperature Range: -55°C to +85°C. Also available for 125°C at lower working voltages

Working Voltage: 200 VDC

Life Test Voltage: 2xVDCW 1000 hours 85°C

Flash Test Voltage: 3xVDCW

Coating: Dipped, resin coated

Style	4815	4825	4835	4845	4855	4865
Max. Size	.150x .150	.200x .200	.300x .300	.400x .400	.500x .500	.600x .500
Thickness	.100"	.100"	.100"	.100"	.150"	.150"
Capacitance	6pf to 3300pf	11pf to 6200pf	25pf to .0135mf	48pf to .025mf	76pf to .040mf	90pf to .05mf

For more information on WEECON Ceramicons, write for New Product Bulletin NP-128-1.



ELECTRONICS DIVISION

ERIE RESISTOR CORPORATION

646 West 12th Street • Erie 6, Pennsylvania

Sales offices in principal cities of USA, Canada, Europe

CIRCLE 240 ON READER-SERVICE CARD



LOW NOISE CHOPPER "TECHNIQUE REPORT" *offered on request*

IN DC INSTRUMENTATION
**THE LOWEST NOISE AND DRIFT
CHOPPERS
ARE
JAMES**

The measure of how low or stable a level of DC signal can be modulated by a chopper is a complexed analysis of circuit and component. JAMES has prepared a complete technical review of measurement techniques and correct use of mechanical choppers.

On all criteria . . . magnetic, electrostatic, triboelectric, electrochemical noise and thermal drift JAMES has the superior components. The correct chopper for commercial, industrial and military.

Write for your free copy of "Chopper Noise Sources and Measurement Techniques." We solicit your chopper engineering application inquiries.

PERFORMANCE • RELIABILITY • SERVICE

JAMES[®]
ELECTRONICS INC.

4050 North Rockwell • Chicago 18, Illinois • CO 7-6333

CIRCLE 761 ON READER-SERVICE CARD



BOOKS

1961 Radio Diagrams and Servicing Information

M. N. Beitman, Supreme Publications, 1760 Balsam Road, Highland Park, Ill., 192 pp, \$2.50

A collection of the "most often needed" 1961 radio schematics. Also includes servicing information.

Introduction To Nuclear Science

Alvin Glassner, D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J., 215 pp, \$3.75

An elementary survey of nuclear science and its impact upon other physical and natural sciences. Reviews atomic structure detection methods, forms of radiation; describes nuclear reactions, and surveys accelerators and reactors.

The Theory of Equations, Volume 1 & 2

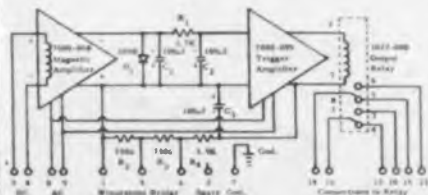
William Snow Burnside and Arthur William Panton, Dover Publications, Inc., 180 Varick St., New York 14, N. Y., 300 pp and 335 pp, \$1.85 each vol. (paperbound).

Advances In Electronics and Electron Physics, Volume XIII

L. Marton, Academic Press Inc., 111 Fifth Ave., New York 3, N. Y., 454 pp, \$13.50

Describes the latest developments in the technical areas of electron probe microanalysis, television camera tubes, field ionization and field ion microscopy, velocity distribution in electron streams, and inelastic collisions between atomic systems.

New RELAY PROVIDES 0.000,000,001 WATT DC SENSITIVITY



Model 301 units available from stock for IMMEDIATE DELIVERY!

Price for 1-5 units: \$98.75 each.
Full details available in Bulletin No. 30-A.

This industrial "ACRO-RELAY", Model 301, closes its output relay with a DC signal of 1.0 microamp and 1.0 millivolt into its 1000 ohm input winding—an input power of only 10^{-9} watts! It is the most sensitive, high-reliability industrial relay unit available. The input magnetic amplifier drives a trigger amplifier which drives the DPDT output relay . . . controlling up to 1800 watts!



acromag
INCORPORATED

22515 TELEGRAPH RD. SOUTHFIELD (DETROIT), MICH.

PHONE: ELGIN 7-0030

TELETYPE:

SFLD-970

On Demonstration at Booth 139, NEC SHOW

CIRCLE 762 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

Alternating Current Electricity

Alexander Efron, John F. Rider Publisher Inc., 116 W. 14 St., New York 11, N. Y., 144 pp, \$2.90

Very basic approach to alternating current circuits, measuring instruments, and power machinery.

Automatic Data-Processing Systems

Robert H. Gregory and Richard L. Van Horn, Wadsworth Publishing Co., Inc., San Francisco, Calif., 705 pp

Principles and procedures of business data-processing are presented from the point of view of management. Text is written on the layman's level and includes material on computer programing and systems analysis.

Introduction To Ceramics

W. D. Kingery, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 781 pp, \$15.00

Considers the physical and chemical properties of the various types of ceramics. Ceramic materials and processes are presented as a basis for engineering applications.

Optics and Optical Instruments

B. K. Johnson, Dover Publications, Inc., 180 Varick St., New York 14, N. Y., 234 pp, \$1.65 (paperbound).

Deals mainly with the practical application of optical principles, instruments and components.

Guide to U. S. Government Statistics (3rd Edition)

John L. Andriot, Documents Index, Box 453, Arlington 10, V., 402 pp, \$15.00

A collection of sources for U. S. Government statistical information.

Progress in Operations Research, Vol. 1

Russell L. Ackoff, Editor; John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 505 pp, \$11.50

The initial volume of a series which will review and evaluate the development of new concepts and techniques in operations research. Volume 1 stresses the progress made in inventory theory, linear and dynamic programming, queuing, sequencing and replacement theory, simulation and gaming.

STORE...
CONVERT...
DELAY...
CONTROL...
TIME...
COUNT...

with this VERSATILE
10-STAGE
MAGNETIC REGISTER



This proven plug-in can wear at least six different hats in your digital systems. Draws less than flea-power from a single $\pm 15\%$ voltage source. Maintains 40:1 ONE:ZERO ratio. Cascades without limit. We mass-produce eleven standard designs up to 750 KC, hence can sell them

at prices that dishearten competition. So reliable we use them ourselves!

Let us show you how to play the hat game with the SRA-10. A bundle of informative, inspiring literature awaits you. Write today.



DI/AN CONTROLS, INC.

944 Dorchester Ave., Boston 23, Mass. • Avenue 8-7700

magnetic digital/analog systems and components

CIRCLE 243 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

AMCO 1000 G's CERTIFIED SHOCK TESTS

Amco Aluminum and Semi-Custom Modular Frames qualify for Airborne, Shipboard and Ground Support Applications

Certified Independent Tests prove Amco Aluminum and Semi-Custom Frames withstand shock & vibration under Mil E-5272C; Procedure XI (5-500cps), Procedure III (approx. 1000g's shock Mil-S901), Procedure II (15g's and drop Mil-S4456). Write for Test Report Supplement E.

ALUMINUM . . . Unique! Meets any size. . . Flush or recessed mounting of panels. Almost any shape from 13 basic parts . . . 3 castings & 10 extrusions. Units from 6" to 20 ft.; slopes from 0° to 90° standard. MilSpecs 6062-T6 extrusions and 356-T6 castings.

SEMI-CUSTOM . . . Heavy-duty, more internal clearance . . . 14 ga. box-channel steel frames, 12 ga. gusseting provides exceptional rigidity both front-to-back and side-to-side. Frames based on 22 $\frac{1}{16}$ " increments provides clearance for recessing 19" wide panels. Meets EIA Standards.

CUSTOM . . . When space and appearance are critical . . . 16 ga. double-channel steel frames, based on increments of 19 $\frac{1}{16}$ " widths, supports in excess of 3000 lbs. Multi-width panels and cowlings give single-unit appearance with series mounted racks. Meets EIA Standards.

Amco manufactures all necessary blowers, chassis slides, doors and drawers, writing surfaces, cowlings lights and other accessories. **Check the extra savings you get thru Amco's combined-discount system of racks and accessories. PLUS FREE ASSEMBLY.**

Amco is your one complete source of Modular Instrument Enclosure Systems and Accessories. Write today for catalog of complete specifications.



Aluminum



Semi-Custom



Custom



REALISTIC 3 WEEK DELIVERY

Factory trained representatives in principal cities of U.S. and in Canada.



AMCO ENGINEERING CO.

7333 West Ainslie Street, Chicago 31, Illinois

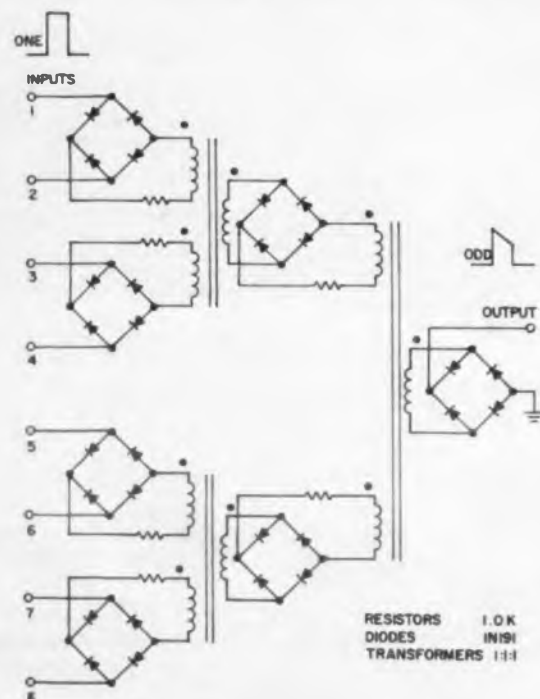


CIRCLE 244 ON READER-SERVICE CARD

IDEAS FOR DESIGN

Transformer-Coupled "Tree" 740 Checks Binary Word Parity

A simple and dependable circuit was required for making parity checks of a perforated tape reader. The circuit's function was to determine if the sum of the eight binary bits read out is even or odd. The cir-



Transformer-coupled parity checker produces output if sum of the eight-binary-bit word is odd.

\$50 "Most Valuable of Issue" Award for Improved Null Detector

Yale Jay Lubkin, senior staff engineer with Loral Electronics Corp., New York, N. Y. has won ELECTRONIC DESIGN's ninth \$50 Most Valuable of Issue Award.

Mr. Lubkin receives the award for his Idea for Design, "Two-Transistor Circuit Increases Null-Detector Sensitivity," which appeared in the July 19 issue. The idea described a circuit which permitted high-accuracy bridge measurements to be made with a relatively insensitive null-detecting device.

cuit shown accomplishes this by using transformer-coupled diode logic.

The parallel input from the reader consists of rectangular, 10-msec pulses representing "ones;" absence of pulses representing "zeros." The individual sections of the circuit are connected in a tree arrangement. Each section produces an output only if its two inputs differ. Therefore, the last stage produces an output if the parity is odd. The number of stages possible is limited by the transformer fidelity and the required repetition rate.

Stewart Coffin, Head of Engineering, Dynamic Controls Co., Cambridge, Mass.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 740.

Fast Pulse Train Synched To Slow Input Trigger 748

We needed a circuit that would generate a pulse train synchronized to an external trigger pulse. The three-transistor circuit we developed, shown in the figure, was originally designed to produce a 625-kc pulse train synched to a 333-cps trigger. However, we found that with the proper combination of inductor L_1 and capacitor C_2 , we could synch a 1.5-mc train to a trigger frequency as low as 100 cps.

The output pulse train is generated by a Colpitts oscillator, of which transistor Q_2 is a part. The trigger pulse, of ± 10 -v amplitude, is applied to capacitor C_1 . The pulse is then differentiated by the capacitor to turn on transistor Q_1 .

With Q_1 turned on, Q_2 is forced into saturation and the oscillations of the Colpitts are stopped. When the differentiated input pulse decays enough to allow Q_1 to cut off, Q_2 resumes oscillating.

Transistor Q_3 is part of a saturated amplifier which clips and shapes the output of Q_2 .

