Additions and Corrections to the Type 1120-A Frequency Standard
Operating Instructions, Form 5301-0111B

page 10, column 1, 4th last line:
30 volts should read -30 volts

page 15, Table 4-2, 3rd entry:
M 100 is used only with 100-kc input

page 17, column 1, 10th last line:
10^{-9} should read 10_9

page 23, Figure 5-6, legend:
REGULATOR INPUT (NEG SIDE) should read REGULATOR OUTPUT (NEG SIDE)

page 25, paragraph 5.3.3, step g, line 1:
1.6 volts should read 1.5 volts

page 25, paragraphs 5.3.4, 5.3.5, 5.3.6, 5.3.7, and 5.3.9, step b, line 2, add:
of the Type 1114-P1

page 25, paragraph 5.3.11, lines 8, 9, 10, change sentence to read:
Connect the fuse in the negative lead through a diode to the emitter of the power transistor Q806 or any equivalent point.

page 26, delete Figure 5-8

page 26, column 2, last 2 lines:
light, nongumming oil should read Lubrico No. H101 grease

page 31, Parts List:
F1, F2, and F4 are Slo-Blo fuses

page 31, Schematic Diagram:
Reverse the leads connected to the 1 KC terminals

page 31, Schematic-diagram note, 3rd last line:
"LESS THAN IN MICROFARADS" should read "LESS THAN ONE IN MICROFARADS."

page 33, add the etched-board layouts for the Type 1113-A shown on the reverse side.

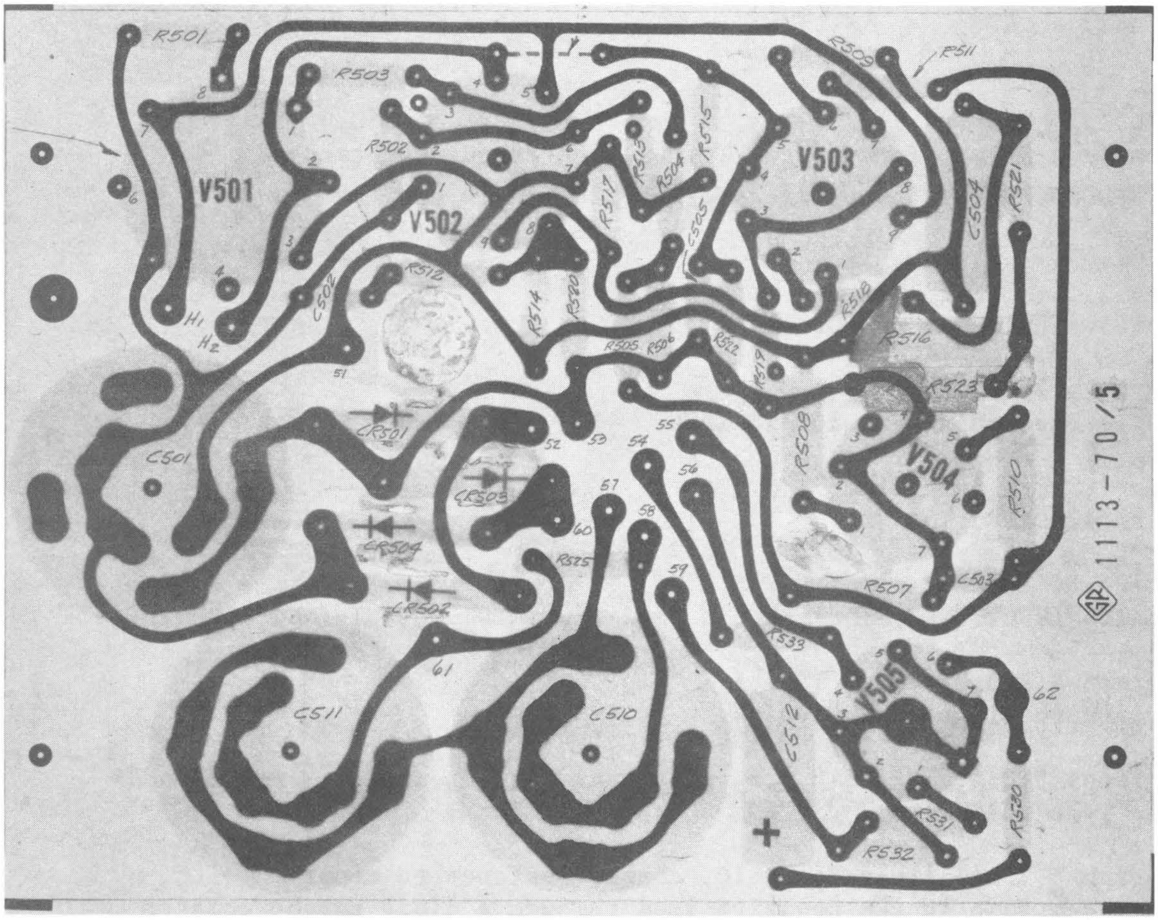
page 34, Schematic diagram for Type 1113-A crystal oven:
Move R608 to the lead running from terminal 2 of SO601 to terminal 6 of PL503.

IMPORTANT

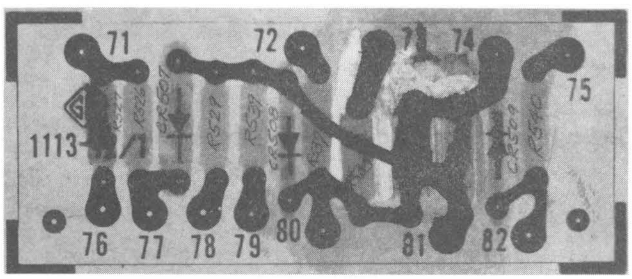
page 50, Interconnecting diagram for the Type 1120-AB:
On the Type 1268-P1, the left-hand terminal should be marked + and the right-hand terminal should be marked -. Connections from 1268-A to 1268-P1 are thus between terminals of like polarity.

General Radio Company
West Concord, Massachusetts

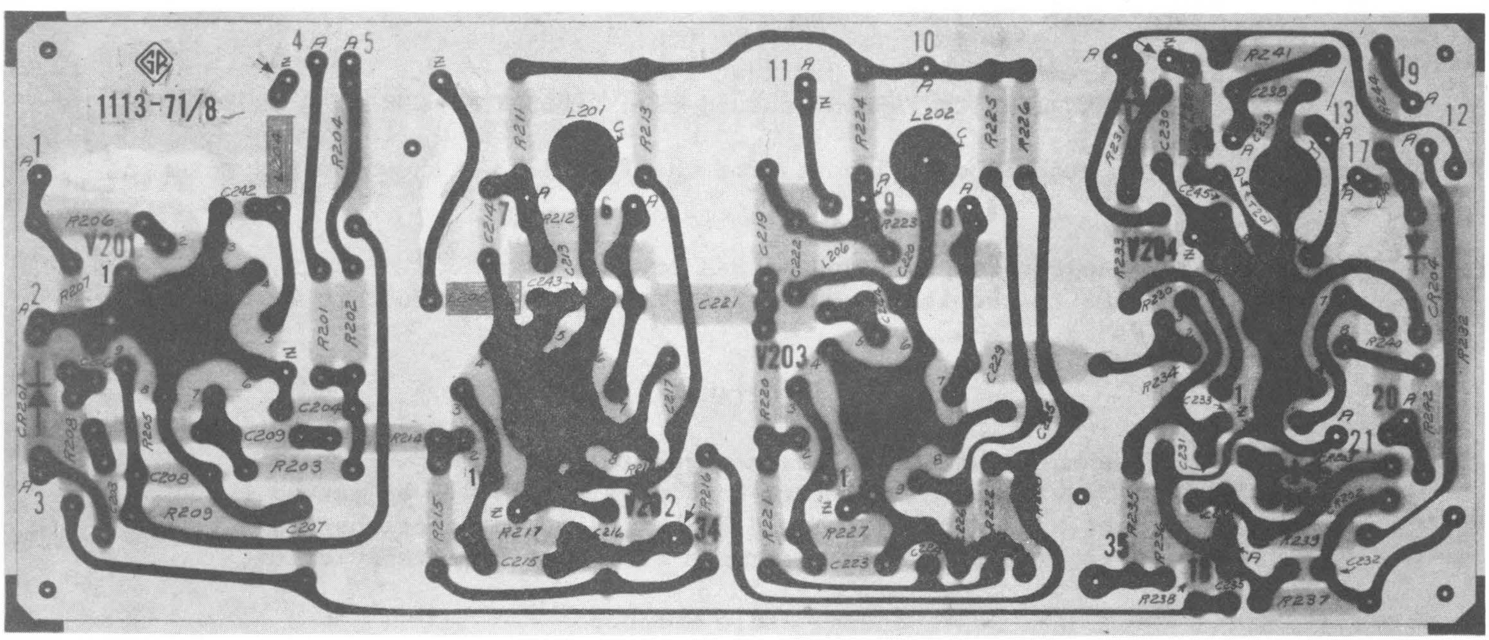
January 1965 Printed in U.S.A.



Etched-board layout for the power-supply circuit.



Etched-board layout for the metering circuit.



Etched-board layout for the oscillator-amplifier circuit.

OPERATING INSTRUCTIONS

J. NYE

TYPE 1120-A, -AB, -AH
FREQUENCY STANDARDS

TYPE 1113-A STANDARD-FREQUENCY OSCILLATOR

TYPE 1114-A FREQUENCY DIVIDER

TYPE 1103-B SYNCRONOMETER® TIME COMPARATOR

1120-A,-AB,-AH

GENERAL RADIO COMPANY

B

OPERATING INSTRUCTIONS

TYPE 1120-A, -AB, -AH
FREQUENCY STANDARDS

TYPE 1113-A STANDARD-FREQUENCY OSCILLATOR

TYPE 1114-A FREQUENCY DIVIDER

TYPE 1103-B SYNCRONOMETER® TIME COMPARATOR

Form 5301-0111-B
May, 1963

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS, USA

TABLE OF CONTENTS

TEST DATA

Type 1120-A____ Frequency Standard____________ Rack No. ________

Type 1103-B Syncronometer ____________ Serial No. ____________

Type 1114-A Divider ____________ Serial No. ____________

Type 1113-A Oscillator ____________ Serial No. ____________

Oscillator plate current ____________ ma

Crystal unit Serial No. ____________

Operating temperature ____________ C

Type 1112-A Multiplier ____________ Serial No. ____________

Type 1112-B Multiplier ____________ Serial No. ____________

Type 1116-B Emergency Power Supply ____________ Serial No. ____________

Type 1268-A Automatic Battery Charger ____________ Serial No. ____________

Type 1268-P1 Battery Drawer ____________ Serial No. ____________

DATE: ____________ OBSERVER: ____________

NOTE

THIS MANUAL COVERS THE TYPE 1120 SYSTEMS AND ALSO SYSTEM COMPONENTS, TYPES 1103-B, 1113-A AND 1114-A, AS INDIVIDUAL INSTRUMENTS. FOR COMPLETE INFORMATION ON THE TYPES 1112-A AND -B, THE TYPE 1116-B OR ON THE TYPES 1268-A AND 1268-P1 REFER TO THEIR RESPECTIVE MANUALS OF OPERATING INSTRUCTIONS.

U.S. Patent Numbers 2,548,457 and D187,740
Licensed under patents of American Telephone and Telegraph

SPECIFICATIONS

TYPE 1120 FREQUENCY STANDARDS

TYPE 1120-A FREQUENCY STANDARD

Components:
- TYPE 1113-A Standard-Frequency Oscillator.
- TYPE 1114-A Frequency Divider.
- TYPE 1103-B Syncronometer® time comparator.
- Floor-type relay rack.
- Blank panels to fill rack.
- Connection cables.

Output Frequencies: 5 Mc, 1 Mc, 100 kc, 10 kc, 1 kc, 100 cps. Plug-in units for 400 cps and 60 cps are also available. See TYPE 1114-A Frequency Divider.

Power Requirements: 140 watts, maximum, at 105 to 125 (or 210 to 250) volts, 50 to 60 cps.

Dimensions: Width 22, height 76½, depth 18½ inches (560 by 1950 by 470 mm), over-all.

Net Weight: 275 pounds (125 kg).

Shipping Weight: 485 pounds (225 kg).

TYPE 1120-AH 1000-MEGACYCLE FREQUENCY STANDARD

Components:
- TYPE 1113-A Standard-Frequency Oscillator.
- TYPE 1114-A Frequency Divider.
- TYPE 1103-B Syncronometer® time comparator.
- TYPE 1112-A Frequency Multiplier.
- TYPE 1112-B Frequency Multiplier.
- Floor-type relay rack.
- Blank panels to fill rack.
- Connection cables.

Output Frequencies: 1000 Mc, 100 Mc, 10 Mc, 5 Mc, 1 Mc, 100 kc, 10 kc, 1 kc, 100 cps; optionally 60 cps and 400 cps.

Power Requirements: 375 watts, maximum at 105 to 125 (or 210 to 250) volts, 50 to 60 cps.

Dimensions: Width 22, height 76½, depth 18½ inches (560 by 1950 by 470 mm), over-all.

Net Weight: 325 pounds (150 kg).

Shipping Weight: 575 pounds (265 kg).

TYPE 1120-AB FREQUENCY STANDARD

Components:
- TYPE 1113-A Standard-Frequency Oscillator.
- TYPE 1114-A Frequency Divider.
- TYPE 1103-B Syncronometer® time comparator.
- TYPE 1116-B Emergency Power Supply.
- TYPE 1268-A Automatic Battery Charger.
- TYPE 1268-P1 Battery Drawer.
- TYPE 1268-9602 Battery.
- Floor-type relay rack.
- Blank panels to fill rack.
- Connection cables.

Output Frequencies: 5 Mc, 1 Mc, 100 kc, 10 kc, 1 kc, 100 cps. Plug-in units for 400 cps and 60 cps are also available. See TYPE 1114-A Frequency Divider.

Power Requirements: 370 watts, maximum at 105 to 125 (or 210 to 250) volts, 50 to 60 cps.

Dimensions: Width 22, height 76½, depth 18½ inches (560 by 1950 by 470 mm), over-all.

Net Weight: 475 pounds (220 kg).

Shipping Weight: 645 pounds (300 kg).

TYPE 1113-A STANDARD-FREQUENCY OSCILLATOR

FREQUENCY STABILITY

Aging: Less than $\pm 5 \times 10^{-10}$ per day, averaged over 10 days, after 60 days of operation. After one year of operation, typical drift is less than $\pm 2 \times 10^{-10}$ per day.

Short-Term: Better than 1×10^{-10} per minute, as measured with one-second samples.

Oven Cycling: Less than 1×10^{-10}, peak-to-peak.

Ambient: Less than 1×10^{-10}/°C (5×10^{-9} for 0 to 50 C).

Line: Less than 1×10^{-10} for 105 to 130 volts.

Loading: Less than $\pm 2 \times 10^{-10}$ for 50 ohms $\pm$ 20%.

FREQUENCY ADJUSTMENTS

Coarse: Approximately 500×10^{-9}.

Fine: $\pm 5 \times 10^{-9}$ in divisions of 5×10^{-10}.

Settability: To 1×10^{-10}.

OUTPUTS 1 volt, rms, into 50 ohms at 5 Mc. 0.4 volt, rms, for General Radio TYPE 1112-A Frequency Multiplier.

GENERAL

Power Requirements: 102 to 125 (or 210 to 250) volts, 50 to 60 cps, 100 watts, maximum.

Cabinet: Rack-bench.

Dimensions: Width 19, height 5¼, depth 16¾ inches (485 by 135 by 425 mm), over-all; rack-model — panel 19 by 5¼ inches (485 by 135 mm); depth behind panel 16 inches (410 mm).

Net Weight: 30 pounds (14 kg). **Shipping Weight:** 40 pounds (18.5 kg).

TYPE 1114-A FREQUENCY DIVIDER

Input: 5 Mc, 1 Mc, 100 kc, 50 ohms, 1 volt ± 50%.

Output (with 5-Mc input):

Sine Waves — 1 Mc, 100 kc: 1 volt $\left\{\begin{matrix}+50\%\\-10\%\end{matrix}\right\}$ into 50 ohms

10 kc, 1 kc, 100 cps: 1 volt $\left\{\begin{matrix}+50\%\\-10\%\end{matrix}\right\}$ into 600 ohms

*400 cps, *60 cps: 1 volt $\left\{\begin{matrix}+50\%\\-10\%\end{matrix}\right\}$ into 600 ohms

Square Waves — 100 kc, 10 kc: Approximately 7 volts peak-to-peak open circuit

Spurious Signals: Better than 34 db down.

Jitter: Less than 0.5 nsec for 100-cycle output with respect to 5-Mc input.

Additional Frequencies Available: 400 cps; 60 cps.

Power Input: 105 to 130 (or 210 to 260) volts, 50 to 400 cps; approximately 7 watts.

Cabinet: Rack-bench.

Dimensions: Width 19, height 5¼, depth 11½ inches (485 by 135 by 295 mm), over-all; rack-model — panel 19 by 5¼ inches (485 by 135 mm); depth behind panel 11 inches (280 mm).

Net Weight: 15 pounds (7 kg).

Shipping Weight: 22 pounds (10 kg).

*Optional accessories.

TYPE 1103-B SYNCRONOMETER® TIME COMPARATOR

Input: 1-kc sine wave, one volt into 50 kilohms.

Microdial Contactor Stability: Maximum contact-closing-time deviation at any microdial setting is ±0.1 millisecond.

Calibration Errors: The maximum deviation between the indicated microdial setting and the actual contactor closing time varies sinusoidally from 0 to ±1 millisecond (maximum) over the 1000-millisecond range.

Accuracy of Time Increments: The maximum error over a time interval of 25 milliseconds is ±2% ± 0.1 millisecond.

Power Requirements: 105 to 125 (or 210 to 250) volts, 50 to 60 cps; 22 watts, continuous; 10 watts additional for starting motor.

Mounting: Relay-rack panel.

Dimensions: Panel 19 by 8¾ inches (485 by 225 mm); depth behind panel 11 inches (280 mm).

Net Weight: 35 pounds (16.0 kg).

Shipping Weight: 46 pounds (21 kg).

TYPE 1112 STANDARD-FREQUENCY MULTIPLIERS

Type	*Input*		*Residual FM Noise*	*Locking Range*	*Bandwidth†*		*Output Power*	*Open-Circuit Output Volts*
	Freq in Mc	*Volts*			*Decade*	*cps*		
1112-A	0.1 1 2.5 5	1 1.5 0.4 0.4	$< \pm 1 \times 10^{-9}$	±15 in 10^6	0.1–1 Mc 1–10 Mc 10–100 Mc	50 500 5000	20 mw into 50Ω 4 channels: 1 at 1 Mc 1 at 10 Mc 2 at 100 Mc	2
1112-B	100	20 mw* (50Ω)	$< \pm 1 \times 10^{-9}$	±100 kc‡	100 kc‡		1000 Mc 50 mw 50Ω Sine wave	>3

* From Type 1112-A. † Expressed as allowable frequency deviation rate. ‡ At input frequency.

Spurious Signals: At least 100 db below output level.

Terminals: Locking Type 874 Coaxial Connectors; adaptors are available to all commonly used types.

Accessories Supplied: Type 1112-A — Type CAP-22 Power Cord, Type 874-R22A Patch Cord, two Type 874-C58A Cable Connectors, spare fuses; Type 1112-B — Type CAP-22 Power Cord, two Type 874-R22A Patch Cords, one Type 874-C58A Cable Connector, spare fuses.

Power Supply: 105 to 125 (or 210 to 250) volts, 50 to 60 cps. Type 1112-A, 110 watts; Type 1112-B, 125 watts.

Dimensions: Relay-rack panel, 19 by 12¼ inches (485 by 330 mm); depth behind panel, 11 inches (280 mm).

Net Weight: Type 1112-A, 25 pounds (11.5 kg); Type 1112-B, 35 pounds (16 kg).

Shipping Weight: Type 1112-A, 50 pounds (23 kg); Type 1112-B, 60 pounds (28 kg).

SPECIFICATIONS (Cont)

TYPE 1116-B EMERGENCY POWER SUPPLY

Input:
From Power Line — 115/230 volts, 50–60 cps.
From Battery (when operating Type 1120-A Frequency Standard) — 28 to 32 volts, 4.5 to 3.5 amperes.
Output: 115 volts, nominal, 60 cps, 180 watts continuous rating.
Operational Range: Battery cuts in when line voltage falls below 105 volts and cuts out when restored line voltage reaches a preset value between 108 and 113 volt ac.
Accessories Supplied: Two TYPE CAP-22 Power Cords, spare fuses.
Accessories Required: 28-, 30-, or 32-volt battery and cables.
Accessories Available: TYPE 1268-A Automatic Battery Charger and TYPE 1268-P1 Battery Drawer.
Cabinet: Relay-rack.
Dimensions: Width 19, height 10½ inches (485 by 270 mm), depth behind panel 13 inches (330 mm).
Net Weight: 58½ pounds (27 kg).
Shipping Weight: 77 pounds (35 kg).

TYPE 1268-A AUTOMATIC BATTERY CHARGER
TYPE 1268-P1 BATTERY DRAWER

TYPE 1268-A Automatic Battery Charger

Constant-Current Charge: 6 hours at 4 amperes, nominal.
Trickle Charge: 33.8 volts ± 2% is maintained at the battery.
Power Required: 105 to 130 (or 210 to 260) volts, 60 cps, 240 watts maximum.
Ambient Temperature Range: 0 to 50 C.
Cabinet: Rack-bench.
Dimensions: Bench model — width 19, height 5¼, depth 12 inches (485 by 135 by 305 mm), over-all; rack model — panel 19 by 5¼ inches (485 by 135 mm), depth behind panel 11½ inches (295 mm).
Net Weight: 29½ pounds (13.5 kg).
Shipping Weight: 50 pounds (23 kg.)

TYPE 1268-P1 Battery Drawer and TYPE 1268-9602 Battery

Voltage: 28 volts dc, nominal.
Ampere-Hours: 15 ampere-hours. At 4.3 to 3.2 amperes required by TYPE 1116-B Emergency Power Supply, batteries will run at least 3½ hours.
Cabinet: Relay-rack.
Dimensions: Width 19, height 12¼, depth 19 inches (485 by 315 by 485 mm), over-all.
Drawer Net Weight: 25 pounds (11.5 kg).
Drawer Shipping Weight: 35 pounds (16 kg).
Battery Net Weight: Approximately 90 pounds (41 kg). Battery shipped direct from supplier.

Type 1120-A   Type 1120-AH   Type 1120-AB

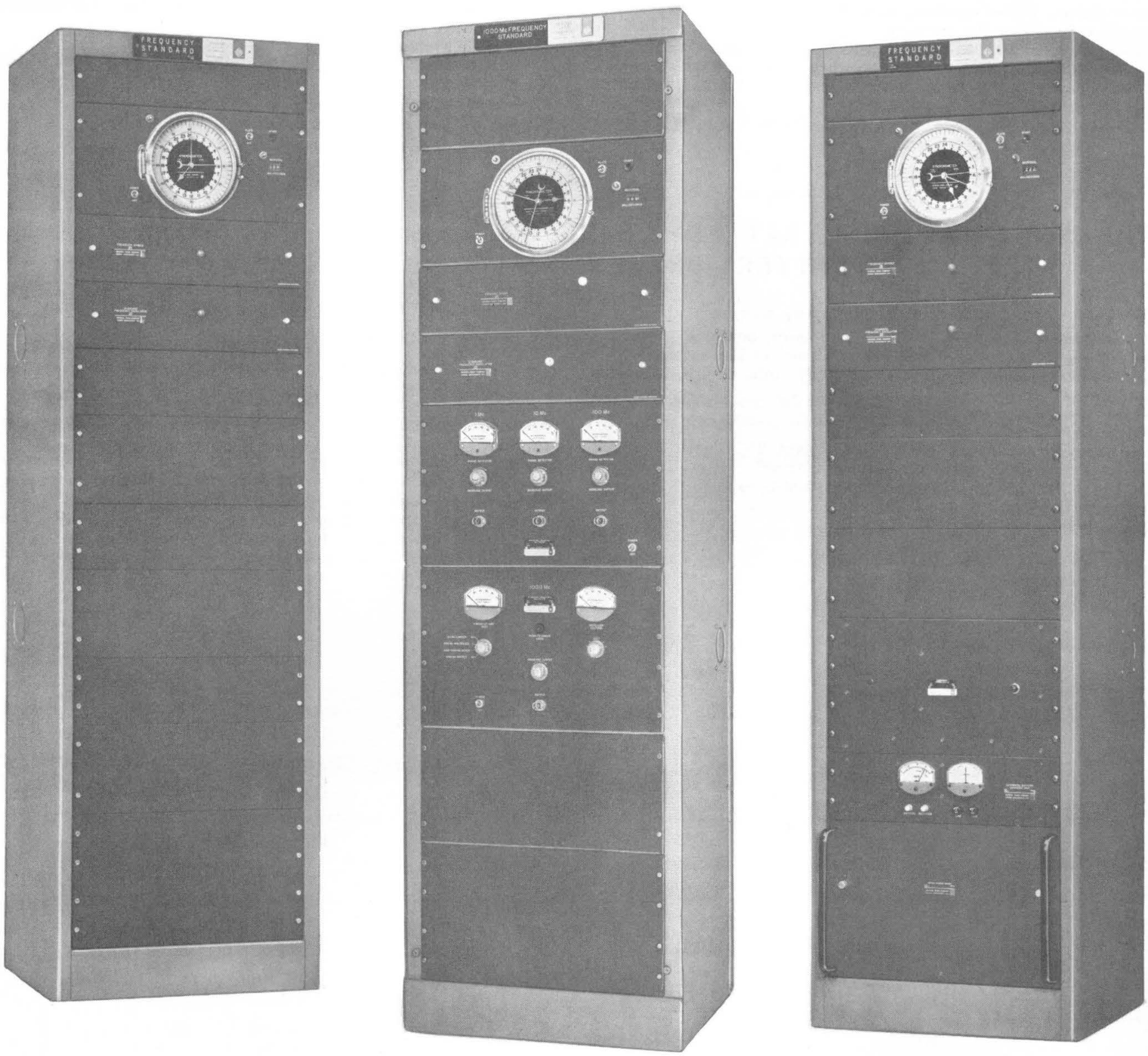


Figure 1-1. Type 1120 Frequency Standards.

TYPE 1120 FREQUENCY STANDARDS

SECTION 1

PRINCIPLES OF FREQUENCY MEASUREMENT

1.1 FREQUENCY AND TIME. Frequency measurement is, by definition, based on time measurement; conversely, time measurement can be based on frequency measurement. The interrelation between frequency and time interval is so fundamental that a highly accurate and precise measurement of one is necessarily an equally accurate and precise measurement of the other. If 100 events, equally spaced in time, occur within, say, a minute, we know that (a) the frequency of occurrence is 100 per minute, and (b) the time interval between the beginning of one event and the beginning of the next is 1/100 minute, or 3/5 second. In this illustration, a succession of regularly occurring events was necessary. As a basis of time measurement, man has always sought the most dependably regular events available - historically, the movements of the stars and planets.

1.2 KINDS OF TIME. The basis of all time measurements, then, has long been astronomical observation. The lengths of the year and of the day, after certain corrections have been applied, are among our most reliable standards of time. Atomic and molecular frequency standards, of presumably ultimate stability, provide new means for calibrating standard frequencies and time intervals. International agreement has been obtained for Ephemeris Time (E.T.) as the basic constant time scale for scientific measurements. The Ephemeris second is defined as 1/31,556,925.975 of the tropical year 1900. The "tropical year" is the time between successive vernal equinoxes. However, Universal Time, based on the rate of rotation of the earth, is used for navigation and daily living. Hence, radio time signals and standard frequency broadcasts are now made on a time scale related to Ephemeris Time, but offset by an amount which produces approximate agreement with Universal Time. The internationally used Ephemeris Time scale is tentatively standardized with respect to the resonance frequency of the cesium atom at 9,192,631,770 cycles per second.

1.3 STANDARD TRANSMISSIONS. Astronomical time observations are carried out by national observatories throughout the world. Their measurements are made available to users through radio time-signal transmissions. The broadcast standard-time and frequency signals are offset by a stated number from the nominal E.T. value. This number was -130×10^{-10} in 1962. In the United States, the U.S. Naval Observatory transmits time signals by radio through the facilities of the U.S. Naval Radio Service. Standard time signals monitored by the Naval Observatory are also broadcast continuously by the standard-frequency transmitters of WWV, operated by the National Bureau of Standards. A similar service is provided in Canada by the Dominion Observatory.

The user of a frequency standard equipped with means for measurement of the time of arrival of a radio time signal can then calibrate the frequency of the standard directly in terms of time. For the most precise result, the errors of the transmitted time signal must be taken into account. Correction data for this purpose may be obtained from the Superintendent, U.S. Naval

Observatory, Washington 25, D.C. In addition, calibration accuracy depends on stability of propagation time from the transmitter to the receiving location. The variation in high-frequency propagation time is usually not less than ±0.1 millisecond and may be greater. Hence, for a precision of calibration of $\pm 1 \times 10^{-9}$, a time interval longer than one day (1 day = 8.64×10^{7} milliseconds) is necessary between observations even if no additional instrumental errors are introduced.

The "working" clocks used at the Naval Observatory are timed by piezo-electric oscillators of the type used in stable frequency standards. These oscillators are checked against astronomical observations and also against atomic frequency standards (whence derives Atomic Time, A1). Through close cooperation between the National Bureau of Standards and the U.S. Naval Observatory, the time signals radiated by WWV and WWVH have been closely synchronized with the time signals transmitted by NBA on 18 kc. International agreement has likewise synchronized time and frequency broadcasts in several countries with United States signals. Since the time signals are derived from the stable oscillators controlling the carrier frequencies of these stations, their standard frequency values are similarly in agreement.

Standard-frequency broadcasts in the United States are primarily the responsibility of the National Bureau of Standards. Transmissions are made by stations WWV (Washington, D.C.), WWVH (Hawaii), and WWVB and WWVL (Colorado). These transmissions are of the greatest possible stability and accuracy and represent a high-precision standard service wherever they can be received (1 part in 10^{10} - 1 part in 10^{11}). It is important to note that WWVB (60 kc) and, especially, WWVL (20 kc) are intended to make use of the stable propagation conditions in the vlf band. For information and schedules of transmission of standard frequencies, apply to the Radio Standards Laboratory, National Bureau of Standards, Department of Commerce, Boulder, Colorado.

The U.S. Naval Radio Station NBA (Panama Canal Zone) on 18 kc also radiates on a standardized carrier frequency. The excellent geographic position of this station makes vlf standard time and frequency signals available over a large portion of the world.

Tables 1-1 and 1-2 list the characteristics of stations broadcasting internationally coordinated time and frequency standards. Their frequencies are maintained closely to the offset value. Their time signals are simultaneous, within a millisecond and usually require only one annual step adjustment (within ±50 ms).

1.4 THE SUBDIVISION OF TIME. Once the length of the day has been rigorously defined, it remains only to subdivide it into equal parts. A source of rapidly and regularly recurring events is needed for this purpose. The period of a pendulum can be made fairly constant, and pendulum clocks were long used as our most reliable timing devices. The period of even the best pendulum depends on the acceleration of gravity, and hence will show variations if the earth's gravity varies. The development of quartz-crystal oscillators for radio use in the 1920's gave us our first time-frequency standards relatively independent of gravity. These oscillators, designed as stable frequency references, were also time-interval determinants of exceptional accuracy and stability.

1.5 THE QUARTZ CRYSTAL. Two outstanding qualities of crystalline quartz make it especially attractive as a control element for an oscillator: the possibility of obtaining resonators of high Q (frequency sensitivity), and the outstanding stability of the quartz itself over long periods of time. The variation of frequency of a quartz crystal resonator with temperature is a function of the shape of the crystal element, its dimensions, and its angle of cut from the mother crystal.

Quartz crystal resonators are produced in the form of bars, rings, and plates for various applications.

1.6 CRYSTAL OSCILLATORS. Crystal-oscillator circuits are designed for many purposes. Some produce relatively large amounts of power at the expense of considerable dissipation in the crystal element. Others yield little power but high frequency stability. The principal crystal-oscillator circuits used in frequency standards are known as (a) the Meacham bridge-stabilized oscillator[1], (b) the Gouriet-Clapp[2] or modified Pierce oscillator, and (c) the quartz servo-controlled oscillator[3]. The General Radio Type 1120 Frequency Standards use a form of the Gouriet - Clapp oscillator, described in paragraph 2.4.

1.7 FREQUENCY DRIFT WITH TIME. For various reasons, crystal oscillators generally drift in frequency of oscillation as time elapses. The shape of this frequency-vs-time curve is usually exponential, with the frequency drifting rapidly at first and then at a decreasing rate. Crystal characteristics change slowly with time, and eventually reach a relatively low, constant drift rate. However, most quartz crystals continue to drift slowly indefinitely. Although this drift rate becomes approximately linear after several years, and can be considered as such without discernible error, the standard must be recalibrated frequently in order to insure output of the nominal standard frequency (refer to paragraph 4.4).

[1]L.A. Meacham, "The Bridge-Stablized Oscillator", PROCEEDINGS OF THE IRE, Vol 26 pp 1278-1294; October, 1938.

[2]U.S. Patent Number 2,012,497

[3]N. Lea, "Quartz Resonator Servo - A New Frequency Standard", MARCONI REVIEW, Vol 17 pp 65-73, 3rd Quarter, 1954.

1.8 FREQUENCY STANDARDS. The frequency standard has many uses. It supplies standard frequencies for both laboratory measurements and production test and calibration. It is useful for standardizing digital counters (either as a source for routine accuracy checks or directly as a counter time base), and for measuring frequency, as in conjunction with frequency meters and other comparison equipment. Frequency dividers and multipliers are necessary, in addition to an extremely stable oscillator, to make a frequency standard a useful source of standard output signals over the range from low audio to microwave frequencies.

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Steel, J.M., "Standard Frequency Transmissions," *Wireless World,* Vol 68, April 1962, pp 160-165.

Watt, A.D., et al, *World-Wide Standard Frequency and Time Signal Broadcasting,* NBS Report 6091, U.S. Department of Commerce, National Bureau of Standards, Boulder, Colorado, March 1960.

TABLE 1–1.
COORDINATED HF STANDARD FREQUENCY AND TIME TRANSMISSIONS

CALL SIGN	SITE	LATITUDE	LONGITUDE	FREQ. Mc	POWER* KW	OPERATION		ACCURACY** (parts in 10^9)	TIME SIGNAL			AUDIO TONES cps
						DAYS/WEEK	HOURS/DAY		NUMBER (per day)	DURATION (Minutes)	ADJUSTMENT	
WWV	Beltsville, Maryland USA	38°51′N	76°50′W	2.5, 5, 10, 15, 20, 25	0.1 – 9	7	24	±0.1	Continuous †		50 ms steps	440 600
WWVH	Maui, Hawaii USA	20°46′N	156°28′W	5.0 10.0 15.0	2.0	7	23.5	±0.1	Continuous		50 ms steps	440 600
CHU	Ottawa Canada	45°17′N	75°45′W	3.330 7.335 14.670	0.3 3.0 5.0	7	24	Carrier Freq. ±5 Time Signals better than ±1 ms.	Continuous		50 ms steps	Nil
HBN	Neuchatel Switzerland	47°00′N	6°57′E	5.0	0.5	7	24	±0.5	144	5	50 ms steps	500
JJY	Tokyo Japan	35°42′N	139°31′E	2.5 5.0 10.0 15.0	2.0	7	24	±5	Continuous		50 ms steps	1000
MSF	Rugby U.K.	52°22′N	1°11′W	2.5 5.0 10.0	0.5	7	24	±0.5	96	10	50 ms steps	Nil
ZUO	Johannesburg, Union S.A.	26°11′S	28°04′E	10	0.25	7	24	±5	Continuous		Steering by WWV	Nil
ZUO	Olifantsfontein, Union S.A.	25°58′S	28°14′E	5	4.0	7	24	±5	Continuous		Steering by WWV	Nil

* Carrier power to antenna.

**Offset from cesium standard approximately -130×10^{10} during 1962. Offset value announced annually by Bureau International de l'Heure.

† Time code (BCD) 11 times per hour.

TABLE 1-2.
COORDINATED LF AND VLF STANDARD FREQUENCY AND TIME TRANSMISSIONS

CALL SIGN	SITE	LATITUDE	LONGITUDE	FREQ. KC	CARRIER FREQUENCY ACCURACY** (parts in 10^{10})	POWER KW	OPERATION		TIME SIGNAL		
							DAYS/WEEK	HOURS/DAY	NUMBER (per day)	DURATION (Minutes)	ADJUSTMENT
WWVB	Boulder,†† Colorado USA	40°00'N	105°27'W	60.0	±0.5	2*	7	23	Nil	Nil	Nil
WWVL	Sunset,†† Colorado USA	40°02'N	105°27'W	20.0	±0.5	8*	7	24	Nil	Nil	Nil
NAA	Cutler, Maine USA	44°00'N	67°14'W	14.7	±1.0	1000 †	7	24	——	——	——
NBA	Balboa, Panama C.Z. USA	9°04'N	79°39'W	18.0	±1.0	30 †	6 Off Wednesday	24	Continuous		50 ms steps
NPG/ NLK	Jim Creek, Washington USA	48°05'N	121°35'W	18.6	±1.0	250†	7 Note A	24	4	5	50 ms steps
NPM	Lualualei, Hawaii USA	21°24'N	158°10'W	19.8	±1.0	100 †	7 Note A	24	4	5	50 ms steps
NSS	Annapolis, Maryland USA	38°59'N	76°30'W	22.3	±1.0	100 †	7 Note A	24	8	5	50 ms steps
GBR	Rugby, U.K.	52°22'N	10°11'W	16.0	±5.0	300*	7 Note B	22	4	5	50 ms steps
MSF	Rugby, U.K.	52°22'N	1°11'W	60.0	±5.0	10*	7	1	4	5	50 ms steps

* Carrier power to antenna.
† Radiated power.
**Offset from cesium standard approximately -130×10^{10} during 1962. Offset value announced annually by Bureau International de l'Heure.
†† To be relocated at Fort Collins, Colorado in 1963, with increased power.