The width and amplitude of the input trigger may be varied so that the first pulse after the trigger will be either positive or negative. The waveforms shown in the figure are of the input pulse and the output

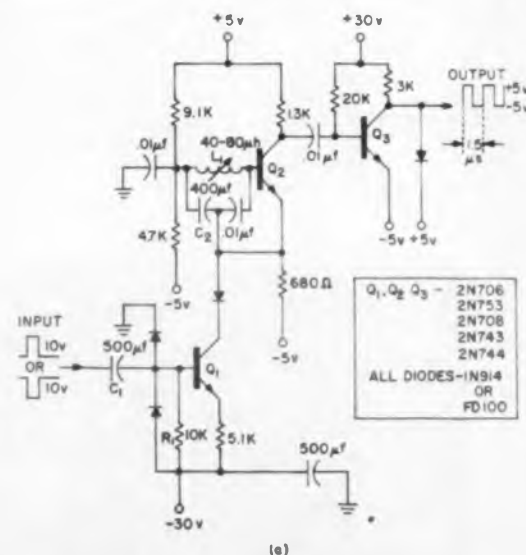
Vote for Ideas Valuable to You

Vote for the Ideas which are valuable to you. Other engineers will vote for the Ideas which are most valuable to them. The Idea which receives the most "Valuable" votes will be judged "Most Valuable of Issue." Its author will receive a \$50 award.

Choose the Ideas which suggest a solution to a problem of your own or stimulate your thinking or which you think are clever.

The Ideas chosen as the most valuable in each issue will be eligible for the \$1,000 Idea of the Year Award.

So vote for the Ideas you find most valuable. And, after you've voted, why not send in an Idea of your own?



(a) Three-transistor circuit produces a 625-kc pulse train, synched to 333-cps trigger.



(b) Photo of input and output waveforms.

pulse train when a negative pulse was required as the first pulse after the trigger.

Paul M. Danzer, Electrical Engineer, Lockheed Electronics Co., Plainfield, N. J.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 748.

SEVENTH ANNIVERSARY AWARDS

IDEAS-FOR-DESIGN

Entry Blank

How You Can Participate

Rules For Awards

Here's how you can participate in Ideas for Design's Seventh Anniversary Awards: All engineer readers of **ELECTRONIC DESIGN** are eligible.

Entries must be accompanied by filled-out Official Entry Blank or facsimile. Ideas submitted must be original with the author, and must not have been previously published (publication in internal company magazines and literature excepted).

Ideas suitable for publication should deal with:

1. new circuits or circuit modifications
2. new design techniques
3. designs for new production methods
4. clever use of new materials or new components in design
5. design or drafting aids
6. new methods of packaging
7. design short cuts
8. cost saving tips

Awards:

1. Each Idea published will receive an honorarium of \$20.
2. The Idea selected as the most valuable in the issue in which it appears will receive \$50.
3. The Idea selected as the Idea of the Year will receive a Grand Prize of \$1,000 in cash.

The Idea of the Year will be selected from those entries chosen Most Valuable of the Issue.

Most Valuable of the Issue and Idea of the Year selections will be made by the readers of **ELECTRONIC DESIGN**. The readers will select the outstanding Ideas by circling keyed numbers on the Reader-Service cards. Payment will be made eight weeks after Ideas are published.

Exclusive publishing rights for all Ideas will remain with the Hayden Publishing Co.

Ideas-for-Design Editor
ELECTRONIC DESIGN
850 Third Ave.
New York 22, N. Y.

Idea (State the problem and then give your solution. Include sketches or photos that will help get the idea across.)

(Use separate sheet if necessary)

I submit my Idea for Design for publication in **ELECTRONIC DESIGN**. I understand it will be eligible for the Seventh Anniversary Awards—\$20 if published, \$50 if chosen Most Valuable of Issue, \$1,000 if chosen Idea of the Year.

I have not submitted my Idea for Design for publication elsewhere. It is entirely original with me and does not violate or infringe any copyrights, patents or trademarks or the property rights of any other person, firm or corporation.
Hayden Publishing Company, Inc. shall have the exclusive publication rights to these Ideas for Design selected for publication in **ELECTRONIC DESIGN**. This right extends to the subsequent use of the Idea for Design by Hayden in any of its other publications. Honorariums, if any, for subsequent publication shall be solely in the discretion of Hayden Publishing Company, Inc.

Name _____ Title _____

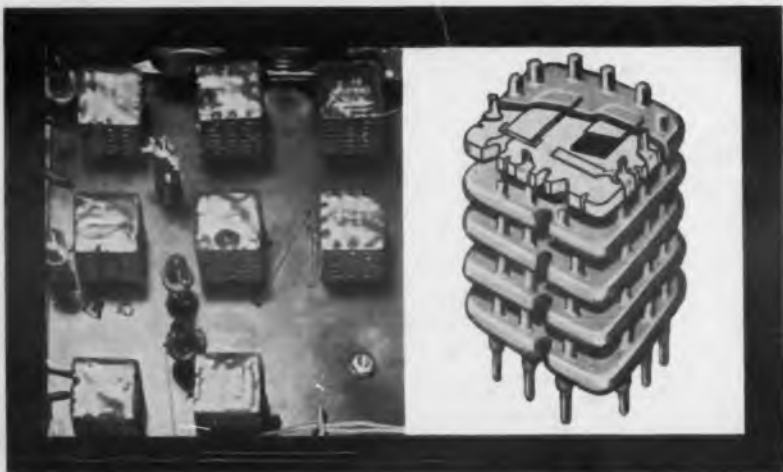
Company Name _____

Address _____

For Additional Entry Blanks, circle 750 on Reader-Service Card.

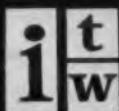


**FROM CLUTTER...
TO CLEAN DESIGN...**



**WITH INTEGRATED ELECTRONIC
COMPONENTS FROM...**

PAKTRON
PACKAGED ELECTRONICS



DIVISION OF ILLINOIS TOOL WORKS
1321 LESLIE AVENUE ALEXANDRIA, VA.

CIRCLE 245 ON READER-SERVICE CARD

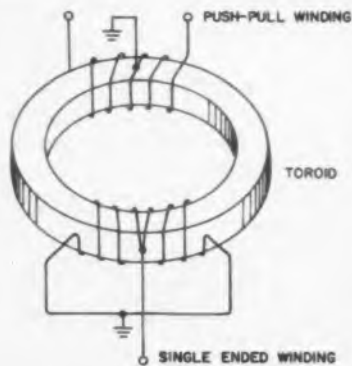
IDEAS FOR DESIGN

Balanced Xformer Windings 735 Can Be Single-Ended or Push-Pull

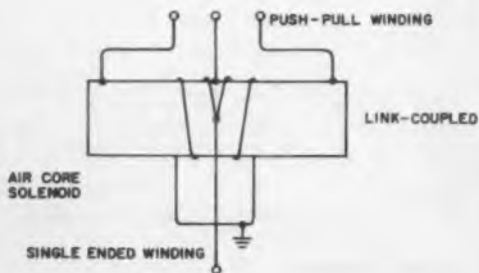
It is often necessary, in many aspects of electronics, to make a transformer that can be changed from single-ended to push-pull, or vice versa. These transformers may be air-cored or core-wound for use at higher frequencies.

The primary difficulty that this change produces is the capacitive unbalance which occurs because one side of the single-ended winding is grounded. In phase-splitting transformers this results in phase unbalance in the push-pull winding. In link-coupled, air-core arrangements the maximum voltage swing and power output, with no loss of linearity, are limited similarly.

This unbalance can be entirely eliminated by the method shown in the figure. It has been used on small ferrite toroids in phase splitters, balanced modulators and phase discriminators. In one case the linear voltage swing of a large power amplifier was almost doubled by rewinding the single-ended link in this fashion.



(a)



(b)

Transformer windings can be readily changed from single-ended to push-pull connection for (a) toroidal or (b) link-coupled units.



MANUFACTURED TO YOUR SPECIFICATIONS



One of a kind, or millions of parts
... you get the closest tolerances
from GARNER—tolerances which
have led the field in the redrawn
glass industry since 1953.

Large stocks of many different glass types and sizes—including the unusual. Available for immediate redraw.

Customer minded—We constantly upgrade equipment and techniques to keep ahead of your needs. You'll find us especially helpful on difficult requirements.

On-time deliveries—GARNER is geared for volume production to tight specifications—on a day-to-day basis. You get the parts you need... when you need them.

Send for complete data.



T. H. GARNER COMPANY

177 S. Indian Hill Blvd.
Claremont, Calif. • National 6 3526

CIRCLE 246 ON READER-SERVICE CARD
ELECTRONIC DESIGN • September 27, 1961

The single-ended winding consists of two windings in parallel, each having the required number of turns. These are wound from the center out, as shown, and the outer ends are joined and become the ground connection. It is seen that the flux in the two windings do not oppose, but rather aid each other. Although there is more winding capacitance due to the additional turns it is more than compensated for by the improvement in balance conditions.

For link-coupled transformers, the single-ended winding is similarly wound, with the single-ended winding centered over the center tap on the push-pull winding.

Martin Plotkin, Electrical Engineer, Brookhaven National Laboratory, Upton, Long Island, N. Y.

If this idea is valuable to you, give it a vote by circling Reader-Service number 735.

Compensating Voltage Reduces Zener Diode Variations 738

When a Zener diode (or ballast lamp, VR tube, etc.) is used as a half-wave ac clipper or dc regulator, Fig. 1, its internal resistance causes the output voltage to vary slightly with changing input. This variation can be eliminated if a compensating voltage, E_R , of equal slope, Fig. 2, is generated at a lower voltage level. The output is then taken between these two levels. This tends to eliminate the output voltage variations.

Resistor R can be adjusted for nearly perfect compensation at any current value. Because of device nonlinearity there will be a slight second-order change in output vs input. However, at least a five-to-one improvement has been obtained. This technique can be applied to dc voltage regulators, square-wave calibrators, electronic tachometers and similar circuits.

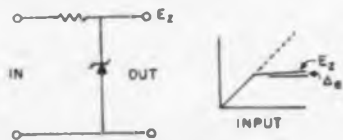


Fig. 1. Internal resistance of Zener causes output voltage to vary by dc as input changes.

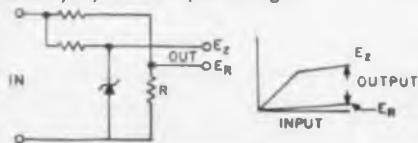


Fig. 2. Output variations are reduced when compensating voltage E_R is generated to form part of output.

Theodore Byles, Project Engineer, Motorola, Inc., Franklin Park, Ill.

If this idea is valuable to you, give it a vote by circling Reader-Service number 738.

75V
60
50
35
20
15
10
6

Only "KEMET" has the widest choice of High-Voltage SOLID TANTALUM CAPACITORS ...at LOW Microfarad Values!

J-SERIES

(Polar Type)

.0047 to 330
MICROFARADS

Temperature Range:
- 55 to +125° C

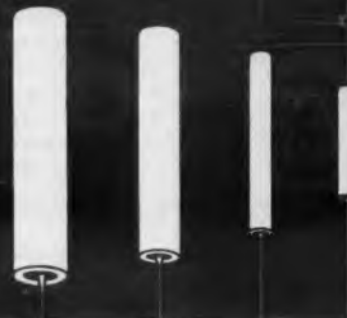


N-SERIES

(Non-Polar Type)

.0024 to 160
MICROFARADS

Temperature Range:
- 55 to +105° C



J-Series meets or exceeds MIL-C-26655A

KEMET offers you the only full line of high-voltage solid tantalum capacitors for a multitude of military/industrial applications. J-Series and N-Series are available in working voltages of 75, 60, 50, 35, 20, 15, 10, and 6—in standard E.I.A. values with $\pm 5\%$, $\pm 10\%$, and $\pm 20\%$ tolerances. Low leakage characteristics are excellent. Four J-Series case sizes conform to MIL-C-26655A—with or without insulating sleeve. Leads are solderable and weldable. All KEMET types have passed approved environmental tests. Whatever your solid tantalum capacitor needs, meet them with KEMET's complete line! Kemet Company, Division of Union Carbide Corporation, 11901 Madison Avenue, Cleveland 1, Ohio.

Write for technical data on the complete line of "KEMET" Solid Tantalum Capacitors!

"Kemet" and "Union Carbide" are registered trade-marks for products of

KEMET COMPANY

UNION
CARBIDE

CIRCLE 247 ON READER-SERVICE CARD

NOW...

YOU CAN ORDER ALL YOUR

MAGNETIC SHIFT REGISTERS

PREDESIGNED OR CUSTOMIZED FROM GENERAL ELECTRIC

General Electric offers a series of magnetic Shift Registers for the exacting requirements of every advanced computer and data processing system. These rugged, encapsulated modular units are available in three distinct designs, or can be custom-built to your specifications.

OUR SHIFT REGISTERS GIVE YOU...

- Reduced size and weight
- High reliability
- Stable operation over wide temperature ranges
- Low peak and average shift-pulse power

VOLTAGE CONTROLLED UNIT



... offering shift speeds to 700 KC's for printed wire-board mounting, G-E voltage-controlled shift register elements are characterized by their high reliability and tolerance to wide variations in the shift pulse width.

SERIAL DRIVEN, GATED TRANSFER



... combines the advantages of low shift-pulse power requirements with the reliability feature of tolerance to wide variations in shift pulse width and amplitude. ... standard serial-driven, gated-transfer shift registers are available in designs to 500 KC's. Specially wafered, multi-bit models, developed by General Electric for maximum miniaturization, provide a new in-line stacked arrangement and can be obtained in multiples of up to 25 bits.

SERIAL DRIVEN, CORE DIODE



... ideally suited to diverse applications where, because of low speeds or relatively low duty factors, shift pulse power requirements are not excessive. Operational to 100 KC's, each of General Electric's three core-diode models offers a simplified circuitry design, packaged for ready adaptability to compact and flexible mounting arrangements.

170-11



For additional data on G-E shift register and other specialized electronic devices, write to: Information Services, 300 S. Geddes Street, Syracuse, New York

DEFENSE SYSTEMS DEPARTMENT
A Department of the Defense Electronics Division

GENERAL  ELECTRIC

CIRCLE 751 ON READER-SERVICE CARD



Fan Mail Department

Dear Sir:

I want to thank you for my subscription to **ELECTRONIC DESIGN**. It is the *one* magazine I really use in my field.

Often weeks and months will slip by and for one reason or another I won't have time to look at my magazines, then all of a sudden the "need to know" occurs and I'll spend many hours pouring over back issues, the "Send for information" cards are old, yet the advertising is still doing a job—for both of us.

I want to also thank you for the special transistor supplement which I received through Semiconductor Specialists, Inc. of Chicago.

Your effort has made my job easier.

Edward Goodrich
A. B. Dick Co.
Chicago, Ill.

Carbon-Film Pot Answer to Gold Pot

Dear Sir:

I have read your editorial of May 24, 1961 and the answers you have received from various manufacturers of potentiometers, July 19, 1961, protesting your editorial comments.

The engineer and his visitor, in your editorial, were not familiar with the Computer Instruments Corp.'s line of potentiometers. Other manufacturers did not care to mention our units in their protests to you. Mr. D. C. McNeely lists six reasons by which the customer aggravates a so-called problem. But Mr. McNeely sees potentiometers through the eyes of the wirewound potentiometer manufacturer. Three of the six causes listed are not problems when Computer Instruments Corp.'s precision infinite resolution carbon film pots are employed. The three so-called causes for "unreliable" pots are not

NEW KODAK

METAL-ETCH RESIST

opens new chemical-milling
applications



Speeds up, simplifies deep etch weight reduction and parts manufacture. Reproduces fine-line detail as in plating, dial and name-plate making. This new photographic process ends time-consuming hand-work, results in high accuracy. Kodak Metal-Etch Resist withstands acids, alkalis, electrolytic fluids . . . adheres well to aluminum, titanium, magnesium, stainless and other alloy steels. High stability and strict uniformity simplify volume production. Send today for a detailed 16-page brochure that gives all the facts.

Text for this advertisement was set photographically.

No statement or suggestion is to be considered a recommendation or inducement of any use, manufacture or sale that may infringe on any patents now or hereafter in existence.

Graphic Reproduction Sales Division
EASTMAN KODAK COMPANY
Rochester 4, N. Y.

Please send me a copy of the booklet,
"Etching, Chemical Milling and Plating
with Kodak Metal-Etch Resist" (P-36).

Name _____
Company _____
Street _____
City _____
Zone _____ State _____

9-252

Kodak
TRADE MARK

CIRCLE 752 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

HIGHEST PURITY PRECISELY DEFINED

to meet critical
electronic manufacturing
needs

J. T. Baker ELECTRONIC CHEMICALS

'Baker Analyzed' Reagents

SEMI-CONDUCTOR CHEMICALS



FERRITE AND
THERMISTOR CHEMICALS

EMISSION CHEMICALS

J. T. Baker electronic chemicals offer you the highest standards of purity in the industry — proved by the Actual Lot Analysis and Actual Lot Assay on the label. Your variables are minimized... rejections are fewer... product performance is improved.

IMPORTANT. 'Baker Analyzed' Reagents have consistently met or exceeded the requirements of the electronics industry. Through a continuing program of establishing additional and more stringent specifications, the 'Baker Analyzed' label consistently defines a degree of purity so high that special electronic labeling is unnecessary.

YOURS FOR THE ASKING—

Important Guide to Electronic Chemicals

Describes J. T. Baker chemicals of exceptional purity for semi-conductors, vacuum tubes, ferrites, thermistors, etc. Also includes specification sheets that define the high standards for 'Baker Analyzed' Reagents. Write for your copy today.



J. T. Baker Chemical Co.

Phillipsburg, New Jersey

CIRCLE 753 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 27, 1961

the cause of the requirement, but the cause of the pot manufacturer, who tries to attain characteristics beyond the capability of his unit. I refer to causes 2, 3, and 4.

2. Resolution and/or linearity requirements dictated by the system need not be sacrificed. Carbon film potentiometers offer a virtually infinite resolution and size for size or length for length offers accuracies better than those available from any other manufacturer.

3. Compensation for errors caused by other components in the system, resulting in tight specification on linearity or conformity are commonplace. Computer Instruments Corp. solves problems of this type daily.


4. Servo response is constantly getting faster. Servo-loop gains are higher. The infinite resolution of Computer Instruments Corp.'s potentiometer, along with its low inertia and running torques... allows rapid servo response. Dither does not affect the potentiometer in the majority of servo designs that will cause a wirewound unit to oscillate. Failure after much use is not catastrophic since the complete circuit does not open.

The Computer Instruments Corp. carbon film potentiometer was designed with reliability in mind. Connections are all multiple (paralleled). Terminations are welded or united. Multiple wipers, of different resonant frequencies (different lengths) are employed for both the rotary and pick off connections. The apparent reliability is in an article by H. H. Adise entitled "Reliability of Precision Potentiometers," an analysis using probability theory, copies of which are available in limited quantity from Computer Instruments Corp., 92 Madison Ave., Hempstead, Long Island, N. Y.


In addition to the above, carbon-film potentiometers have a rated life of 5 to 50 millions of revolutions depending on circuitry. They operate without quadrature as they are noninductive. They operate in both dc and ac circuits as well as in the megacycle region, have withstood shock to 115 g, and most important, have received field reject rates and reliability reports that conclusively show that the engineer and his visitor were not familiar with our product.

We at Computer Instruments Corp. feel your answer to "Wanted: a Gold Plated Pot" is "Have it: A Carbon-Film Pot".

J. Herman
Sales Manager
Computer Instruments Corp.
Hempstead, L. I., N. Y.



COMBINE VIBRATION AND SHOCK TESTING



Model ST-300

IN ONE COMPACT 250 FORCE-POUND INSTRUMENT


FOR LARGE COMPONENTS AND SMALL SUBSYSTEMS . . . the new ITT ST-300 offers a 250 force-pound exciter for vibration and shock testing. This latest in a series of dynamic new vibration equipment utilizes the unique concepts of lateral motion excitation and air-bearing support—both developed by ITT engineering and proved on ITT's other vibration exciters of the 100 and 200 Series.

The exceptionally flat frequency response of the ST-300 permits precise testing without the need for elaborate compensating devices. Natural resonances are unaffected by table loadings. In addition, by checking shock and vibration on the same instrument, testing time and cost are substantially reduced. Other significant features of the ST-300 include:


- no significant distortion throughout normal test range
- first major resonance above 5 Kc
- useful frequency from 5 cycles to 50 Kc
- shock testing to over 5,000 g's
- table size: 5" x 8"

For complete information and applications data, call an ITT Instruments representative or write for Data File ED-1426-2

Other ITT vibration exciters include:



ST-150 for testing one ounce loads to over 100 g's



ST-100 for small component production testing and accelerometer calibration



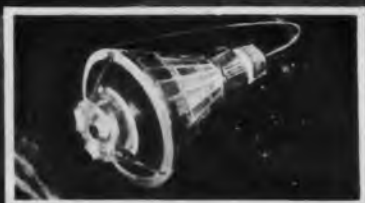
Industrial Products Division

International Telephone and Telegraph Corporation
15191 Bledsoe Street • San Fernando, Calif. • EMpire 7-6161

power conversion • instruments • closed circuit TV • avionics • mobile radio/telephony

CIRCLE 754 ON READER-SERVICE CARD

ELECTRONICS



in astronautics



... aeronautics



... and automation

McDonnell achievements in aeronautics, astronautics and automation are often directly related to swift-paced developments in electronics. Wherever McDonnell requirements cannot be met by standard electronics systems, special equipment is designed and developed by McDonnell's own electronic engineers. These consistently demanding objectives have fashioned an electronics division geared to the design of highly specialized systems and components — products which often prove to be broad-scope advancements with many applications. McDonnell Electronics is now being expanded, and desirable openings exist for *electronic engineers* who are qualified to provide leadership in areas of systems and equipment development.

DEPARTMENT and DIVISION MANAGERS

Advanced degree in E.E., M.E. or Physics required
(experience at the supervisory level is desirable
in at least one of the following areas:)

COMMUNICATIONS ● DIGITAL TECHNIQUES ● AUTOMATIC TEST EQUIPMENT ● MILITARY AIRBORNE
& SOLID STATE ELECTRONICS ● ELECTROMAGNETIC FIELD THEORY ● MASER AND LASER THEORIES ●
MICROWAVE TECHNIQUES ● RADIATION AND ABSORPTION PHENOMENA ● ELECTRODYNAMICS

For full details, please submit your resume in complete confidence to:
MR. R. F. KALETTA, PROFESSIONAL PLACEMENT, DEPT. E,

MCDONNELL

P.O. Box 516, St. Louis 66, Missouri

ALL QUALIFIED APPLICANTS WILL RECEIVE CONSIDERATION FOR EMPLOYMENT WITHOUT
REGARD TO RACE, CREED, COLOR OR NATIONAL ORIGIN.

•CIRCLE 901 ON CAREER INQUIRY FORM

YOUR CAREER

Will Physicist Replace Electronic Engineer?

The electronic engineer is slowly being replaced by the physicist and physical chemist, says Lee Fox, employment consultant in Chicago with Executive Consultants, specialists in finding executive and engineering talent.

Mr. Fox says he has already seen signs of a trend toward replacing electronic engineers with physicists in key creative areas of electronics. He believes that in five or ten years the EE will be relegated to a secondary role, similar in status to that now held by the ME in electronics. The EE, Mr. Fox contends, will no longer be in on the original circuit concepts but will work at the packaging, chassis, heat-shielding and radiation-shielding levels.

The initial signs to which Mr. Fox refers center on the increased demand by electronics companies for men with graduate academic backgrounds in solid-state physics. These are the men the companies are hiring for advanced programs to compound present circuits into solid-state functional blocks. The men must be capable of rearranging molecules in solids to produce electrical effects.

Demand for Systems Engineers Linked to Military Programs

Others in industry have felt this phenomenon will merely upgrade the EE into the systems aspects of uniting functional blocks into larger equipments, but Mr. Fox is pessimistic about this possibility. He believes the present demand for systems engineers will last only so long as the military build-up continues. In industrial and consumer areas the electronic equipment will be either so small or so mass-produced, he says, that it will amount to merely larger functional blocks.