Note A: Communications (Morse Code)
Note B: Communications and Time Signals

SECTION **2**

GENERAL RADIO FREQUENCY STANDARDS

2.1 NOMENCLATURE. The General Radio Type 1120 Frequency Standard is available in three system forms.

The Type 1120-A comprises the following:

- Type 1113-A Standard Frequency Oscillator
- Type 1114-A Frequency Divider
- Type 1103-B Syncronometer® time comparator
- Floor-type relay rack and cables

The Type 1120-AH 1000-MC Frequency Standard comprises all of the above elements plus:

- Type 1112-A Frequency Multiplier
- Type 1112-B Frequency Multiplier

The Type 1120-AB Standby-Powered Frequency Standard comprises all of the elements of the Type 1120-A above, plus:

- Type 1116-B Emergency Power Supply
- Type 1268-A Automatic Battery-Charging Unit
- Type 1268-P1 Battery Storage Drawer (battery included)

2.2 GENERAL. The Type 1120 Frequency Standard (see Figure 2-1) makes available, in various combinations, equipment to produce fundamental frequencies from 60 cps to 1000 Mc. It includes instruments for generating the standard frequency, for deriving the desired low-frequency sub-multiples, and for developing harmonic-rich outputs. A Syncronometer® integrates the 1000-cycle output to permit time comparisons with standard-time transmissions, and the Types 1112-A and 1112-B Standard-Frequency Multipliers provide high-frequency output up to thousands of megacycles. The Type 1116-B Emergency Power Supply, with the Type 1268-A Automatic Battery-Charging unit and the Type 1268-P1 Battery Storage Drawer, supplies standby power for the frequency standards for not less than 3.5 hours.

These several instruments can be used individually or in various combinations to meet specific needs. They complement the General Radio Type 1105-B Frequency-Measuring Equipment as well as counter-type frequency-measuring systems.

The Type 1120 Frequency Standard is a "fail-safe" system; that is, there is no possibility that either the output frequencies or the indicated time will be in error as a result of failure of the standard-frequency signal. There are two fail-safe conditions. First, the synchronous clock will fall out of synchronism and not restart if the driving signal fails or changes frequency momentarily; and, second, the frequency dividers have no output in the absence of an input signal.

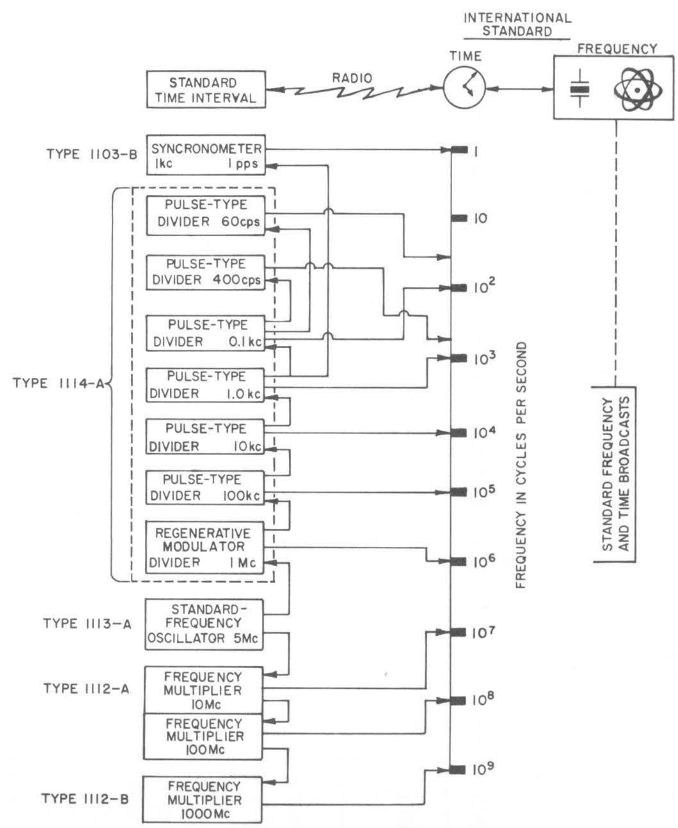


Figure 2-1.
Block diagram of Type 1120 Frequency Standard system.

The dividers, however, are designed to restart when the input signal reappears. With the Types 1120-A and -AH, no valuable data will be lost in such applications as automatic frequency-comparison systems in the event of temporary power failure, while the clock stoppage indicates that the timing sequence has been interrupted.

The Type 1120-AH Frequency Standard incorporates "locked-oscillator" frequency multipliers which

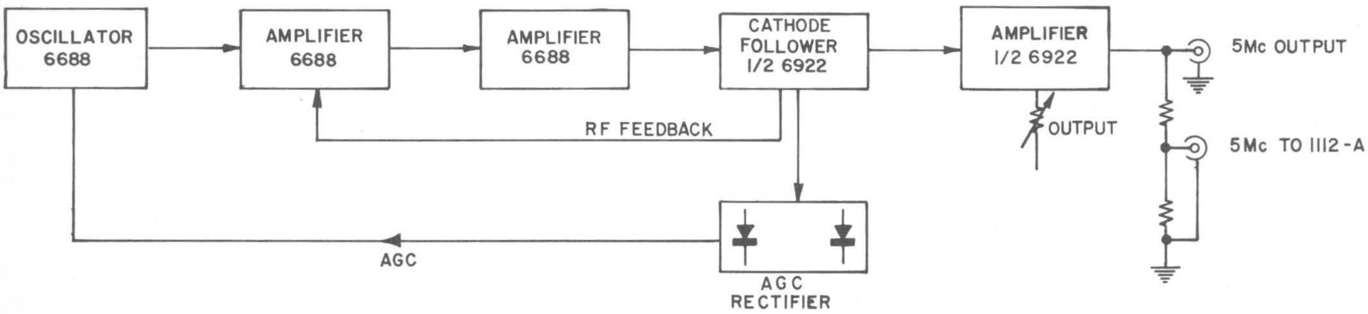


Figure 2-2. Type 1113-A Block Diagram.

may operate unsynchronized in the absence of driving signals, and are hence not fail-safe. These multipliers are self-locking when the proper driving signal is available, but are not in the time-integrating chain and cannot affect the performance of the time comparison units (Synchronometer and dividers). The Type 1120-AB eliminates problems associated with temporary power failure.

2.3 TYPE 1120-A FREQUENCY STANDARD. This is the basic configuration in the Type 1120 series. It consists of the Type 1113-A Standard Frequency Oscillator, the Type 1114-A Frequency Divider, and the Type 1103-B Synchronometer time comparator. The three instruments are rack-mounted, and all interconnecting wiring has been accomplished. The Type 1120-A has been completely factory tested, as a system, prior to shipment.

The system can function as a primary standard with available frequency outputs of 100 cps, 1 kc, 10 kc, 100 kc, 1 Mc, and 5 Mc.

2.4 TYPE 1113-A STANDARD-FREQUENCY OSCILLATOR. The Type 1113-A Standard-Frequency Oscillator contains a crystal oscillator, amplifiers, temperature control circuits, and power supplies for line operation. As shown in the block diagram (Figure 2-2), the output from the crystal oscillator is amplified by two tuned amplifiers, then rectified and returned as an AGC voltage to the grid of the oscillator tube. This keeps the rf level at the grid below 10 mv and the dissipation in the crystal very low.

Figure 2-3 shows details of the oscillator circuit. The crystal unit X601 operates in the fifth overtone mode. It uses the Gouriet-Clapp circuit, and a contoured AT-cut quartz plate, operating at 5 Mc. This plate, has a storage factor, Q, in the range of 2 to 3 x 10^6, which makes possible a high degree of decoupling between the frequency-control element and its maintaining circuit. This, in turn, minimizes short-term frequency variations. Care in processing, with particular attention to avoiding contamination, minimizes long-term drift. Overall stability is therefore excellent, as shown in Figures 2-4 and 2-5. In order to ensure that it cannot oscillate in the third overtone mode (about 3 Mc), the combination of C604 and L602 is inductive below about 3.7 Mc. At the proper operating frequency (5 Mc), this LC combination is capacitive to provide positive feedback. The

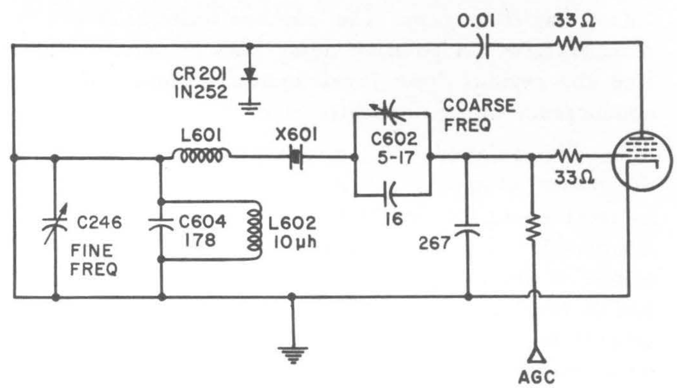


Figure 2-3. Type 1113-A Oscillator Circuit. Capacitance values less than 1 are in μf, over 1 in pf.

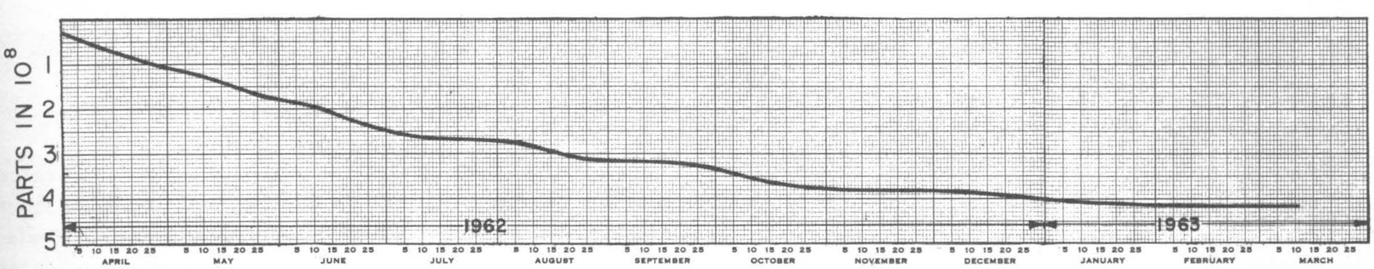


Figure 2-4. Typical long-term frequency drift of Type 1113-A Standard-Frequency Oscillator.

inductor L601 is needed for initial frequency adjustment, and its value must be determined for each crystal unit. The diode CR201 protects the crystal from transients when the oscillator starts.

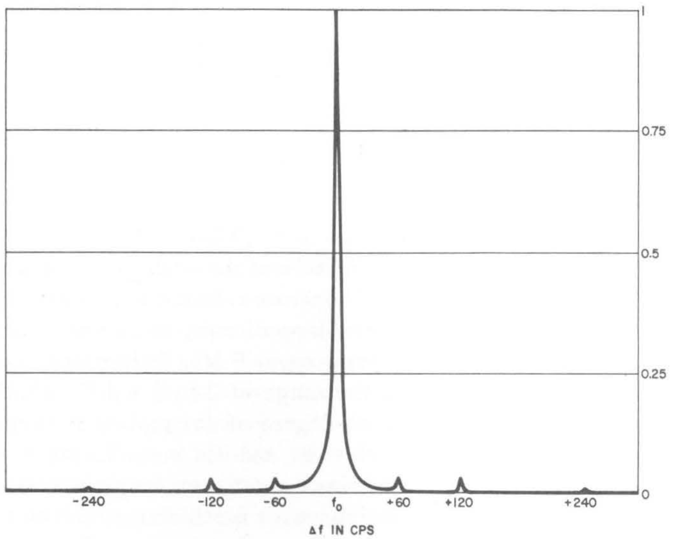


Figure 2-5. Spectrum of the Type 1113-A Standard-Frequency Oscillator as measured at 23,900 Mc by the National Bureau of Standards.

The crystal oscillator is followed by two tuned amplifiers and a cathode follower. Rf feedback stabilizes amplifier gain. The cathode follower drives the AGC rectifier. A positive delay bias is used to stabilize the crystal drive level against changes of transconductance of the oscillator tube.

The delayed AGC, maintains the drive power to the crystal at approximately 0.5 x 10^{-6} watt. This level is large enough to be "out of the noise" for short-term fluctuations, but small enough so that aging and variations of frequency with drive level, are minimal. Ac and dc feedback in the AGC amplifier system keeps the crystal drive level within 10% for a 2:1 change in the transconductance of the tubes.

The output amplifier provides additional isolation and gain. The output level can be varied over a 2:1 range by adjustment of rf feedback in this stage. This gain control affects the output impedance slightly.

Premium quality, long-life tubes are used for the oscillator and amplifiers to assure reliability and to increase the time between tube replacements. To minimize effects of cathode-interface impedance the oscillator tube is operated at relatively low transconductance and at reduced heater temperature.

The temperature-control for the quartz plate is a two-stage system based upon a vacuum-bottle oven of excellent reliability. The temperature of this oven is determined by a mercury thermostat, which provides an on-off signal to the grid of a thyratron that controls directly the low-power oven heater in the inner stage. A bimetallic thermostat controls the power of the outer stage. Cyclical temperature changes arising from this on-off heating system have been reduced to the order of 0.001 C at the quartz plate, and a resultant frequency cycling of less than 10^{-10}.

A fan is used to equalize the temperature in the cabinet in order to keep the instrument components cool and to provide a suitable ambient for the outer stage of the temperature-control system. The fan's precision bearings are hermetically sealed and lubricated for life.

The outer stage, itself, makes it necessary for the inner stage to cope with only a small temperature range. The combination maintains at least a 1500:1 control ratio over an ambient temperature range of 0 to 50 C.

To provide maximum protection against changes in ambient temperature, the oscillator-circuit components that enter into the establishment of frequency are all mounted in the oven with the quartz plate. The COARSE FREQ control, C602, which covers a range of adjustment of about 5 x 10^{-7}, is included among these components, and is provided with an ingenious drive mechanism that minimizes heat-leakage problems while assuring precise settability. The FINE FREQ control, C246, however, covers an adjustment range of only ±5 x 10^{-9} and is not sensitive enough to ambient changes to warrant temperature control. It is individually calibrated to be direct reading with divisions provided at intervals of 5 x 10^{-10} and is settable to 10^{-10}.

The power supply operates from 105-130 (or 210-260) volts, 50-60 cps. Oscillator plate and heater supplies are regulated. A transistorized low-voltage regulator supplies dc for the heaters. Filtered dc heater voltage minimizes 60-cycle frequency modulation, and well-regulated heater and plate supplies make the operation of the instrument substantially independent of line voltage.

A five-point meter circuit permits monitoring of the unit during operation. The five switch positions are:

AGC, in which the meter measures the dc grid voltage of the oscillator tube (5 volts full scale);

OUTPUT, in which the meter indicates rf output (5 volts full scale);

OSC PLATE, in which the meter indicates plate current of the oscillator tube (5 ma full scale);

INNER OVEN TEMP, in which the meter indicates the temperature of the inner oven. Full scale is about ±3 C from nominal. Normal indication is center of scale;

OUTER OVEN TEMP, in which the meter indicates the temperature of the outer oven. Full scale is about 100 C, normal indication about 28 μa.

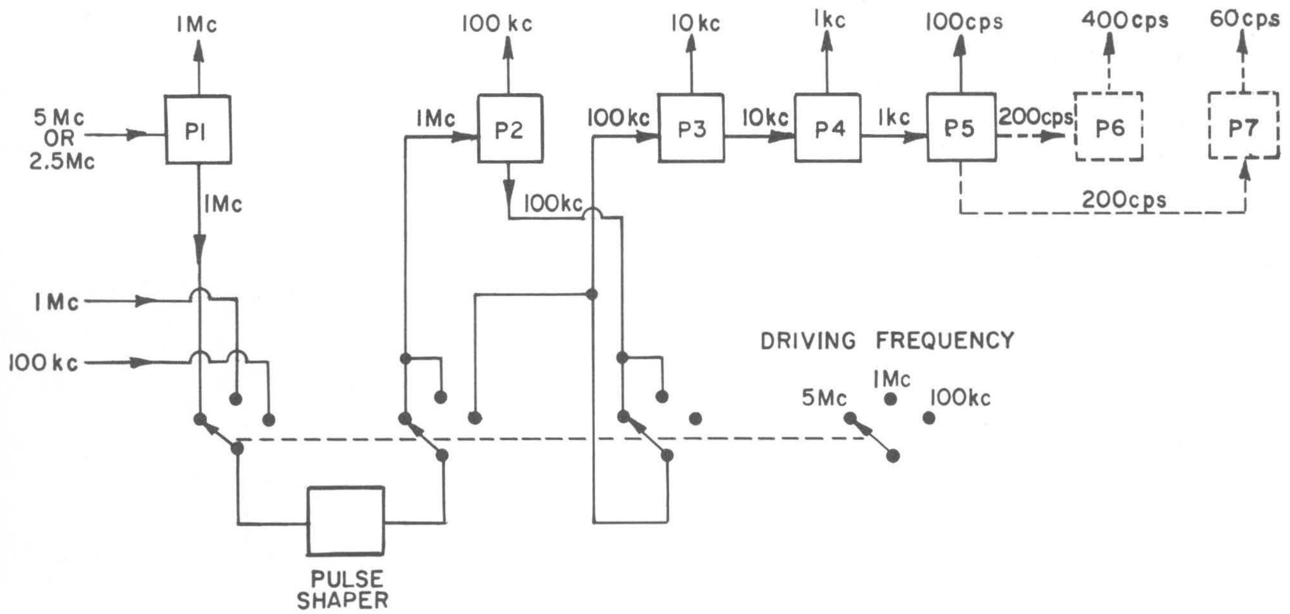


Figure 2-6. Type 1114-A Block Diagram.

2.5 TYPE 1114-A FREQUENCY DIVIDER. The Type 1114-A Frequency Divider converts an input signal into fundamental frequencies of 1 Mc, 100 kc, 10 kc, 1 kc, and 100 cps. Optional plug-in units for 400 cps and 60 cps are available. The divider will operate with input frequencies of 5 Mc, 1 Mc, or 100 kc, selectable by a front panel switch marked DRIVING FREQUENCY. Figure 2-6 is a block diagram of the divider. The 5:1-Mc divider is a regenerative modulator system, while the lower-frequency dividers are of the switching type. The divider is completely monostable – there is no output when the driving signal is absent. All output frequencies are available as sine waves.

The regenerative P1-unit divides the original 5-Mc frequency (or, optionally, 2.5 Mc) to 1 Mc. Each of the following units (P2 to P5) divides by 10. The optional 400-cycle unit selects the second harmonic of a 200-cycle signal, and the optional 60-cycle unit divides 200 by 10 and selects the third harmonic of the 20-cycle signal.

The 5:1-Mc regenerative divider is shown in elementary form in Figure 2-7. To explain its operation, let us assume the presence of a small 1-Mc noise voltage in the 1-Mc circuit. This is multiplied to 4-Mc, which is fed back to the mixer and heterodyned with the 5-Mc input, increasing the 1-Mc output. This action is regenerative and may be compared to the starting of an oscillator.

This regenerative process produces a 1-Mc sine wave. Its sine wave output is formed into pulses to drive the lower-frequency switching-type dividers. If 1-Mc or 100-kc input is used, the pulses are generated at the input frequency. The operating conditions of the circuit are set to obtain limiting on a few tenths of a volt input, and the output is essentially constant over 5:1 drive range. For 2.5-Mc input, the mixer generates the 5-Mc second harmonic and works as described above, dividing effectively by 2/5.

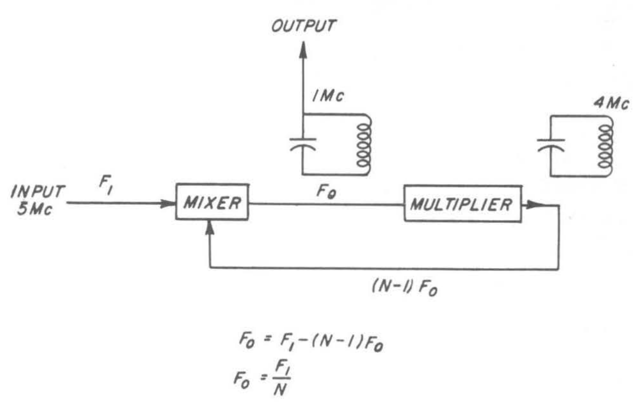


Figure 2-7. Block Diagram of Regenerative Divider.

The lower-frequency dividers are of the "switching" type. Figure 2-8 is a block diagram. The input signal, a square wave, is differentiated. The trigger generator is an amplifier generating short, positive trigger pulses. They are used to drive a monostable multivibrator (one-shot). The time constant of this circuit is chosen to reset at every fifth trigger pulse. Hence, one output pulse is generated for every 5 input pulses. The next stage is a bistable multivibrator (flip-flop). The square wave from this flip-flop is one tenth of the input frequency. A narrow-band filter selects the fundamental component which is available at the output terminal.

Below 1 Mc, switching dividers have high-phase stability so that the output signals can be used for the generation of high-order harmonic spectra with a minimum of phase modulation. For such applications, square-wave outputs are provided at 100 kc and 10 kc in addition to the sine-wave outputs.

The phase stability of the divider may be expressed in two ways: either in degrees phase angle of the output, or in terms of absolute time variation (jitter). Switching dividers may be assumed to have constant rise time regardless of fundamental frequency so that the time jitter remains invariant. This means that the phase noise is reduced by an order of magnitude for each 10:1 division. Given an over-all division ratio of 1000, say from 1 Mc to 1 kc, and assuming that for each stage a switching divider contributed 1 nsec, then we will have a total of 3 nsec time jitter at the 1-kc output.

While this hypothetical example is for illustrative purposes only, measurements have shown similar jitter results with such circuits. A typical figure for the circuits of the Type 1114-A is an average of .05 nsec of jitter per decade. The measurement was made with a sampling oscilloscope measuring the total jitter of the 100-c output with respect to the 5-Mc input.

Transistors are used throughout for reliability, small size, and low-power consumption.

All units are powered by a single power supply of -18 volts (positive side grounded). A high-gain series regulator reduces hum and permits unregulated dc input of -20 to 30 volts. The built-in rectifier operates from 100 to 130 (or 200 to 260) volts, 50 to 400 cps.

In cases where direct battery operation is desired, a 20- to 30-v battery may be connected to the regulator input, provided its positive side can be grounded. The total drain will be less than 200 ma (5 w at 24 v). The front panel can be removed to make test points easily accessible from the front of the relay rack. Plug-in units for the desired output frequencies are inserted from the rear.

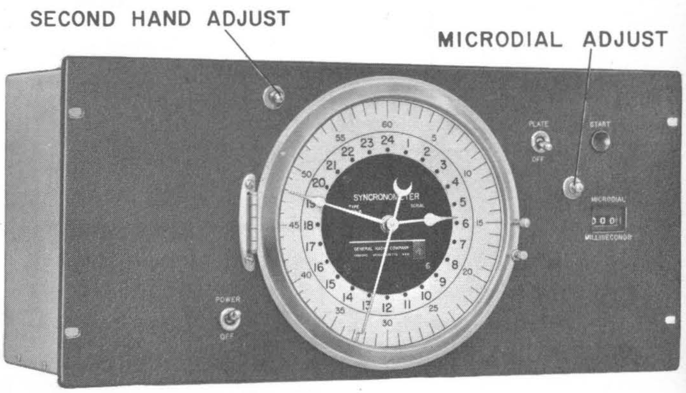


Figure 2-9. Type 1103-B Syncronometer. The microdial and second-hand shafts are accessible to the right and left of the clock face, respectively, and can be set with a crank supplied.

2.6 TYPE 1103-B SYNCRONOMETER® TIME COMPARATOR (Figure 2-9). The time comparator comprises a 1-kc synchronous motor and clock to display the integral of the number of cycles executed by the standard-frequency oscillator as a standard time interval. By means of the MICRODIAL, the "second", as indicated by the synchronous motor driven by the standard, can be compared with the standard second, as received from standard time radio transmissions (e.g., from WWV). A contactor in the MICRODIAL opens for about 0.05 second, once each second (i.e., once each 10 revolutions of the synchronous motor). The time of closing can be adjusted with respect to the incoming time signals so that, for instance, only the start of each time signal is heard. The amount of adjustment necessary to achieve synchronism is indicated on the calibrated MICRODIAL; in this manner the performance of the frequency standard can be checked against standard time, offering a means of calibration accurate to ±1 part in 10^9 over a 48-hour period. When the Syncronometer is used with a Type

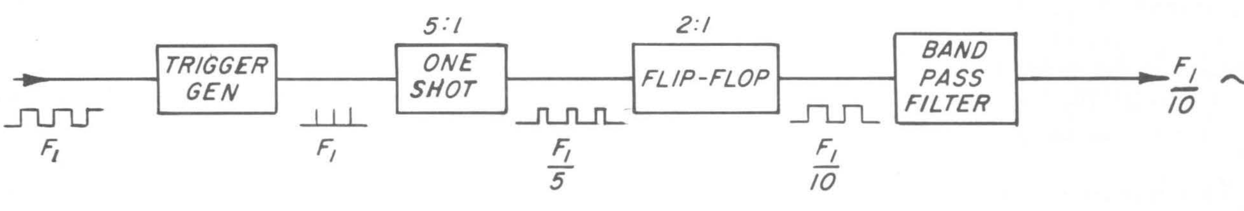


Figure 2-8. Typical Switching Divider for Lower Frequencies.

1109-B Comparison Oscilloscope as an accessory, time comparisons can be made to ±0.1 millisecond or one part in 10^9 for 24 hours. Variations in radio propagation may reduce the over-all accuracy of this time-interval comparison by approximately 2:1. Vlf time signals exhibit less variation in propagation time, but it is difficult to determine the starting time of a pulse because of the narrow bandwidth available.

The Type 1103-B Syncronometer is based primarily upon a 1000-cycle synchronous motor having a 100-tooth rotor fabricated from high-grade silicon-steel laminations. Two driving coils, oppositely disposed with respect to the rotor shaft, carry the 1000-cycle driving signal superimposed upon a dc biasing current. Pulses of torque are therefore exerted upon the teeth at a 1000-cycle rate as they pass the pole pieces, and the rotor shaft turns at 10 revolutions per second, so that its shaft angle bears a constant relationship to the electrical angle of the sinusoidal driving signal. The rotor itself carries a circular well, coaxial with the shaft, which contains radial baffles and which is partially filled with mercury. The mercury, in this configuration, does double duty in serving as a heavy mass to produce flywheel action and as a damping agent to minimize hunting.

The rotor shaft, which is vertical when the instrument is in its normal operating position, drives a horizontal shaft at 1 revolution per second through the combination of a worm and gear. This shaft, in turn, drives the clock mechanism through another right-angle worm-and-gear combination, which reduces the speed to 2 revolutions per minute. The second hand of the clock is driven from this shaft through a 2:1 differential gear, which makes possible continuous adjustment of the second-hand position without affecting the operation of the clock motor in any way. The minute-hand and hour-hand shafts are positively driven by the second-hand shaft, so that their relative positions remain correct when adjustments are made. The hands themselves, however, are driven through slip clutches so that they can be individually set, when desired.

The one-revolution-per-second shaft also drives the contactor that is used to determine the value of the shaft angle at a given moment in time. The contactor is mounted on a disc, whose plane is normal to the shaft, on a bearing that is accurately coaxial with the shaft. The contactor is actuated by a cam on the shaft, and the angular position of the disc is adjustable from the front panel through a worm-and-wheel drive. A mechanical counter, driven from the adjusting shaft, provides an in-line digital readout that is direct reading in milliseconds and that can be read to 0.1 millisecond on an interpolating scale having marks at 0.2-millisecond intervals. This choice of scale makes the resolution compatible with the uncertainty in pulse-starting time that arises from propagation anomalies for time signals received over radio paths. This uncertainty, which may be as little as 2 microseconds for ground-wave reception, is generally about 0.1 millisecond for sky-wave reception.

The Type 1103-B is completely self-contained, with its own power supply, and can be driven from any one-volt 1000-cycle source. The 24-hour clock face is illuminated and easy to read.

2.7 TYPE 1120-AH 1000 MC FREQUENCY STANDARD. In the Type 1120-AH system, decade frequencies of 10 to 1000 Mc are produced in locked-oscillator-type, low-noise, frequency-multiplier units. They offer high-quality standard-frequency signals for uhf and microwave applications. The vhf and uhf signals are essentially free from submultiple output frequencies.

The Type 1120-AH Frequency Standard consists of the basic Type 1120-A system plus the Types 1112-A and -B Standard Frequency Multipliers. The Type 1112-A, driven by the Type 1113-A Standard Frequency Oscillator, has three outputs: one of 10 Mc and two of 100 Mc. The Type 1112-B multiplies the 100-Mc output of the Type 1112-A to provide a 1000-Mc signal.

The Type 1112-A drive is taken from the output connector marked "5 MC to 1112-A" on the Type 1113-A and by-passes the top 1 Mc channel in the Type 1112-A, which is left inoperative since it duplicates a similar Type 1114-A output. There is no connection made to the coaxial input jack, J2, and the output cable, terminated in PL3, is not used on this channel. As supplied, the "100 kc-1 Mc HTR-PLATE" switch is in the OFF position to eliminate unnecessary power drain. The drive level into channel two (10 Mc) can be monitored by means of M1, the microammeter at the rear of the instrument, if PL4 of its phone-plug patch cord is connected to J200. The meter should read approximately 30 μa on TEST MULT for proper operation; if not, the setting of the recessed screw-driver-adjustment control at the rear of the Type 1113-A, marked OUTPUT LEVEL, should be altered. It may not be possible to reduce the indication to 30 μa. In this case, the level should be set to the lowest value obtainable (say 40 μa) and, with meter switch at USE, the level should then read $\sqrt{(30)^2+(40)^2} =$ 50 μa for proper lock. For other values of input level, adjust accordingly.

For full information on the Standard Frequency Multipliers, refer to the Type 1112-A/B Operating Instructions.

2.8 TYPE 1120-AB STANDBY POWERED FREQUENCY STANDARD. To maintain the continuity of output of the Type 1120 Frequency Standard it should be protected from power failure. This is particularly important if the system is functioning as a primary standard for time and/or frequency. In the Type 1120-AB, provision is made for full standby power during ac line interruptions, either momentary or of some duration. The standby power equipments consists of a battery, a battery charging unit and a power control unit. These equipments will maintain continuous operation of a frequency standard comprising an oscillator, frequency divider, and clock unit. They furnish power from storage batteries, the switchover being accomplished automatically in less than two cycles of the supply frequency, upon failure of the main ac supply (see Figure 2-10). The transition to battery supply occurs without interruption of the continuous operation of the oscillator and timing system, so that calibration on procedure involving time integration can be fully relied upon.

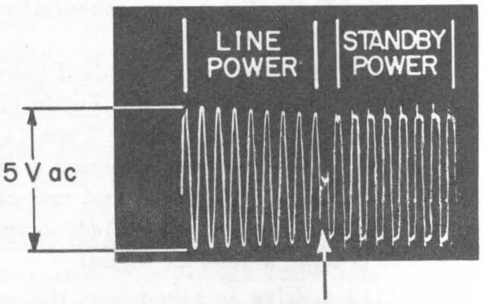


Figure 2-10. Ac input to Type 1120-A elements from Type 1116-B output during transition from line to battery power.

While the design of the Type 1113-A Standard-Frequency Oscillator prevents the possibility of permanent damage in the event of power failure, a period of hours or even days may be necessary for the standard to recover equilibrium after a temporary unsettlement caused by power failure.

Three banks of 8 nickle-cadium-cells in a corrosion-resistant mounting (Type 1268-P1) supply a nominal 28 volts dc at 3.2 amperes (average) for not less than 3.5 hours. An automatic battery charger (Type 1268-A) keeps the battery continually at rated charge, when the system is operating on ac power. Fast-acting switch-over from ac line to battery power is controlled by the Type 1116-B Emergency Power Supply.

2.9 TYPE 1116-B EMERGENCY POWER SUPPLY. The Type 1116-B Emergency Power Supply is a combination dc-to-ac inverter and relay-controlled switching device which monitors ac line voltage and sets the levels at which the system power input transfers from line to battery, and back to line. It furnishes 115v ac power, in either event, for the Frequency Standard. It functions when the line voltage sags below a preset level, in addition to the instance in which power failure is complete; it is not adversely affected by transients in the line voltage, even those of substantial amplitude. A front-panel indicator light is illuminated whenever the system is on battery power. Detailed instruction for the Type 1116-B are supplied in a separate manual.

CAUTION

The Type 1113-A Standard Frequency Oscillator, the Type 1114-A Frequency Divider and the Type 1103-B Syncronometer power cords must always be connected to the 115v AC OUTLET of the Type 1116-B and never directly to the 115v service strip.

2.10 TYPE 1268-A AUTOMATIC BATTERY CHARGING UNIT. This unit is phase-regulated silicon-controlled-rectifier device utilizing solid-state reference circuits to provide a "float" voltage which automatically maintains the battery supply at optimum charge, over a range of current demands. The charging cycle is determined by a timing motor. Front-panel meters indicate d-c volts available and the amount of current being drawn, under either charge or discharge conditions. Detailed instructions are supplied in a separate manual.

2.11 TYPE 1268-P1 BATTERY STORAGE DRAWER. This is a slide-mounted stainless-steel drawer which holds 3 banks of 8-celled nickle-cadium-alkaline rechargeable storage batteries. The batteries provide a reliable primary source of standby power for the Type 1120-AB system. They are shipped separately and should be installed in accordance with instructions in the manual supplied with the Type 1268-A.

SECTION **3**

INSTALLATION

3.1 MOUNTING. The components of the Type 1120-A, -AB or -AH Frequency Standards are shipped already mounted in a standard relay rack, complete with blank panels to fill the available rack space of 70 inches. The sole exception is the battery for the Type 1120-AB which is shipped separately, to prevent accidental damage to the system. All internal wiring is complete, and the only connection required is to the power line. Individual instruments receive power from an interior service strip run vertically at the hinge side of the rear access door. The strip is terminated in a duplex receptacle box, an external accessory power outlet, at the bottom rear of the rack. The box should be permanently wired to the power line. Three common types of cabinet access are provided nearby, to permit wiring through any convenient knockout on the box. See system interconnecting wiring diagrams. Before connecting power, determine the line voltage for which the rack is wired. Units are normally shipped wired for 115-volt service, but can be rewired for 230-volt use (refer to Section 5).

The motor of the Type 1103-B Syncronometer is shock-mounted. In shipment the mountings are clamped by two 1-1/2-inch 10-32 screws. These screws, on the bottom of the Syncronometer, are identified by large washers, and should be removed before operation. The clamping screws must be reinstalled every time the equipment is to be shipped.

CAUTION

If the Type 1113-A Standard-Frequency Oscillator is purchased separately and is to be rack mounted, be sure to install the triangular supports supplied with the instrument. The Type 1113-A must not be supported by its flanges.

3.2 USE OF DIVIDER WITH OTHER OSCILLATORS. The Type 1114-A Frequency Divider can be driven by any oscillator capable of supplying 1 volt rms into 50 ohms at 5 Mc, 1 Mc, or 100 kc. At 5 Mc, the input should be sinusoidal; at 1 Mc and 100 kc, square waves and pulses can be used. The input voltage requirement for nonsinusoidal waveforms is from 1.5 to 5 volts peak-to-peak. With nonsinusoidal waveforms, it is important that the pulse shaper be adjusted as described in paragraph 5.3.2.

The DRIVING FREQ switch behind the front panel of the Type 1114-A should be set to the appropriate position, and the signal applied to the appropriate input connector (5 Mc, 1Mc, or 100 kc). As part of a Type 1120 system, the unit is driven by a 5-Mc input from the Type 1113-A and the switch should always be in the 5 Mc position.

SECTION **4**

OPERATING PROCEDURE

4.1 GENERAL. Table 4-1, 4-2 and 4-3 list operator controls and indicators for the three system configurations.

4.2 PLACING THE STANDARD IN OPERATION. Remove the front dress panel, by releasing the two captive fasteners. Set the power switch on the Type 1113-A Standard Frequency Oscillator to STANDBY ONLY and the meter switch to OSC PLATE. Observe that the lamp adjacent to the FREQ FINE control is energized. After a warmup period of six hours or longer, set the power switch on the Type 1113-A Standard Frequency Oscillator to ON. Watch the meter; it should start slowly from zero, swing beyond full scale, and then drop back. Compare the meter readings in all positions of the meter switch with the table on the rear of the front panel.

4.3 STARTING AND SETTING SYNCRONOMETER. Throw the POWER switch on. To start the Syncronometer motor, depress the start button on the panel of the Type 1103-B Syncronometer and momentarily throw the PLATE switch to OFF until the motor starts. Then

TABLE 4-1.
OPERATOR CONTROLS AND INDICATORS
TYPE 1120-A FREQUENCY STANDARD

REF. DESIG.	NAME	TYPE	LOCATION	FUNCTION
S3	POWER	Switch, DPST	Type 1103-B	AC power control
S1	PLATE	Switch, SPST	Type 1103-B	1000 ~ amp. plate power (To OFF momentarily when starting, then back ON.)
S2	START	Switch, SPST	Type 1103-B	Push to start clock
—	——	Rotary shaft	Type 1103-B	Adjust MICRODIAL setting to calibrate standard
—	——	Rotary shaft	Type 1103-B	Adjust second hand of clock (continuously adjustable)
—	SYNCRONOMETER	Clock, 24-hour	Type 1103-B	Calibrate standard, indicate power failure or failure of divider chain
—	MICRODIAL	Counter	Type 1103-B	Millisecond indication of standard drift
P201	——	Lamp, red lens	Type 1113-A	Indicates ac power present
P501	OVEN CYCLING INNER	Lamp, white lens	Type 1113-A	Indicates inner crystal oven on
P502	OVEN CYCLING OUTER	Lamp, white lens	Type 1113-A	Indicates outer crystal oven on
M501	——	Meter, 50 μa	Type 1113-A	Indicates voltage, current and temperature
S502	POWER	Switch, TPST	Type 1113-A	Standby/operate control for ac power
S503	METER SWITCH	Rotary switch	Type 1113-A	Used with M501
P801	——	Lamp, red lens	Type 1114-A	Indicates ac power present
S801	DRIVING FREQ	Switch, rotary	Type 1114-A	Selects input frequency

release the START button and leave the PLATE switch ON. When the Syncronometer motor comes up almost to synchronous speed, give the start button successive short pushes to bring the motor into synchronism. When starting the motor, open the door covering the clock face in order to hear the beating of the motor with the 1000-cycle driving signal. When the motor "locks in", the the tone will become stable.

To set the Syncronometer, insert the crank (P/N 611-378) into the opening at the upper left of the clock face. Each "turn" advances or retards the second hand by 15 seconds. If it is necessary to reset by a considerable amount, open the door and manually advance or retard the clock hands. When the adjustment is finished, be sure that the minute and sweep second hands are synchronized. Make the final fine setting with the crank. The crank adjustment sets the second, minute, and hour hands.

4.4 USE OF THE MICRODIAL FOR TIME CHECKS.

Several agencies throughout the world operate standard frequency and time radio stations whose signals can be used to check the frequency standard. (See Tables 1-1, 1-2). The principal stations in North America are WWV (Washington, D.C.), NSS (Annapolis, Md), NBA (Balboa, Canal Zone), and CHU (Ottawa, Ont).

Time signals are broadcast from observatories or standards laboratories at one-pulse-per-second intervals. Such signals can be used to calibrate the frequency of an oscillator, if the oscillator frequency is divided, by electrical or mechanical means, down to a frequency of one event per second. The time of occurrence of the locally generated pulse is set to coincide with the time of reception of the standard time signal. After one day of operation, the relative time of occurrence of the local pulse is compared with the time of reception of the stand-

TABLE 4-2.
ADDITIONAL CONTROLS AND INDICATORS FOR
TYPE 1120-AH FREQUENCY STANDARD

REF. DESIG.	NAME	TYPE	LOCATION	FUNCTION
S1	POWER	Switch, DPDT	Type 1112-A	Controls ac power
R100	INCREASE OUTPUT (1 Mc)	Potentiometer	Type 1112-A	Regulates 1-Mc output NOT USED
M100	PHASE DETECTOR (1 Mc)	Meter, 100 μa	Type 1112-A	Indicates r-f input and phase detector level
R200	INCREASE OUTPUT (10 Mc)	Potentiometer	Type 1112-A	Regulates 10-Mc output level
M200	PHASE DETECTOR (10 Mc)	Meter, 100 μa	Type 1112-A	Indicates r-f phase detector level
R300	INCREASE OUTPUT (100 Mc)	Potentiometer	Type 1112-A	Regulates 100-Mc output level
M300	PHASE DETECTOR (100 Mc)	Meter, 100 μa	Type 1112-A	Indicates r-f phase detector level
S1	POWER	Switch, DPST	Type 1112-B	Controls ac power
M1	MONITOR AND TEST	Meter, 100 μa	Type 1112-B	Multifunction indicator
S2	———	Switch, rotary, 4-position	Type 1112-B	Used with M1
R116	———	Potentiometer	Type 1112-B	Adjust repeller voltage of V108
M2	REPELLER VOLTAGE	Meter, 100 μa	Type 1112-B	Indicates repeller voltage in proportion to current
—	PUSH TO CHECK LOCK	———	Type 1112-B	Actuates detuning device in klystron cavity
R100	INCREASE OUTPUT	Potentiometer	Type 1112-B	Adjusts 1000-Mc r-f output

TABLE 4-3.
ADDITIONAL CONTROLS AND INDICATORS FOR
TYPE 1120-AB FREQUENCY STANDARD

REF. DESIG.	NAME	TYPE	LOCATION	FUNCTION
P1	———	Lamp, red lens	Type 1116-B	Indicates system on standby power
S1	BATTERY	Switch, DPST	Type 1116-B (rear apron)	Controls battery power input
S2	LINE INPUT	Switch, DPST	Type 1116-B (rear apron)	Controls ac power input
S3	115V AC OUTPUT	Switch, DPST	Type 1116-B (rear apron)	Controls standby ac power
M1	VOLTS	0-40 V Meter	Type 1268-A	Indicates battery voltage
M2	AMPS	5-0-5 A Meter	Type 1268-A	Indicates rate of battery charge or discharge

ard time signal. Suppose that the start of the local pulse is found to occur 86.4 milliseconds before the start of the time signal (after one day of elapsed time). Since there are 86.4 x 10^7 milliseconds per day, the oscillation is

$$\frac{86.4}{8.64 \times 10^{7}} = 1 \times 10^{-6}$$

high, or 1 part per million above its nominal value. The frequency is too high because the oscillator completed its quota of oscillations in a shorter time than it should have. Or, stated another way, the oscillator exceeded the nominal number of oscillations each second by the amount derived from the calibration, $+1 \times 10^{-6}$.

The microdial on the Syncronometer allows the user to check time as a function of the oscillator frequency against time as received from a source such as WWV. To make such a comparison, first connect the microdial contactor leads (the cable marked A4, at the rear of the Syncronometer) across the audio-frequency output of a communications receiver. Then tune the receiver to the time-signal frequency. The microdial contactor opens for only 0.05 second each second, and at all other times the receiver output will be shorted, and the time signals muted. The time of opening can be brought into coincidence with the very beginning of each time tick by means of the crank adjustment adjacent to the microdial scale. For a time diagram of this operation, see Figure 4-1. Turn the crank so that the microdial setting decreases, until the sound of the time tick is audible only as a very short click.

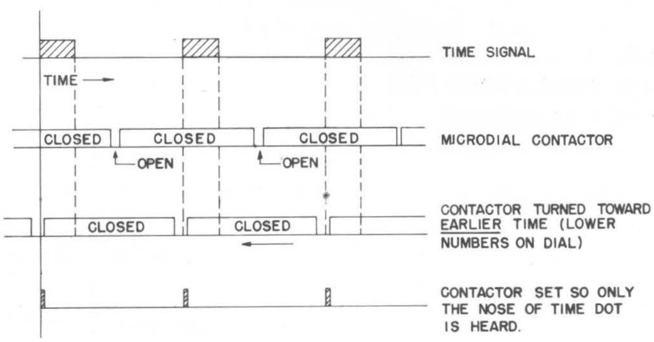
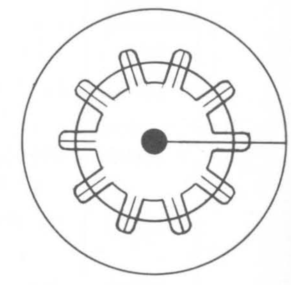
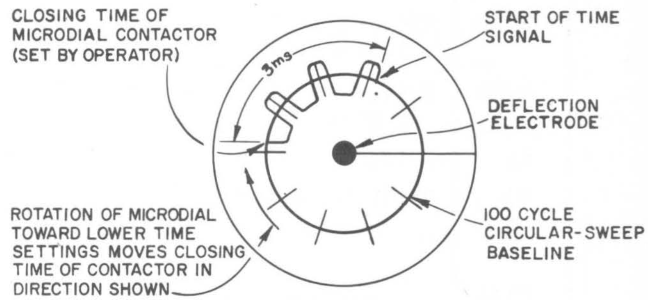


Figure 4-1.
Diagram of Time Comparison Using the Microdial.

A more precise and more reliable check of frequency against time signals is afforded by use of the Type 1109-B Comparison Oscilloscope, a component of the Type 1105-B Frequency Measuring System. This system uses a visual display of the time signals on the circular-sweep oscilloscope; details are available on request. The use of this oscilloscope provides an accurate time-of-arrival indicator driven directly by the standard oscillator and independent of variations in the microdial contactor. The display should appear as shown in Figure 4-2.

Figure 4-2.
(right) 1 Kc time signals as displayed on 100 cps sweep.
(below) Display with Microdial Set to Close 3 Milliseconds after Start of Time Signal.





The user who lacks the Type 1105-B Frequency Measuring System can nevertheless use an oscilloscopic display. A trigger pulse may be derived using the circuit shown in Figure 4-3. The terminals of the microdial are closed for about 0.95 second and open for about 0.05 second (these figures are representative only; the actual length of the "open" period may vary 2:1 from this value). The battery-resistor suppressor-network combination used with the microdial contactor provides a pulse suitable for triggering an oscilloscope with an externally controlled sweep circuit. The time signal from the output of the radio receiver or detector is applied to the

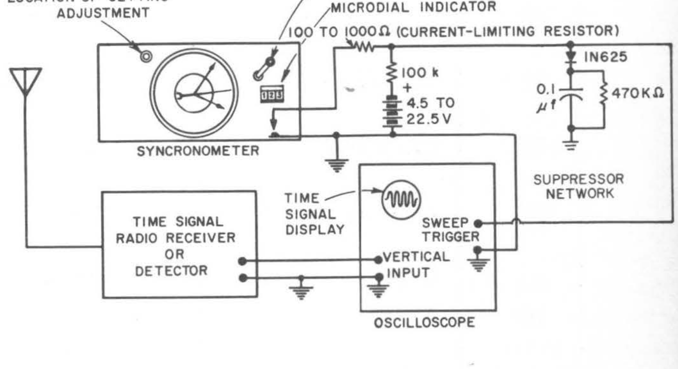


Figure 4-3. Setup for Time Checks Using Microdial.

vertical deflection terminals of the oscilloscope. A preliminary check on time of arrival of the time signal can be made with a sweep duration slightly longer than one second (total) in order to estimate the delay of the time signal relative to the setting of the microdial contactor which initiates the sweep. The MICRODIAL should then be adjusted to bring the time signal near the starting time of the sweep. Then the sweep duration should be decreased to increase resolution. The time of arrival of the time signal may then be logged from the microdial setting. If the same time delay is allowed at all times between the starting time of the sweep (as determined by the microdial setting) and the start of the time signal (as displayed on the oscilloscope), then the difference between microdial time readings over a given time interval will be an accurate measure of time gained or lost on the Syncronometer.

Once the MICRODIAL is synchronized with the time signals, any subsequent deviation is represented by the number of milliseconds the dial must be readjusted to restore synchronization. The MICRODIAL is direct reading in milliseconds, and each millisecond is divided into 0.2-millisecond graduations. For instance, if the initial microdial setting is 250.0 milliseconds and 24 hours later it must be reset to 249.0 to synchronize with the time signal, the change in indicated time (Δt) is -1.0 millisecond or -0.001 second. Since there are 86,400 seconds in a day, this 0.001-second change represents a time gain of $\frac{0.001}{86,400}$ or 1.16×10^{-8}. Since the clock lost time, the frequency standard was low in frequency.

The following table will be found useful in correlating microdial readings with parts per 100 million (based on a 24-hour time interval):

PARTS IN 10^8	MILLISECONDS PER DAY
0.5	0.43
1	0.86
1.5	1.30
2	1.73
2.5	2.16
3	2.59

Since one can easily read half divisions (0.1 millisecond) on the microdial scale, comparisons can be made to better than ± 1 part in 10^{-9}. The ultimate accuracy of the time-signal transmissions can be realized only by the use of an oscilloscope. Ultimately, small variations in the contactor closing time (less than ± 0.1 millisecond) and variations in propagation time of the time signals limit the over-all accuracy to about $\pm 2 \times 10^{-9}$ in 24 hours using high frequency broadcasts.

It should be noted that high-frequency (3 to 30 Mc) radio time signals arriving by sky-wave paths are subject to appreciable variations in propagation time, even over relatively short time intervals. Consequently, it is not advisable to use short-time measurements of arrival time of high-frequency signals in frequency calibrations. Measurements made over an interval of 24 hours or longer are recommended for such use.

4.5 LOGGING PERFORMANCE. A good log is indispensable to the user who desires a continuous check on the accuracy of his frequency standard. Such a log may be a running account of frequency comparisons (refer to paragraph 4.6) or a chronicle of daily microdial resettings.

Time signals are generally available from WWV throughout the United States; however, for maximum reliability, it is recommended that the microdial be checked daily against as many time-signal stations as can ordinarily be received. The primary frequency standard at General Radio is checked daily against WWV, CHU, and NSS.

In this way, not only will checks be less dependent on vagaries of radio transmission paths, but a correction applied at one of the standard transmitters will be recognized as such and not misinterpreted as instability in the Type 1120-A.

It should be noted that a fixed day-to-day microdial adjustment indicates that the frequency standard is high or low in frequency – but not that the standard is drifting. If microdial settings for successive days are 50.0, 49.9, 49.8, 49.7, etc., there is a constant error of one-tenth division, or 0.1 millisecond per day. Thus the frequency error is about -1 part in 10^9, but the standard is not drifting in frequency. It is merely set low in frequency and can be corrected by adjustment of the FINE FREQ control (C246) behind the dress panel of the Type 1113-A by the necessary amount. It is important to remember that, even if the frequency remains rock-steady, there will be a constantly increasing time deviation as long as the frequency is the slightest bit high or low.

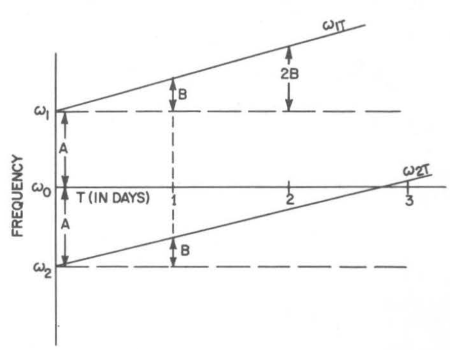


Figure 4-4. Effects of Constant Oscillator Drift.

The relationship between time gained or lost and frequency change as a function of elapsed time is shown. Figure 4-4 shows the effects of a constant oscillator

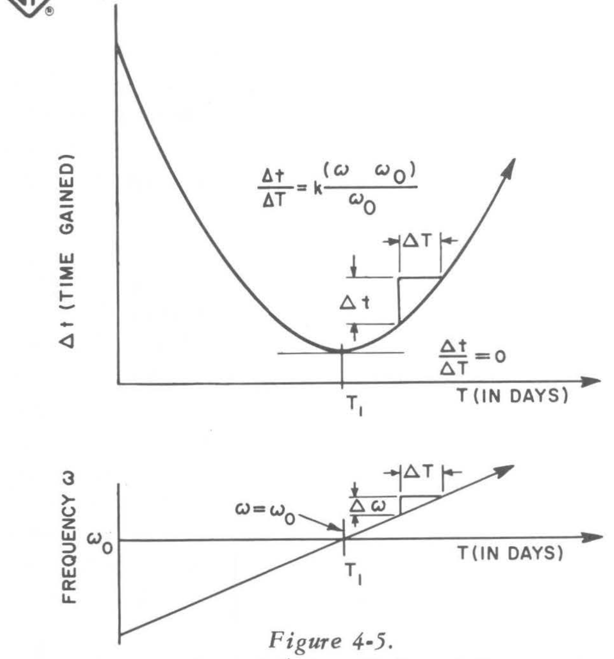


Figure 4-5.
Plot of Time Gained (Δt) vs T (Days) Compared with Frequency (ω) vs T (Days) for Same Oscillator.

frequency drift rate on the frequency of the standard oscillator. Figure 4-5 shows the parabolic shape of the Δt (time gained or lost) curve and its relation to the oscillator frequency. (Not all oscillators exhibit linear frequency change vs time, but this characteristic is that most often observed in good frequency standards after an initial stabilization period.)

In Figure 4-4, ω_o is the nominal oscillator frequency, ω_1 is a frequency setting initially high by an amount A (i.e. A is positive), and ω_2 is a setting initially low by an amount A (A is negative). B is the amount the frequency has drifted after one day. After two days, the total drift is 2B, etc. The frequency error, ω_T, may be expressed as:

$$\omega_T = 2\pi f = A + BT$$

where: $A = \omega_1$, or ω_2 = initial setting of oscillator frequency
B = change in frequency per day
T = time in days

In Figure 4-5, the time gained, Δt, is plotted against T, elapsed time in days. The change in the Δt curve for a time increment ΔT gives the slope $\frac{\Delta t}{\Delta T}$, of the Δt curve. This slope is proportional to the difference between the nominal correct frequency, ω_o, and the actual frequency, ω. If this frequency difference is divided by ω_o and multiplied by the proper value, k, it can be expressed as a frequency deviation in parts per 10^8, or as any other convenient ratio. Thus $\frac{\Delta t}{\Delta T} = \frac{k(\omega - \omega_o)}{\omega_o}$. Note that as ω departs farther from ω_o, $\frac{\Delta t}{\Delta T}$ becomes larger. Thus, although $\frac{\Delta \omega}{\Delta T}$ is constant, $\frac{\Delta t}{\Delta T}$ increases as the square of the elapsed time, T.

A suggested log form for daily microdial checks is shown in Figure 4-6.

4.6 FREQUENCY COMPARISONS.

The frequency of the Type 1120 can be checked against the frequency of a standard radio transmission by a simple system of beating one against the other. Because of the presence of interfering signals, fading, or other difficulties in reception of the transmitted frequency, comparison against

FREQUENCY-STANDARD LOG

DATE	TIME (EST)	MICRODIAL READINGS						REMARKS
		WWV	Δt(ms/day)	NSS	Δt(ms/day)	CHU	Δt(ms/day)	
8/14/59	0900	5mc 49.7		9425kc 50.1		7335kc 49.6		Fading on all signals
8/15	0900	49.9	+0.2	50.1	0	49.7	+0.1	
8/16	0900	50.1	+0.2	50.3	+0.2	49.9	+0.2	Propagation
	1300	50.2	(+0.1)	missed		50.1	(+0.2)	(daily change)
	1500	50.2−	(−0.05?)			50.0	(−0.1)	
8/17	0900	50.3+	+0.2+	50.5+	+0.2(+)	50.1	+0.2	Reset FINE FREQ adj
	0905	→						-1.5×10^{-9} (from +3.0 to +1.5)

Figure 4-6. Suggested Microdial Log Form.

time is usually a more convenient and reliable method of checking the standard.

The standard frequencies supplied by the Type 1120, with Type 1108-B Coupling Panel added, coincide with those transmitted by the U.S. Bureau of Standards' Station WWV. If a communications receiver is tuned to a frequency on which both WWV and the Type 1120 harmonics are audible, any slight difference in the two frequencies will produce a "beat", a periodic waxing and waning in intensity. The rate of this waxing and waning is the difference in frequency, which can be counted against a stop watch or against the sweep second hand of the Type 1103-B Syncronometer.

Frequency comparisons with very-low-frequency standard broadcasts are probably the most precise means of calibrating local frequency standards. Frequency calibrations to an accuracy of $\pm 1 \times 10^{-9}$ can be made with averaging times of less than 10 minutes, and an accuracy of $\pm 1 \times 10^{-10}$ can be achieved over 30 minutes with proper equipment. For a discussion of the methods and procedures used in vlf calibration, refer to "Intercontinental Frequency Comparison by Very Low Frequency Radio Transmission," by John A. Pierce, *Proc IRE*, Vol 45 No. 6, June 1957, pp 794-803. Most precise calibration requires the use of synchronous detection systems with very narrow effective bandwidth achieved by servo-control techniques.

4.7 FREQUENCY ADJUSTMENTS OF THE OSCILLATOR. After the frequency standard has been found high or low by either time or frequency comparison, it is possible to correct the frequency of the oscillator to compensate for the error. There are two frequency adjustments, one coarse (FREQ COARSE) and one fine (FREQ FINE). The coarse adjustment has a range of about 500 $\times 10^{-9}$. The dial is calibrated for logging purposes only; the frequency is not a linear function of dial reading. The fine frequency adjustment has a total range of about 10×10^{-9}, and is calibrated in divisions of 5×10^{-10}.

4.8 FREQUENCY MEASURING EQUIPMENT. The General Radio Type 1105-B Frequency Measuring Equipment contains all the auxiliary equipment necessary for the accurate measurement of unknown frequencies in terms of standard frequencies from the Type 1120. The Type 1105 contains the following instruments, each available separately as well as part of the assembly:

Type 1106-A, -B, -C Frequency Transfer Units
Type 1107-A Interpolation Oscillator
Type 1108-B Coupling Panel, including harmonic generator
Type 1109-B Comparison Oscilloscope
Type 480-MA Relay Rack (includes loudspeaker, Type 1105-P1)

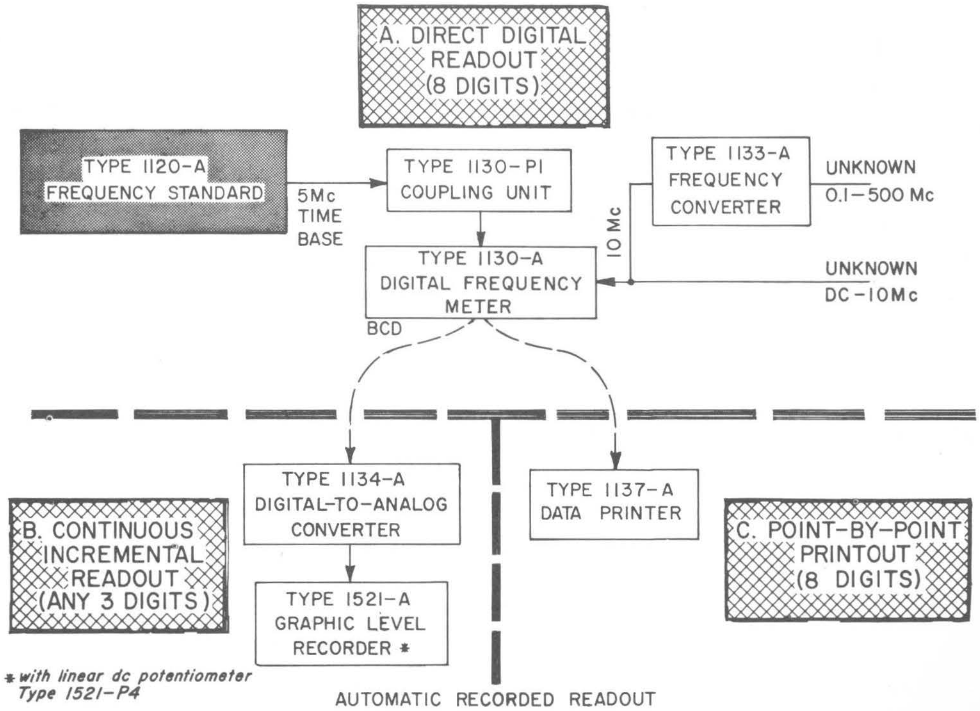


Figure 4-7. Frequency Measurement Systems using Type 1120-A which give a digital readout.

SECTION **5**

SERVICE AND MAINTENANCE

5.1 GENERAL.

5.1.1 WARRANTY. We warrant that each new instrument sold by us is free from defects in material and workmanship, and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two-year period not to meet these standards after examination by our factory, district office, or authorized repair agency personnel, will be repaired, or, at our option, replaced without charge, except for tubes or batteries that have given normal service.

5.1.2 SERVICE. The two-year warranty stated above attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please write or phone our Service Department (see rear cover), giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest district office, requesting a Returned Material Tag. Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

5.2 TYPE 1113-A STANDARD-FREQUENCY OSCILLATOR.

5.2.1 FREQUENCY ADJUSTMENT. Refer to paragraph 4.7.

5.2.2 ALIGNMENT OF AGC AND OUTPUT AMPLIFIER. Do not attempt to tune the inductors on the amplifier board without following the specified procedure. Tuning with the feedback loop closed causes little change in output but may result in instabilities.

a. Remove the FINE FREQ dial and the plate behind it.

b. Disconnect the plate lead and connect a signal generator as shown in Figure 5-1. Remove the feedback link (see Figure 5-2) completely.

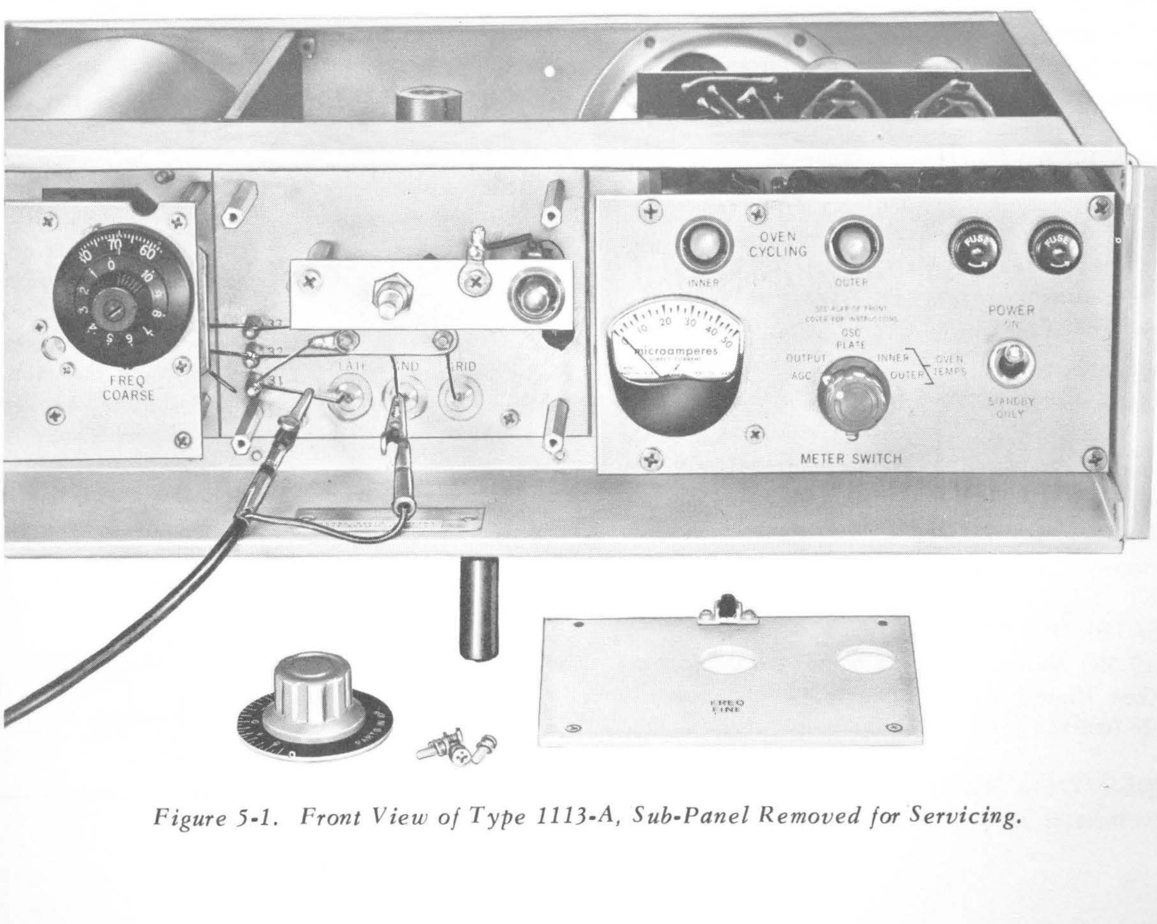


Figure 5-1. Front View of Type 1113-A, Sub-Panel Removed for Servicing.

Descriptions of this equipment are given in the current General Radio Catalog.

An alternative frequency-measuring system can be assembled from other General Radio instruments for applications in which a digital readout is desired. Figure 4-7 shows a block diagram of such a system. The Type 1130-A Digital Time and Frequency Meter measures the unknown frequency directly within the range from dc to 10 Mc. For frequencies from 10 Mc to 500 Mc, the Type 1133-A Frequency Converter is inserted ahead of the frequency meter, for continuous measurements over the stated range. The 5-Mc output of the Type 1120 Frequency Standard is substituted for internal time base oscillator of the Type 1130-A Frequency Meter.

This arrangement affords an accuracy of ±1 count ±2 parts in 10^{10} per day, or ±1 part in 10^{10} per minute.

Block A in Figure 4-7 shows the basic equipment necessary for direct digital readout. For observations over a period of time, or for a documentary record of measurements, the arrangements shown in Blocks B or C are recommended.

The Type 1521-A Graphic Level Recorder provides a continuous plot of frequency over a protracted period and is ideally suited for drift measurements. The Type 1137-A Data Printer is suggested for measurements on varied or varying sources, in which a record of a number of discrete, identifiable frequencies is desired.

4.9 OUTPUT SIGNAL PATCH PANEL. Users desiring front-panel accessibility for any signal output of the system may install up to 10 Type 874 coaxial connectors in line on one of the small blank panels. The Type 874-PFL Panel Feedthrough Locking Connector, used in conjunction with either Type 874-R20LA or -R22LA Patch Cords, is recommended. The six Type 874-CL58A Cable Connectors supplied with each system may be used with RG-58/U (series) cable to fabricate three patch cords. In some instances, minor rearrangement of the instruments in the rack may be required.

The Type 874-PFL is a convenient, low-reflection, low-leakage, 50-ohm, feedthrough connector. It consists of a short section of air line with locking Type 874 connectors at each end. A flange to permit recessed panel mounting is provided with each, as are complete instructions for panel preparation and connector installation. Other Type 874 coaxial elements available are listed at the end of the manual.

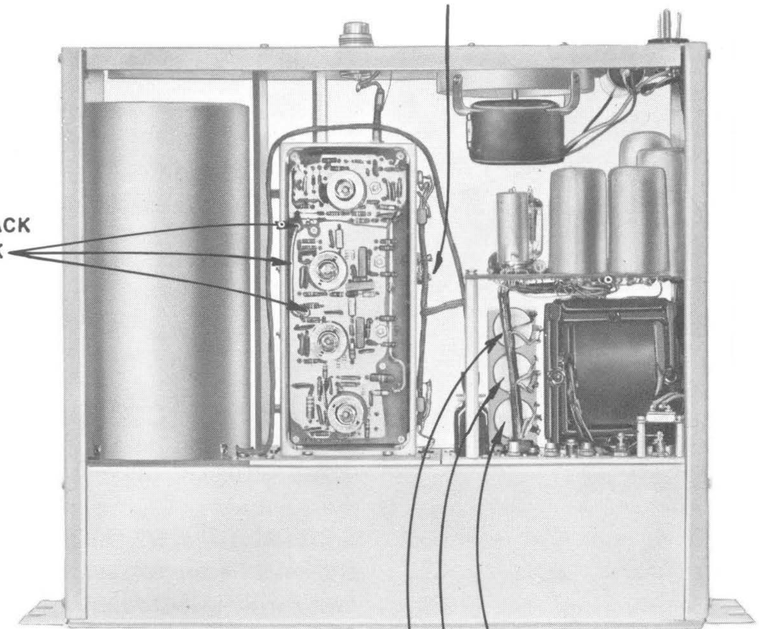


Figure 5-2. Top View of Type 1113-A.

c. Set the signal-generator frequency to 5 Mc.

d. Set the meter switch on the Type 1113-A to AGC.

e. Set the power switch to ON.

f. After allowing five minutes for warm-up, increase the signal-generator output until the meter shows some deflection.

g. Tune L201 and L202 for maximum meter deflection.

NOTE

Control output of the signal generator so as not to exceed 15 μa on the meter. A 10-μa meter reading should require an input of about 4 mv.

h. Disconnect power.

i. Replace the feedback link and resolder the plate lead.

j. Mount the FINE FREQ plate and dial. To set the dial, turn the shaft fully counterclockwise and set the knob so that the mark on the dial is lined up with the dial indicator.

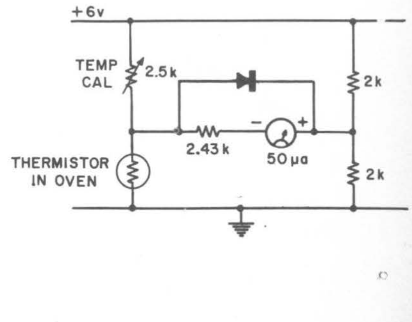
5.2.3 HEATER VOLTAGE ADJUSTMENT.

Connect an accurate (0.5%) dc meter from the heater terminal on the casting (see Figure 5-2) to chassis. Adjust potentiometer R528 (marked HTR VOLTS) to 6.5 v ±.05 v.

5.2.4 INNER-OVEN THERMOMETER CALIBRATION.

The potentiometer R543 (marked INNER OVEN TEMP CAL) adjusts a thermistor bridge so that the meter M501 reads 25 μa at the proper operating temperature of the crystal. This temperature varies from unit to unit and is listed on page iv of this instruction book. The meter functions as a deviation meter with 25 μa (center) as the normal reading. Full-scale meter range corresponds to a temperature variation of ±3 C from normal. The circuit is shown in Figure 5-3. When the thermistor is cold its resistance is high and decreases with increasing temperature. At the operating temperature of the oven the TEMP CAL potentiometer has slightly more resistance than the thermistor so that a current of +25 μa flows. Recalibration requires insertion of a very small-gage thermocouple. If the operation of the oven appears otherwise normal, the potentiometer may be set for +25 μa without actual measurement of temperature. "Normal" here means that the frequency of the unit appears to be stable and the oven cycle (cycling lamp) has an on-off ratio of about 1 to 3, say 20 seconds on and 60 seconds

Figure 5-3. Inner-Oven Thermometer.



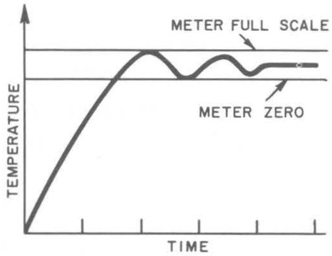


Figure 5-4. Temperature vs Time During Warm-up.

off. Moderate departures from these values do not indicate failure, and the figures are for guidance only. It is normal for the temperature to exceed full scale during warmup (see Figure 5-4). Because of the suppressed zero, the meter may swing from full scale to zero several times during the warmup period.

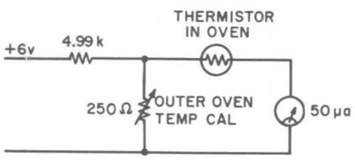


Figure 5-5. Outer-Oven Thermometer.

5.2.5 OUTER-OVEN TEMPERATURE CALIBRATION.

The potentiometer R536 marked OUTER OVEN TEMP CAL may be set at room temperature as follows: Make sure that the ovens have been turned off for at least 24 hours. Measure room temperature. Apply power and set the calibration potentiometer to give room-temperature reading (1 μa for every 2 C; 25 C equals 12.5 μa). The scale of this meter is approximately linear from 20 to 80 C. Normal reading of the meter for a hot oven is 27 to 30 μa. See diagram, Figure 5-5.

5.2.6 CONVERTING TO 230-V OPERATION.

The Type 1113-A is normally supplied for 115-volt operation. For 230-volt use the following changes must be made:

Remove the screws from the right-hand panel. The panel can then be swung out supported by its cables, exposing the transformer terminal board. Remove the jumpers from terminal 1 to 3 and 2 to 4 and connect terminal 2 to 3. Make sure not to disturb any other wires connected to these terminals. Replace the 1.2-amp slow-blow fuses supplied for 115 v with 0.6 amp slow-blow fuses, and remove the 115-v nameplate (near power plug).

5.3 TYPE 1114-A FREQUENCY DIVIDER.

5.3.1 POWER SUPPLY.

To set the regulator output adjust R802 for -18 volts, as measured from the point indicated in Figure 5-6 to chassis.

5.3.2 PULSE SHAPER.

Connect a 1-Mc signal to the INPUT 1-Mc connector in back of the instrument. Set the DRIVING FREQ switch to 1 Mc. Connect an oscilloscope to the output terminal of the pulse shaper. (See Figure 5-6). Adjust R906 for best sensitivity and output waveform as shown in Figure 5-7. Not more than 1 volt drive peak-to-peak should be required for proper operation.

5.3.3 TYPE 1114-P1 5-TO-1-MC DIVIDER.

a. Remove the unit from the cabinet and connect it to the assembly using the Type 1114-P9 Servicing Extension.

b. Apply a 5-Mc (±1 kc) 1-volt rms signal to the input terminal.

c. Connect an oscilloscope to TP101.

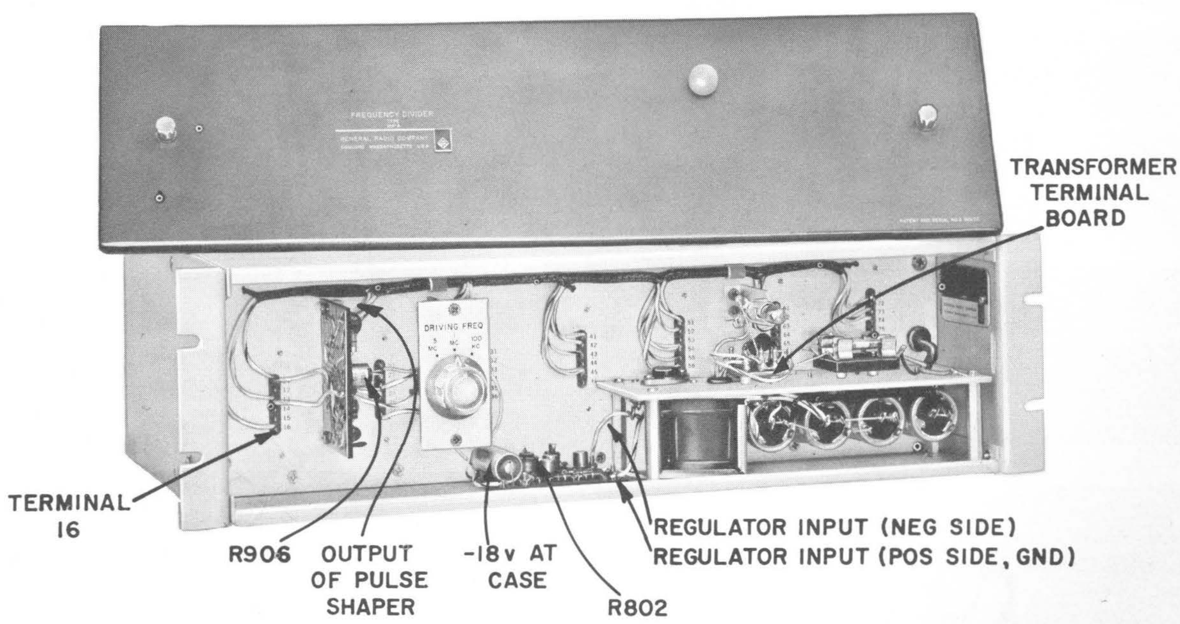
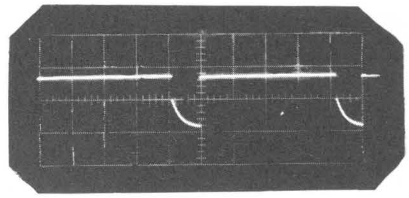
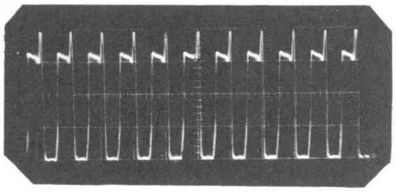


Figure 5-6. Front View of Type 1114-A.

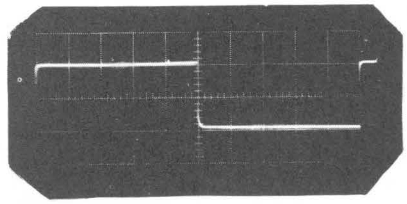
Figure 5-7. Oscillograms.