Mr. Fox did not, however, discuss the very real possibility of larger industrial systems, which would need systems engineers as much as present military systems. Nor did he comment on the possibility that EE's would still be needed for initial lumped-parameter breadboards of new designs before these were committed to functional blocks.

As for the physicist, Mr. Fox recalls the advice he recently gave to a physicist friend who was trying to decide where to direct his graduate studies.

"If you go into the chemical field," Mr. Fox told him, "you will probably only be offered eight and a half to nine thousand a year

ELECTRONIC DESIGN **CAREER INQUIRY SERVICE** USE BEFORE NOV. 8, 1961

After completing, mail career form to ELECTRONIC DESIGN, 850 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below.

20

(Please print with a soft pencil or type.)

Name _____ Telephone _____

Home Address _____ City _____ Zone _____ State _____

Date of Birth _____ Place of Birth _____ Citizenship _____

Position Desired _____

Educational History

College	Dates	Degree	Major	Honors

Recent Special Training _____

Employment History

Company	City and State	Dates	Title	Engineering Specialty

Outstanding Engineering and Administrative Experience _____

Professional Societies _____

Published Articles _____

Minimum Salary Requirements (Optional) _____

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924
925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949

Advancement Your Goal? Use CONFIDENTIAL Action Form

ELECTRONIC DESIGN's Confidential Career Inquiry Service helps engineers "sell" themselves to employers—as confidentially and discreetly as they would do in person. The service is fast. It is the first of its kind in the electronics field and is receiving high praise from personnel managers.

To present your job qualifications immediately to companies, simply fill in the attached resume.

Study the employment opportunity ads in this section. Then circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN will act as your secretary, type neat duplicates of your application and send them to all companies you select—the same day the resume is received.

The standardized form permits personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you.

Painstaking procedures have been set up to ensure that your application receives complete, confidential protection. We take the following precautions:

- All forms are delivered unopened to one reliable specialist at ELECTRONIC DESIGN.
- Your form is kept confidential and is processed only by this specialist.
- The "circle number" portion of the form is detached before the application is sent to an employer, so that no company will know how many numbers you have circled.
- All original applications are placed in confidential files at ELECTRONIC DESIGN, and after a reasonable lapse of time, they are destroyed.

If you are seeking a new job, act now!

Opportunities in / Large Scale Commercial, Real-Time Digital Data Processing Systems

Pioneering Work Continues Creating Immediate Openings for:

In 1952 Teleregister installed the world's first real-time digital computer for commercial applications. In continuous operation, 24 hours-a-day, 7 days-a-week since then, this system has demonstrated its reliability and maintainability with 99.8% uptime. Teleregister systems are nation-wide in scope, with over 100,000 miles of leased communications lines and terminals in over 140 cities—encompassing airline reservations, savings and commercial bank accounting and stock exchange quotation and display.

Applications are invited from Engineers and Scientists who would like to join an organization which sparks advances by an aggressive applied research and development program financed by the company. Please send resume to D. N. Frazier.

T H E



C O R P O R A T I O N

445 Fairfield Ave., Stamford, Connecticut
An Equal Opportunity Employer

SYSTEMS ENGINEERS

For operational analysis of current procedures, establishment of system requirements, formulation of systems concepts, programming analysis and proposal preparation in application for industrial and business problems. Requires 3 to 7 years experience and a degree in EE or Math with a business background, or an Economics degree with an engineering background.

ADVANCED ELECTRONIC DEVELOPMENT ENGINEERS

Senior and Supervisory positions in the generation of new products in the computer-communications field. Requires sound theoretical background plus heavy experience in the development of semi-conductor circuitry associated with computers and/or their various subsystems including displays, magnetic tape, core and drum storage equipment.

SENIOR PROGRAMMERS

Requires 4 to 7 years well-rounded experience (from analyzing to flow charts to de-bugging) in computer programming for either scientific or commercial applications. Degree in science or business desirable.

CIRCLE 902 ON CAREER INQUIRY FORM



MAN IS HIS WORK

And next to spiritual progress, advancement in his work is his highest form of expression.

When a man is blocked in his work, he dies a little. For some, a vacation or a slight change in responsibilities suffices to put him back on the track. For others, a complete change of positions is necessary.

The scientist of job satisfaction in electronics is Davies-Shea, Inc., of Chicago, combining over 50 years experience in helping professional men plan and attain their career objectives.

For an objective analysis of your career and how it may be improved, send your name and home address to:

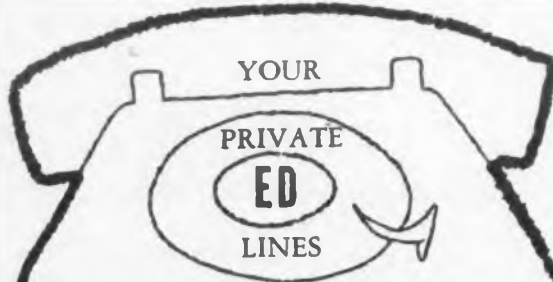


DAVIES - SHEA, Inc. WEbster 9-3833

332 South Michigan Chicago 4, Illinois

Electronics Personnel Consultants

CIRCLE 888 ON READER-SERVICE CARD



When employment information is obtained through **ELECTRONIC DESIGN**, it's sent direct to your home, so that only you and one prospective employer at a time know about it. You can conduct your employment campaign privately—as it should be conducted.

This is why every Reader Service Card reserves a line for your home address, and why circled numbers are detached from Career Inquiry Service Forms sent to companies.

You can apply for many jobs simultaneously . . . only *you* will know how many.

Use the Career Inquiry Service Form, and the Reader Service Card when job hunting. They're your *private lines* to employment opportunities . . . another service for you from **ELECTRONIC DESIGN**.

CAREERS

when you get your Ph.D. But if you think ahead and go into an electronics-oriented solid-state course, you will surely command eleven to twelve thousand a year."

Looking at the present employment picture, Mr. Fox says that in his Chicago area demand continues for the BSEE with three or more years' experience in transistor circuitry or microwaves, and for the systems engineer in flight control and inertial guidance.

The emphasis is still on men with unusual records of circuit and systems creativity, Mr. Fox says. And to illustrate the difficulty in obtaining really creative men, Mr. Fox notes ruefully that although he reviewed the qualifications of about 4,000 men last year, only one really met the criterion of creativity.

Is your vacation the proper time for you to look for a job? Men now change jobs at any time of the year, but vacations are the poorest time of the year to do it, advises Lon D. Barton of the employment counselling firm, Cadillac Associates, Inc., Chicago.

A two- or three-week vacation period does not afford sufficient time to find good opportunities and make such an important decision as changing jobs. A vacation should be a time to refuel your mind with a complete change of pace, then return to work refreshed and much better able to conduct a search for a new job, if you are so inclined.

A new graduate study program has been announced by the MITRE Corp., enabling selected technical personnel to pursue advanced degrees. The "Staff Scholar Program" permits four members of the technical staff to continue their studies at the school of their choice, beginning in the fall. They are: Socrates Litsios, Air Traffic Control Department, seeking to complete a doctorate in electrical engineering at MIT; Alan Braver, Command Systems Department, seeking his master's degree in mathematics at MIT; Irwin W. Miller, Human Factors Department, who will attend Michigan State University for his doctorate in psychology; and Charles C. Joyce, Jr., Weapons Control and Sensor Systems Department, who will seek a master's degree in industrial management at MIT.

Industry and university graduate schools are steadily merging their efforts to obtain both better research and better engineers. While some purists in education might say this will erode the freedom of the university, the trend shows every sign of becoming an increasing one.

Latest signpost is the announcement by Iowa State University, Ames, Iowa, that it is expanding its industry affiliate research program. Under the program, said Iowa's President, Dr. James H. Hilton, industrial organizations have an opportunity to participate in Iowa's solid-state research at the Iowa Engineering Experiment Station.

An obvious reason for this expansion is that it will open the way for further industry funding of university research projects.

In return the affiliate companies will have direct access to the new ideas and applications developed in the program. They will also probably be in a better position to make offers to the graduate students trained in solid-state.

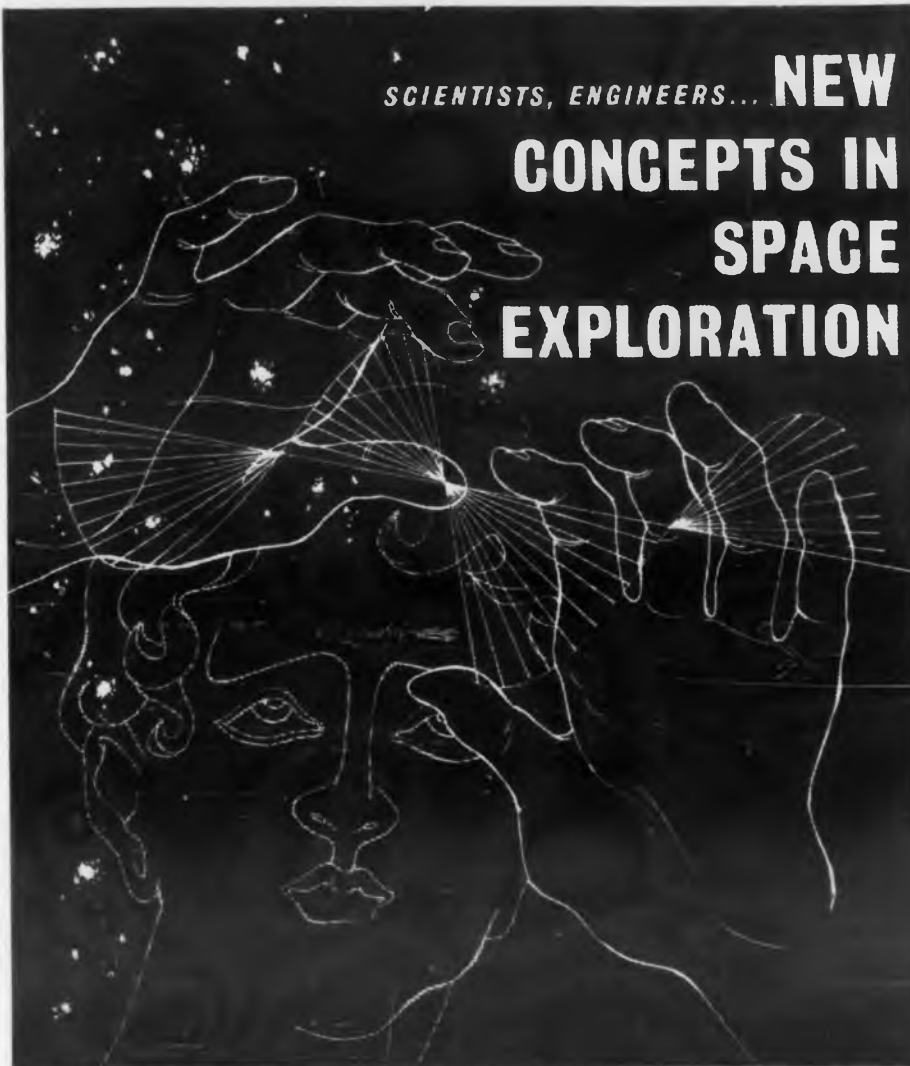
Industry affiliates are to provide \$5,000 annually with the option of terminating support at a year's notice. The Experimental Station, itself, will choose the research activities, President Hilton said. An important feature of this type of support is that it will make it possible for research to be maintained for a long period of time rather than on a year-to-year basis. For advanced research, such as basic solid-state phenomena investigations this is important.

The results of all research will also be available to the general public. In accordance with Iowa procedure, any patents resulting from the program will be assigned to the University Research Foundation. Sponsoring affiliates will be granted nonexclusive licenses to any inventions and discoveries coming from research they have supported.

Compared to other industry-university research programs in solid-state, Iowa believes its program is less limited to only those areas which show promise of immediate commercial success. Four major solid-state research areas will be encompassed in this program:

- Thin films: studies of magnetic and non-magnetic thin film materials for use in memory circuits and logical elements of computers.
- Thermoelectric devices: direct conversion of heat into electricity.
- Semiconductor material application: use of new semiconductor materials to improve electronic devices.
- Bio-medical instrumentation: search for better transducer materials.