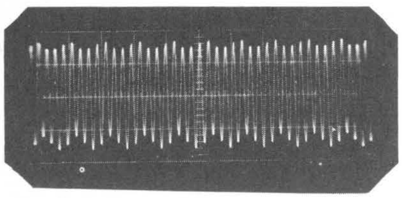
H. TP401
100 μsec/cm,
5 v/cm.



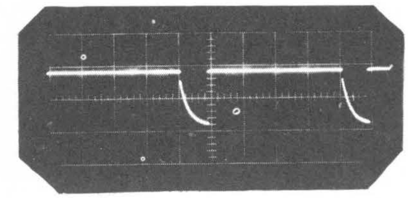
A. Output of pulse shaper. 1 μsec/cm, 2 v/cm.



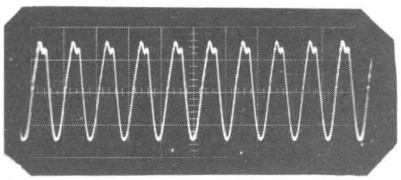
I. TP402.
100 μsec/cm,
5 v/cm.



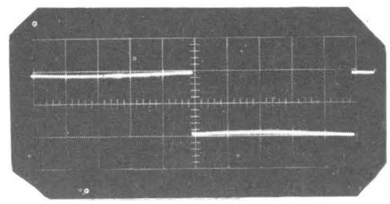
B. TP101
1 μsec/cm,
0.5 v/cm.



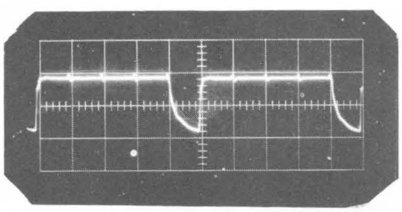
J. TP501.
1 msec/cm,
5 v/cm.



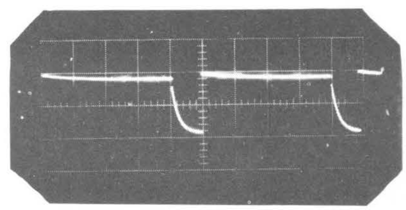
C. TP102.
1 μsec/cm,
0.5 v/cm.



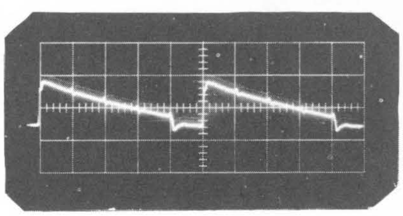
K. TP502.
1 msec/cm,
5 v/cm.



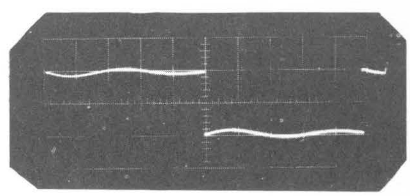
D. TP201
1 μsec/cm,
5 v/cm.



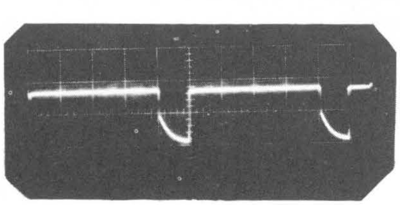
L. TP701.
5 msec/cm,
5 v/cm.



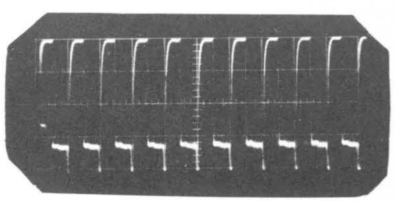
E. TP202
1 μsec/cm,
5 v/cm.



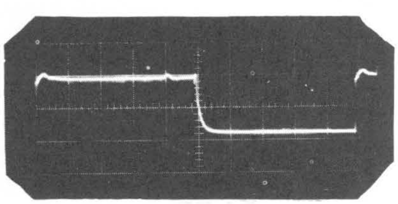
M. TP702.
5 msec/cm,
5 v/cm.



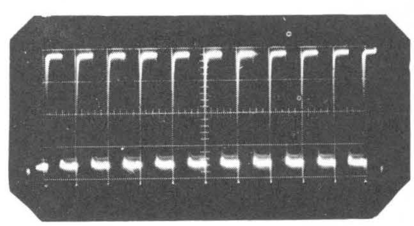
F. TP301
10 μsec/cm,
5 v/cm.



N. 100 KC ⊓⊔ output. 10 μsec/cm, 2 v/cm.



G. TP302
10 μsec/cm,
5 v/cm.



O. 10 KC ⊓⊔ output. 100 μsec/cm, 2 v/cm.

d. Adjust trimmer capacitors C103 and C109 for a maximum 4-Mc signal.

e. Reduce the 5-Mc input to zero. The 4-Mc signal should disappear.

f. Slowly increase the 5-Mc input to 0.35 volt rms. If the 4-Mc signal does not appear, increase the capacitance of C109 slightly for maximum amplitude of the 4-Mc signal. (See Figures 5-7B and 5-7C.)

g. Vary the input from 0.3 to 1.6 volts rms and carefully observe the waveform at TP102. There must be no trace of any lower-frequency envelope over the range of input voltage. If there is, adjust C103 slightly until the 1-Mc output at TP102 is clean.

h. Connect a 50-ohm load to the 1-Mc output terminal and an oscilloscope across it. Adjust T102 for maximum amplitude.

i. Set the DRIVING FREQ switch to 5 Mc and connect the oscilloscope to terminal 16 on the female connector for the plug-in unit (the terminal numbers are stamped on the front of the main mounting plate). Adjust T101 for maximum amplitude.

5.3.4 TYPE 1114-P2 1-MC TO 100-KC DIVIDER.

a. Remove the unit from the cabinet and connect it to the assembly using the Type 1114-P9 Servicing Extension.

b. Connect a 5-Mc (±1 kc) 1-volt rms signal to the 5-Mc input terminal.

c. Connect an oscilloscope to TP301 and adjust R208 for a waveform as shown in Figure 5-7D.

d. Find the limits of the potentiometer (R208) setting, and set the potentiometer for the highest resistance showing proper waveform (this is near the point where the pulse duration increases).

5.3.5 TYPE 1114-P3 100-TO-10-KC DIVIDER.

a. Remove the unit from the cabinet and connect it to the assembly using the Type 1114-P9 Servicing Extension.

b. Connect a 5-Mc (±1 kc) 1-volt rms signal to the 5-Mc input terminal.

c. Connect an oscilloscope to TP301 and adjust R308 for a waveform as shown in Figure 5-7F.

d. Find the limits of the potentiometer (R308) setting, and set the potentiometer for the highest resistance showing proper waveform (this is near the point where the pulse duration increases).

5.3.6 TYPE 1114-P4 10-TO-1-KC DIVIDER.

a. Remove the unit from the cabinet and connect it to the assembly using the Type 1114-P9 Servicing Extension.

b. Connect a 5-Mc (±1 kc) 1-volt rms signal to the 5-Mc input terminal.

c. Connect an oscilloscope to TP401 and adjust R408 for a waveform as shown in Figure 5-7H.

d. Find the limits of the potentiometer (R408) setting, and set the potentiometer for the highest resistance showing proper waveform (this is near the point where the pulse duration increases).

5.3.7 TYPE 1114-P5 1-KC TO 100-CPS DIVIDER.

a. Remove the unit from the cabinet and connect it to the assembly using the Type 1114-P9 Servicing Extension.

b. Connect a 5-Mc (±1 kc) 1-volt rms signal to the 5-Mc input terminal.

c. Connect an oscilloscope to TP501 and adjust R509 for a waveform as shown in Figure 5-7J.

d. Find the limits of the potentiometer (R509) setting, and set the potentiometer for the highest resistance showing proper waveform (this is near the point where the pulse duration increases).

5.3.8 TYPE 1114-P6 400-CPS UNIT. No adjustment of this unit should be required.

5.3.9 TYPE 1114-P7 60-CPS DIVIDER.

a. Remove the unit from the cabinet and connect it to the assembly using the Type 1114-P9 Servicing Extension.

b. Connect a 5-Mc (±1 kc) 1-volt rms signal to the 5-Mc input terminal.

c. Connect an oscilloscope to TP701 and adjust R703 for a waveform as shown in Figure 5-7L.

d. Find the limits of the potentiometer (R703) setting, and set the potentiometer for the highest resistance showing proper waveform (this is near the point where the pulse duration increases).

5.3.10 230-VOLT OPERATION. The Type 1114-A is normally supplied for 115-volt operation. For 230-volt use, the following changes must be made: On the transformer terminal board on top of the power supply, remove the two jumpers (terminals 1 to 3 and 2 to 4), and connect an insulated jumper between terminals 2 and 3. Replace the 0.1-amp slow-blow fuse with one rated at 0.05 amp.

5.3.11 BATTERY OPERATION. The Type 1114-A can be operated from a 20-to-30-volt battery if the positive side is grounded. Remove the line cord and replace with a cable suitable for battery connection (the line cord may be used if the ac line plug is removed and replaced with a suitable terminal that cannot accidentally connect to the power line). Unsolder the two connections at the left-hand side of the fuse holder. Connect the fuse in the negative lead through a diode to the negative input terminal of the regulator (see Figures 5-6 and 5-8). The diode protects the circuit from reversed battery polarity. If it is left out, the regulator will be damaged instantly if the wrong polarity is applied. The diode may be any unit with an inverse rating of at least 50 volts and average forward current of 250 ma. A 1N1692 is suitable.

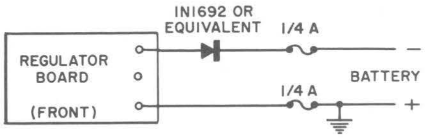


Figure 5-8. Connections for Battery Operation.

5.4 TYPE 1103-B SYNCRONOMETER. (See Figure 5-9).

5.4.1 SERVICE AND MAINTENANCE. The Syncronometer will usually operate for long periods without maintenance. The items most likely to require occasional maintenance are described in the following paragraphs.

The Syncronometer motor includes a vertical spindle, with a plastic rotor surrounded by a 100-tooth rim of magnetic metal. In the rotor is a circular trough with damping vanes, which is partially filled with mercury. This arrangement provides viscous rotary damping to stabilize the angular velocity of the rotor. The magnetic rim rotates past teeth of matching pitch on the stator magnets. Since there are 100 teeth on the rotor, rotation of this rotor at 10 revolutions per second produces 1000 passages of rotor teeth past each stator tooth during each second. Thus, the synchronous speed of this motor, when driven by a 1000-cps signal, is 10 revolutions per second or 600 rpm. Direct current is superimposed on the 1000-cps signal to polarize the magnetic field.

All bearings in the motor assembly are ball bearings except (1) the gear train driven by the sweep second hand, (2) the pivot bearing of the contactor arm, and (3) the setting mechanism chain drive. The ball bearings normally require no lubrication. The gear reduction following the sweep second hand should not require lubrication since it operates at relatively slow speeds. If the hands bind and do not rotate easily, it may be necessary to clean this gear train. Since this operation requires removal of the motor assembly from the chassis and removal of the hands and dial from the motor assembly, it is recommended that the General Radio Service Department be consulted about the advisability of returning the Syncronometer for servicing.

The 10-to-1 reduction gear between the vertical and horizontal shafts requires very little lubrication. If this gear squeaks, apply a little light, nongumming oil as necessary.

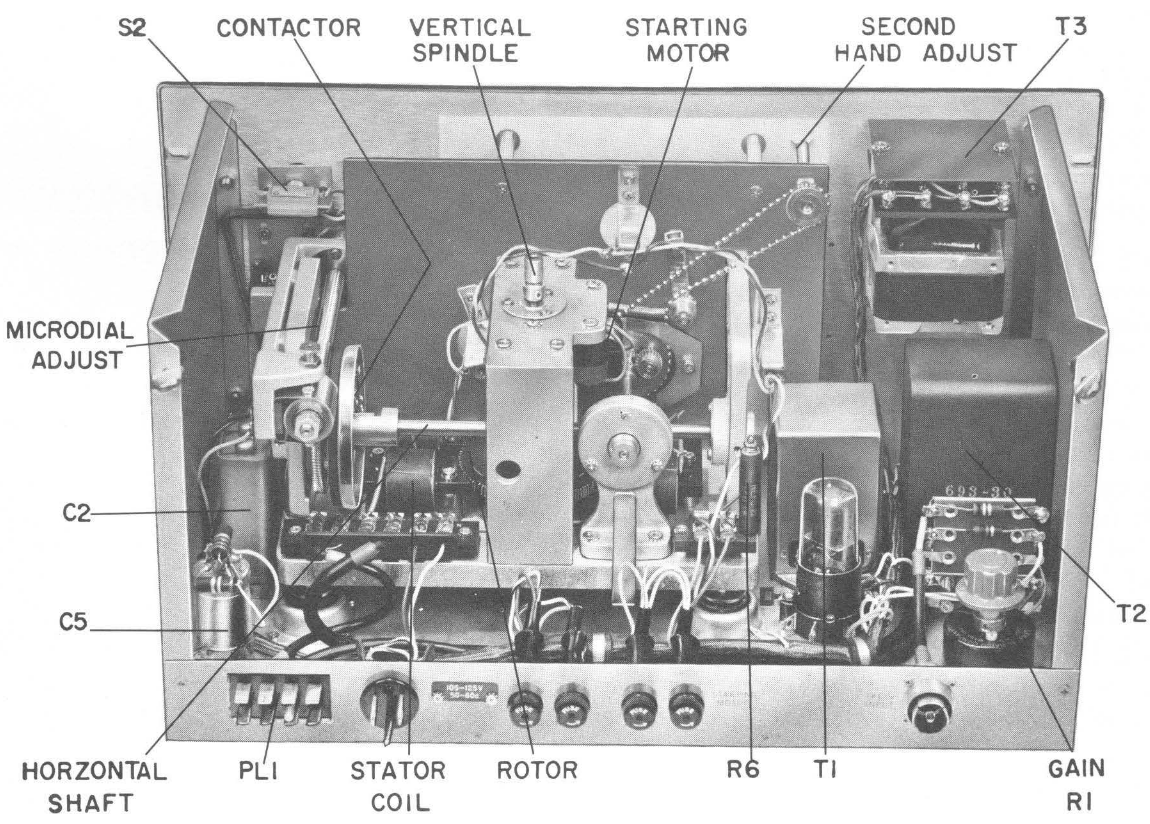


Figure. 5-9. Interior view of Type 1103-B Synchronometer.

The 30-to-1 worm reduction gear requires very little lubrication - a little light, nongumming oil about once a year.

The setting mechanism is designed to operate stiffly to retain setting. If it slips, clean the brake surfaces.

The cam-follower shoe and pivot require a very small amount of light oil about once a year. It is very important that the cam and shoe be kept free from dirt for best operation of the contactor.

In addition to the cam and shoe, the cam-driven contacts, slip ring, and contact brush should be kept clean. The anvil against which the contact spring bottoms must also be kept clean and free from oil at all times. If the anvil becomes dirty, the contact spring may stick or bounce, causing erratic contact operation.

The bronze gear used to set the contactor position is grounded by a silver-alloy wiper spring. If the gear face becomes dirty or oily and the wiper spring does not ground the gear properly, faulty contact operation may occur.

If it is necessary to adjust the level of the input signal to the 1-kc amplifier tube (V1), set the voltage from the arm of R1 to ground to about 1.0 volt rms, using a vacuum-tube voltmeter. If the motor does not run reliably, check that this voltage is 1.0 volt rms. If this voltage is present but operation is still not reliable, the voltage input may be increased up to 1.5 volts rms. If the motor still fails to operate reliably, check the plate, screen, cathode bias, and heater voltages against those given below. If these voltages are correct, examine the waveforms of the 1000-cps driving voltage. In most cases of unreliable motor operation, difficulty can be traced to transients or phase jumps in the driving signal. These must be eliminated before the motor will run reliably.

If the microdial contactor is to be used with a high-impedance audio signal source, it may be necessary to shunt the microdial contacts with a resistor of a few thousand ohms (4700 ohms is usually low enough) to reduce the effects of stray induced voltages on this lead.

Fuses are mounted on the rear of the chassis for ac line (2), ac starting motor (1), and plate supply voltage (1). A breakdown of the filter capacitors can damage the silicon-diode power rectifiers, since the fuse is in the output lead from the filter. Most other circuit malfunctions will blow a fuse. The starting motor is connected across one 115-volt primary of the power transformer to allow operation on 230-volt lines if required; therefore the starting motor requires an additional fuse.

5.4.2 230-VOLT OPERATION.

The Type 1103-B Syncronometer is normally supplied wired for 115-volt service, but can be easily converted to 230-volt operation, as follows: On the power transformer terminal board, remove the two leads from terminals 1 to 3 and 2 to 4. (Do not disturb the motor connections.) Connect an insulated lead between terminals 2 and 3. Replace the two 0.6-ampere fuses with 0.3-ampere fuses. Do not change the starting-motor fuse. Remove the nameplate on the rear panel.

5.4.3 USE OF SYNCRONOMETER WITH TYPE 1102-A MULTIVIBRATOR.

There is on the Type 1103-B Syncronometer a special terminal (pin 1 of PL1) for connection to the Type 1102-A Multivibrator. If the 1000-cps driving signal is to be obtained from this source, a shielded cable must be used to connect the Syncronometer to pin 1 of socket SO1 on the Type 1102-A. (This extra cable is supplied when the Syncronometer is ordered for use with the Type 1102-A.)

When the Type 1102-A Multivibrator is used to drive the Syncronometer, the waveform and voltage are such that R5 and C1 (see schematic) must be used ahead of R1 to produce the correct driving voltage. Thus the normal input through J1 is not used when the Type 1102-A Multivibrator is used as the source.

Table 5-1. Voltage and Resistance Measurements for Type 1113-A.

TUBE (TYPE)	PIN	VOLTS DC	RES TO GND
V201 (6688)	1	0	0
	2	-1.2	300 k
	3	0	0
	4	0	0
	5	6.0	<2Ω
	7	175	22 k
	8	0	0
	9	115	19 k
V202 (6688)	1	10	1 k
	2	8.5	200 k
	3	10	1 k
	4	0	0
	5	6.3	< 2Ω
	7	190	17 k
	8	0	0
	9	155	38 k
V203 (6688)	1	10	1 k
	2	8.5	200 k
	3	10	1 k
	4	0	0
	5	6.3	<2Ω
	7	190	17 k
	8	0	0
	9	145	38 k
V204 (6922)	1	190	17 k
	2	22	31 k
	3	27	3.17 k
	4	0	0
	5	6.3	< 2Ω
	6	160	20 k
	7	8.5	100 k
	8	12.5	0.5 - 1.5 k
	9	0	0
V501 (6AV5GA)	1	185	490 k
	3	200	16 k
	5	320	*
	8	320	*
V502 (6AN8)	1	320	*
	2	170	2.2 M
	3	180	490 k
	6	170	2.2 M
V502 (cont.)	7	200	16 k
	8	90	65 k
	9	94	47 k
V503 (5965)	1	94	47 k
	2	37	500 k
	3	38	6.8 k
	6	128	47 k
	7	36	52 k
	8	38	6.8 k
V504 (5651)	1	80	47 k
	2	0	0
	4	0	0
	5	80	47 k
	7	0	0
V505 (5727)	1	6.3 ac †	133 k
	2, 3	0	0
	4	6.3 ac	<1Ω
	5	0	0
	6	80 ac †	600
	7	0	0
Q501 (2N1138)	E	9.5	Do not attempt to measure these resistances.
	B	9.0	
	C	6.6	
Q502 (2N1372)	E	9.0	
	B	8.8	
	C	4.0	
Q503 (2N445A) BR	E	4.0	
	B	4.1	
	C	8.8	
Q504 (2N445A) BR	E	4.0	
	B	4.1	
	C	6.6	

NOTES:

Conditions of measurement:

1. All voltages measured with VTVM.
2. Power input 115 v, 60 cps.
3. POWER ON
4. Resistance measurements made with power disconnected, POWER switch at STANDBY.

* Leakage resistance of C501B, C501C, and CR501-4, depending on polarity of ohmmeter.

† With inner oven off (INNER OVEN CYCLING lamp off).

Table 5-2. Voltage and Resistance Measurements for Type 1103-B.

	PIN	VOLTS	OHMS
TUBE V1 (6K6GT)	1	NC	NC
	2-7	6.3 ac	0
	3	275 dc	120 k
	4	285 dc	120 k
	5	5.3 ac*	10 k
	8	25 dc	1 k
CLOCK MOTOR TERMINAL STRIP	Starting Motor (115 v)		80
	Clock Motor (1 KC)		160
	Microdial		0 or ∞

NOTES:

* at 1 kc

Voltages are to ground, except heater voltage is measured between pins 2 and 7. Tube pin resistances are to ground. Resistances at clock motor terminal strip are between terminals of indicated pairs.

Table 5-3. Voltage and Resistance Measurements for Type 1114-A.

TRANSISTOR (TYPE)	PIN	DC VOLTS	TRANSISTOR (TYPE)	PIN	DC VOLTS	TRANSISTOR (TYPE)	PIN	DC VOLTS
Q101 (2N1396)	E B C	-0.3 -0.4 -18	Q401 (2N404)	E B C	0 0 -18	Q603 (2N1374)	E B C	-8.2 -8.4 -18
Q102 (2N1372)	E B C	-2.6 -2.8 -18	Q402 (2N404)	E B C	-9.4 -9 -18	Q701 (2N404)	E B C	-7.2 -6.9 -18
Q103 (2N1396)	E B C	-0.3 -0.9 -18	Q403 (2N520A)	E B C	-9.4 -9.6 -9.5	Q702 (2N520A)	E B C	-7.2 -7.4 -8.7
Q104 (2N1372)	E B C	-2.6 -2.8 -1.8	Q404 (2N404)	E B C	-6.5 -7 -7	Q703 (2N404)	E B C	-5.8 -5 -16.5
Q201 (2N645A)	E B C	0 0 -18	Q405 (2N404)	E B C	-6.5 -5 -16	Q704 (2N404)	E B C	-5.8 -6.2 -6
Q202 (2N582)	E B C	-9 -8.8 -18	Q406 (2N1374)	E B C	-8.9 -9 -18	Q705 (2N1374)	E B C	-9 -9.2 -18
Q203 (2N779)	E B C	-10.2 -9.6 -10.3	Q407 (2N1374)	E B C	-8.8 -8.9 -18	Q706 (2N1374)	E B C	-8.8 -9 -18
Q204 (2N582)	E B C	-6.5 -7 -7	Q408 (2N1374)	E B C	-8.9 -9 -18	Q801 (2N169A)	E B C	-8.6 -8.4 -5.4
Q205 (2N582)	E B C	-6.5 -5 -16	Q409 (2N1374)	E B C	-8.8 -8.9 -18	Q802 (2N169A)	E B C	-8.6 -8.4 -5.4
Q206 (2N169A)	E B C	-16.1 -16.1 0	Q501 (2N404)	E B C	0 0 -18	Q803 (2N1374)	E B C	-5.2 -5.4 -13.9
Q207 (2N1372)	E B C	-2.3 -2.5 -18	Q502 (2N404)	E B C	-7.2 -7 -18	Q804 (2N1374)	E B C	-5.2 -5.4 -12.4
Q208 (2N169A)	E B C	-7.7 -7.4 -7.4	Q503 (2N520A)	E B C	-7.2 -7.5 -8.9	Q805 (2N1374)	E B C	-2.7 -2.9 -5.2
Q301 (2N582)	E B C	0 0 -18	Q504 (2N169A)	E B C	-8.9 -8.7 -8.7	Q806 (2N1218)	E B C	-20 to -30* -19.5 to -29.5* -18
Q302 (2N404)	E B C	-9.5 -9.1 -18	Q505 (2M169A)	E B C	-17 -16.5 0	Q901 (2N582)	E B C	-4.4 -4.6 -17
Q303 (2N520A)	E B C	-9.5 -9.8 -9.6	Q506 (2N404)	E B C	-5.8 -5 -16.5	Q902 (2N582)	E B C	-10.7 -10.9 -11
Q304 (2N404)	E B C	-6.5 -7 -7	Q507 (2N404)	E B C	-5.8 -6.2 -6	Q903 (2N582)	E B C	-10.7 -8.1 -18
Q305 (2N404)	E B C	-6.5 -5 -16	Q508 (2N1374)	E B C	-8.9 -9 -18			
Q306 (2N1374)	E B C	-9 -9.1 -18	Q509 (2N1374)	E B C	-8.7 -8.9 -18			
Q307 (2N1374)	E B C	-8.8 -9 -18	Q601 (2N1374)	E B C	-1.6 -1.5 -18			
Q308 (2N169A)	E B C	-7.7 -7.4 -7.4	Q602 (2N1374)	E B C	-1.2 -1.6 -8.4			

NOTES:

conditions of measurement:

1. Power input 115 v, 60 cps.
2. No input signal.
3. All voltages measured with VTVM.

* Depending on line voltage.

Do not attempt to measure resistances at these transistors.

SECTION **6**

SCHEMATICS

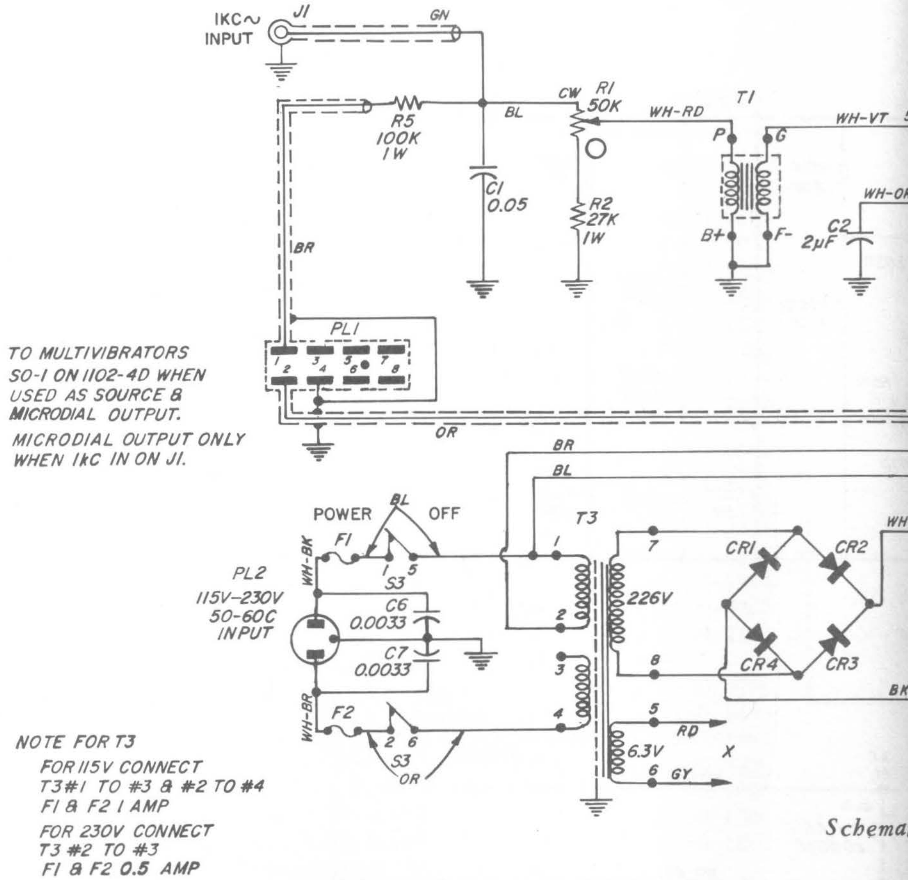
6.1 GENERAL. This section contains complete schematic diagrams for the Types 1113-A, 1114-A and 1103-B, plus system interconnecting wiring diagrams for Type 1120-A, -AH and -AB Frequency Standards. Parts lists and etched board layouts associated with each schematic are also supplied.

6.2 INDEX. Schematic diagrams appear in this section in the order shown in the following index.

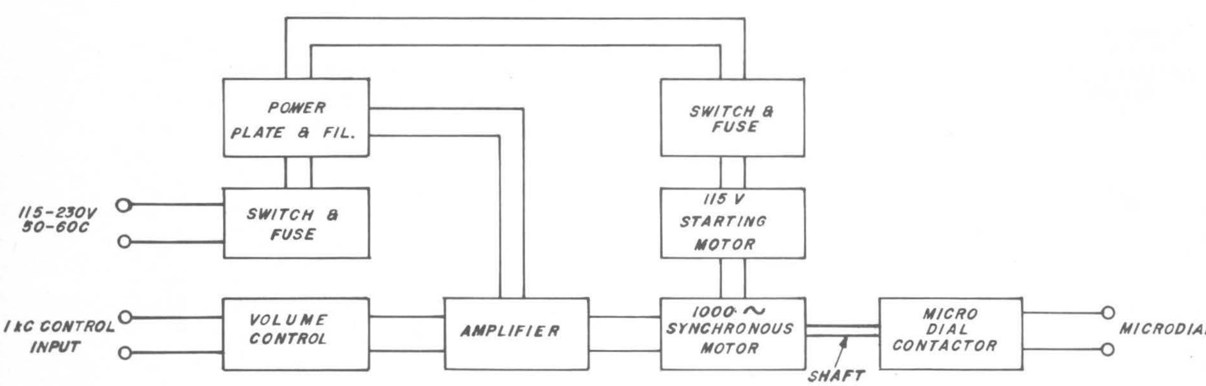
PARTS LIST

TYPE 1103-B SYNCRONOMETER

RESISTORS				PART NO. (NOTE A)
R1	50 k	±5%		973-412
R2	27 k	±10%	1 w	REC-30BF(273C)
R3	680	±10%	2 w	REC-41BF(681C)
R4	1 k	±10%	1 w	REW-4C(102C)
R5	100 k	±10%	1 w	REC-30BF(104C)
R6	1.5	±5%	5 w	REPO-22(015B)
R7	120 k	±10%	2 w	REC-41BF(124C)
CAPACITORS				**PART NO. (NOTE A)**
C1	0.05 µf	±10%	300 dcwv	COM-50B(503C)
C2	2 µf		600 dcwv	COL-6(205)
C3A	0.0125 µf	±10%	600 dcwv	COM-50B(1252C)
C3B	0.0125 µf	±10%	600 dcwv	COM-50B(1252C)
C4	1 µf		600 dcwv	COL-5(105)
C5A	15 µf		350 dcwv	COE-53
C5B	15 µf			
C6	0.0033 µf	±20%		COC-62(332D)
C7	0.0033 µf	±20%		COC-62(332D)
MISCELLANEOUS				
CR1	Diode			1N1695
CR2	Diode			1N1695
CR3	Diode			1N1695
CR4	Diode			1N1695
F1	Fuse, 1 amp (0.5 amp for 230 v)			FUF-1
F2	Fuse, 1 amp (0.5 amp for 230 v)			FUF-1
F3	Fuse, 0.2 amp			FUF-2
F4	Fuse, 1 amp			FUF-1
J1	Connector, Coaxial			874-4543
P1	Lamp, 6.3 v, Mazda 44			2LAP-939
P2	Lamp, 6.3 v, Mazda 44			2LAP-939
P3	Lamp, 6.3 v, Mazda 44			2LAP-939
P4	Lamp, 6.3 v, Mazda 44			2LAP-939
S1	Switch, spst			SWT-323,NP
S2	Switch, spst			SWP-809
S3	Switch, dpst			SWT-333,NP
T1	Transformer			345-H
T2	Transformer			693-30
T3	Transformer			0485-4005
V1	Tube			6K6-GT

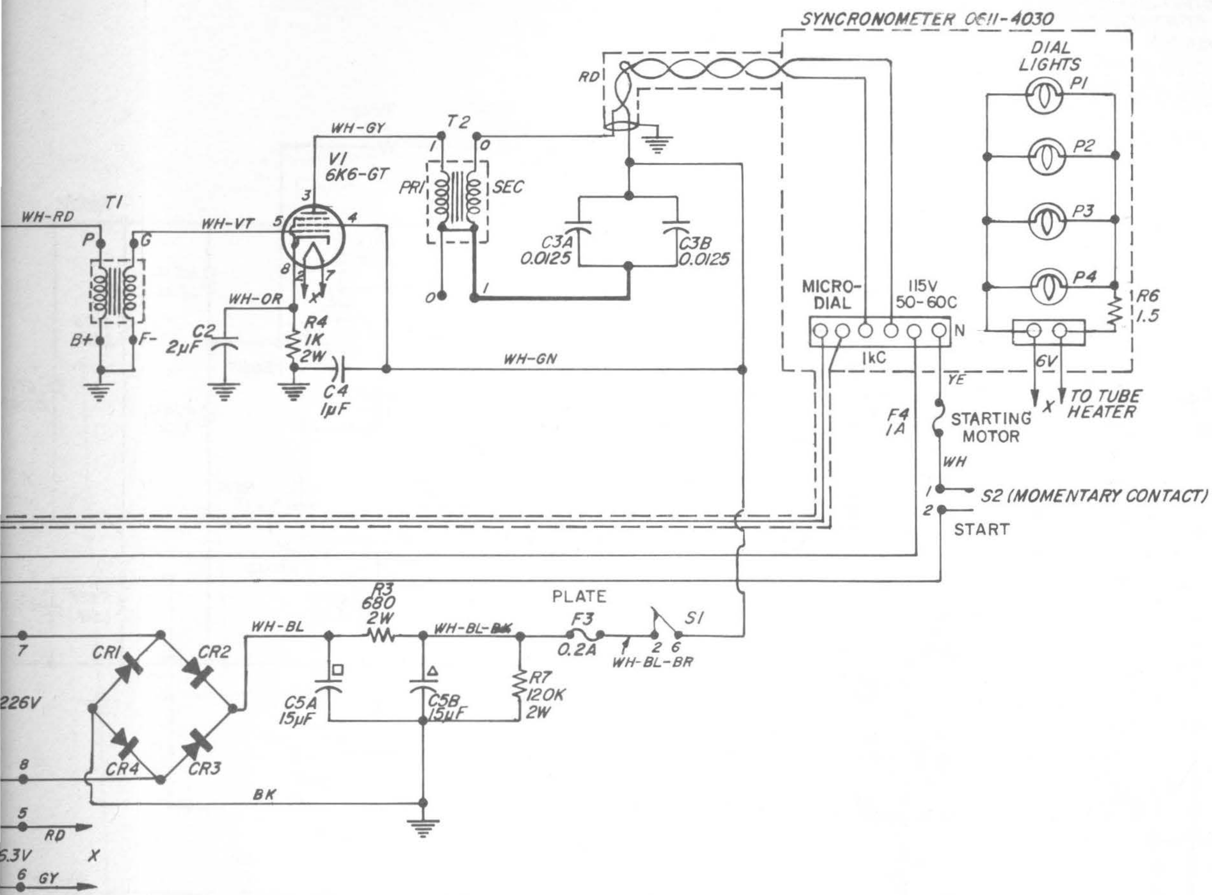


Schema



Block Diagram

Schematic Diagram of



Schematic Diagram, Type 1103-B Syncronometer

NOTE:

REFER TO SERVICE NOTES IN THE INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.

RESISTANCE 1/2 WATT UNLESS OTHERWISE SPECIFIED

RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K=1000 OHMS M= 1MEGOHM

CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN IN MICROFARADS UNLESS OTHERWISE SPECIFIED

○ KNOB CONTROL

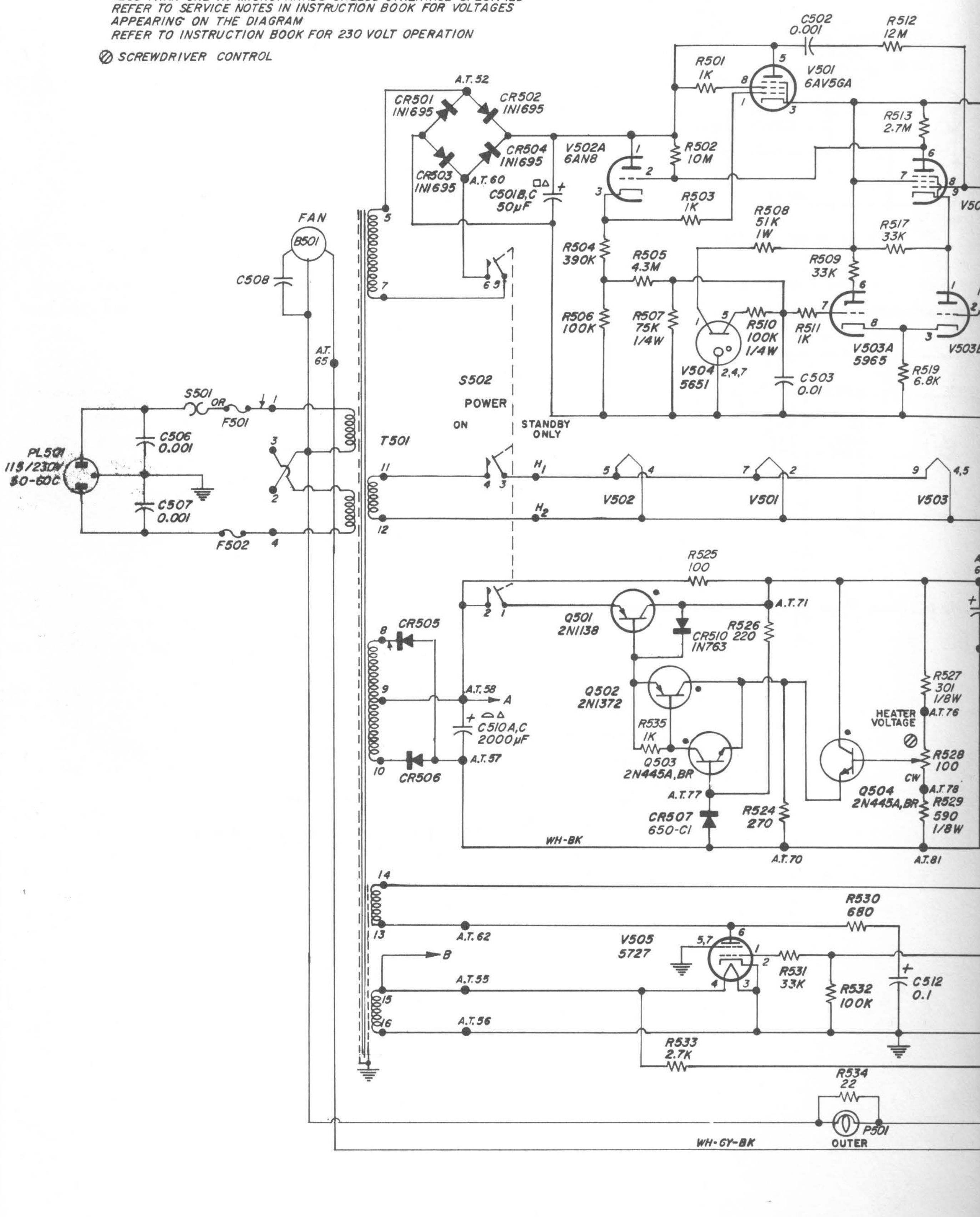
Block Diagram

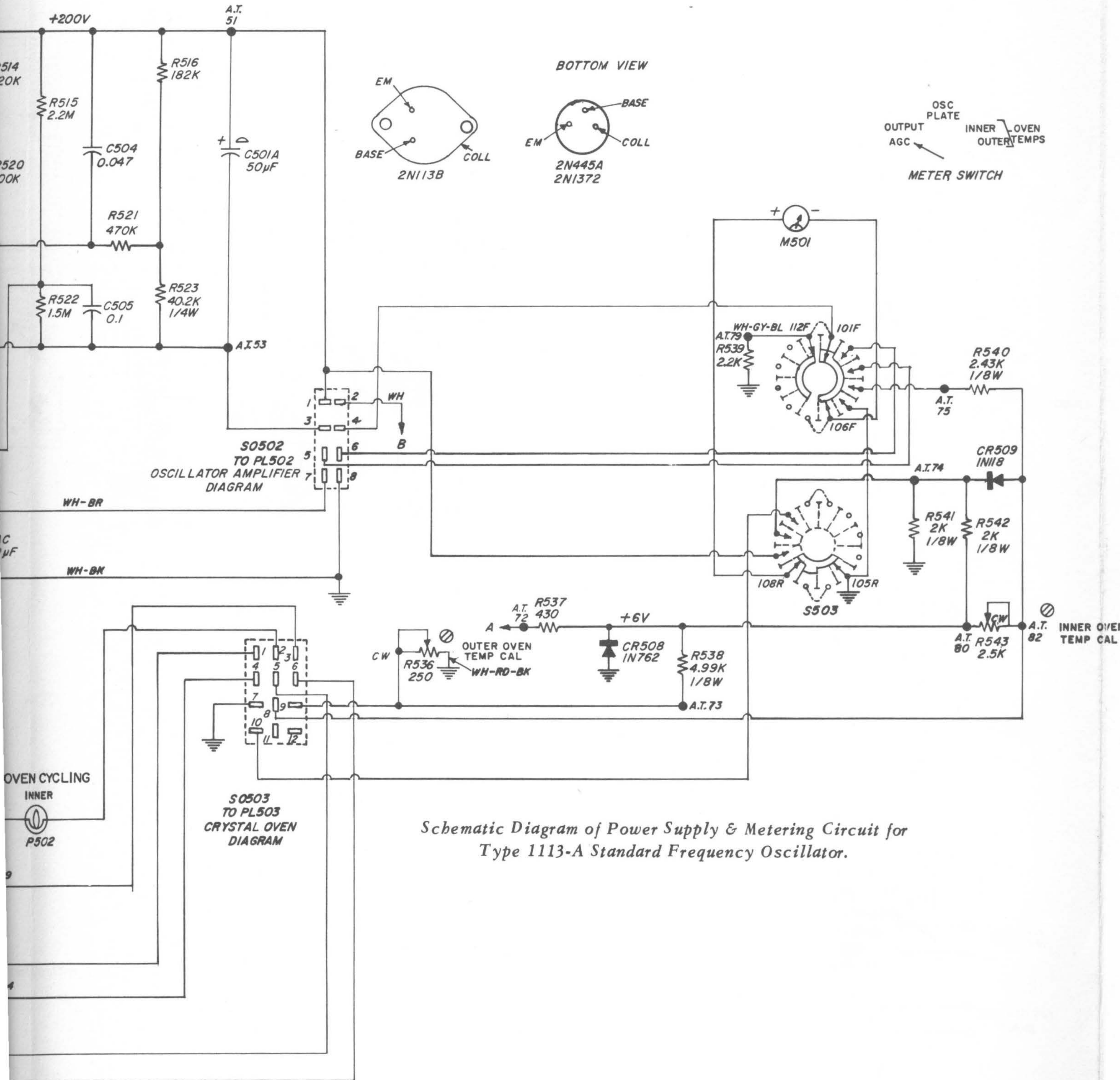
SECTI

6.1 GEN
matic dia
plus sys
1120-A,

NOTES:
RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED
RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K=1000 OHMS M= 1 MEGOHM
CAPACITANCE VALUES ONE & OVER IN PICOFARADS,
LESS THAN ONE IN MICROFARADS UNLESS OTHERWISE SPECIFIED
REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES
APPEARING ON THE DIAGRAM
REFER TO INSTRUCTION BOOK FOR 230 VOLT OPERATION

⊘ SCREWDRIVER CONTROL





Schematic Diagram of Power Supply & Metering Circuit for Type 1113-A Standard Frequency Oscillator.

PARTS LIST
TYPE 1113-A STANDARD FREQUENCY OSCILLATOR

REF NO.	RESISTORS	PART NO.
R201	Film, 47.5kΩ ±1% 1/8w	6250-2475
R202	Film, 499Ω ±1% 1/8w	6250-0499
R203	Composition, 6.8kΩ ±5% 1/2w	6100-2685
R204	Composition, 20kΩ ±5% 1w	6110-3200
R205	Composition, 33Ω ±5% 1/2w	6100-0335
R206	Composition, 33Ω ±5% 1/2w	6100-0335
R207	Composition, 100kΩ ±5% 1/2w	6100-4105
R208	Composition, 47kΩ ±5% 1/2w	6100-3475
R209	Composition, 33kΩ ±5% 1w	6110-3335
R211	Composition, 1kΩ ±5% 1/2w	6100-2105
R212	Composition, 10kΩ ±5% 1/2w	6100-3105
R213	Composition, 22kΩ ±5% 1/2w	6100-3225
R214	Composition, 33Ω ±5% 1/2w	6100-0335
R215	Composition, 100kΩ ±5% 1/2w	6100-4105
R216	Composition, 100kΩ ±5% 1/2w	6100-4105
R217	Composition, 1kΩ, ±5% 1/2w	6100-2105
R218	Film, 46.4Ω ±1% 1/8w	6250-0046
R219	Composition, 75Ω ±5% 1/2w	6100-0755
R220	Composition, 33Ω ±5% 1/2w	6100-0335
R221	Composition, 100kΩ ±5% 1/2w	6100-4105
R222	Composition, 100kΩ ±5% 1/2w	6100-4105
R223	Composition, 10kΩ ±5% 1/2w	6100-3105
R224	Composition, 1kΩ ±5% 1/2w	6100-2105
R225	Composition, 22kΩ ±5% 1/2w	6100-3225
R226	Composition, 200kΩ ±5% 1/2w	6100-4205
R227	Composition, 1kΩ ±5% 1/2w	6100-2105
R228	Composition, 9.1kΩ ±5% 1/2w	6100-2905
R229	Composition, 56Ω ±5% 1/2w	6100-0565
R230	Composition, 270kΩ ±5% 1/2w	6100-4275
R231	Composition, 1kΩ ±5% 1/2w	6100-2105
R232	Precision, 40.2kΩ ±0.5%	6690-5140
R233	Composition, 33kΩ ±5% 1/2w	6100-3335
R234	Composition, 33kΩ ±5% 1/2w	6100-3335
R235	Precision, 3.16kΩ ±0.5%	6690-6260
R236	Precision, 15Ω 1/2w	1113-2000
R237	Precision, 1.82kΩ ±0.5%	6690-6240
R238	Composition, 47kΩ ±5% 1/2w	6100-3475
R239	Film, 97.6kΩ ±1% 1/8w	6250-2976
R240	Composition, 100kΩ ±5% 1/2w	6100-4105
R241	Composition, 5.1kΩ ±5% 1/2w	6100-2515
R242	Composition, 510Ω ±5% 1/2w	6100-1515
R243	Potentiometer, 1kΩ ±20% 1/2w	1113-0440
R244	Film, 124kΩ ±1% 1/8w	6250-3124
R245	Wire-Wound, 6.8Ω ±10% 1/2w	5600-0700
R501	Composition, 1kΩ ±5% 1/2w	6100-2105
R502	Composition, 10MΩ, ±5% 1/2w	6100-6105
R503	Composition, 1kΩ ±5% 1/2w	6100-2105
R504	Composition, 390kΩ ±5% 1/2w	6100-4395
R505	Composition, 4.3MΩ ±5% 1/2w	6100-5435
R506	Composition, 100kΩ ±5% 1/2w	6100-4105
R507	Film, 75kΩ ±1% 1/4w	6350-2750
R508	Composition, 51kΩ ±5% 1w	6110-3515
R509	Composition, 33kΩ ±5% 1/2w	6100-3335
R510	Film, 100kΩ ±1% 1/4w	6350-3100
R511	Composition, 1kΩ ±5% 1/2w	6100-2105
R512	Composition, 12MΩ ±5% 1/2w	6100-6125
R513	Composition, 2.7MΩ ±5% 1/2w	6100-5275
R514	Composition, 120 kΩ ±5% 1/2w	6100-4125
R515	Composition, 2.2MΩ ±5% 1/2w	6100-5225
R516	Film, 182kΩ ±1% 1/2w	6450-3182
R517	Composition, 33kΩ ±5% 1/2w	6100-3335

REF NO.	RESISTORS	PART NO.
R518	Composition, 1kΩ ±5% 1/2w	6100-2105
R519	Composition, 6.8kΩ ±5% 1/2w	6100-2685
R520	Composition, 180kΩ ±5% 1/2w	6100-4105
R521	Composition, 470kΩ ±5% 1/2w	6100-4475
R522	Composition, 1.5MΩ ±5% 1/2w	6100-5155
R523	Film, 40.2kΩ ±1% 1/4w	6350-2402
R524	Composition, 270Ω ±5% 1/2w	6100-1275
R525	Composition, 100Ω ±5% 1/2w	6100-1105
R526	Composition, 220Ω ±5% 1/2w	6100-1225
R527	Film, 301Ω ±1% 1/8w	6250-0348
R528	Potentiometer, Wire-Wound, 100Ω ±10% 2w	6050-0800
R529	Film, 590Ω ±1% 1/8w	6250-0590
R530	Composition, 680Ω ±5% 1/2w	6100-1685
R531	Composition, 33kΩ ±5% 1/2w	6100-3335
R532	Composition, 100kΩ ±5% 1/2w	6100-4105
R533	Composition, 2.7kΩ ±5% 1/2w	6100-2275
R534	Composition, 22Ω ±5% 1/2w	6100-0225
R535	Composition, 1kΩ ±5% 1/2w	6100-2105
R536	Potentiometer, Wire-Wound, 250Ω ±10% 2w	6050-0900
R537	Composition, 430Ω ±5% 1/2w	6100-1435
R538	Film, 4.99kΩ ±1% 1/8w	6250-1499
R539	Composition, 2.2kΩ ±5% 1/2w	6100-2225
R540	Film, 2.43kΩ ±1% 1/8w	6250-1243
R541	Film, 2.00kΩ ±1% 1/8w	6250-1200
R542	Film, 2.00kΩ ±1% 1/8w	6250-1200
R543	Potentiometer, Wire-Wound, 2.5kΩ ±10% 2w	6050-1500
R601	Outer Oven Heater	1113-2310
R602	Composition, 47kΩ ±5% 1/2w	6100-3475
R603	Thermistor	1113-4010
R604	Thermistor	1113-4010
R605	Inner Oven Heater	1113-2330
R606	Anticipator	1113-2340
R607	Composition, 47Ω ±5% 5w	6095-0047
R608	Composition, 47Ω ±5% 5w	6095-0047

REF NO.	CAPACITORS	PART NO.
C201	Ceramic, 0.001µf ±10% 500dcwv	4400-1800
C202	Ceramic, 0.001µf ±10% 500dcwv	4400-1800
C203	Ceramic, 0.01µf ±20% 500dcwv	4406-3109
C204	Ceramic, 0.01µf ±20% 500dcwv	4406-3109
C206	Ceramic, 0.01µf +80-20% 50dcwv	4401-3100
C207	Ceramic, 0.01µf ±20% 500dcwv	4406-3109
C208	Ceramic, 0.01µf ±20% 500dcwv	4406-3109
C209	Ceramic, 47pf ±5%NPO 500 dcwv	4410-0475
C213	Mica, 150pf ±2% 500dcwv	4590-0500
C214	Ceramic, 0.01µf ±20% 500dcwv	4406-3109
C215	Ceramic, 0.1µf +80-20% 50dcwv	4403-3100
C216	Ceramic, 0.01µf ±20% 500dcwv	4406-3109
C217	Ceramic, 0.01µf ±20% 500 dcwv	4406-3109
C218	Ceramic, 0.001µf ±10% 500dcwv	4400-1800
C219	Ceramic, 2.4pf ±5% 500dcwv	4400-0250
C220	Mica, 150pf ±2% 500dcwv	4590-0500
C221	Ceramic, 47pf ±10%N750 500dcwv	4400-4300
C222	Mica, 0.001µf ±5% 500dcwv	4580-0100
C223	Ceramic, 0.1µf +80-20% 50dcwv	4403-3100
C224	Ceramic, 0.01µf +80-20% 50dcwv	4401-3100

PARTS LIST (cont)

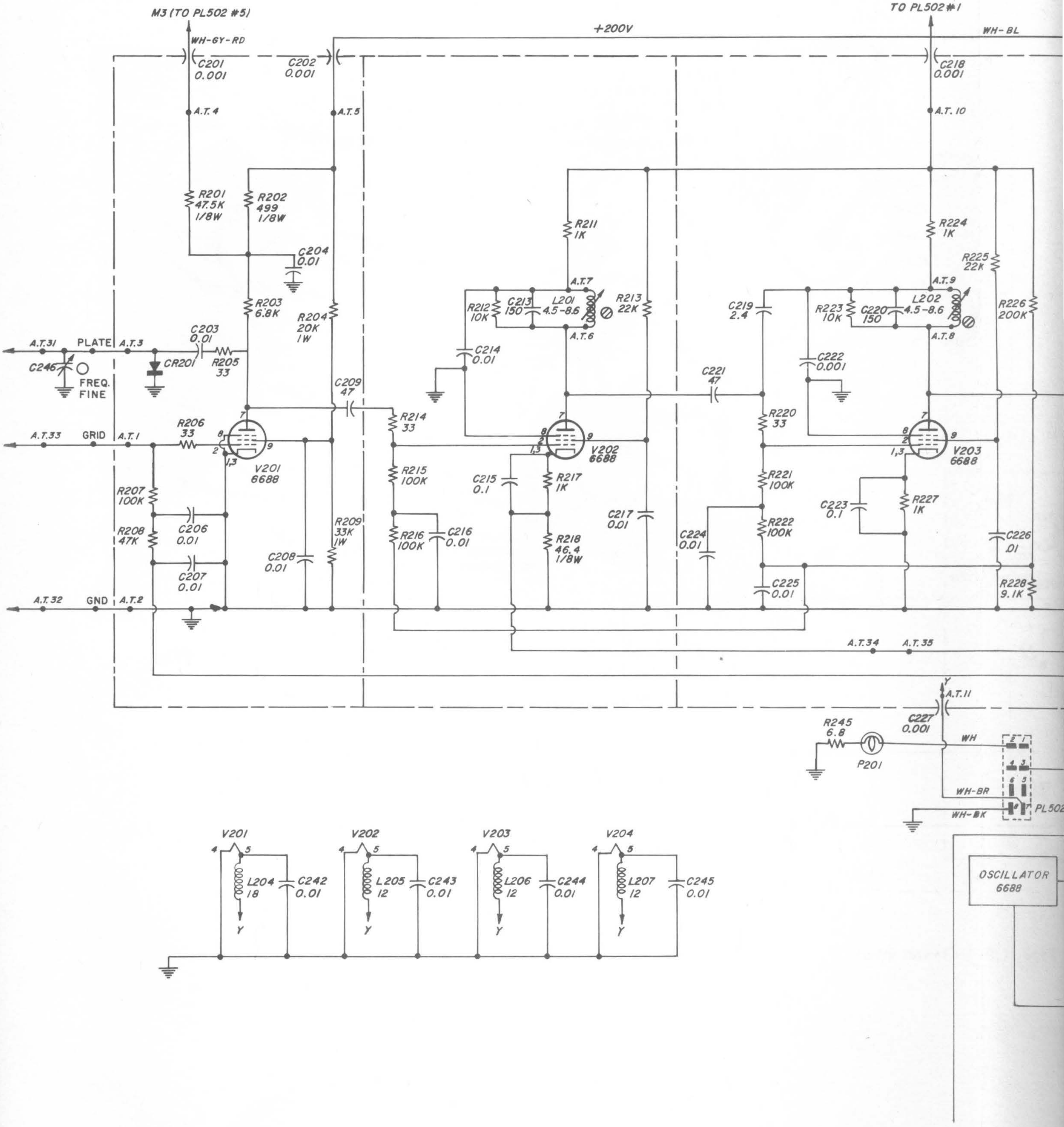
REF NO.	CAPACITORS	PART NO.
C225	Ceramic, 0.01µf ±20% 500dcwv	4406-3109
C226	Ceramic, 0.01µf ±20% 500dcwv	4406-3109
C227	Ceramic, 0.001µf ±10% 500dcwv	4400-1800
C229	Ceramic, 47pf ±10%N750 500dcwv	4400-4300
C230	Ceramic, 0.01µf ±20% 500 dcwv	4406-3109
C231	Ceramic, 0.01µf +80-20% 50dcwv	4401-3100
C232	Ceramic, 0.01µf +80-20% 50dcwv	4401-3100
C233	Ceramic, 24pf ±5%NPO 500dcwv	4410-0245
C234	Ceramic, 0.01µf +80-20% 50dcwv	4401-3100
C235	Ceramic, 0.01µf +80-20% 50dcwv	4401-3100
C236	Ceramic, 0.001µf ±10% 500dcwv	4400-1800
C237	Ceramic, 0.001µf ±10% 500dcwv	4400-1800
C238	Ceramic, 0.01µf ±20% 500dcwv	4406-3109
C239	Ceramic, 47pf ±5%NPO 500dcwv	4410-0475
C240	Ceramic, 0.01µf +80-20% 50dcwv	4401-3100
C241	Ceramic, 0.001µf ±10% 500dcwv	4400-1800
C242	Ceramic, 0.01µf +80-20% 50dcwv	4401-3100
C243	Ceramic, 0.01µf +80-20% 50dcwv	4401-3100
C244	Ceramic, 0.01µf +80-20% 50dcwv	4401-3100
C245	Ceramic, 0.01µf +80-20% 50dcwv	4401-3100
C246	0.01µf	0368-4180
C501A	Electrolytic, 50µf 450dcwv	4450-0800
C501B	Electrolytic, 25µf 450dcwv	4450-0800
C501C	Electrolytic, 25µf 450dcwv	4450-0800
C502	Ceramic, 0.001µf ±20% 500dcwv	4404-2109
C503	Ceramic, 0.01µf ±20% 500dcwv	4406-3109
C504	Wax, 0.047µf ±10% 400dcwv	5020-1000
C505	Ceramic, 0.01µf ±20% 500dcwv	4406-3109
C506	Ceramic, 0.001µf ±20% 500dcwv	4404-2109
C507	Ceramic, 0.001µf ±20% 500dcwv	4404-2109
C508	0.75µf	5750-1052
C510A	Electrolytic Block, 1000µf 15dcwv	4460-1400
C501C	Electrolytic Block, 1000µf 15dcwv	4460-1400
C511A	Electrolytic Block, 1000µf 15dcwv	4460-1400
C511C	Electrolytic Block, 1000µf 15dcwv	4460-1400
C512	Wax, 0.1µf ±10% 100dcwv	5010-2700
C601	Ceramic, 0.01µf ±20% 500dcwv	4406-3109
C602		1113-0412
C603	Ceramic, 16pf ±5%NPO 50dcwv	4410-0165
C604	Mica, 178pf ±1% 500dcwv	4600-0400
C605	Mica, 267pf ±1% 500dcwv	4600-0450
C606	Ceramic, 0.047µf ±20%	4408-3479
C607	Ceramic, 0.047µf ±20%	4408-3479

REF NO.	MISCELLANEOUS	PART NO.
CR201	DIODE, Type 1N252	6082-1018
CR202	DIODE, Type 1N251	6082-1001
CR203	DIODE, Type 1N251	6082-1001
CR204	DIODE, Type 1N191	6082-1008
CR501	RECTIFIER, Type 1N1695	6081-1002
CR502	RECTIFIER, Type 1N1695	6081-1002
CR503	RECTIFIER, Type 1N1695	6081-1002
CR504	RECTIFIER, Type 1N1695	6081-1002
CR505	RECTIFIER, Type 2RE-41	6080-3500
CR506	RECTIFIER, Type 2RE-41	6080-3500
CR507	DIODE, Type 650-C1	6083-1002
CR508	DIODE, Type 1N762	6083-1004
CR509	DIODE, Type 1N118	6082-1006
CR510	RECTIFIER, Type 1N763	6083-1008
L201	CHOKE, Air 4.5-8.6µh	4290-4050
L202	CHOKE, Air 4.5-8.6µh	4290-4050
L204	CHOKE, Metal 18µh ±10%	4300-2500
L205	CHOKE, Metal 12µh ±10%	4300-2300
L206	CHOKE, Metal 12µh ±10%	4300-2300
L207	CHOKE, Metal 12µh ±10%	4300-2300
L601	COIL ASSEMBLY	1113-2362
L602	COIL ASSEMBLY	1113-2362
Q501	TRANSISTOR, Type 2N1138	8210-1138
Q502	TRANSISTOR, Type 2N1372	8210-1372
Q503	TRANSISTOR, Type 2N445A, BR	8210-4451
Q504	TRANSISTOR, Type 2N445A, BR	8210-4451
V201	TUBE, Type 6688	8380-6688
V202	TUBE, Type 6688	8380-6688
V203	TUBE, Type 6688	8380-6688
V204	TUBE, Type 6922	8380-6922
V501	TUBE, Type 6AV5GA	8360-2390
V502	TUBE, Type 6AN8	8360-1300
V503	TUBE, Type 5965	8380-5965
V504	TUBE, Type 5651	8380-5652
V505	TUBE, Type 5727	8380-5727
B501	MOTOR, (part of fan assembly 1113-3200)	5760-1050
F501	FUSE for 115v: Slo-Blo, 1.25a	5330-1600
	for 230v: Slo-Blo, 0.6a	5330-1100
F502	FUSE for 115v: Slo-Blo, 1.25a	5330-1600
	for 230v: Slo-Blo, 0.6a	5330-1100
J201	CONNECTOR, Coaxial Type 874	0874-4502
J202	CONNECTOR, Coaxial Type 874	0874-4502
M501	METER, 0-50µa 2200Ω ±10%	5730-0990
P201	PILOT LAMP, Mazda No. 44	5600-0700
P501	PILOT LAMP, Mazda No. 47	5600-0900
P502	PILOT LAMP, Mazda No. 47	5600-0900
PL201	PLUG	4220-5000
PL501	PLUG	4240-0600
PL502	PLUG	
PL503	PLUG	4220-5100
PL601	PLUG	1113-0490
S501	THERMOSWITCH	7980-0102
S502	SWITCH, 3pst	1113-0460
S503	SWITCH, Rotary Wafer	7890-2020
S601	THERMOSWITCH, spst	7980-0102
S602	THERMOSTAT	1113-4040
S603	THERMOSWITCH, spst	7980-0100
SO502	SOCKET	4230-3600
SO503	SOCKET	4230-3700
SO601	SOCKET	1113-0493
T201	TRANSFORMER	1113-2020
T501	TRANSFORMER	0365-4940
X601	CRYSTAL	1113-0420

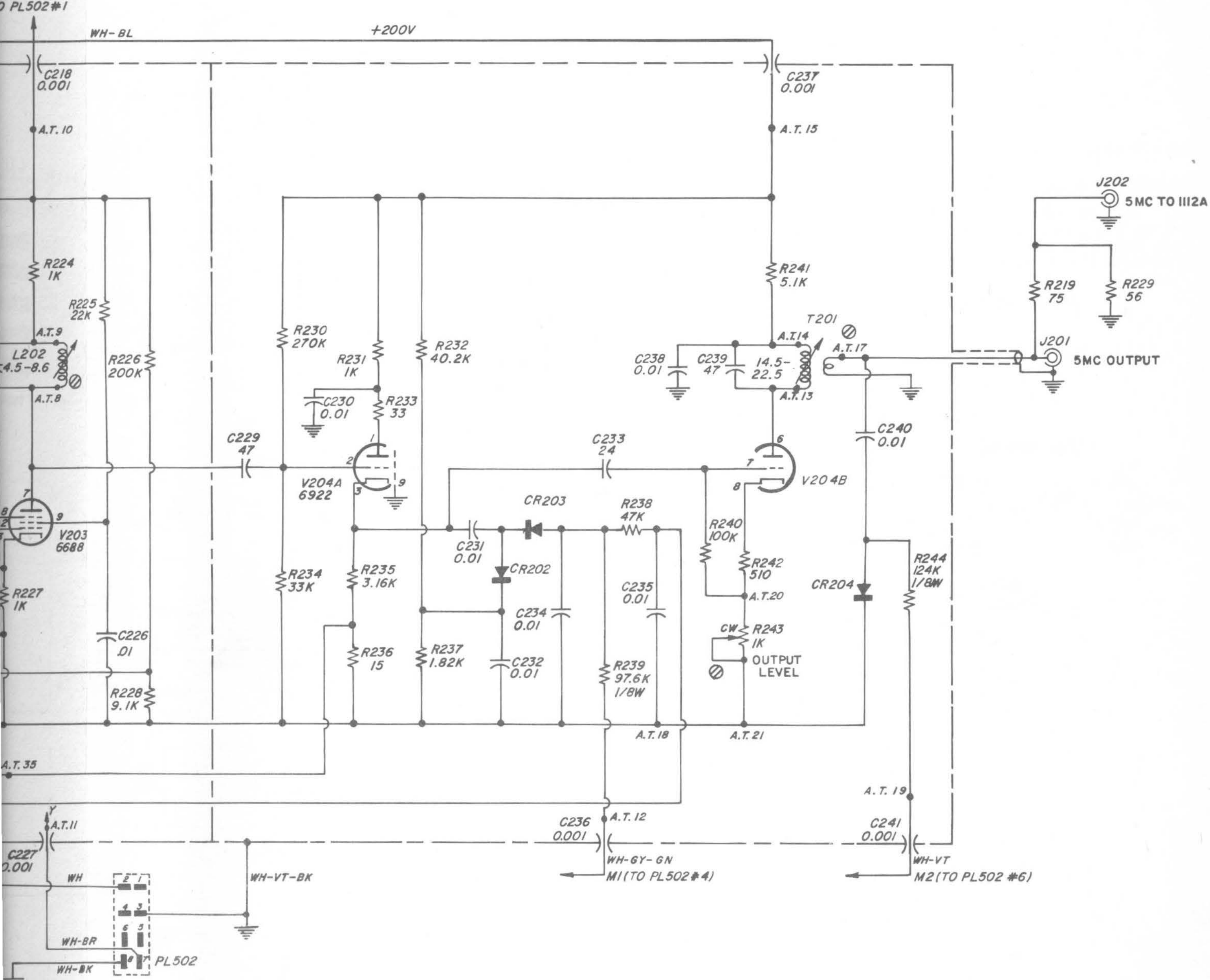
NOTES: RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED
RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED, K = 1000 OHMS, M = 1 MEGOHM
CAPACITANCE VALUES ONE & OVER IN PICOFARADS, LESS THAN ONE
IN MICROFARADS UNLESS OTHERWISE SPECIFIED
INDUCTANCE VALUES IN MICROHENRIES
REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON
THE DIAGRAM AND ALSO FOR THE D-C RESISTANCE OF IRON CORED INDUCTORS

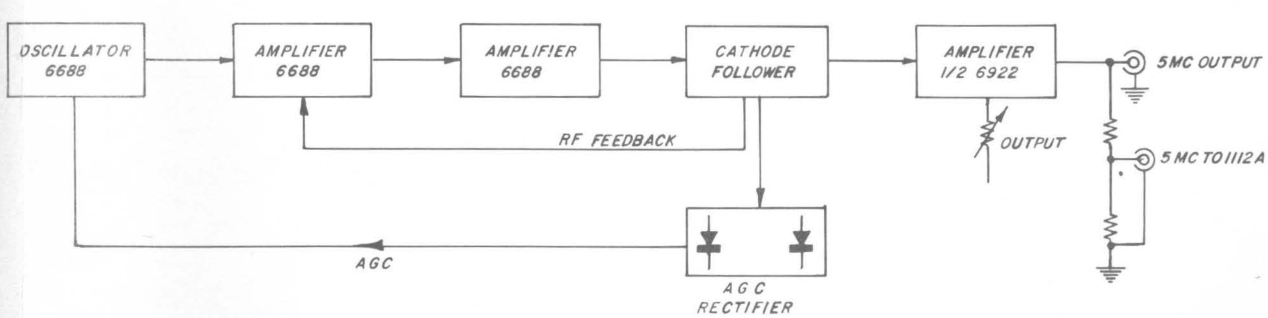
⊘ SCREWDRIVER CONTROL

○ KNOB CONTROL

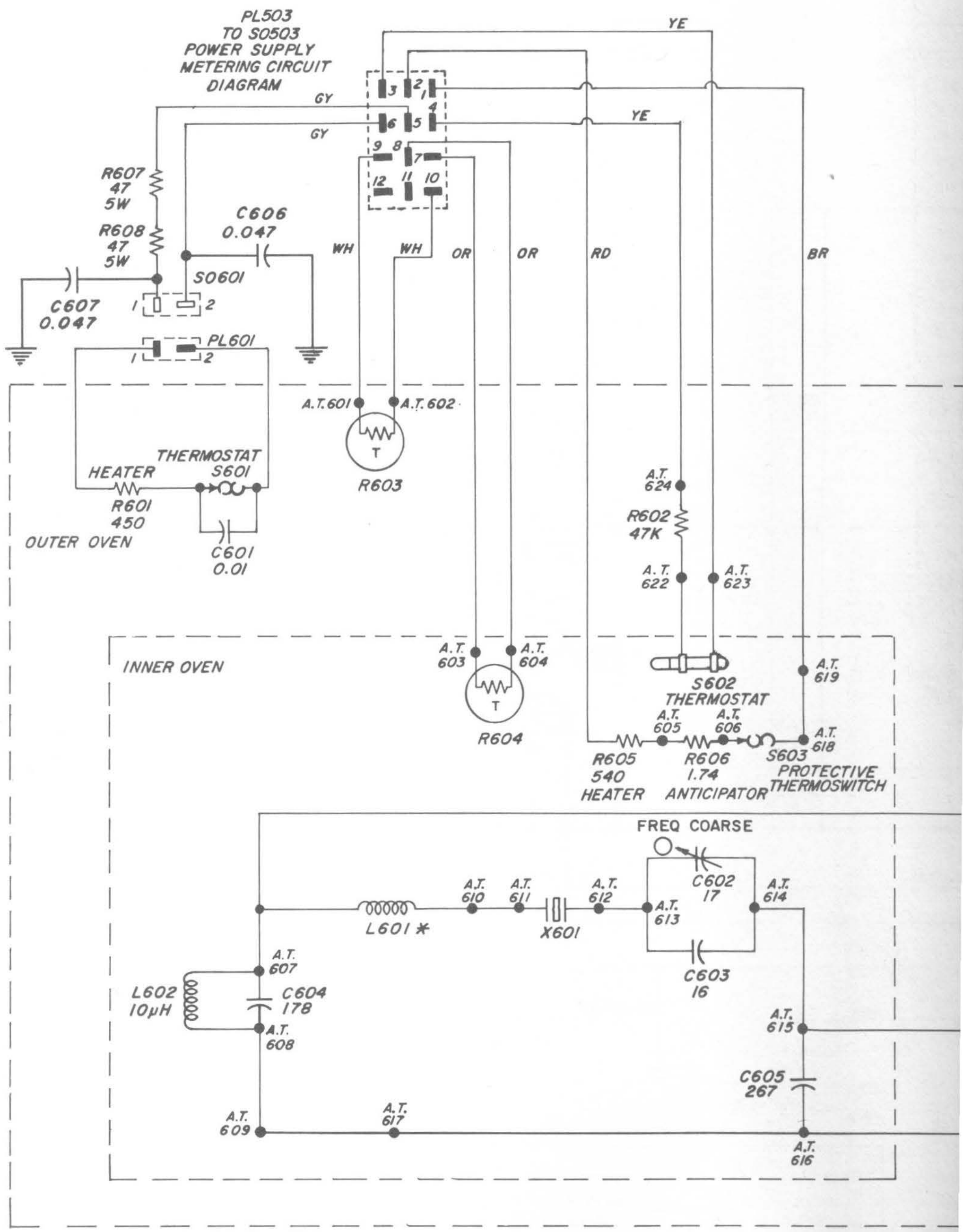


Schematic Diagram of Oscillator Amplifier for Type 1113-A Standard Frequency Oscillator.

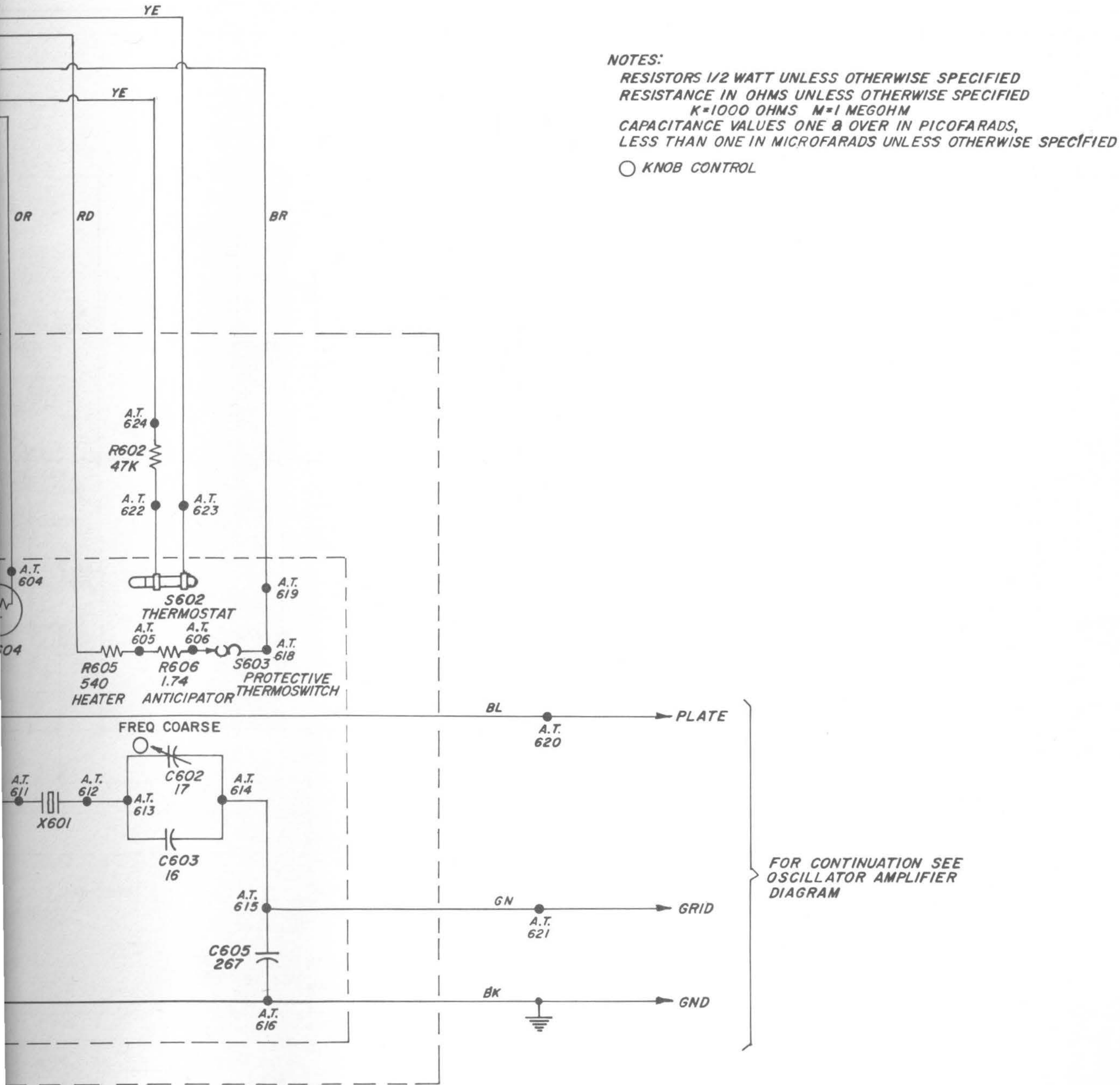




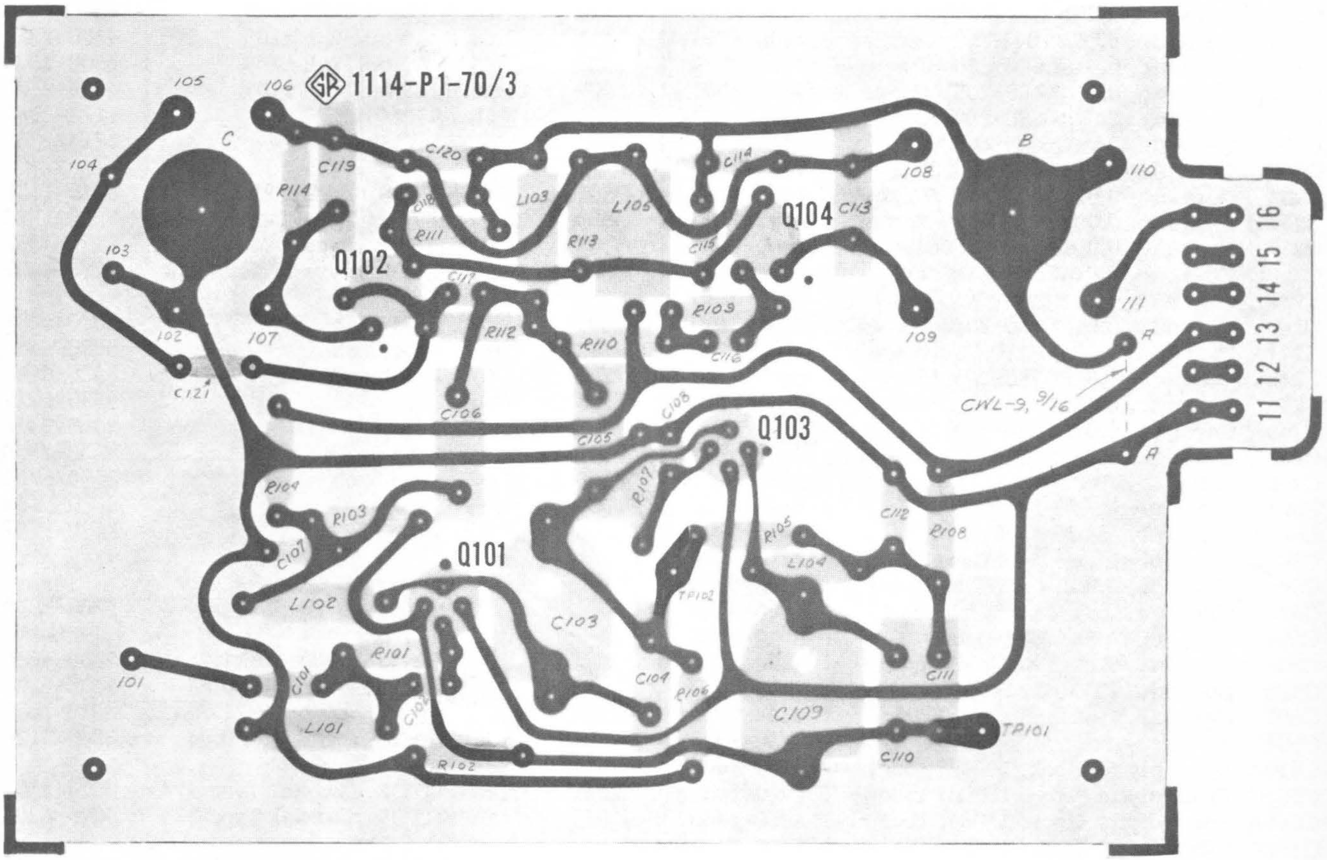
Block Diagram of Oscillator Amplifier for Type 1113-A Standard Frequency Oscillator.