SCIENTISTS, ENGINEERS... **NEW**
CONCEPTS IN
SPACE
EXPLORATION



at **RCA'S Astro-Electronics Division**
Princeton, N. J.
Creator of Tiros

Continued research and investigation into new areas of electronics and space technology have opened up a number of challenging opportunities for creative scientists and engineers at this rapidly growing division of RCA. Immediate openings are available in the following areas:

- **APPLIED PHYSICS RESEARCH** / Advanced space electrical power and propulsion
- **SPACE SYSTEM ANALYSIS** / Applied mathematics/Thermodynamics and mechanics
- **PROPULSION STUDY AND DESIGN** / For final stage space craft
- **ELECTRONIC SYSTEMS AND CIRCUIT DEVELOPMENT** / Communications / Video and digital data processing / TV camera and pickup tube design
- **INFORMATION PROCESSING** / Data systems analysis / Computer applications and programming research



To arrange a personal interview, call collect or write:

MR. D. D. BRODHEAD, Hightstown 8-3177
Astro-Electronics Division, Princeton, New Jersey, Dept. PE -368

All qualified applicants considered regardless of race, creed, color or national origin.



The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA

CIRCLE 903 ON CAREER INQUIRY FORM

looking for a special potentiometer?

...reach for



Your copy of EDC lists 157 different types of potentiometers in its PRODUCT LOCATOR. 27 categories from "AC" to "Wire-wound" are included. Each sub-listing such as "Clutch," "Linear Motion," "Microminiature," "Precision," or "Self-trimming" gives manufacturers' name and thumbnail specs to aid in rapid selection. 52 items are further described by special literature bound in sections 2 or 3 of EDC.

This is only one example of the more than 7,000 products from 2,212 companies which are displayed.

Handy Inquiry Cards or Application Data Forms are bound in to make it easier for you to obtain additional data — and manufacturers' reps are also listed if you wish to phone for quick price and delivery information.

Electronic Designers' Catalog is one more service provided by the publishers of *Electronic Design*.



CAREERS

A record of 242 papers on developments in computer hardware and concepts leading total systems control have been sifted down to 31 selected for presentation to the Eastern Joint Computer Conference, Dec. 12-14, in Washington.

For the first time, the proceedings will be bound in a hard-cover edition, and the semi-annual computer conference will be under the sponsorship of the American Federation of Information Processing Sciences, comprising the Institute of Radio Engineers, the American Institute of Electrical Engineers and the Association for Computing Machinery.

It is estimated that more than 60 manufacturers will be represented. The theme will be "Computers—Key to Total Systems Control."

The Keough-Utt bill would end one form of tax discrimination against self-employed professionals, the National Society of Professional Engineers has told the Senate Finance Committee. The bill (H.R.10) would permit self-employed persons with less than four regular employes to establish retirement plans, deferring up to 10 per cent of their earnings (or \$2,500 if that is less).

Self-employed persons with four or more employes, however, would be required to set up a nondiscriminatory retirement program for their employes before they could establish one for themselves.

The Keough-Utt bill has already been passed by the House.

When reading ELECTRONIC DESIGN, remember—



**Now The
Time To
Convert?**

Electronic engineers make good editors. ELECTRONIC DESIGN's editors have all "converted" from engineering duties to editing duties. You may be interested.

We have new assistant editor openings. EE's with 2-3 years circuit design experience have the ideal background.

If you get satisfaction out of communicating with others, if you enjoy pulling out the important, if you enjoy using words to convey ideas, you will like editorial work.

Write

Edward E. Grazda, Editor

**ELECTRONIC DESIGN
850 Third Ave.
New York 22, N.Y.**

High-speed computers are able to process data many times faster than the data can be entered manually from the checks, invoices, premium notices and other documents that are the source of most business information. Now IBM has developed a character-sensing system that can "read" numerical data right from printed documents and translate it for direct input to a computer at the rate of 480 characters a second. The system is able to read type styles used by IBM accounting machines.

The IBM engineering group that developed this remarkable system started its inquiry with a theoretical question: What amount of information must a machine acquire and maintain in order to distinguish one character from another? The investigation then ranged across many technical boundaries—optics, for developing scanning methods; photosensing, for converting the light image into electric impulses; electronic circuit design, for converting the analog signals of characters to digital information; and statistical analysis, for creating logic capable of distinguishing between the many character

patterns. The next step for this engineering team is to develop equipment that can recognize alphabetic and special characters.

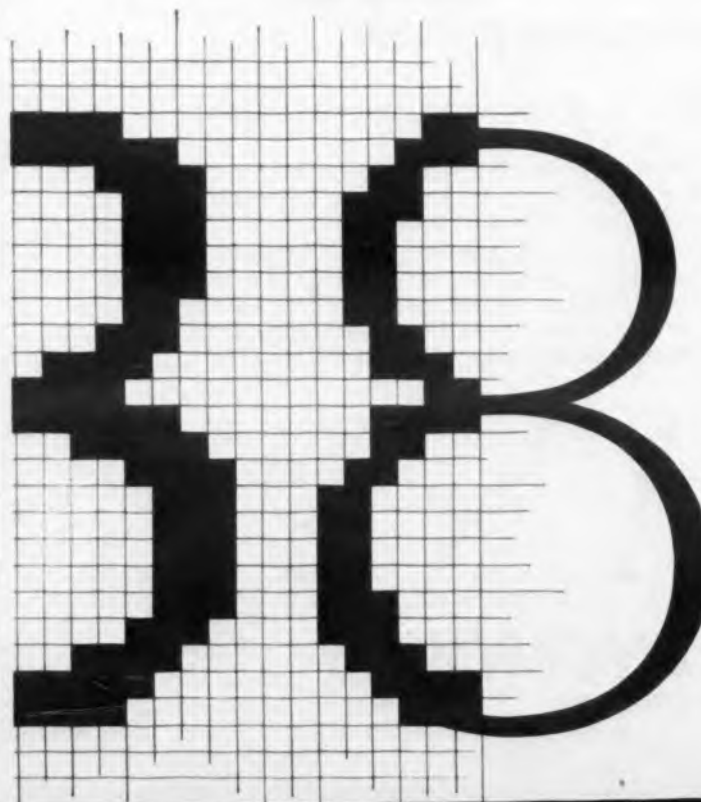
This wide-spectrum approach to problem-solving is typical of the development work IBM currently is doing in such areas as control systems, semiconductors, polymers, and optics. It is an approach that requires people who can think creatively. In turn, it provides these people with an unusual opportunity to grow professionally and personally. If this approach interests you—and you have a degree and experience in engineering, mathematics or one of the sciences—we'd like to hear from you.

All eligible applicants will be considered for employment without regard to race, creed, color or national origin. Please write:

Manager of Technical Employment
IBM Corporation, Dept. 555J4
590 Madison Avenue
New York 22, New York

IBM

**CHARACTER SENSING:
Developing machines
that can read**





New Flexi-core transformers offer—
Freedom of design never before possible
...at standard transformer prices!

It's a fact! New Sylvania Flexi-core transformers are entirely unlike any you've ever seen before! Every one is custom-made to *your* specifications.

No longer do you need to compromise on size, shape and linear design. No longer are you restricted by conventional E.I., C, U, or D configurations. *Odd sizes and special shapes can be made without the usual penalties in tooling and delivery.*

Reason? The heart of the new Flexi-core transformer is a core consisting of nests of laminations of formed steel strips.

These nests are fitted together to produce 100% interleaving for optimum design.

Results: Sylvania Flexi-core transformers operate cooler, provide higher reliability and are up to 30% lighter and smaller than conventional types.

Whatever your transformer application, Sylvania can build you a better one custom-designed to meet your needs at a competitive price. For details on production quantities, consult your Sylvania Special Products representative. Or write Sylvania Electric Products Inc., Ipswich, Mass.

SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS



CIRCLE 755 ON READER-SERVICE CARD

ADVERTISERS' INDEX

September 27, 1961

Advertiser	Page
ACF Electronics	196
AMP, Inc.	13, 59
Ace Electronics Associates, Inc.	166
Acromag, Inc.	204
Aerovox Corporation	104
Allen-Bradley Co.	152 A-B
Alpha Metals, Inc.	174
Amco Engineering Co.	209
American Bosch Arma Corp.	172
American Machine and Foundry Co.	160
Amphenol-Borg Electronics Corporation	72, B, C
*Applied Electronics Corp.	162
Applied Physics Corporation	119
Arco Electronics Inc.	101
*Arnold Engineering Company, The	41
Associated Research, Inc.	165
Atlas Chemical Industries, Inc.	152
Augat Bros., Inc.	118
Automatic Electric Co.	121
B & K Instruments, Inc.	18
*Baker Chemical Co., J. T.	215
Bendix Corporation, The Eclipse Pioneer Components Div.	130
Bird Electronic Corp.	90
Bircher Corporation, The	49
*Bourns, Inc.	203
Bowmar Instrument Corp.	155
Brush Instruments, Division of Clevite Corporation	96A
Bulova Electronics	7
Bulova Research and Development	14
*Burdly Corporation	22
Burton-Rogers Co.	114
Cadillac Associates, Inc.	155
Cambridge Thermionic Corp.	171
*Celco Constantine Engineering Labs, Inc.	157
Centralab, The Electronics Div. of Globe-Union, Inc.	120 A-B
*Cincinnati Sub-Zero Products	151
Cinch Mfg. Co.	127
Circo Corp.	161
*Clifton Precision Products Co., Inc.	Cover II
*Computer Instruments Corp.	116
Computer-Measurements Co.	104
Consolidated Electrodynamics Corp.	118
Continental Connector Corp.	65
Corning Glass Works	114, 115
Couch Ordnance, Inc.	225
Cratex Mfg. Co., Inc.	161
Cubic Corporation	89
*Dale Electronics Inc.	45
Davies-Shea, Inc.	218
Daystrom, Inc.	67
Dearborn Electronic Laboratories, Inc.	122
Delco Radio, Div. of General Motors Corp.	131
Del Electronics Corp.	174
De Mornay-Bonardi, Inc.	181
DI/An Controls Inc.	209
Donner Scientific Co.	205
Dorsett Electronics, Inc.	75, 148

*Manufacturers' catalog appears in 1960-1961 ELECTRONIC DESIGNERS' CATALOG

*Dow Corning Corp.	47
DuPont de Nemours & Co., E. I., Mylar Div.	153
Duncan Electronics Inc.	168
Dytronics, Inc.	136

EICO	175
*ESC Electronics Corporation	82, 83
Eastman Kodak Co.	214
Elastic Stop Nut Corp. of America	16, 157
Elco Corporation	27
*Elec. Inc.	145
Electrical Industries	26
Electro-Motive Mfg. Co., Inc., The	101
Electro Tec Corp.	112
Electronic Associates, Inc.	144
Electronic Designers' Catalog	220
Electronic Research Associates, Inc.	174
Empire Devices Pmts. Corp.	176
Englehard Industries, Inc.	110, 111
Erie Resistor Corp.	207

FXR, a Div. of Amphenol-Borg Electronics Corp.	188
Faber-Castell, A. W. Pencil Co., Inc.	148
*Fairchild Semiconductor Corp.	92, 93
*Fenwal Electronics, Inc.	167
Ferrocube Corp. of America	2
*Fluke Mfg. Co., Inc., John	66
Furane Plastics, Inc.	149
Fusite Corp., The	42

Gamewell Co., The	112
Garner Co., T. H.	212
General Bronze Corp.	194
General Control Co.	175
General Electric Company, Chemical Materials Dept.	224
General Electric Company, Defense Systems Dept.	214
*General Electric Company, Lamp Metals & Components Dept.	72A
General Electric Company, Panel Instruments	167, 169, 171, 173
General Electric Company, Rectifier Corp.	28
General Electric Company, Silicone Products Dept.	164
General Electric Company, Capacitors	79
General Electric Company, Special Controls Dept.	128
General Instrument Corporation	95
General Magnetics, Inc.	164, 165
General Radio Company	201
Globe Industries, Inc.	51
Good-All Electric Mfg. Co.	77
Goold-National Batteries, Inc.	25
Graphic Circuits	164
Greiner Mfg. Co., Inc.	124
Gries Reproducer Corp.	154