Schematic Diagram for Type 1113-A Crystal



ematic Diagram for Type 1113-A Crystal Oven.



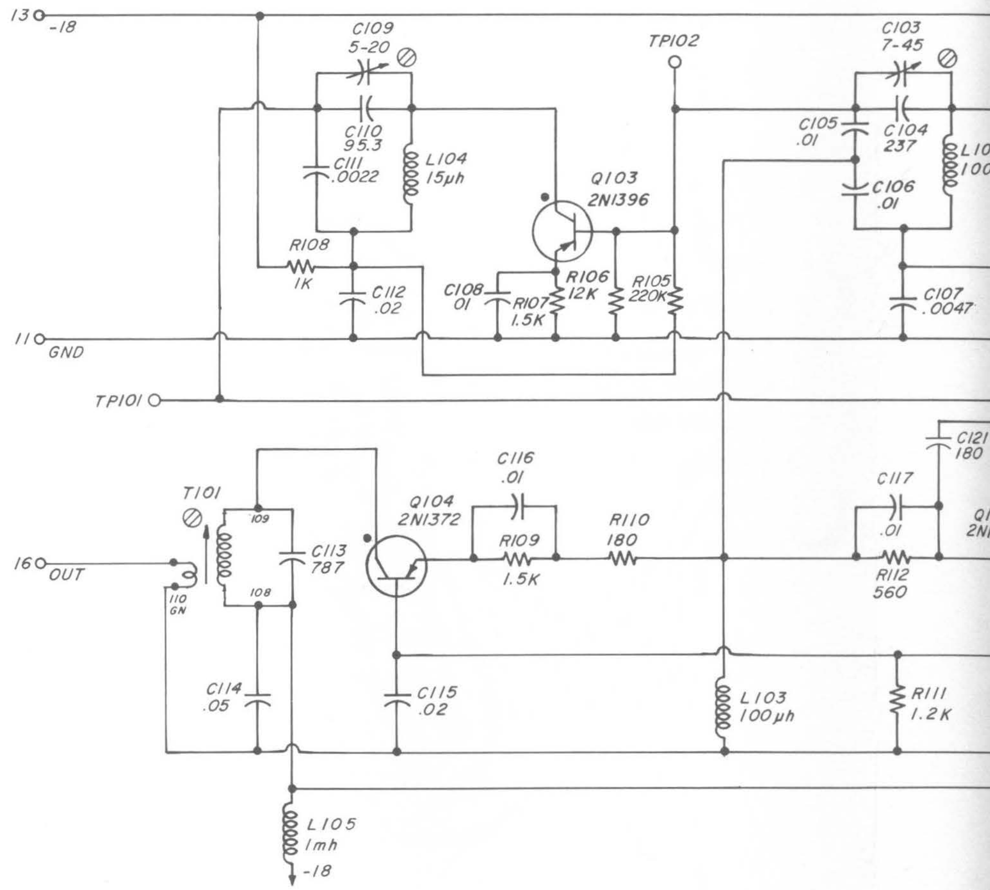
Etched Board Layout, Type 1114-P1 1-Mc Plug-In Unit.

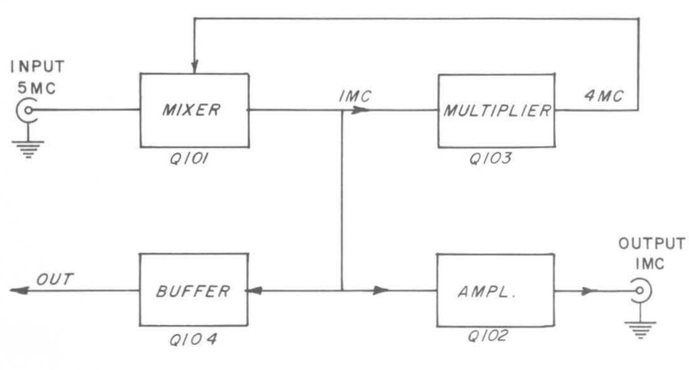
PARTS LIST

TYPE 1114-P1 1-MC PLUG-IN UNIT

REF NO.	RESISTORS	PART NO.
R101	Composition, 2.2kΩ ±5% 1/2w	6100-2225
R102	Composition, 12kΩ ±5% 1/2w	6100-3125
R103	Composition, 470kΩ ±5% 1/2w	6100-4475
R104	Composition, 470Ω ±5% 1/2w	6100-1475
R105	Composition, 220kΩ ±5% 1/2w	6100-4225
R106	Composition, 12kΩ ±5%1/2w	6100-3125
R107	Composition, 1.5kΩ ±5% 1/2w	6100-2155
R108	Composition, 1kΩ ±5% 1/2w	6100-2105
R109	Composition, 1.5kΩ ±5% 1/2w	6100-2155
R110	Composition, 180Ω ±5% 1/2w	6100-1185
R111	Composition, 1.2kΩ ±5% 1/2w	6100-2125
R112	Composition, 560Ω ±5% 1/2w	6100-1565
R113	Composition, 6.2kΩ ±5% 1/2w	6100-2625
R114	Composition, 36kΩ ±5% 1/2w	6100-3365
	CAPACITORS	
C101	Ceramic, 0.01μf ±20% 500dcwv	4406-3109
C102	Ceramic, 0.01μf +80-20% 50dcwv	4401-3100
C103	Trimmer, 7-45pf	4910-0100
C104	Mica, 237pf ±2% 500dcwv	4590-0520
C105	Mica, 0.01μf ±5% 500dcwv	4540-0105
C106	Mica, 0.01μf ±5% 500dcwv	4540-0105
C107	Ceramic, 0.0047μf ±20% 500dcwv	4406-2479
C108	Ceramic, 0.01μf +80-20% 50dcwv	4401-3100
C109	Trimmer, 5-20pf	4910-0400
C110	Mica, 95.3pf ±2% 500dcwv	4590-0390
C111	Mica, 0.0022μf ±5% 500dcwv	4580-0500

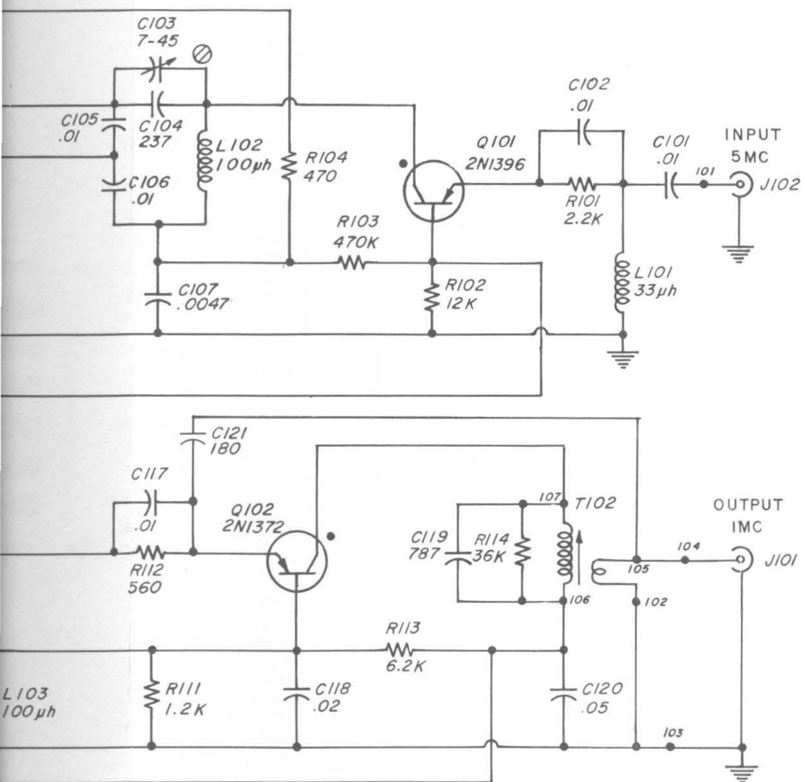
REF NO.	CAPACITORS	PART NO.
C112	Ceramic, 0.02μf +80-20% 50dcwv	4402-3200
C113	Mica, 787pf ±2% 500dcwv	4590-0570
C114	Ceramic, 0.05μf +80-20% 50dcwv	4403-3500
C115	Ceramic, 0.02μf +80-20% 50dcwv	4402-3200
C116	Ceramic, 0.01μf +80-20% 50dcwv	4401-3100
C117	Ceramic, 0.01μf +80-20% 50dcwv	4401-3100
C118	Ceramic, 0.02μf +80-20% 50dcwv	4402-3200
C119	Mica, 787pf ±2% 500dcwv	4590-0570
C120	Ceramic, 0.05μf +80-20% 50dcwv	4403-3500
C121	Ceramic, 180pf ±5% 500dcwv	4404-1185
	MISCELLANEOUS	
J101	CONNECTOR, Coaxial Type 874	0874-4501
J102	CONNECTOR, Coaxial Type 874	0874-4501
L101	CHOKE, Metal 33μh	4300-2900
L102	INDUCTOR, 100μh	1114-0401
L103	INDUCTOR, 100μh	1114-0401
L104	CHOKE, Metal 15μh	4300-2400
L105	CHOKE, Metal 1mh	4300-4850
Q101	TRANSISTOR, Type 2N1396	8210-1396
Q102	TRANSISTOR, Type 2N1372	8210-1372
Q103	TRANSISTOR, Type 2N1396	8210-1396
Q104	TRANSISTOR, Type 2N1372	8210-1372
T101	TRANSFORMER	1114-2010
T102	TRANSFORMER	1114-2010





Block Diagram

Schematic Diagram, Type 1114-P1 1-Mc Plug-In Unit.



NOTES:

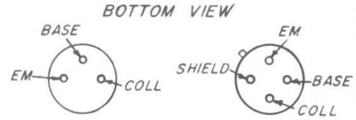
RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED

RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K=1000 M=1 MEGOHM

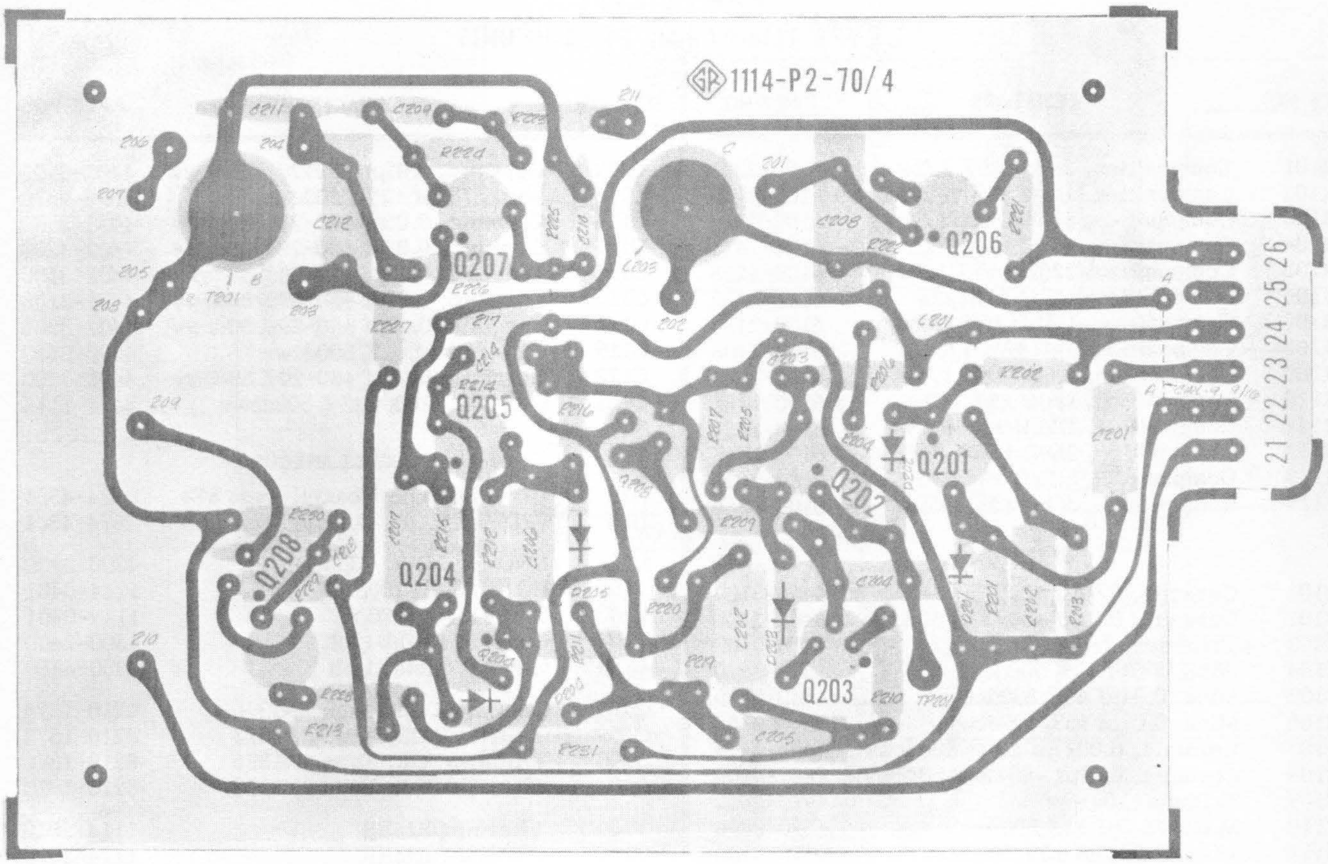
CAPACITANCE VALUES ONE & OVER IN MICROMICROFARADS, LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.

⊘ SCREWDRIVER CONTROL

BOTTOM VIEW



2N1372 2N1396



Etched Board Layout, Type 1114-P2 100-KC Plug-In Unit

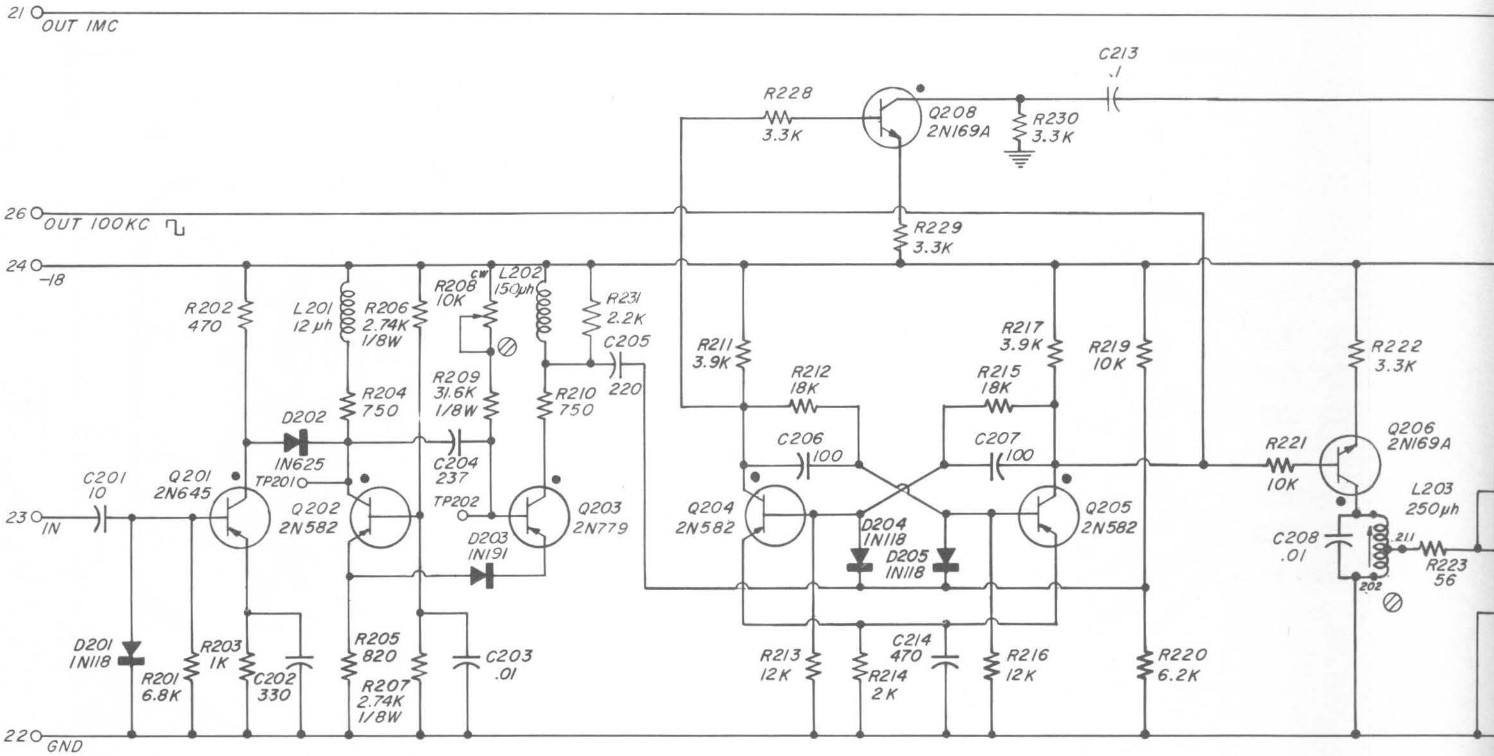
PARTS LIST

TYPE 1114-P2 100-KC PLUG-IN UNIT

REF NO.	RESISTORS	PART NO.
R201	Composition, 6.8kΩ ±5% 1/2w	6100-2685
R202	Composition, 470Ω ±5% 1/2w	6100-1475
R203	Composition, 1kΩ ±5% 1/2w	6100-2105
R204	Composition, 750Ω ±5% 1/2w	6100-1755
R205	Composition, 820Ω ±5% 1/2w	6100-1825
R206	Film, 2.74kΩ ±1% 1/8w	6250-1274
R207	Film, 2.74kΩ ±1% 1/8w	6250-1274
R208	Potentiometer, Composition, 10kΩ ±20%	6040-0700
R209	Film, 31.6kΩ ±1% 1/8w	6250-2316
R210	Composition, 820Ω ±5% 1/2w	6100-1755
R211	Composition, 3.9kΩ ±5% 1/2w	6100-2395
R212	Composition, 18kΩ ±5% 1/2w	6100-3185
R213	Composition, 12kΩ ±5% 1/2w	6100-3125
R214	Composition, 2kΩ ±5% 1/2w	6100-2205
R215	Composition, 18kΩ ±5% 1/2w	6100-3185
R216	Composition, 12kΩ ±5% 1/2w	6100-3125
R217	Composition, 3.9kΩ ±5% 1/2w	6100-2395
R219	Composition, 10kΩ ±5% 1/2w	6100-3105
R220	Composition, 6.2kΩ ±5% 1/2w	6100-2625
R221	Composition, 10kΩ ±5% 1/2w	6100-3105
R222	Composition, 3.3kΩ ±5% 1/2w	6100-2335
R223	Composition, 56Ω ±5% 1/2w	6100-0565
R224	Composition, 820Ω ±5% 1/2w	6100-1825
R225	Composition, 2.4kΩ ±5% 1/2w	6100-2245
R226	Composition, 13kΩ ±5% 1/2w	6100-3135
R227	Composition, 150Ω ±5% 1/2w	6100-1155
R228	Composition, 3.3kΩ ±5% 1/2w	6100-2335
R229	Composition, 3.3kΩ ±5% 1/2w	6100-2335
R230	Composition, 3.3kΩ ±5% 1/2w	6100-2335
R231	Composition, 2.2kΩ ±5% 1/2w	6100-2225

REF NO.	CAPACITORS	PART NO.
C201	Ceramic, 100pf ±10%NM 500dcwv	4400-2999
C202	Ceramic, 330pf ±10%NM 500dcwv	4400-4700
C203	Ceramic, 0.01μf +80-20% 50dcwv	4401-3100
C204	Mica, 383pf ±2% 500dcwv	4590-0520
C205	Ceramic, 220pf ±10%NM 500dcwv	4400-4655
C206	Ceramic, 100pf ±10%NM 500dcwv	4400-4600
C207	Ceramic, 100pf ±10%NM 500dcwv	4400-4600
C208	Mica, 0.01μf ±1% 500dcwv	4560-0300
C209	Ceramic, 0.1μf +80-20% 50dcwv	4403-4100
C210	Ceramic, 0.1μf +80-20% 50dcwv	4403-4100
C211	Ceramic, 0.1μf +80-20% 50dcwv	4403-4100
C212	Mica, 0.01μf ±1% 500dcwv	4560-0300
C213	Ceramic, 0.1μf +80-20% 50dcwv	4403-4100
C214	Ceramic, 470pf ±20% 500dcwv	4404-1479

REF NO.	MISCELLANEOUS	PART NO.
D201	DIODE, Type 1N118	8200-1180
D202	DIODE, Type 1N625	8200-6250
D203	DIODE, Type 1N118	8200-1910
D204	DIODE, Type 1N118	8200-1180
D205	DIODE, Type 1N118	8200-1180
J201	CONNECTOR, Coaxial Type 874	0874-4501
J202	CONNECTOR, Coaxial Type 874	0874-4501
J203	CONNECTOR, Coaxial Type 874	0874-4501
L201	CHOKE, Metal 12μh ±10%	4300-2300
L202	CHOKE, Metal 150μh ±10%	4300-3810
L203	INDUCTOR, 250μh	1114-2200
Q201	TRANSISTOR, Type 2N645	8210-6450
Q202	TRANSISTOR, Type 2N582	8210-5820
Q203	TRANSISTOR, Type 2N582	8210-7791
Q204	TRANSISTOR, Type 2N582	8210-5820
Q205	TRANSISTOR, Type 2N582	8210-5820
Q206	TRANSISTOR, Type 2N169A	8210-1692
Q207	TRANSISTOR, Type 2N1372	8210-1372
Q208	TRANSISTOR, Type 2N169A	8210-1692
T201	TRANSFORMER	1114-2220



NOTES:

RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED

RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED

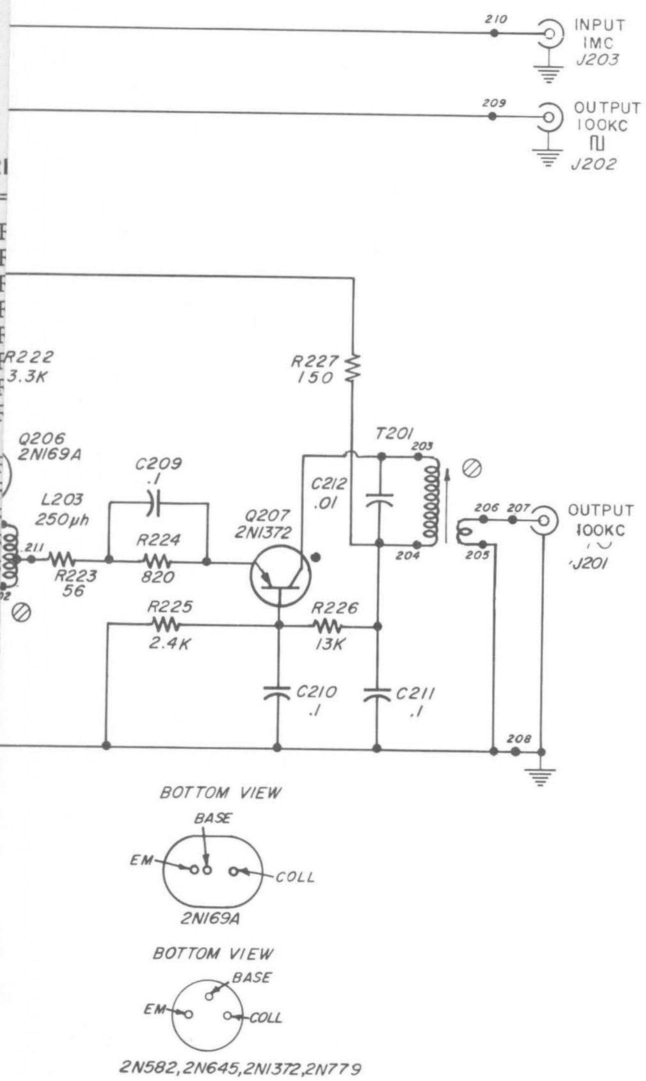
K = 1000 OHMS M = 1 MEGOHM

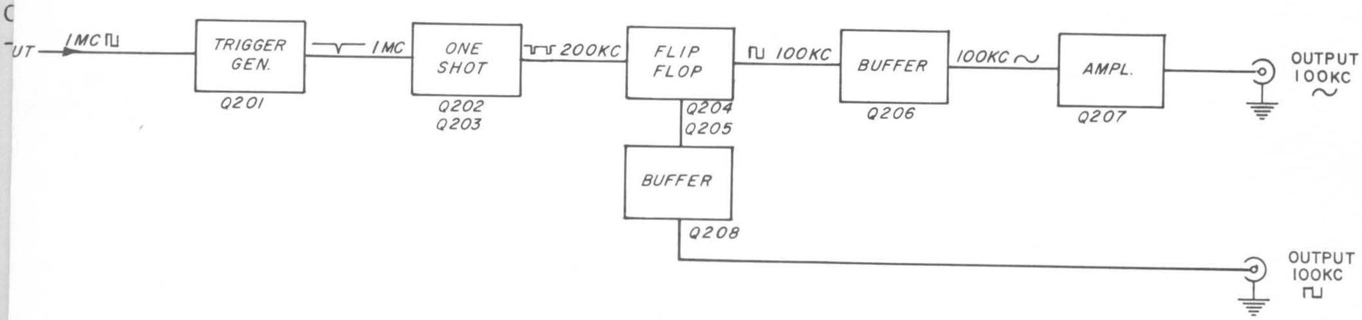
CAPACITANCE VALUES ONE & OVER IN MICRO-MICROFARADS, LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED

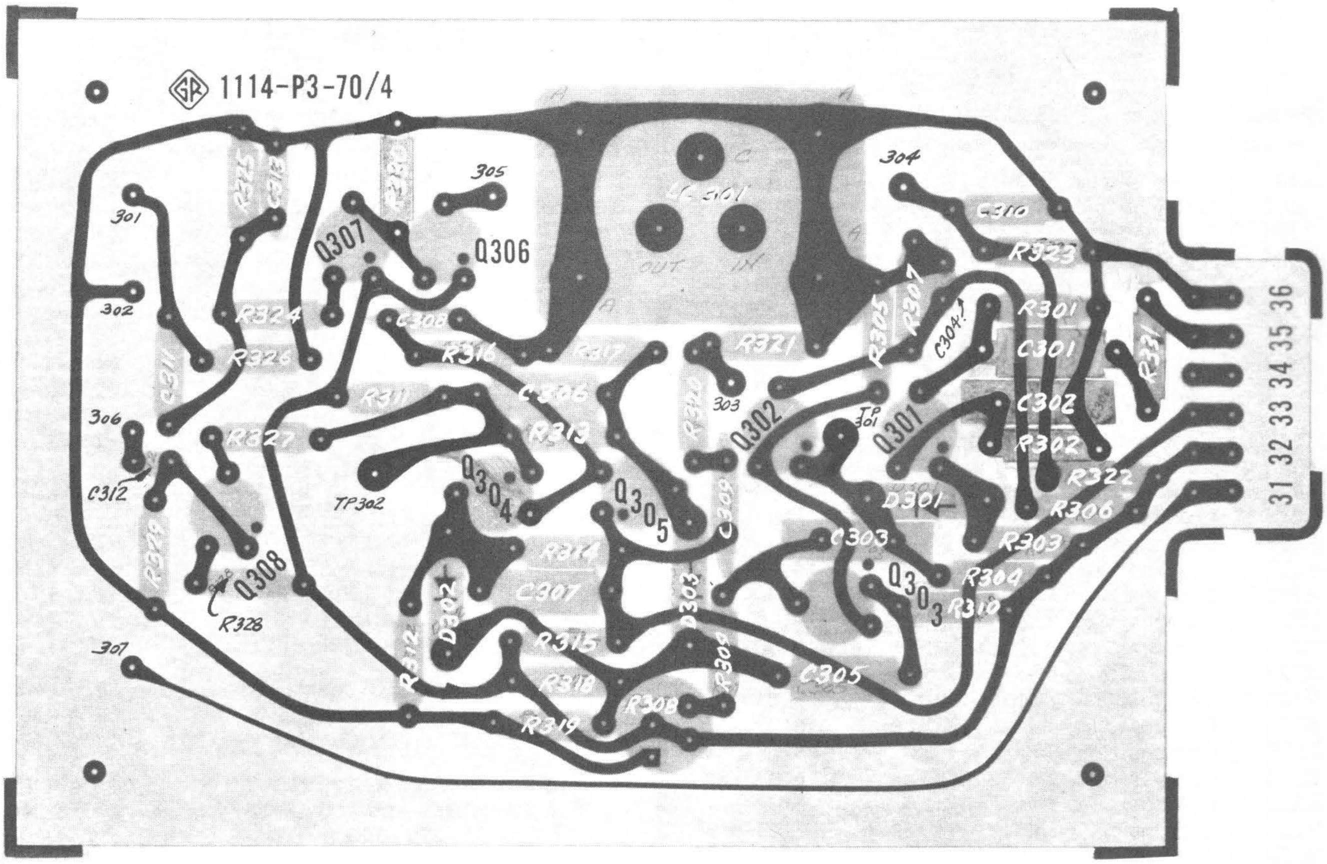
⊘ SCREWDRIVER CONTROL

Block Diagram

Schematic Diagram, Type 1114-P2 100-KC Plug-In Unit.







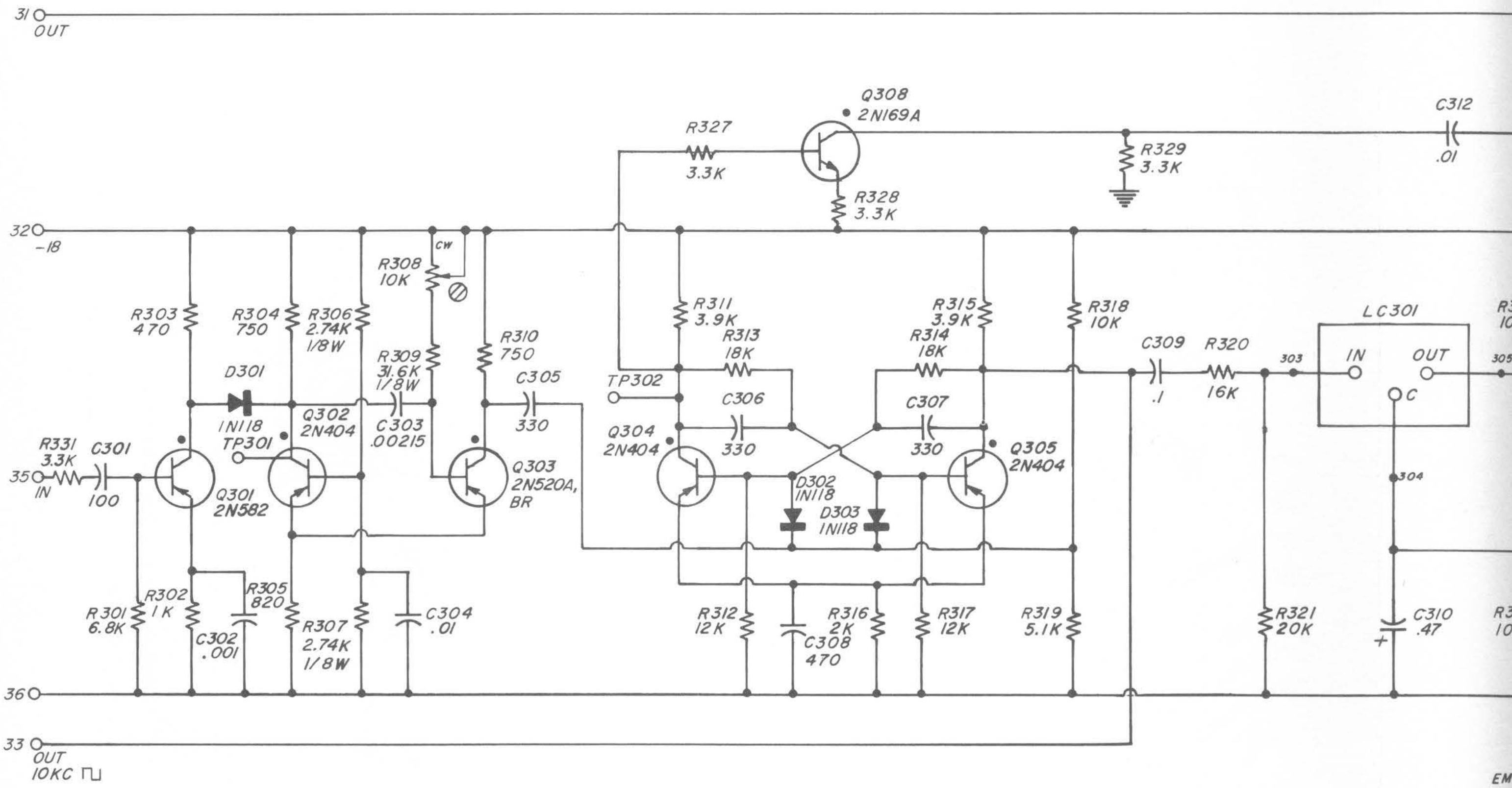
Etched Board Layout, Type 1114-P3 10-KC Plug-In Unit.

PARTS LIST

TYPE 1114-P3 10-KC PLUG-IN UNIT

REF NO.	RESISTORS	PART NO.
R301	Composition, 6.8kΩ ±5% 1/2w	6100-2685
R302	Composition, 1kΩ ±5% 1/2w	6100-2105
R303	Composition, 470Ω ±5% 1/2w	6100-1475
R304	Composition, 750Ω ±5% 1/2w	6100-1755
R305	Composition, 820Ω ±5% 1/2w	6100-1825
R306	Film, 2.74kΩ ±1% 1/8w	6250-1274
R307	Film, 2.74kΩ ±1% 1/8w	6250-1274
R308	Potentiometer, Composition, 10kΩ ±20%	6040-0700
R309	Film, 31.6kΩ ±1% 1/8w	6250-2316
R310	Composition, 750Ω ±5% 1/2w	6100-1755
R311	Composition, 3.9kΩ ±5% 1/2w	6100-2395
R312	Composition, 12kΩ ±5% 1/2w	6100-3125
R313	Composition, 18kΩ ±5% 1/2w	6100-3185
R314	Composition, 18kΩ ±5% 1/2w	6100-3185
R315	Composition, 3.9kΩ ±5% 1/2w	6100-2395
R316	Composition, 2kΩ ±5% 1/2w	6100-2205
R317	Composition, 12kΩ ±5% 1/2w	6100-3125
R318	Composition, 10kΩ ±5% 1/2w	6100-3105
R319	Composition, 5.1kΩ ±5% 1/2w	6100-2515
R320	Composition, 16kΩ ±5% 1/2w	6100-3165
R321	Composition, 20kΩ ±5% 1/2w	6100-3205
R322	Composition, 10kΩ ±5% 1/2w	6100-3105
R323	Composition, 10kΩ ±5% 1/2w	6100-3105
R324	Composition, 620Ω ±5% 1/2w	6100-1625
R325	Composition, 620Ω ±5% 1/2w	6100-1625
R326	Composition, 33kΩ ±5% 1/2w	6100-3335
R327	Composition, 3.3kΩ ±5% 1/2w	6100-2335
R328	Composition, 3.3kΩ ±5% 1/2w	6100-2335
R329	Composition, 3.3kΩ ±5% 1/2w	6100-2335
R330	Composition, 15kΩ ±5% 1/2w	6100-3155
R331	Composition, 3.3kΩ ±5% 1/2w	6100-2335

REF NO.	CAPACITORS	PART NO.
C301	Ceramic, 100pf ±10%NM 500dcwv	4400-4600
C302	Mica, 0.001μf ±10% 500dcwv	4570-1200
C303	Mica, 0.00215μf ±2% 500dcwv	4590-0850
C304	Ceramic, 0.01μf +80-20% 50dcwv	4401-3100
C305	Ceramic, 330pf ±10%NM 500dcwv	4400-4700
C306	Ceramic, 330pf ±10%NM 500dcwv	4400-4700
C307	Ceramic, 330pf ±10%NM 500dcwv	4400-4700
C308	Ceramic, 470pf ±20% 500dcwv	4404-1479
C309	Ceramic, 0.1μf +80-20% 50dcwv	4403-4100
C310	Electrolytic, 0.47μf ±20% 35dcwv	4450-4310
C311	Electrolytic, 0.47μf ±20% 35dcwv	4450-4310
C312	Ceramic, 0.01μf +80-20% 50dcwv	4401-3100
C313	Ceramic, 0.0047μf ±20% 500dcwv	4406-2479
	MISCELLANEOUS	
D301	DIODE, Type 1N118	8200-1180
D302	DIODE, Type 1N118	8200-1180
D303	DIODE, Type 1N118	8200-1180
J301	CONNECTOR, Coaxial Type 874	0874-4501
J302	CONNECTOR, Coaxial Type 874	0874-4501
J303	CONNECTOR, Coaxial Type 874	0874-4501
LC301	FILTER	1114-0413
Q301	TRANSISTOR, Type 2N582	8210-5820
Q302	TRANSISTOR, Type 2N404	8200-4040
Q303	TRANSISTOR, Type 2N520A, BR	8210-5200
Q304	TRANSISTOR, Type 2N404	8200-4040
Q305	TRANSISTOR, Type 2N404	8200-4040
Q306	TRANSISTOR, Type 2N1374	8210-1374
Q307	TRANSISTOR, Type 2N1374	8210-1374
Q308	TRANSISTOR, Type 2N169A	8210-1692

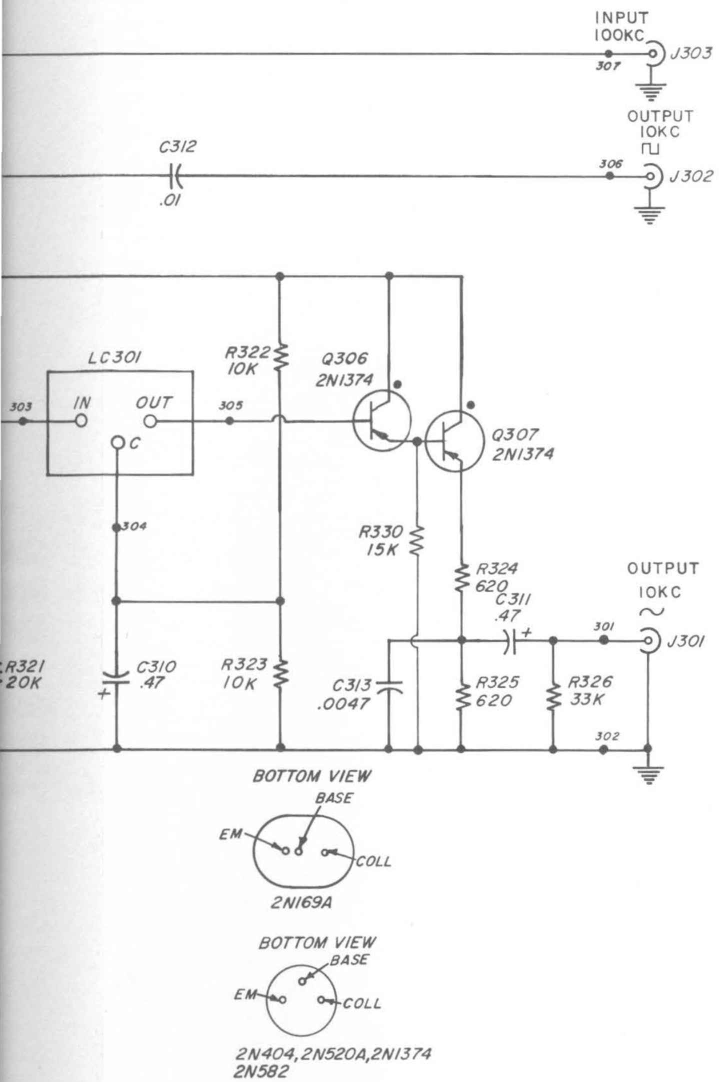


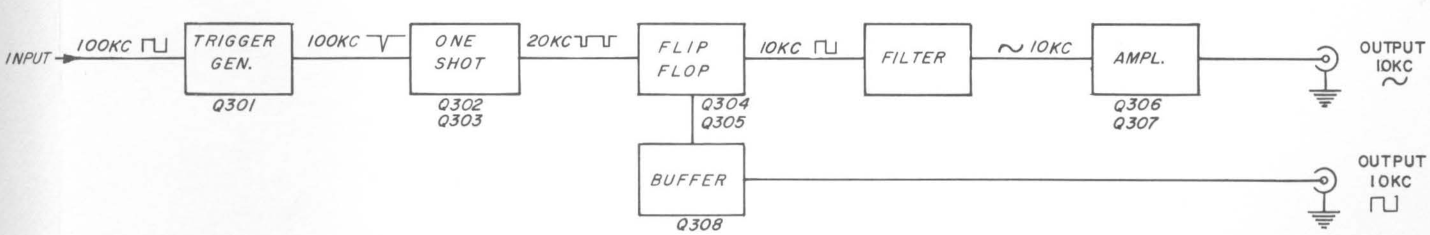
NOTES:
RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED
RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K=1000 OHMS M= 1 MEGOHM
CAPACITANCE VALUES ONE & OVER IN MICRO-MICROFARADS LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.
⊘ SCREWDRIVER CONTROL

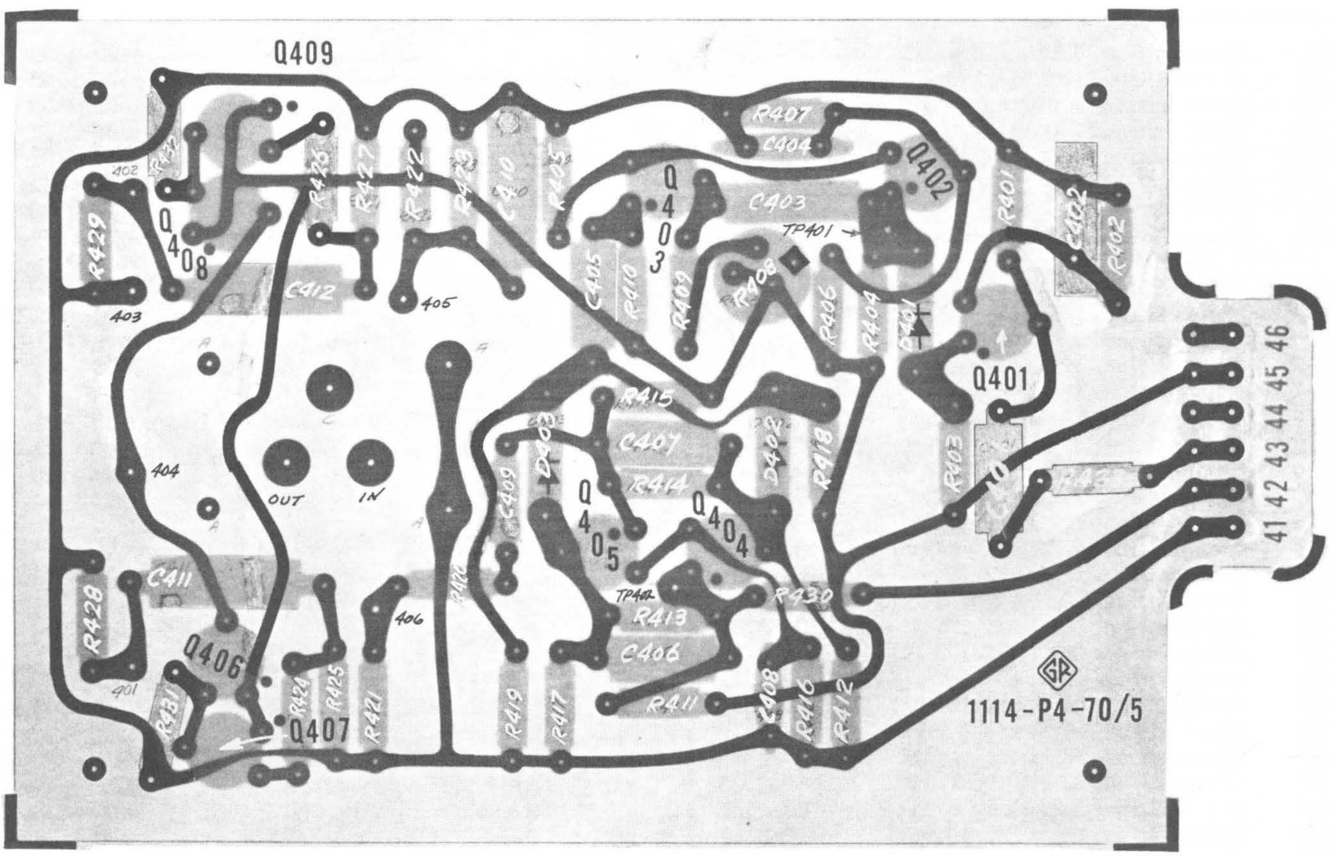
Block Diagram

INPUT → 100KC

Schematic Diagram, Type 1114-P3 10-KC Plug-In Unit





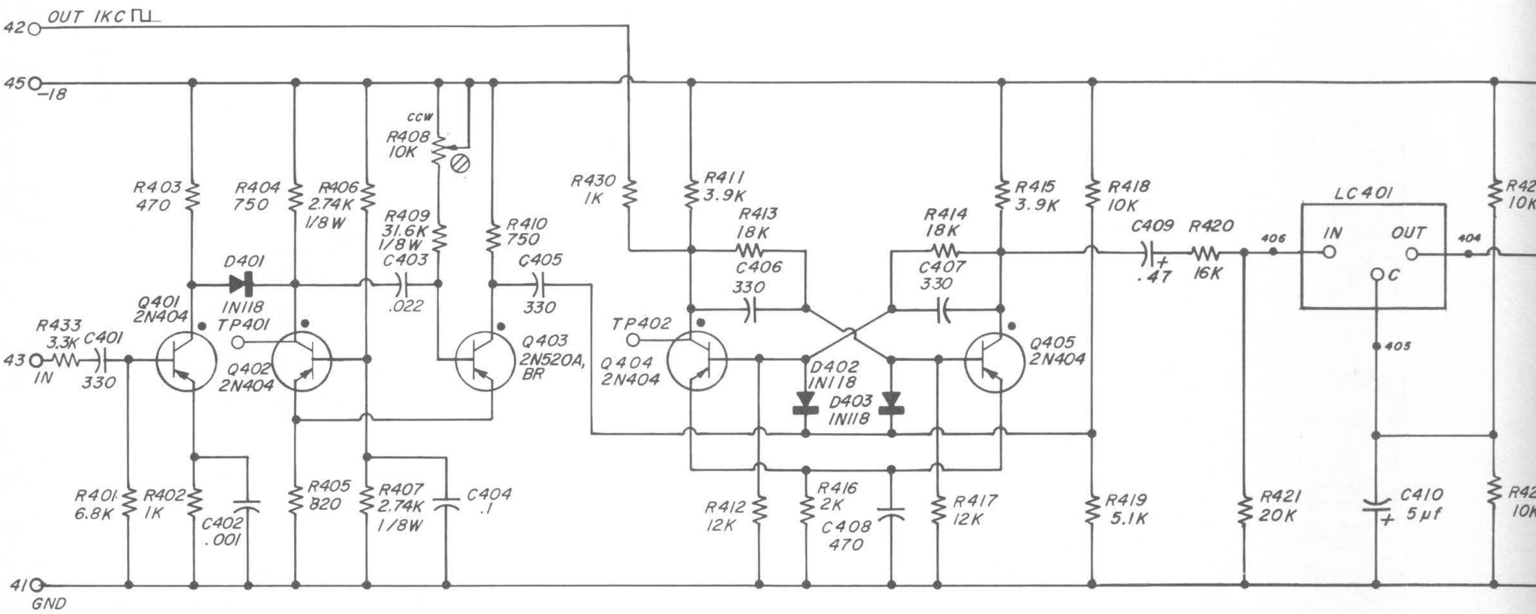


Etched Board Layout, Type 1114-P4 1-KC Plug-In Unit.

PARTS LIST
TYPE 1114-P4 1-KC PLUG-IN UNIT

REF NO.	RESISTORS	PART NO.
R401	Composition, 6.8kΩ ±5% 1/2w	6100-2685
R402	Composition, 1kΩ ±5% 1/2w	6100-2105
R403	Composition, 470Ω ±5% 1/2w	6100-1475
R404	Composition, 750Ω ±5% 1/2w	6100-1755
R405	Composition, 820Ω ±5% 1/2w	6100-1825
R406	Film, 2.74kΩ ±1% 1/8w	6250-1274
R407	Film, 2.74kΩ ±1% 1/8w	6250-1274
R408	Potentiometer, Composition, 10kΩ, ±20%	6040-0700
R409	Film, 31.6kΩ ±1% 1/8w	6250-2316
R410	Composition, 750Ω ±5% 1/2w	6100-1755
R411	Composition, 3.9kΩ ±5% 1/2w	6100-2395
R412	Composition, 12kΩ ±5% 1/2w	6100-3125
R413	Composition, 18kΩ ±5% 1/2w	6100-3185
R414	Composition, 18kΩ ±5% 1/2w	6100-3185
R415	Composition, 3.9kΩ ±5% 1/2w	6100-2395
R416	Composition, 2kΩ ±5% 1/2w	6100-2205
R417	Composition, 12kΩ ±5% 1/2w	6100-3125
R418	Composition, 10kΩ ±5% 1/2w	6100-3105
R419	Composition, 5.1kΩ ±5% 1/2w	6100-2515
R420	Composition, 16kΩ ±5% 1/2w	6100-3165
R421	Composition, 20kΩ ±5% 1/2w	6100-3205
R422	Composition, 10kΩ ±5% 1/2w	6100-3105
R423	Composition, 10kΩ ±5% 1/2w	6100-3105
R424	Composition, 620Ω ±5% 1/2w	6100-1625
R425	Composition, 620Ω ±5% 1/2w	6100-1625
R426	Composition, 620Ω ±5% 1/2w	6100-1625
R427	Composition, 620Ω ±5% 1/2w	6100-1625
R428	Composition, 33kΩ ±5% 1/2w	6100-3335
R429	Composition, 33kΩ ±5% 1/2w	6100-3335
R430	Composition, 1kΩ ±5% 1/2w	6100-2105
R431	Composition, 15kΩ ±5% 1/2w	6100-3155
R432	Composition, 15kΩ ±5% 1/2w	6100-3155
R433	Composition, 4.3kΩ ±5% 1/2w	6100-2335

REF NO.	CAPACITORS	PART NO.
C401	Ceramic, 330pf ±10%NM 500dcwv	4400-4700
C402	Mica, 0.001μf ±10% 500dcwv	4570-1200
C403	Plastic, 0.022μf ±2% 100dcwv	4860-7858
C404	Ceramic. 0.1μf +80-20% 50dcwv	4403-4100
C405	Ceramic, 330pf ±10%NM 500dcwv	4400-4700
C406	Ceramic, 330pf ±10%NM 500dcwv	4400-4700
C407	Ceramic, 330pf ±10%NM 500dcwv	4400-4700
C408	Ceramic, 470pf ±20% 500dcwv	4404-1479
C409	Electrolytic, 0.47μf ±20% 35dcwv	4450-4310
C410	Electrolytic, 5μf 50dcwv	4450-3900
C411	Electrolytic, 5μf 50dcwv	4450-3900
C412	Electrolytic, 5μf 50dcwv	4450-3900
	MISCELLANEOUS	
D401	DIODE, Type 1N118	8200-1180
D402	DIODE, Type 1N118	8200-1180
D403	DIODE, Type 1N118	8200-1180
J401	CONNECTOR, Coaxial Type 874	0874-4501
J402	CONNECTOR, Coaxial Type 874	0874-4501
LC401	FILTER	1114-0414
Q401	TRANSISTOR, Type 2N404	8200-4040
Q402	TRANSISTOR, Type 2N404	8200-4040
Q403	TRANSISTOR, Type 2N520A, BR	8210-5200
Q404	TRANSISTOR, Type 2N404	8200-4040
Q405	TRANSISTOR, Type 2N404	8200-4040
Q406	TRANSISTOR, Type 2N1374	8210-1374
Q407	TRANSISTOR, Type 2N1374	8210-1374
Q408	TRANSISTOR, Type 2N1374	8210-1374
Q409	TRANSISTOR, Type 2N1374	8210-1374



NOTES:

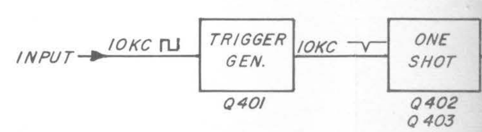
RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED

RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED

K = 1000 OHMS M = 1 MEGOHM

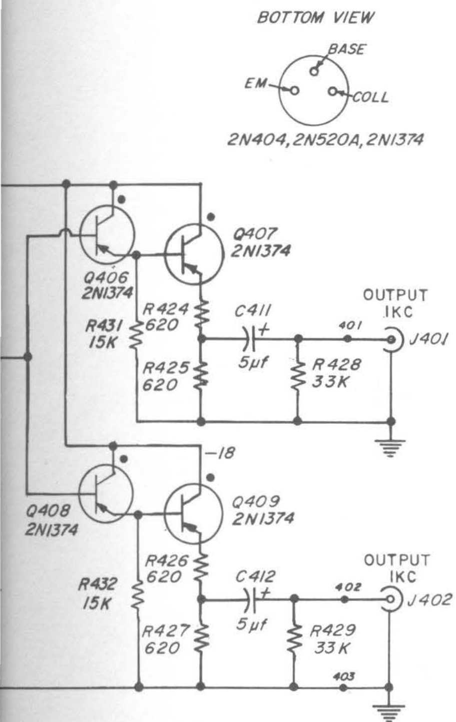
CAPACITANCE VALUES ONE & OVER IN MICRO-MICRO-FARADS, LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.

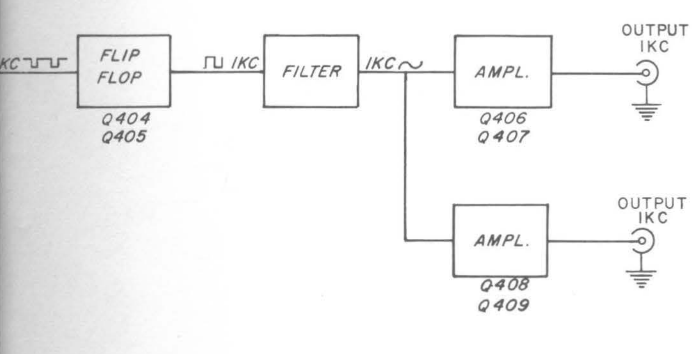
⊘ SCREWDRIVER CONTROL

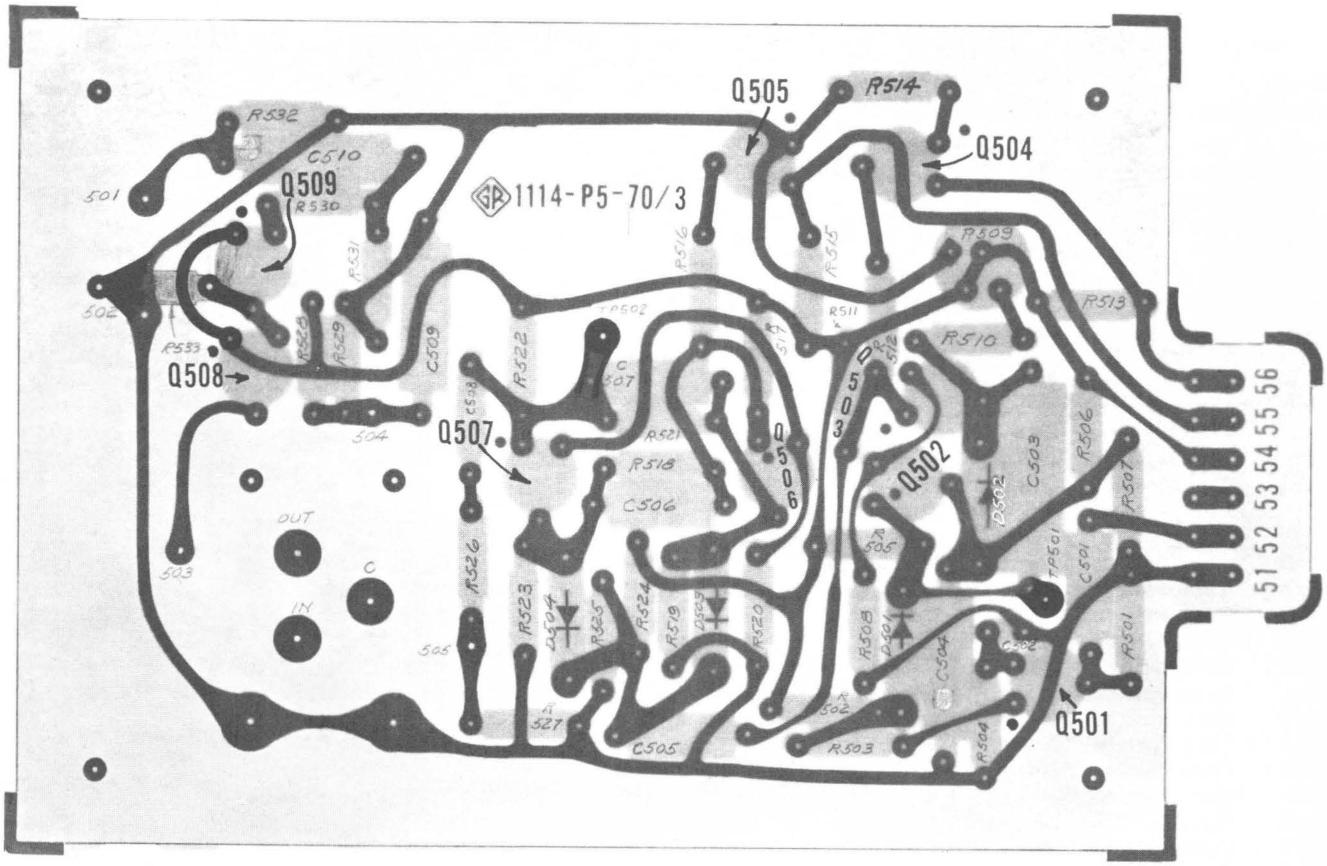


Block Diagram

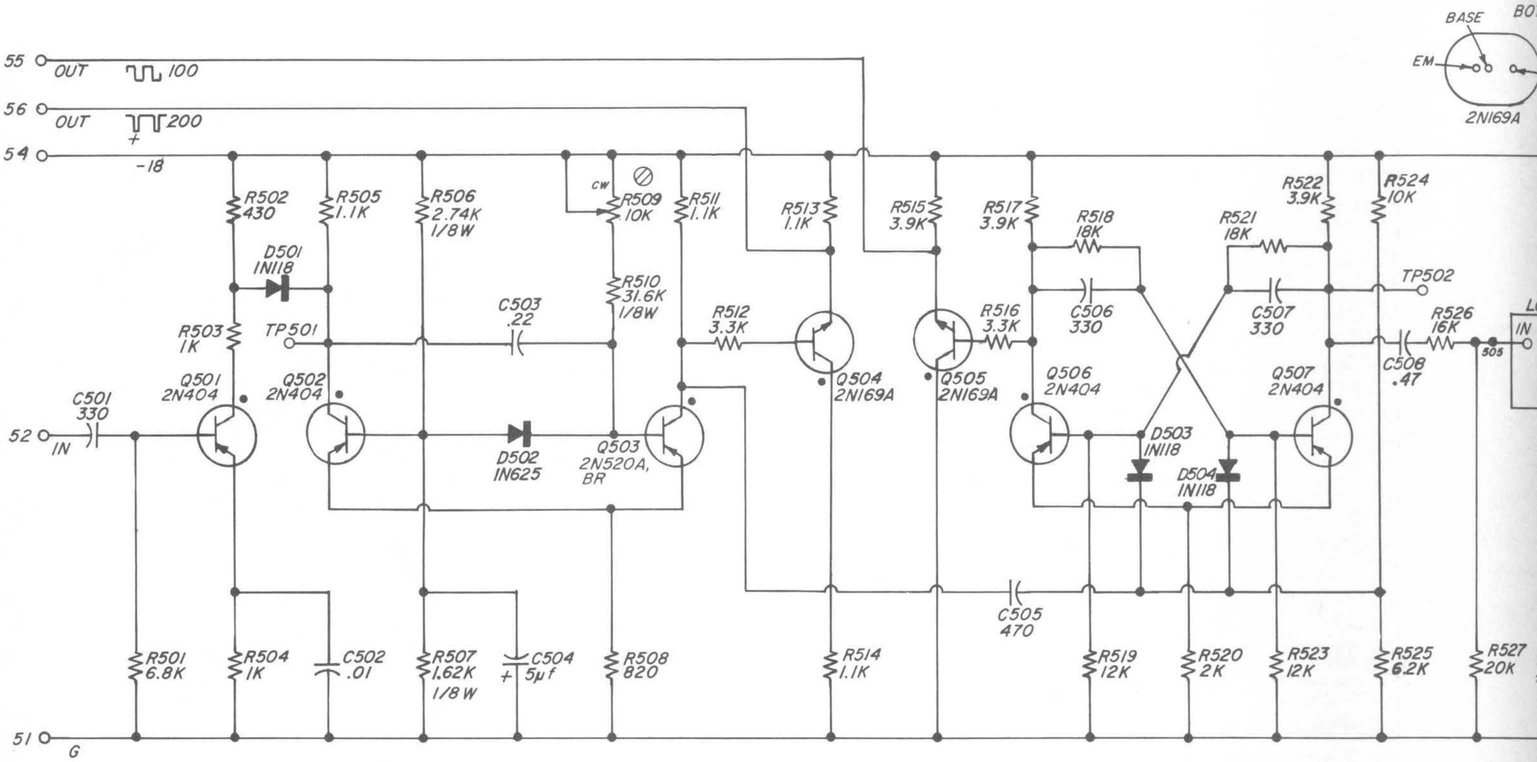
Schematic Diagram, Type 1114-P4 1-KC Plug-In Unit







Etched Board Layout, Type 1114-P5 100-CPS Plug-In Unit.



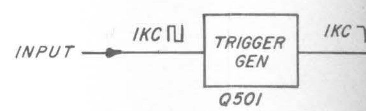
RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED

RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K=1000 M=1 MEGOHM

CAPACITANCE VALUES ONE AND OVER IN MICRO-MICROFARADS, LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED

⊘ SCREWDRIVER CONTROL

Block Diagram



PARTS LIST

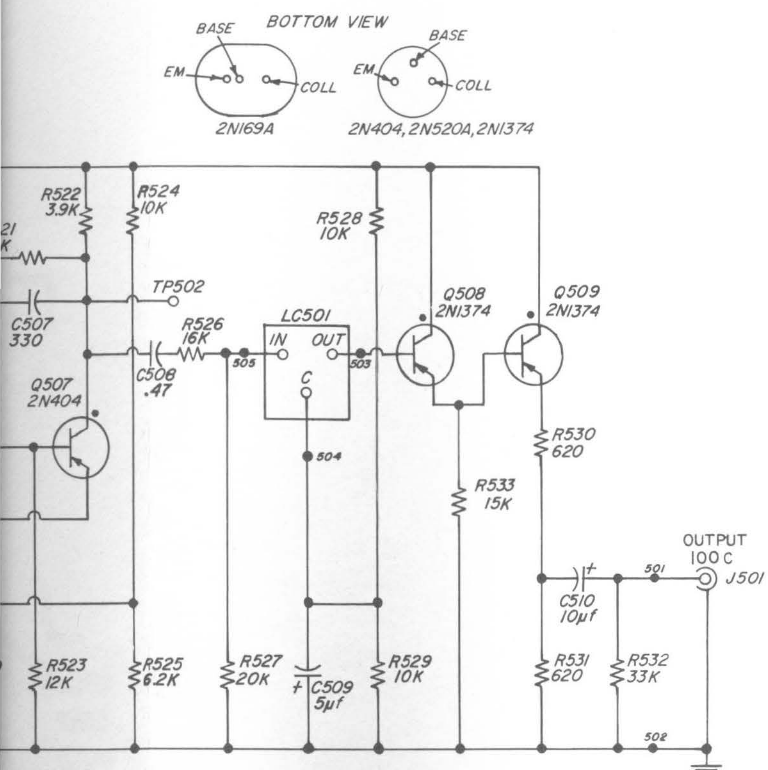
TYPE 1114-P5 100-CPS PLUG-IN UNIT

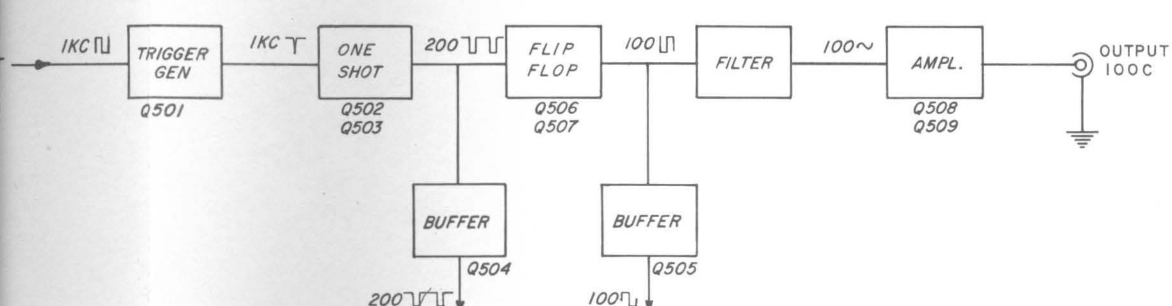
REF NO.	RESISTORS	PART NO.
R501	Composition, 6.8kΩ ±5% 1/2w	6100-2685
R502	Composition, 430Ω ±5% 1/2w	6100-1435
R503	Composition, 1kΩ ±5% 1/2w	6100-2105
R504	Composition, 1kΩ ±5% 1/2w	6100-2105
R505	Composition, 1.1kΩ ±5% 1/2w	6100-2115
R506	Film, 2.74kΩ ±1% 1/8w	6250-1274
R507	Film, 1.62kΩ ±1% 1/8w	6250-1162
R508	Composition, 820Ω ±5% 1/2w	6100-1825
R509	Potentiometer, Composition, 10kΩ ±20%	6040-0700
R510	Film, 31.6kΩ ±1% 1/8w	6250-2316
R511	Composition, 1.1kΩ ±5% 1/2w	6100-2115
R512	Composition, 3.3kΩ ±5% 1/2w	6100-2335
R513	Composition, 1.1kΩ ±5% 1/2w	6100-2115
R514	Composition, 1.1kΩ ±5% 1/2w	6100-2115
R515	Composition, 3.9kΩ ±5% 1/2w	6100-2395
R516	Composition, 3.3kΩ ±5% 1/2w	6100-2335
R517	Composition, 3.9kΩ ±5% 1/2w	6100-2395
R518	Composition, 18kΩ ±5% 1/2w	6100-3185
R519	Composition, 12kΩ ±5% 1/2w	6100-3125
R520	Composition, 2kΩ ±5% 1/2w	6100-2205
R521	Composition, 18kΩ ±5% 1/2w	6100-3185
R522	Composition, 3.9kΩ ±5% 1/2w	6100-2395
R523	Composition, 12kΩ ±5% 1/2w	6100-3125
R524	Composition, 10kΩ ±5% 1/2w	6100-3105
R525	Composition, 6.2kΩ ±5% 1/2w	6100-2625
R526	Composition, 16kΩ ±5% 1/2w	6100-3165
R527	Composition, 20kΩ ±5% 1/2w	6100-3205
R528	Composition, 10kΩ ±5% 1/2w	6100-3105
R529	Composition, 10kΩ ±5% 1/2w	6100-3105
R530	Composition, 620Ω ±5% 1/2w	6100-1625
R531	Composition, 620Ω ±5% 1/2w	6100-1625
R532	Composition, 33kΩ ±5% 1/2w	6100-3335
R533	Composition, 15kΩ ±5% 1/2w	6100-3155

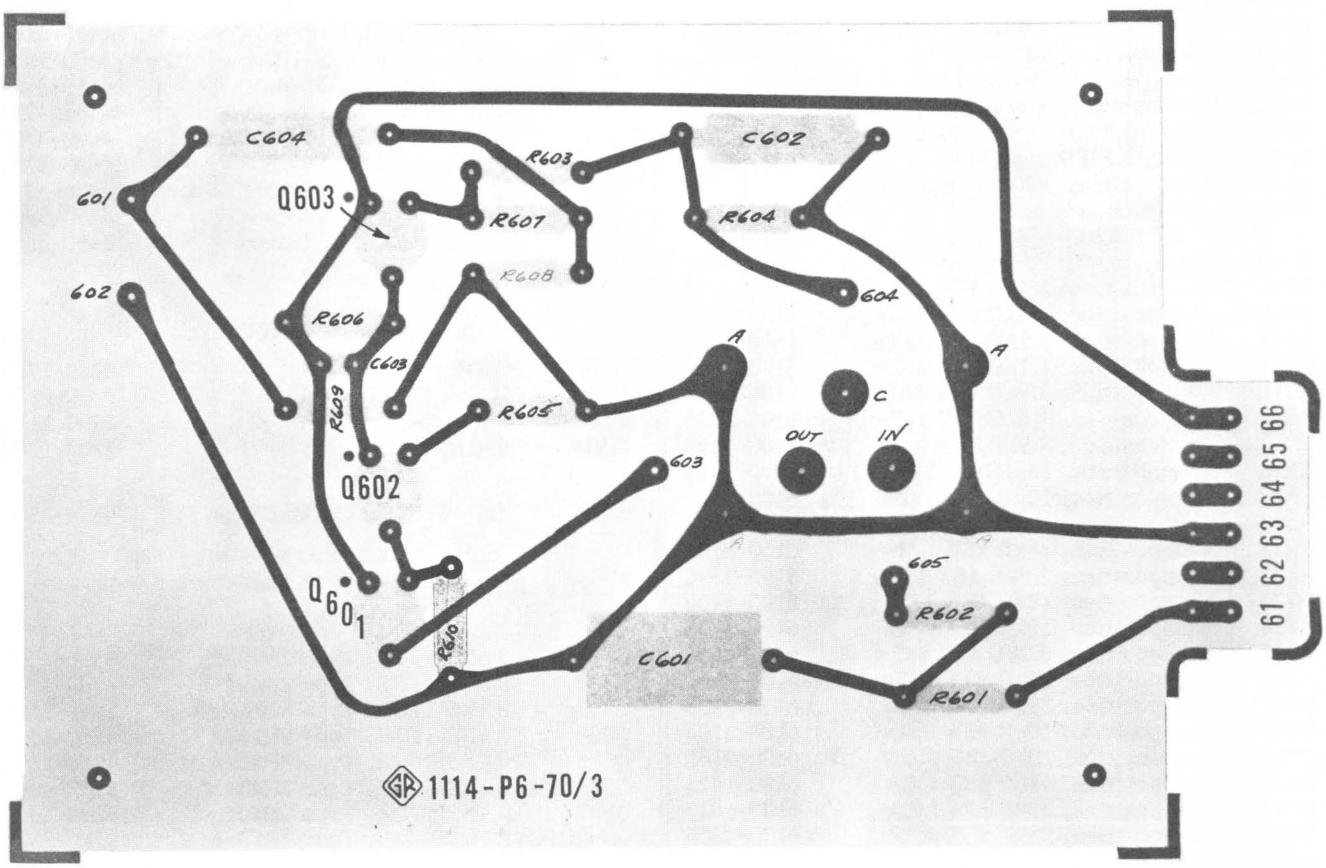
REF NO.	CAPACITORS	PART NO.
C501	Ceramic, 330pf ±10%NM 500dcwv	4400-4700
C502	Ceramic, 0.01μf +80-20% 50dcwv	4401-3100
C503	Plastic, 0.22μf ±2% 100dcwv	4860-7950
C504	Electrolytic, 5μf 50dcwv	4450-3900
C505	Ceramic, 470pf ±10% 500dcwv	4400-4775
C506	Ceramic, 330pf ±10% 500dcwv	4400-4700
C507	Ceramic, 330pf ±10% 500dcwv	4400-4700
C508	Electrolytic, 0.47μf ±20% 35dcwv	4450-4310
C509	Electrolytic, 5μf 50dcwv	4450-3900
C510	Electrolytic, 10μf 25dcwv	4450-3800

MISCELLANEOUS

REF NO.		PART NO.
D501	DIODE, Type 1N118	8200-1180
D502	DIODE, Type 1N625	8200-6250
D503	DIODE, Type 1N118	8200-1180
D504	DIODE, Type 1N118	8200-1180
J501	CONNECTOR, Coaxial Type 874	0874-4501
LC501	FILTER	1114-0415
Q501	TRANSISTOR, Type 2N404	8200-4040
Q502	TRANSISTOR, Type 2N404	8200-4040
Q503	TRANSISTOR, Type 520A, BR	8210-5200
Q504	TRANSISTOR, Type 2N169A	8210-1692
Q505	TRANSISTOR, Type 2N169A	8210-1692
Q506	TRANSISTOR, Type 2N404	8200-4040
Q507	TRANSISTOR, Type 2N404	8200-4040
Q508	TRANSISTOR, Type 2N1374	8210-1374
Q509	TRANSISTOR, Type 2N1374	8210-1374


BOTTOM VIEW
BASE
EM
COLL
2N169A
2N404, 2N520A, 2N1374
R522 3.9K
R524 10K
R528 10K
TP502
C507 330
LC501
IN
OUT
C
R526 16K
C508 .47
Q507 2N404
Q508 2N1374
Q509 2N1374
R530 620
R533 15K
OUTPUT 100C
J501
C510 10µf
R523 12K
R525 6.2K
R527 20K
C509 5µf
R529 10K
R531 620
R532 33K


1KC
TRIGGER GEN
Q501
1KC
ONE SHOT
Q502
Q503
200
FLIP FLOP
Q506
Q507
100
FILTER
100~
AMPL.
Q508
Q509
OUTPUT 100C
BUFFER
Q504
200
BUFFER
Q505
100



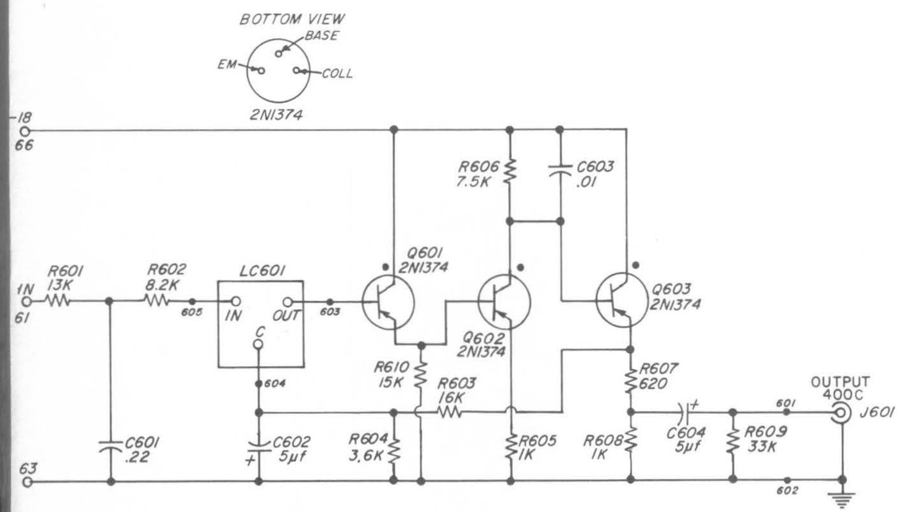
Etched Board Layout, Type 1114-P6 400-CPS Plug-In Unit.