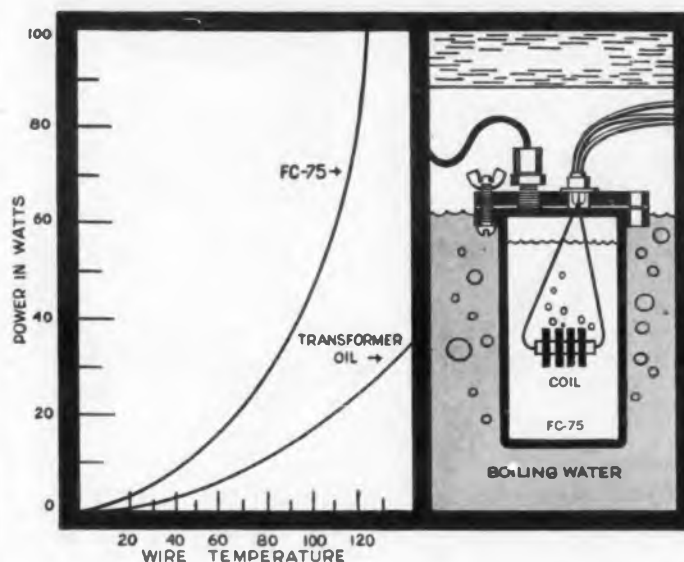
*Hart Mfg. Co. The	170
Hewlett-Packard Company	24A-B, 226, Cover III
Hi-G, Inc.	73
Hogan Faximile Corp.	164
Huggins Laboratories Inc.	206

ITT Components Division	31
ITT Industrial Products Division	215

*Manufacturers' catalog appears in 1960-1961 ELECTRONIC DESIGNERS' CATALOG



THE RAW MATERIALS OF PROGRESS



FC-75 Moves 10 Times More Heat... Dwarfs Design "Cube" by 4!

When the heat's on the electronics designer to crowd more and more into less and less space, he can count on 3M Brand Fluorochemical Liquids FC-75 and FC-43 for real help with cooling problems.

Graphed above are results of heat transfer tests where a wire coil was immersed first in standard transformer oil, then in FC-75. In each medium varying power inputs were applied to the coil and temperature rises charted. Quick summary: FC-75 transferred 10 times as much heat as did the oil, for the same temperature rise!

Many designers have used FC-75 successfully to reduce the size of electronic units. For

example, a transformer designer using FC-75 achieved volume reduction of 4 to 1, weight reduction of 2 to 1, without compromise of performance or power output. A leading aerospace designer used FC-75 to help miniaturize a power unit by a factor of six.

FC-75 is equally effective as a convective or evaporative coolant; and in both liquid and vapor forms is non-flammable and non-corrosive. The vapors at one atmosphere have a dielectric strength comparable to that of the liquid. For more information about FC-75 and FC-43, see the "Profile" column, right. Then write for specific application details.

PROPERTIES PROFILE

on 3M Brand Inert Liquids FC-75 AND FC-43

These unique dielectric coolants possess unusual properties that can prove advantageous to the designer of electrical devices and instruments, as well as to the manufacturer. Increased range of operating temperatures, improved heat dissipation which permits miniaturization, and greatly increased protection from thermal or electrical overload are possible with their use.

FC-75 and FC-43 are non-explosive, non-flammable, non-toxic, odorless and non-corrosive. They are stable up to 750° F., and are completely compatible with most materials... even above the maximum temperatures permissible with all other dielectric coolants. Both are self-healing after repeated arcing in either the liquid or vapor state.

ELECTRICAL PROPERTIES

	FC-75	FC-43
Electrical Strength	35KV	40KV
Dielectric Constant (1 to 40KC @ 75°F.)	1.86	1.86
Dissipation Factor (1000 cycles)	< 0.0005	< 0.0005

TYPICAL PHYSICAL PROPERTIES

	FC-75	FC-43
Pour Point	< -100°F.	-58°F.
Boiling Point	212°F.	340°F.
Density	1.77	1.88
Surface Tension (77°F.) (dynes/cm)	15	16
Viscosity Centistokes	0.65 min.	2.74
Thermal Stability	750°F.	> 600°F.
Chemical Stability	Inert	Inert
Radiation Resistance	25% change @ 1 x 10 ⁸ rads	25% change @ 1 x 10 ⁸ rads

FC-75 and FC-43 have nearly equivalent heat capacities in the liquid and gaseous states.

For more information on FC-75 and FC-43, write today, stating area of interest to: 3M Chemical Division, Dept. KAP-91, St. Paul 6, Minn.

CHEMICAL DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

... WHERE RESEARCH IS THE KEY TO TOMORROW



CIRCLE 756 ON READER-SERVICE CARD

G-E LEXAN® POLYCARBONATE RESIN

GOOD DIELECTRIC—AND MUCH MORE!



STABLE ELECTRICALS. Binding posts made of LEXAN resin retain electricals even under moist, hot conditions. They do not loosen, are molded in six attractive LEXAN colors for coding. Other features are: low loss and power factor, low dielectric constant, high voltage insulation, non-sink surfaces.

(Superior Electric)



HEAT RESISTANCE. Beautiful handles of LEXAN polycarbonate resin are used in rugged service on U.L. approved soldering irons. They resist the impact, heat and abrasion of daily bench work. The hard, glossy handles are light in weight. Molded in three pastel colors, they provide toughness and sales appeal.

(Ungar Electric Tools)



TRANSPARENCY of LEXAN resin is important in chart guide for recorder. LEXAN resin is the only transparent plastic able to withstand heat generated by internal lights. It is distortion-free at temperatures up to 270°F and self-extinguishing. Its extremely high impact strength eliminates cracking of guides.

(The Foxboro Co.)



DIMENSIONAL STABILITY. Maximum allowable change in this 5-inch aircraft instrument part is only 5 mils over a temperature range of -65° to 300°F! And it must maintain this tolerance under high humidity. Part is injection molded of LEXAN resin as half spheres which are solvent cemented, lathed and painted. (Lear, Inc.)



TOUGHNESS. Press-fitted into metal gear used in an electric drill, bushing of LEXAN polycarbonate resin provides safety from electric shock . . . helps eliminate need for additional grounding. Strength and creep resistance of LEXAN resin enables bushing to withstand torque and load requirements of drill.

(Millers Falls Co.)

ARE YOU LOOKING FOR A PLASTIC THAT CAN REALLY TAKE IT?

To demonstrate the toughness of LEXAN resin, salesmen will sometimes slam and hammer a product made of the material. LEXAN has the highest impact strength of any plastic—amounting to 12-16 foot-pounds per inch of notch—and it usually emerges unscathed from encounters with such "merchandising stresses". It is a high-performance material, likewise, with regard to high-temperature behavior and dimensional stability.

Its many other advantages make it a priority material for thorough investigation by all designers, engineers and molders. We will be pleased to supply you with information on the properties, processing and end-uses of LEXAN resin. Don't hesitate to write to us, General Electric, Chemical Materials Department, Section ED-51, Pittsfield, Mass.

LEXAN®

Polycarbonate Resin

GENERAL ELECTRIC

Advertiser Page

Illinois Tool Works, Paktron Div.	212
Indiana General Corporation	29
*Industrial Electronic Engineers, Inc. . .	150
Instrument Specialties Co. Inc.	159
International Business Machine Corp. . .	221
International Electronic Industries, Inc. .	132
International Electronic Research Corp. .	136
*International Rectifier Corp.	129
International Resistance Co.	109
International Steel Co.	68
Invar Electronics Corp.	150

James Electronics, Inc.	208
Jonathan Mfg. Co.	170

Kay Electric Company	96B
Kemet Co.	213
Key Resistor Corp.	10
Kintel, Div. of Cohu Electronics, Inc. . .	5
Krohn-Hite Corporation	156
Kulka Electric Corp.	207

Laboratory for Electronics, Inc.	124
Langevin	163
*Lavole Laboratories, Inc.	90
Leach Corp.	169
Ledex, Inc.	37
Lerner Plastics, Inc.	81
Linde Company	19, 172
Lionel Electronic Labs	159
Lord Mfg. Co.	96
*Lumatron Electronics, Inc.	76

McDonnell Electronics	216
*Magnetics, Inc.	24
Mallory & Co., P. R.	32, 98, 99
Maxxon Electronics Corp.	126
Methode Electronics Inc.	149
Micon Electronics	168
Microdot, Inc.	105
Microtran Company, Inc.	104
Microwave Associates, Inc.	185
Microwave Electronics	197
*Miller Co., J. W.	119
Minneapolis Honeywell Regulator Co., Semiconductor Div.	63
*Minneapolis Honeywell Regulator Co., Boston Div.	142
*Minnesota Mining & Mfg. Co., Chemical Div.	223
*Motorola Semiconductor Products, Inc.	58, 133
Mullard Overseas, Ltd.	146, 147

NJE Corporation	135
Narda Microwave Corporation, The . . .	199
National Semiconductor Corp.	134
Newark Electronics	158
Norbatrol Electronics Corp.	165
Nytronics, Inc.	154

*Manufacturers' catalog appears in 1960-1961 ELECTRONIC DESIGNERS' CATALOG

Oak Manufacturing Co.106, 107
Ohmite Mfg. Co. 57
Ortho Precision Resistors Inc. 140

PM Electronics 3
PRD Electronics, Inc. 190
Pacific Semiconductors, Inc. 69, 141
Panoramic Electronics Inc. 140
Paramount Paper Tube Corp. 162
Parsons Co., The Ralph M. 36
Perkin Electronics Corp. 6
*Philco, Lansdale Division 9
Plastoid Corp. 117
*Polarad Electronic Corporation 192, 193
Porter, Co., H. K. 138, 139
Post Co., Frederick 139
Potter & Brumfield 102
Potter Instrument Co. Inc. 21
Power Designs, Inc. 148
Premier Metal Products Co. 158
Price Electric Corp. 173

RF Products, Div. of Amphenol-Borg 137
Radio Corporation of America, Astro-Electronics Div. 219
Radio Corporation of America, Cover IV Ramsey Corporation 155
*Raytheon Co., Industrial Components Div. 1, 206
Raytheon Co., Microwave and Power Tube 200
Raytheon Co., Semiconductor Div. 44
Raytheon Co., Special Microwave Devices Operation 15
Reeves Instrument Corp. 100
Rlxon Electronics 156
Robinson Technical Products, Inc. 141
Rohde & Schwarz 72-D
Rome Cable, Div. of Alcoa 91
Rowan Controller Co. The 160

Sage Electronics Corporation 81
Sams Co. Inc., Howard W. 166
*Sarkes Tarzian, Inc. 94
Scientific Atlanta 187
*Sealectro Corporation 12
Sel-Rex Corp. 159
*Servo Corporation of America 97, 202
*Sierra Electronic Corporation 191
Sola Electric Company 30
Sperry Microwave Electronics Co. 195, 198
*Sperry Semiconductor, Div. of Sperry Rand Corp. 125
Sprague Electric Co. 20, 23
Standard Pressed Steel Co., IEI Div. 132
Stevens Mfg. Co., Inc. 103
Stimpson Co. Inc., Edwin B. 91
Struthers-Dunn 43
Switchcraft, Inc. 104
Sylvania Electric Products, Inc., Electronic Tubes Div. 144 A-B
Sylvania Electric Products, Inc., Flexicore 222
*Sylvania Electric Products, Inc., Semiconductor Div. 11
Synthane Corp. 151
Syston Division of Syston-Donner Corporation 143

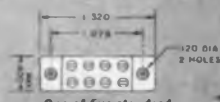


RUGGED ROTARY RELAYS

EXCEPTIONAL RELIABILITY WHERE THE ENVIRONMENT IS EXTREME



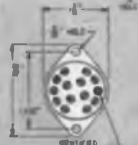
Type 2R Relay CVE Type



One of five standard mounting styles



4C36B Relay CVE Type



One of six standard mounting styles



15 section JR Switch

DATA
SHEET
NO.

MICRO-MINIATURE ROTARY RELAYS

ONE SIZE — 3 DIFFERENT SENSITIVITIES

Catalog Number	Coil Resistance ±10% @ 25°C	Maximum Pull-In Current	Minimum Drop-Out Current	Nominal Operating Value	Coil Sensitivity
	Ohms	MA.	MA.	Volts	Milliwatts
2R25A420-B	625	19	1.9	26.5	250
2R10A440-B	1500	8.2	.82	26.5	100
2R04A460-B	4000	5.2	.52	26.5	40

Weight: 18 ± 1 Gram

Ambient Temperature: -65°C to +125°C

Contacts: 2PDT (2 Form C) 2A @ 30 VDC

Vibration: 30 G to 2,000 CPS

Shock: 100 G

Dielectric Strength: 1,000 VAC

DATA
SHEET
NO.

SUB-MINIATURE ROTARY RELAYS

STANDARD 26.5 VDC RELAYS

Catalog Number	Number Form C Contacts	Contact Rating 100,000 Operations	Coil Resistance ±10% @ 25°C	Maximum Pull-In Current	Nominal Operating Value	Notes
			Ohms	MA.	Volts	
2A37-B	2	3 AMPS 30VDC	475	27	26.5	Dry Ckt. Capability
4A36-B	4	3 AMPS 30VDC	300	41	26.5	Dry Ckt. Capability
4C36-B	4	5 AMPS 30VDC	300	41	26.5	Heavy Duty
2B36-B	2	10 AMPS 30VDC	300	41	26.5	Heavy Duty
4AP36-AF	4	3 AMPS 30VDC	300	41	26.5	Dry Ckt. Plug-In
Other Available Values			19 to 27K	165 to 5.0	6.6 to 250	Wide Range of Mounting Styles Avail.

Weight: 3.2 oz. Max.

Ambient Temperature: -65° to +125°C

Vibration: 20G to 2000 CPS

Insulation Resistance: 1000 Megohms Min.

Shock: 75G Min.

DATA
SHEET
NO.

THE JR MULTIPOLE ROTARY SWITCH

The JR Switch is manufactured in accordance with MIL-S-21604 (Ships). It features contact ratings of 10A at 125VAC and 5A at 125VDC. Switches can be assembled with any number of sections up to 25 and can contain any combination of rotor types.

Write for Data Sheets which contain complete technical specifications

S-1



COUCH ORDNANCE INC. A Subsidiary of S. H. Couch Company, Inc.

3 Arlington Street, North Quincy 71, Massachusetts • Tel. (Boston)CY 8-4147

CIRCLE 758 ON READER-SERVICE CARD

Teleregister Corp. The	218
Teltronics, Inc.	158
Telrex Laboratories	151
Texas Instruments Incorporated	84, 85, 88, 180
Thermolloy Co.	204
Timely Technical Products, Inc.	150
Trans Electronics Inc.	154
Transco Products, Inc.	190
*Transistor Electronics Corp.	122
Transistor Specialties, Inc.	113
*Transitron Electronic Corporation	123
*Tung-Sol Electric, Inc.	53

Union Switch & Signal, Div. Westing- house Air Brake	50
United Electronics Company	64
Universal Toroid Coil Winding, Inc. ...	149
Universal Mfg Co., Inc.	150

Varian Associates	178
Vitramon, Inc.	17

Ward Leonard Electric Co.	74
Welwyn International Inc.	126
Western Devices, Inc.	161
*Westinghouse Electric Corporation	86, 87

Yokogawa Electric Works Inc.	120
-----------------------------------	-----

*Manufacturers' catalog appears in 1960-1961
ELECTRONIC DESIGNERS' CATALOG.

Advertising Representatives

Sales Service Supvr.: Alvin D. Ross
New York: Berry Conner, Jr., James
P. Quinn, Charles J. Stillman, Jr.,
John M. Weber, Thomas P. Barth,
850 Third Avenue, Plaza 1-5530

Boston: Richard Parker, Copley 7-
0288

Philadelphia: Blair McClenachan, Mo-
hawk 7-0625

Chicago: Thomas P. Kavooras,
Fred T. Bruce, 664 N. Michigan
Avenue, Superior 7-8054

Cleveland: Douglas H. Boynton, 442-
5055

Los Angeles: John V. Quillman, Ken-
neth M. George, Pierre J. Braudé,
5276 Wilshire Blvd., Dunkirk 2-7337

Southeastern: Pirnie & Brown, Mor-
gan Pirnie, Harold V. Brown, G. H.
Krimmier, 1722 Rhodes-Haverty Bldg.,
Atlanta, Ga., Jackson 2-8113

London, WI: Brayton Nichols, 7 Blen-
heim Street

Tokyo: Karl H. Bachmeyer Associ-
ates, 27 Morimoto-cho, 1-chome,
Azabu, Minato-ku

MEASURE AC VOLTAGE to 500 KC WITH YOUR DC VOLTMETER

ELECTRONIC DESIGN - ONE DAY SERVICE USE BEFORE NOVEMBER 8th, 1961

Name _____

Title _____

Company _____

Company Address				City				Zone				State			
10 20 30 40	50 60 70 80 90	100 110 120 130 140	150 160 170 180 190	200 210 220 230 240	250 260 270 280 290										
1 11 21 31 41	51 61 71 81 91	101 111 121 131 141	151 161 171 181 191	201 211 221 231 241	251 261 271 281 291										
2 12 22 32 42	52 62 72 82 92	102 112 122 132 142	152 162 172 182 192	202 212 222 232 242	252 262 272 282 292										
3 13 23 33 43	53 63 73 83 93	103 113 123 133 143	153 163 173 183 193	203 213 223 233 243	253 263 273 283 293										
4 14 24 34 44	54 64 74 84 94	104 114 124 134 144	154 164 174 184 194	204 214 224 234 244	254 264 274 284 294										
5 15 25 35 45	55 65 75 85 95	105 115 125 135 145	155 165 175 185 195	205 215 225 235 245	255 265 275 285 295										
6 16 26 36 46	56 66 76 86 96	106 116 126 136 146	156 166 176 186 196	206 216 226 236 246	256 266 276 286 296										
7 17 27 37 47	57 67 77 87 97	107 117 127 137 147	157 167 177 187 197	207 217 227 237 247	257 267 277 287 297										
8 18 28 38 48	58 68 78 88 98	108 118 128 138 148	158 168 178 188 198	208 218 228 238 248	258 268 278 288 298										
9 19 29 39 49	59 69 79 89 99	109 119 129 139 149	159 169 179 189 199	209 219 229 239 249	259 269 279 289 299										
300 310 320 330 340	350 360 370 380 390	400 410 420 430 440	450 460 470 480 490	500 510 520 530 540	550 560 570 580 590										
301 311 321 331 341	351 361 371 381 391	401 411 421 431 441	451 461 471 481 491	501 511 521 531 541	551 561 571 581 591										
302 312 322 332 342	352 362 372 382 392	402 412 422 432 442	452 462 472 482 492	502 512 522 532 542	552 562 572 582 592										
303 313 323 333 343	353 363 373 383 393	403 413 423 433 443	453 463 473 483 493	503 513 523 533 543	553 563 573 583 593										
304 314 324 334 344	354 364 374 384 394	404 414 424 434 444	454 464 474 484 494	504 514 524 534 544	554 564 574 584 594										
305 315 325 335 345	355 365 375 385 395	405 415 425 435 445	455 465 475 485 495	505 515 525 535 545	555 565 575 585 595										
306 316 326 336 346	356 366 376 386 396	406 416 426 436 446	456 466 476 486 496	506 516 526 536 546	556 566 576 586 596										
307 317 327 337 347	357 367 377 387 397	407 417 427 437 447	457 467 477 487 497	507 517 527 537 547	557 567 577 587 597										
308 318 328 338 348	358 368 378 388 398	408 418 428 438 448	458 468 478 488 498	508 518 528 538 548	558 568 578 588 598										
309 319 329 339 349	359 369 379 389 399	409 419 429 439 449	459 469 479 489 499	509 519 529 539 549	559 569 579 589 599										
600 610 620 630 640	650 660 670 680 690	700 710 720 730 740	750 760 770 780 790	For employment brochures give home address	870 880 890										
601 611 621 631 641	651 661 671 681 691	701 711 721 731 741	751 761 771 781 791	_____	871 881 891										
602 612 622 632 642	652 662 672 682 692	702 712 722 732 742	752 762 772 782 792	_____	872 882 892										
603 613 623 633 643	653 663 673 683 693	703 713 723 733 743	753 763 773 783 793	_____	873 883 893										
604 614 624 634 644	654 664 674 684 694	704 714 724 734 744	754 764 774 784 794	_____	874 884 894										
605 615 625 635 645	655 665 675 685 695	705 715 725 735 745	755 765 775 785 795	_____	875 885 895										
606 616 626 636 646	656 666 676 686 696	706 716 726 736 746	756 766 776 786 796	_____	876 886 896										
607 617 627 637 647	657 667 677 687 697	707 717 727 737 747	757 767 777 787 797	_____	877 887 897										
608 618 628 638 648	658 668 678 688 698	708 718 728 738 748	758 768 778 788 798	_____	878 888 898										
609 619 629 639 649	659 669 679 689 699	709 719 729 739 749	759 769 779 789 799	_____	879 889 899										

If 25 or more items circled
please describe reasons:

For Change of Address:
Old Company Name _____

- I Do Design Work
 I Supervise Design Work
 I Do No Design Work

Old Company Address _____

City _____

Zone _____

State _____

ELECTRONIC DESIGN - ONE DAY SERVICE USE BEFORE NOVEMBER 8th, 1961

Name _____

Title _____

Company _____

Company Address				City				Zone				State			
10 20 30 40	50 60 70 80 90	100 110 120 130 140	150 160 170 180 190	200 210 220 230 240	250 260 270 280 290										
1 11 21 31 41	51 61 71 81 91	101 111 121 131 141	151 161 171 181 191	201 211 221 231 241	251 261 271 281 291										
2 12 22 32 42	52 62 72 82 92	102 112 122 132 142	152 162 172 182 192	202 212 222 232 242	252 262 272 282 292										
3 13 23 33 43	53 63 73 83 93	103 113 123 133 143	153 163 173 183 193	203 213 223 233 243	253 263 273 283 293										
4 14 24 34 44	54 64 74 84 94	104 114 124 134 144	154 164 174 184 194	204 214 224 234 244	254 264 274 284 294										
5 15 25 35 45	55 65 75 85 95	105 115 125 135 145	155 165 175 185 195	205 215 225 235 245	255 265 275 285 295										
6 16 26 36 46	56 66 76 86 96	106 116 126 136 146	156 166 176 186 196	206 216 226 236 246	256 266 276 286 296										
7 17 27 37 47	57 67 77 87 97	107 117 127 137 147	157 167 177 187 197	207 217 227 237 247	257 267 277 287 297										
8 18 28 38 48	58 68 78 88 98	108 118 128 138 148	158 168 178 188 198	208 218 228 238 248	258 268 278 288 298										
9 19 29 39 49	59 69 79 89 99	109 119 129 139 149	159 169 179 189 199	209 219 229 239 249	259 269 279 289 299										
300 310 320 330 340	350 360 370 380 390	400 410 420 430 440	450 460 470 480 490	500 510 520 530 540	550 560 570 580 590										
301 311 321 331 341	351 361 371 381 391	401 411 421 431 441	451 461 471 481 491	501 511 521 531 541	551 561 571 581 591										
302 312 322 332 342	352 362 372 382 392	402 412 422 432 442	452 462 472 482 492	502 512 522 532 542	552 562 572 582 592										
303 313 323 333 343	353 363 373 383 393	403 413 423 433 443	453 463 473 483 493	503 513 523 533 543	553 563 573 583 593										
304 314 324 334 344	354 364 374 384 394	404 414 424 434 444	454 464 474 484 494	504 514 524 534 544	554 564 574 584 594										
305 315 325 335 345	355 365 375 385 395	405 415 425 435 445	455 465 475 485 495	505 515 525 535 545	555 565 575 585 595										
306 316 326 336 346	356 366 376 386 396	406 416 426 436 446	456 466 476 486 496	506 516 526 536 546	556 566 576 586 596										
307 317 327 337 347	357 367 377 387 397	407 417 427 437 447	457 467 477 487 497	507 517 527 537 547	557 567 577 587 597										
308 318 328 338 348	358 368 378 388 398	408 418 428 438 448	458 468 478 488 498	508 518 528 538 548	558 568 578 588 598										
309 319 329 339 349	359 369 379 389 399	409 419 429 439 449	459 469 479 489 499	509 519 529 539 549	559 569 579 589 599										
600 610 620 630 640	650 660 670 680 690	700 710 720 730 740	750 760 770 780 790	For employment brochures give home address	870 880 890										
601 611 621 631 641	651 661 671 681 691	701 711 721 731 741	751 761 771 781 791	_____	871 881 891										
602 612 622 632 642	652 662 672 682 692	702 712 722 732 742	752 762 772 782 792	_____	872 882 892										
603 613 623 633 643	653 663 673 683 693	703 713 723 733 743	753 763 773 783 793	_____	873 883 893										
604 614 624 634 644	654 664 674 684 694	704 714 724 734 744	754 764 774 784 794	_____	874 884 894										
605 615 625 635 645	655 665 675 685 695	705 715 725 735 745	755 765 775 785 795	_____	875 885 895										
606 616 626 636 646	656 666 676 686 696	706 716 726 736 746	756 766 776 786 796	_____	876 886 896										
607 617 627 637 647	657 667 677 687 697	707 717 727 737 747	757 767 777 787 797	_____	877 887 897										
608 618 628 638 648	658 668 678 688 698	708 718 728 738 748	758 768 778 788 798	_____	878 888 898										
609 619 629 639 649	659 669 679 689 699	709 719 729 739 749	759 769 779 789 799	_____	879 889 899										