44

PARTS LIST

TYPE 1114-P6 400-CPS PLUG-IN UNIT

REF NO.	RESISTORS	PART NO.
R601	Composition, 13kΩ ±5% 1/2w	6100-3135
R602	Composition, 8.2kΩ ±5% 1/2w	6100-2825
R603	Composition, 16kΩ ±5% 1/2w	6100-3165
R604	Composition, 3.6kΩ ±5% 1/2w	6100-2365
R605	Composition, 1kΩ ±5% 1/2w	6100-2105
R606	Composition, 7.5kΩ ±5% 1/2w	6100-2755
R607	Composition, 620Ω ±5% 1/2w	6100-1625
R608	Composition, 1kΩ ±5% 1/2w	6100-2105
R609	Composition, 33kΩ ±5% 1/2w	6100-3335
R610	Composition, 15kΩ ±5% 1/2w	6100-3155
	CAPACITORS	
C601	Wax, 22µf ±10% 1000dcwv	5010-3300
C602	Electrolytic, 5µf 50dcwv	4450-3900
C603	Ceramic, 0.01µf +80-20% 50dcwv	4401-3100
C604	Electrolytic, 5µf 50dcwv	4450-3900
	MISCELLANEOUS	
J601	CONNECTOR, Coaxial Type 874	0874-4501
LC601	FILTER	1114-0416
Q601	TRANSISTOR, Type 2N1374	8210-1374
Q602	TRANSISTOR, Type 2N1374	8210-1374
Q603	TRANSISTOR, Type 2N1374	8210-1374



NOTES:

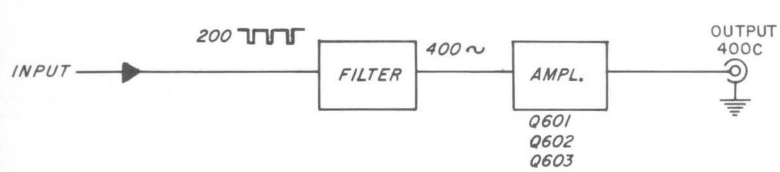
RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED

RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED

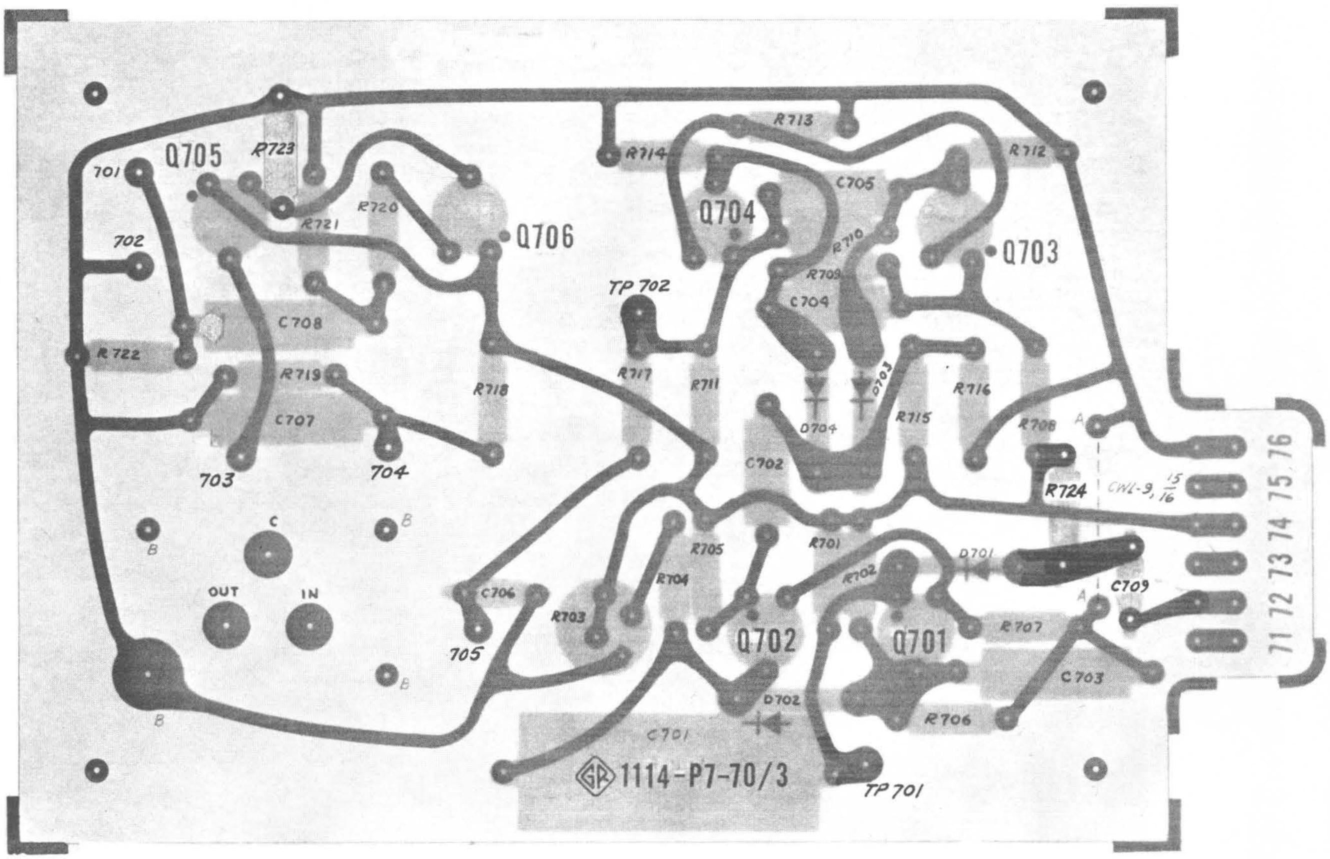
K=1000 M=1 MEGOHM

CAPACITANCE VALUES ONE AND OVER IN MICRO-MICROFARADS, LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.

Schematic Diagram, Type 1114-P6 400-CPS Plug-In Unit



Block Diagram



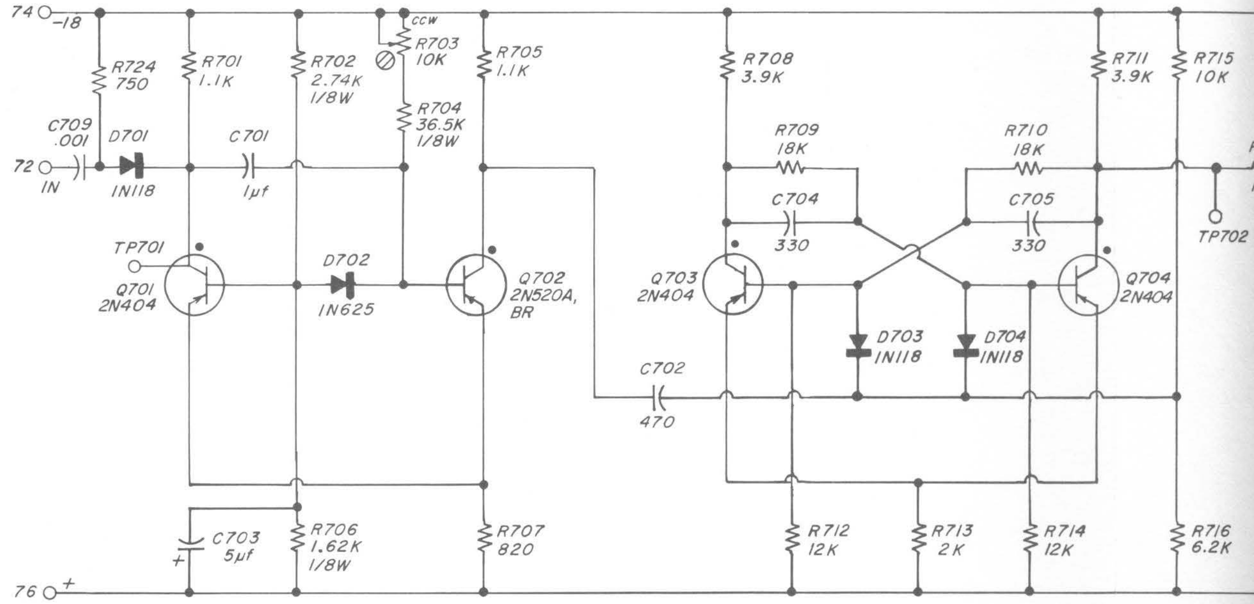
Etched Board Layout, Type 1114-P7 60-CPS Plug-In Unit.

PARTS LIST

TYPE 1114-P7 60-CPS PLUG-IN UNIT

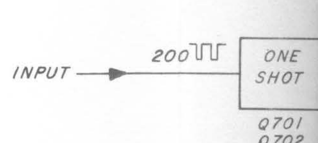
REF NO.	RESISTORS	PART NO.
R701	Composition, 1.1kΩ ±5% 1/2w	6100-2115
R702	Film, 2.74kΩ ±1% 1/8w	6250-1274
R703	Potentiometer, Composition, 10kΩ ±20%	6040-0700
R704	Film, 36.5kΩ ±1% 1/8w	6250-2365
R705	Composition, 1.1kΩ ±5% 1/2w	6100-2115
R706	Film, 1.62kΩ ±5% 1/8w	6250-1162
R707	Composition, 820Ω ±5% 1/2w	6100-1825
R708	Composition, 3.9kΩ ±5% 1/2w	6100-2395
R709	Composition, 18kΩ ±5% 1/2w	6100-3185
R710	Composition, 18kΩ ±5% 1/2w	6100-3185
R711	Composition, 3.9kΩ ±5% 1/2w	6100-2395
R712	Composition, 12kΩ ±5% 1/2w	6100-3125
R713	Composition, 2kΩ ±5% 1/2w	6100-2205
R714	Composition, 12kΩ ±5% 1/2w	6100-3125
R715	Composition, 10kΩ ±5% 1/2w	6100-3105
R716	Composition, 6.2kΩ ±5% 1/2w	6100-2625
R717	Composition, 1.5kΩ ±5% 1/2w	6100-2155
R718	Composition, 10kΩ ±5% 1/2w	6100-3105
R719	Composition, 10kΩ ±5% 1/2w	6100-3105
R720	Composition, 470Ω ±5% 1/2w	6100-1475
R721	Composition, 1kΩ ±5% 1/2w	6100-2105
R722	Composition, 33kΩ ±5% 1/2w	6100-3335
R723	Composition, 15kΩ ±5% 1/2w	6100-3155
R724	Composition, 750Ω ±5% 1/2w	6100-1755

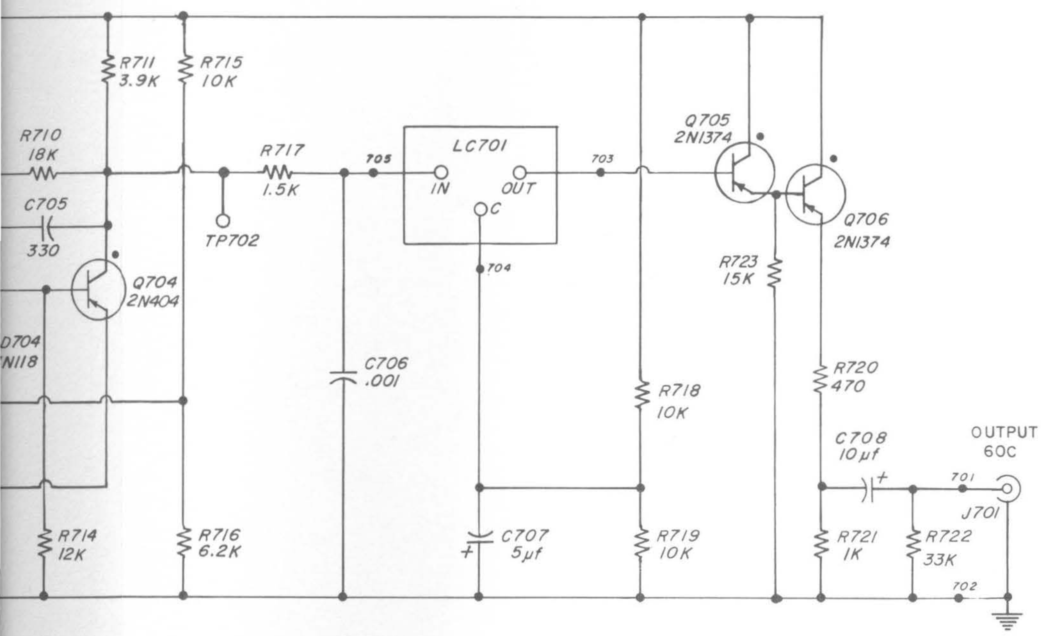
REF NO.	CAPACITORS	PART NO.
C701	Plastic, 1μf ±2% 100dcwv	4860-8251
C702	Ceramic, 470pf ±10%NM 500dcwv	4400-4775
C703	Electrolytic, 5μf 50dcwv	4450-3900
C704	Ceramic, 330pf ±10%NM 500dcwv	4400-4700
C705	Ceramic, 330pf ±10%NM 500dcwv	4400-4700
C706	Ceramic, 0.001μf ±20% 500dcwv	4404-2109
C707	Electrolytic, 5μf 50dcwv	4450-3900
C708	Electrolytic, 10μf 25dcwv	4450-3800
C709	Ceramic, 0.001μf ±20% 500dcwv	4404-2109
	MISCELLANEOUS	
D701	DIODE, Type 1N118	8200-1180
D702	DIODE, Type 1N625	8200-6250
D703	DIODE, Type 1N118	8200-1180
D704	DIODE, Type 1N118	8200-1180
J701	CONNECTOR, Coaxial Type 874	0874-4501
LC701	FILTER	1114-0417
Q701	TRANSISTOR, Type 2N404	8200-4040
Q702	TRANSISTOR, Type 2N520A, BR	8210-5200
Q703	TRANSISTOR, Type 2N404	8200-4040
Q704	TRANSISTOR, Type 2N404	8200-4040
Q705	TRANSISTOR, Type 2N1374	8210-1374
Q706	TRANSISTOR, Type 2N1374	8210-1374

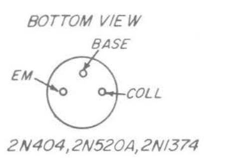


NOTE:
RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED
RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K = 1000 M = 1 MEGOHM
CAPACITANCE VALUES ONE & OVER IN MICRO-MICRO-FARADS, LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.
⊘ SCREWDRIVER CONTROL
ANCHOR TERMINALS USED: 701, 702, 703, 704, 705

Block Diagram




R711
3.9K
R715
10K
R710
18K
R717
1.5K
705
LC701
IN
OUT
C
703
704
C705
330
TP702
Q704
2N404
D704
N118
Q705
2N1374
Q706
2N1374
R723
15K
C706
.001
R718
10K
R720
470
C708
10µf
OUTPUT
60C
701
J701
R714
12K
R716
6.2K
C707
5µf
R719
10K
R721
1K
R722
33K
702


BOTTOM VIEW
BASE
EM
COLL
2N404, 2N520A, 2N1374

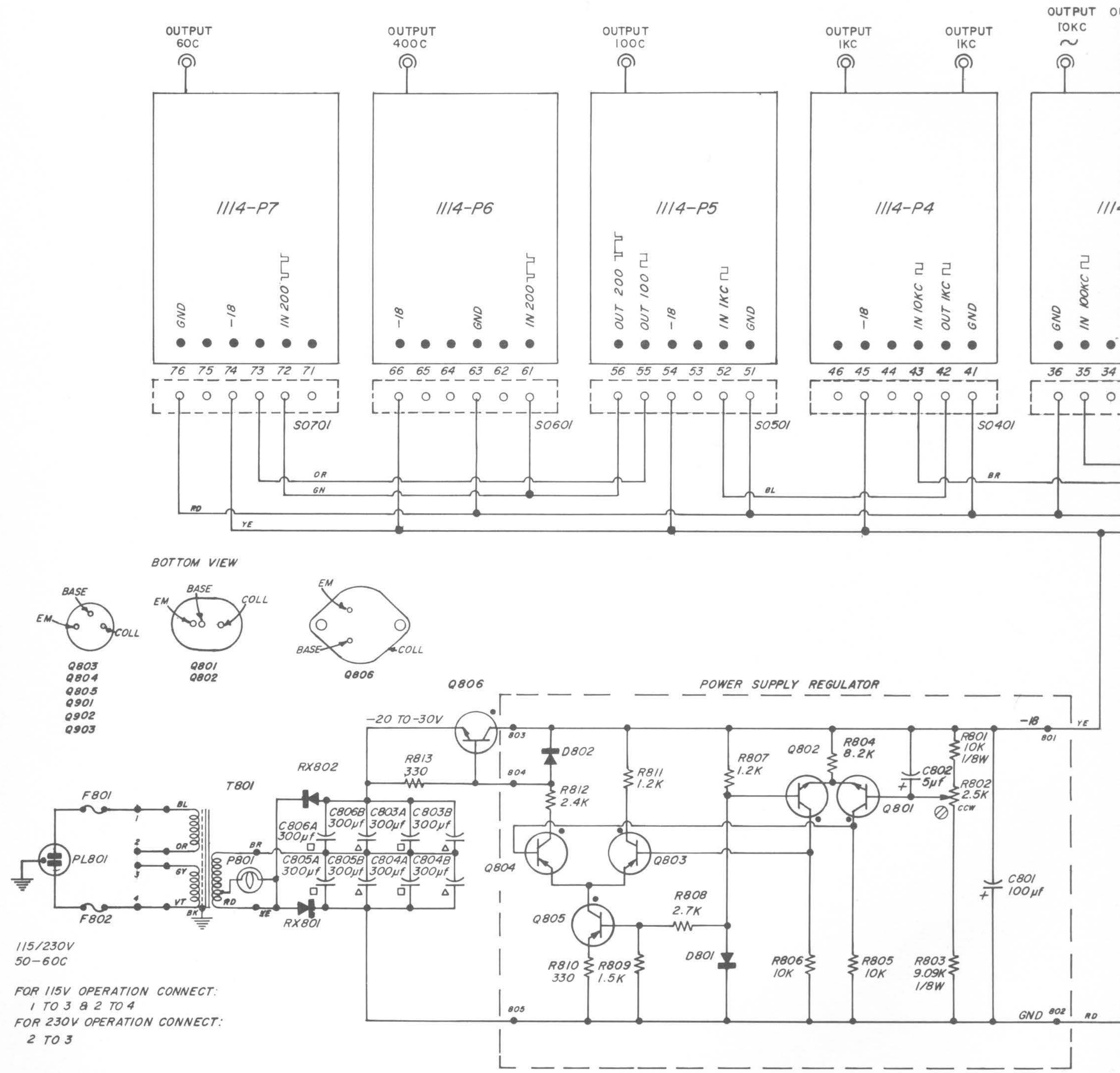

200
ONE SHOT
Q701
Q702
40
FLIP FLOP
Q703
Q704
20
FILTER
60 ~
AMPL.
Q705
Q706
OUTPUT
60C

PARTS LIST

TYPE 1114-A FREQUENCY DIVIDER

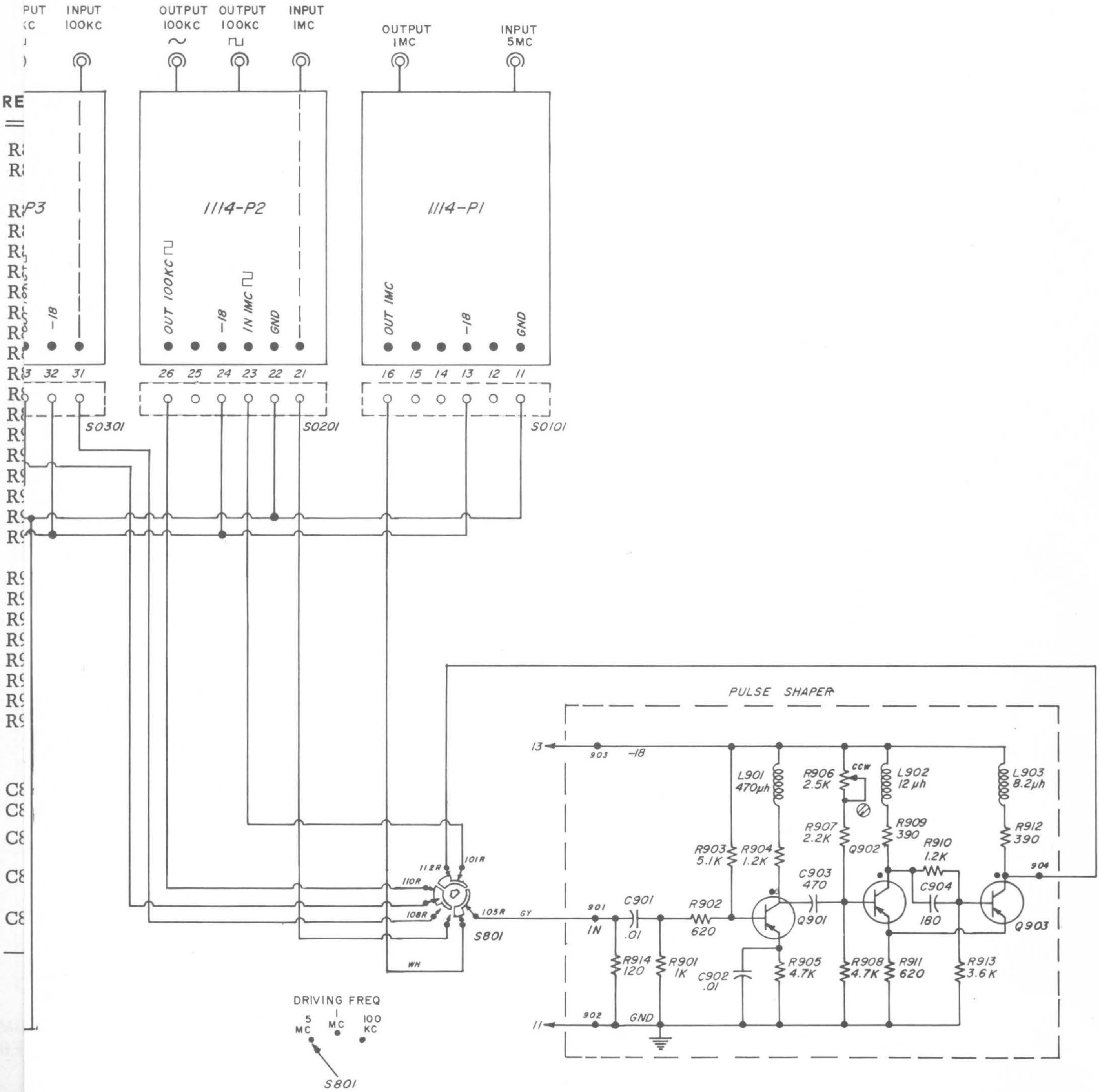
REF NO.	RESISTORS	PART NO.
R801	Film, 10kΩ ±1% 1/8w	6250-2100
R802	Potentiometer, Composition, 2.5kΩ ±20%	6040-0500
R803	Film, 9.09kΩ ±1% 1/8w	6250-1909
R804	Composition, 8.2kΩ ±5% 1/2w	6100-2825
R805	Composition, 10kΩ ±5% 1/2w	6100-3105
R806	Composition, 10kΩ ±5% 1/2w	6100-3105
R807	Composition, 1.2kΩ ±5% 1/2w	6100-2125
R808	Composition, 2.7kΩ ±5% 1/2w	6100-2275
R809	Composition, 1.5kΩ ±5% 1/2w	6100-2155
R810	Composition, 330Ω ±5% 1/2w	6100-1335
R811	Composition, 1.2kΩ ±5% 1/2w	6100-2125
R812	Composition, 2.4kΩ ±5% 1/2w	6100-2245
R813	Composition, 330Ω ±5% 1/2w	6100-1335
R901	Composition, 1kΩ ±5% 1/2w	6100-2105
R902	Composition, 680Ω ±5% 1/2w	6100-1685
R903	Composition, 5.1kΩ ±5% 1/2w	6100-2515
R904	Composition, 1.2kΩ ±5% 1/2w	6100-2125
R905	Composition, 4.7kΩ ±5% 1/2w	6100-2475
R906	Potentiometer, Composition, 2.5kΩ ±20%	6040-0500
R907	Composition, 2.2kΩ ±5% 1/2w	6100-2225
R908	Composition, 4.7kΩ ±5% 1/2w	6100-2475
R909	Composition, 390Ω ±5% 1/2w	6100-1395
R910	Composition, 1.2kΩ ±5% 1/2w	6100-2125
R911	Composition, 620Ω ±5% 1/2w	6100-1625
R912	Composition, 390Ω ±5% 1/2w	6100-1395
R913	Composition, 3.6kΩ ±5% 1/2w	6100-2365
R914	Composition, 120Ω ±5% 1/2w	6100-1125
	CAPACITORS	
C801	Electrolytic, 100µf 25dcwv	4450-2300
C802	Electrolytic, 5µf 50dcwv	4450-3900
C803	Electrolytic, 300µf 15dcwv Electrolytic, 300µf 15dcwv	4450-2400
C804	Electrolytic, 300µf 15dcwv Electrolytic, 300µf 15dcwv	4450-2400
C805	Electrolytic, 300µf 15dcwv Electrolytic, 300µf 15dcwv	4450-2400

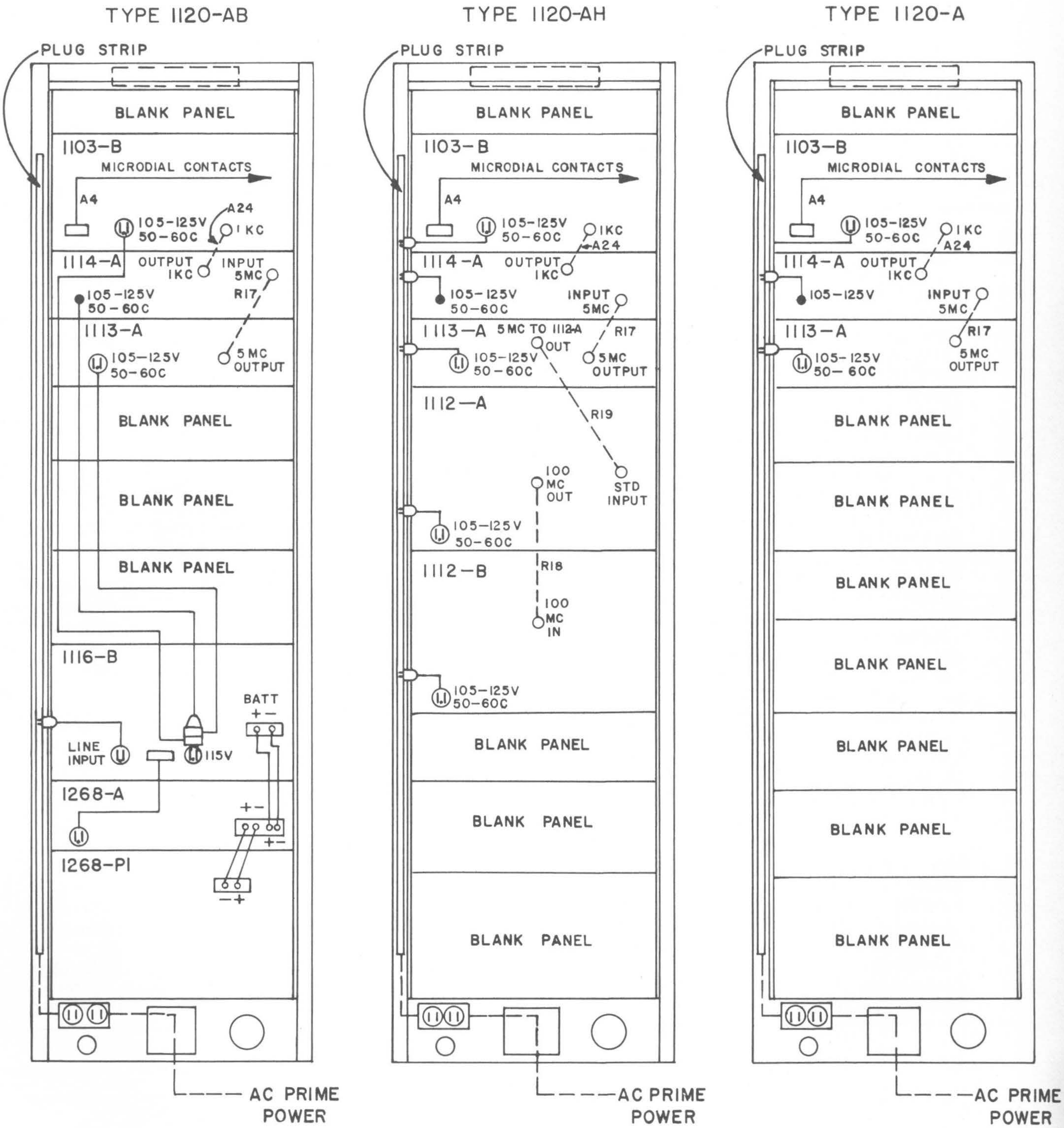
REF NO.	CAPACITORS	PART NO.
C806	Electrolytic, 300µf 15dcwv Electrolytic, 300µf 15dcwv	4450-2400
C901	Ceramic, 0.01µf +80-20% 50dcwv	4401-4100
C902	Ceramic, 0.01µf +80-20% 50dcwv	4401-4100
C903	Ceramic, 470pf ±20% 500dcwv	4404-1479
C904	Ceramic, 180pf ±10% 500dcwv	4404-1188
	MISCELLANEOUS	
D801	DIODE, Type SV129	6083-1010
D802	DIODE, Type 1N966	6083-1015
F801	FUSE for 115v: Slo-Blo, 1/10a for 230v: Slo-Blo, 1/16a	5330-0400 5330-0300
F802	FUSE for 115v: Slo-Blo, 1/10a for 230v: Slo-Blo, 1/16a	5330-0400 5330-0300
L901	CHOKE, Metal 470µh ±10%	4300-4890
L902	CHOKE, Metal 12µh ±10%	4300-2300
L903	CHOKE, Metal 8.2µh ±10%	4300-2100
P801	PILOT LIGHT, Mazda No. 44	5600-0700
Q801	TRANSISTOR, Type 2N169A	8210-1692
Q802	TRANSISTOR, Type 2N169A	8210-1692
Q803	TRANSISTOR, Type 2N1374	8210-1374
Q804	TRANSISTOR, Type 2N1374	8210-1374
Q805	TRANSISTOR, Type 2N1374	8210-1374
Q806	TRANSISTOR, Type 2N1218	8210-1218
Q901	TRANSISTOR, Type 2N582	8210-5820
Q902	TRANSISTOR, Type 2N711A	8210-7111
Q903	TRANSISTOR, Type 2N711A	8210-7111
RX801	RECTIFIER, Type 1N3253	6081-1001
RX802	RECTIFIER, Type 1N3253	6081-1001
S801	SWITCH, Rotary Wafer	7890-2090
T801	TRANSFORMER	0745-4200



OUTPUT 60C
OUTPUT 400C
OUTPUT 100C
OUTPUT 1KC
OUTPUT 1KC
OUTPUT 10KC
1114-P7
1114-P6
1114-P5
1114-P4
GND
-18
IN 200
OUT 200
OUT 100
IN 1KC
IN 10KC
OUT 1KC
IN 100KC
76 75 74 73 72 71
66 65 64 63 62 61
56 55 54 53 52 51
46 45 44 43 42 41
36 35 34
SO701
SO601
SO501
SO401
OR
GN
RD
YE
BL
BR
BOTTOM VIEW
BASE
EM
COLL
Q803
Q804
Q805
Q901
Q902
Q903
Q801
Q802
Q806
POWER SUPPLY REGULATOR
-20 TO -30V
R813 330
D802
R812 2.4K
R811 1.2K
R807 1.2K
R804 8.2K
C802 5µf
R801 10K 1/8W
R802 2.5K
CCW
C801 100µf
R808 2.7K
D801
R810 330
R809 1.5K
R806 10K
R805 10K
R803 9.09K 1/8W
-18
GND
F801
F802
PL801
T801
RX802
RX801
P801
C806A 300µf
C806B 300µf
C803A 300µf
C803B 300µf
C805A 300µf
C805B 300µf
C804A 300µf
C804B 300µf
115/230V
50-60C
FOR 115V OPERATION CONNECT:
1 TO 3 & 2 TO 4
FOR 230V OPERATION CONNECT:
2 TO 3

Schematic Diagram for Type 1114-A Frequency Divider





Interconnecting Wiring Diagrams for Type 1120 Frequency Standards.

TYPE 874 COAXIAL COMPONENTS

TYPE 874 CABLE CONNECTORS

APPLICABLE CABLE TYPES	CONNECTOR TYPE	CABLE	CABLE LOCKING	PANEL FLANGED	PANEL LOCKING	PANEL LOCKING RECESSED
	874-A2	-CA	-CLA	-PBA	-PLA	-PRLA
50-OHM	RG-8A/U RG-9B/U RG-10A/U RG-87A/U RG-116/U RG-156/U RG-165/U RG-166/U RG-213/U RG-214/U RG-215/U RG-225/U RG-227/U	-C8A	-CL8A	-PB8A	-PL8A	-PRL8A
NON-50-OHM	RG-11A/U RG-12A/U RG-13A/U RG-63B/U RG-79B/U RG-89/U RG-144/U RG-146/U RG-149/U RG-216/U					
50-OHM	874-A3 RG-29/U RG-55/U (Series) RG-58/U (Series) RG-141A/U RG-142A/U RG-159/U RG-223/U	-C58A	-CL58A	-PB58A	-PL58A	-PRL58A
NON-50-OHM	RG-59/U RG-62/U (Series) RG-71B/U RG-140/U RG-210/U	-C62A	-CL62A	-PB62A	-PL62A	-PRL62A
50-OHM	RG-174/U RG-188/U RG-316/U	-C174A	-CL174A	-PB174A	-PL174A	-PRL174A
NON 50-OHM	RG-161/U RG-187/U RG-179/U					

Example: For a locking cable connector for RG-8A/U, order Type 874-CL8A.

TYPE 874 ADAPTORS

TO TYPE		874–
BNC	plug	QBJA QBJL*
	jack	QBPA
C	plug	QCJA QCJL*
	jack	QCP
HN	plug	QHJA
	jack	QHPA
LC	plug	QLJA QLPA
LT	plug	QLTJ
	jack	QLTP
Microdot	plug	QMDJ QMDJL*
	jack	QMDP
N	plug	QNJA QNJL*
	jack	QNP
SC (Sandia)	plug	QSCJ QSCJL*
	jack	QSCP
TNC	plug	QTNJ QTNJL*
	jack	QTNP
UHF	plug	QUJ QUJL*
	jack	QUP
UHF 50-Ω Air Line	7/8-in.	QU1A
	1-5/8-in.	QU2
	3-1/8-in.	QU3A

*Locking Type 874 Connector.

Example: To connect Type 874 to a Type N jack, order Type 874-QNP.

CONNECTOR ASSEMBLY TOOLS

TYPE 874–	FUNCTION
TOK	Tool Kit
TO58	Crimping Tool
TO8	Crimping Tool

OTHER COAXIAL ELEMENTS

TYPE 874–		TYPE 874–	
A2	50 Ω cable (low loss)	LR	radiating line
A3	50 Ω cable	LTL	trombone constant-Z line
D20L, D50L	20-, 50-cm adjustable stubs	ML	component mount
EL, EL-L	90° ell	MB	coupling probe
F185L	185-Mc low-pass filter	MR, MRL	mixer-rectifier
F500L	500-Mc low-pass filter	R20A, R20LA	patch cord, double coax
F1000L	1000-Mc low-pass filter	R22A, R22LA	patch cord, double coax
F2000L	2000-Mc low-pass filter	R33	patch cord, single coax
F4000L	4000-Mc low-pass filter	R34	patch cord, single coax
G3, G3L		T, TL	tee
G6, G6L	3-, 6-, 10-, & 20-db attenuators	UBL	balun
G10, G10L		VCL	variable capacitor
G20, G20L		VI	voltmeter indicator
GAL	adjustable attenuator	VQ, VQL	voltmeter detector
H500L	isolator	VR, VRL	voltmeter rectifier
H1000L	isolator	W100	100-Ω termination
H2000L	isolator	W200	200-Ω termination
JR	rotary joint	W50, W50L	50-Ω termination
K, KL	coupling capacitor	WN, WN3	short-circuit terminations
L10, L10L		WO, WO3	open-circuit terminations
L20, L20L	10-, 20-, & 30-cm rigid air lines	X	insertion unit
L30, L30L		XL	series inductor
LAL	33-58 cm adjustable line	Y	cliplock
LK10L, LK20L	constant-Z adjustable lines	Z	stand

MISCELLANEOUS COAXIAL CONNECTORS

CONNECTOR TYPE	TYPE NO.	USED WITH
Basic	874-B	50-ohm Air Line
Basic Locking	874-BL	50-ohm Air Line
Panel Locking	874-PLT	Wire Lead
Panel Locking Recessed	874-PRLT	Wire Lead
Panel Locking Feedthrough	874-PFL	Type 874 Patch Cords

L suffix indicates locking Type 874 Connector.

FOR COMPLETE DETAILS, REFER TO THE GENERAL RADIO CATALOG.

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Printed in USA