If 25 or more items circled
please describe reasons:

For Change of Address:
Old Company Name _____

- I Do Design Work
 I Supervise Design Work
 I Do No Design Work

Old Company Address _____

City _____

Zone _____

State _____

VIA
AIR
MAIL

FIRST CLASS
Permit No. 725
New York, N. Y.

B U S I N E S S R E P L Y M A I L

No Postage Stamp Necessary If Mailed in U. S.

POSTAGE WILL BE PAID BY

ELECTRONIC DESIGN

ONE DAY READERS INQUIRY SERVICE

850 Third Avenue
New York 22, New York

VIA
AIR
MAIL

FIRST CLASS
Permit No. 725
New York, N. Y.

B U S I N E S S R E P L Y M A I L

No Postage Stamp Necessary If Mailed in U. S.

POSTAGE WILL BE PAID BY

ELECTRONIC DESIGN

ONE DAY READERS INQUIRY SERVICE

850 Third Avenue
New York 22, New York

NEW 457A AC TO DC CONVERTER

New hp 457A AC to DC Converter lets you inexpensively measure ac voltage, 50 cps to 500 KC, with the ease and high resolution of a dc digital voltmeter.

The highly accurate, average-responding 457A permits ac measurements to $\pm 0.3\% \pm 0.001$ v to 50 KC and $\pm 0.75\% \pm 0.001$ v to 500 KC. This accuracy permits you to read ac voltages on a dc digital voltmeter (such as the hp 405BR/CR) with three digits resolution.

Waveform errors are minimized by this new converter. The dc output of the 457A is always between 0 and 1 volt for up to full scale input. Full scale is selected manually in decade ranges. Your measurement convenience is further increased with overranging by more than 2 to 1 and an input impedance of 1 megohm.

The 457A Converter can be used with an hp 560 series Digital Recorder, plus a digital voltmeter, to provide a permanent printed record. Either the 457A analog or digital voltmeter output data is suitable for other data logging equipment. The digital data may be transferred, for example, to card or tape punches.

New hp instrument modular packaging permits easy stacking of instruments on the bench and simple conversion to rack mount.



Specifications

Input Range:	0 to 300 v rms, in 4 decade ranges corresponding to 1, 10, 100 and 1,000 v rms full scale.
Frequency Range:	50 cps to 500 KC.
Accuracy:	$\pm 0.3\% \pm 1$ mv, 50 cps to 50 KC; $\pm 0.75\% \pm 1$ mv, 50 KC to 500 KC.
Output:	hp to 1.0 v dc, responding to average value of ac input, with output calibrated as rms value of sine wave.
Output Impedance:	10,000 ohms.
Input Impedance:	1 megohm, shunted by 30 pf .
Size:	16 $\frac{3}{4}$ " wide, 3 $\frac{3}{8}$ " high, 13 $\frac{1}{4}$ " deep.
Weight:	12 lbs.
Price:	\$350.00

DEPENDABLE AUTOMATIC DIGITAL VOLTMETERS

405BR/CR Digital Voltmeter

Ideal for use with the hp 457A AC to DC Converter, the hp 405BR/CR Digital Voltmeters feature auto-

matic ranging, simple touch-and-read measurement and bright, clear readout. By using the hp 405 in conjunction with the hp 457A, you can read ac voltages on the 405 to three digits with an overall accuracy of $\pm 0.4\%$ of reading ± 0.001 v to 50 KC, $\pm 0.75\%$ of reading ± 0.002 v to 500 KC. The hp 405BR and CR are identical except that the 405CR includes (a) provision for external sampling command, (b) digital recording outputs, plus (c) reading hold-off capability, (d) print command when overranging, and (e) remote readout outputs.

Specifications

Ranges:	0.001 to 999 v dc, 4 ranges.
Presentation:	3 significant figures, polarity indicator.
Accuracy:	$\pm 0.2\%$ of reading ± 1 count.
Ranging Time:	0.2 sec to 2 sec.
Input Impedance:	11 megohms to dc, all ranges.
Response Time:	Less than 1 sec.
AC Rejection:	3 db at 0.7 cps; min. 44 db at 60 cps.
Size:	7" high, 19" wide, 13 $\frac{1}{8}$ " deep behind panel. Weight, 26 lbs.
Price:	hp 405BR, \$850.00; hp 405CR, \$925.00.

FOR EVEN GREATER SYSTEMS FLEXIBILITY, USE DYMEC 2401 INTEGRATING DIGITAL VOLTMETER!

DY-2401 Integrating Digital Voltmeter

Unique flexibility for simple and complex systems applications is yours with the Dymec 2401 Integrating Digital Voltmeter, which effectively eliminates the effects of noise and hum by reading the average value of voltage applied over a definite, selected sample period. Range, sample period and sample rate are externally programmable. Applications are further extended by the nature of the 2401, actually a voltage-to-frequency converter, combined with a 300 KC electronic counter.

Equally versatile in systems application is the Dymec Model 2410 Multi-Converter (not shown), which converts ac volts, resistance and dc volts to a proportional dc voltage with 1 volt nominal full-scale output. \$1,975.00.

Call your Hewlett-Packard/Dymec representative today for further information or for a demonstration on your bench.



HEWLETT-PACKARD COMPANY

1091K Page Mill Road Palo Alto, California, U.S.A.
Cable "HEWPACK" Davenport 6-7000

Field representatives in all principal areas



Specifications

DC Voltage Ranges:	$\pm 0.1, 1, 10, 100, 1,000$ v nominal full scale.
Overall Accuracy:	0.05% nominal.
Stability:	Greater than 0.01%/day, 1 v range and above.
Input Impedance:	1 megohm on 1 v and higher ranges. 100,000 ohms on 0.1 v range.
Price:	\$3,750.00.

Data subject to change without notice.
Prices f.o.b. factory.

HEWLETT-PACKARD S. A.

Rue du Vieux Billard No. 1 Geneva, Switzerland
Cable "HEWPACKSA" Tel. No. (022) 26.43.36

ELECTRONIC DESIGN

Publisher: Robert E. Ahrensdorf

Editor: Edward E. Grazza

Managing Editor: James A. Lippke

Technical Editors: G. H. Rostky, H. Bierman, R. H. Cushman, M. W. Meisels, A. Rosenblatt

News Editors: R. Haavind, Chief; A. Corneretto, R. N. Ross

New Products Editors: A. W. Solda, Chief; C. H. Farley, E. G. Farrell

Washington Editor: A. Warren

West Coast Editor: T. E. Mount

Consulting Editor: R. N. DeFloria

Contributing Editors: J. G. Adashko, E. Brenner, B. Bernstein

Editorial Production: D. S. Viebig, A. Abramoff, G. S. Goodman

Art Director: R. A. Schulze

Art Assistants: J. Aruego, R. Podhirny

Technical Illustrator: C. Westphal

Production Manager: T. V. Sedita

Asst. Prod. Mgr.: H. De Polo

Production Assistants: P. Bergang, M. Spector

Circulation Manager: N. M. Elston

Asst. Circ. Mgr.: H. A. Hunter

Reader-Service: L. Blair

Hayden Publishing Company, Inc.

Chairman of the Board:

T. Richard Gascoigne

President: James S. Mulholland, Jr.

Accuracy Policy

Recognizing the power of the printed word to influence, it is ELECTRONIC DESIGN's policy:

To make all reasonable efforts to insure accuracy of editorial matter.
To publish promptly corrections brought to our attention.

To not knowingly publish misleading advertisements.

To reserve the right to refuse any advertisement.

Readers noting errors or misstatements of facts are encouraged to write the editor.

Subscription Policy

ELECTRONIC DESIGN is circulated only to qualified design engineers of U. S. manufacturing companies, industrial consultants and government agencies. If design for manufacturing is your responsibility, you qualify for subscription without charge provided you send us the following information on your company's letterhead: Your name and engineering title, your company's main products and description of your design duties. The letter must be signed by you personally. ANY ADDRESS CHANGES FOR OLD SUBSCRIBERS NECESSITATE A RESTATEMENT OF THESE QUALIFICATIONS. Please include a copy of your old address stencil with your request. Allow six weeks for change to become effective. Subscription rate for nonqualified subscribers—\$25.00 per year U.S.A., \$35.00 per year all other countries. Single copy \$1.50.



1,000,000 nuvistors

...and now the new RCA-6DS4 high-mu TV and FM tuner triode with semi-remote-cutoff characteristic to reduce cross-modulation distortion

In July, 1961 RCA produced its millionth nuvistor...evidence of the fast-growing popularity of this remarkable tube family.

Newest member of the nuvistor family is the RCA-6DS4, a high-mu triode for TV and FM tuner designs. In VHF TV tuners, the 6DS4 makes possible better reception in many difficult station areas. In addition, the semiremote-cutoff characteristic of the 6DS4 reduces cross-modulation distortion. The 6DS4 makes possible the design of compact TV and FM tuners with very low noise figure and high sensitivity.

This newest nuvistor triode owes its high gain and low-noise capabilities to very high transconductance and excellent transconductance-to-plate current ratio (12500 μ mhos at a plate current of 8 ma and plate voltage of 70 volts).

The 6DS4 is just one of 6 commercial nuvistors now

at your design command. The others are:

RCA-7587 General-purpose sharp-cutoff industrial tetrode

RCA-7586 General-purpose medium-mu industrial triode

RCA-7895 High-mu industrial triode

RCA-6CW4 TV and FM tuner triode

RCA-2CW4 TV and FM tuner triode

Inherent nuvistor design features include: low heater drain • exceptional mechanical ruggedness due to all ceramic and metal construction • exceptional uniformity of characteristics from tube to tube • extremely low interelectrode leakage • high sensitivity and stability • very small size and light weight.

Discover for yourself how much more you can expect from nuvistORIZED circuitry. See your RCA Field representative or write: Commercial Engineering, Section I-18-DE-2, RCA Electron Tube Division, Harrison, N. J.



The Most Trusted Name in Electronics

RCA FIELD OFFICES ... **EAST:** 744 Broad Street, Newark 2, New Jersey. HUmboldt 5-3900 • **MIDWEST:** Suite 1154, Merchandise Mart Plaza, Chicago 54, Illinois. WHirehall 4-2900 • **WEST:** 6801 E. Washington Blvd., Los Angeles 22, Cal. RAymond 3-8361 • 1838 El Camino Real, Burlingame, Cal., OXford 7-1620.

HAYDEN PUBLISHING COMPANY, INC.
850 Third Avenue, New York 22, N. Y.

D E S I G N