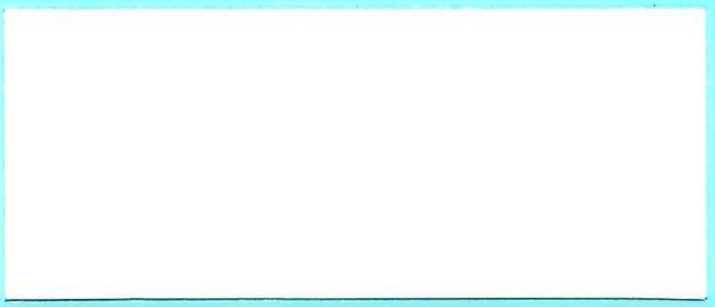

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CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period. No other warranty is expressed or implied. We are not liable for consequential damages.

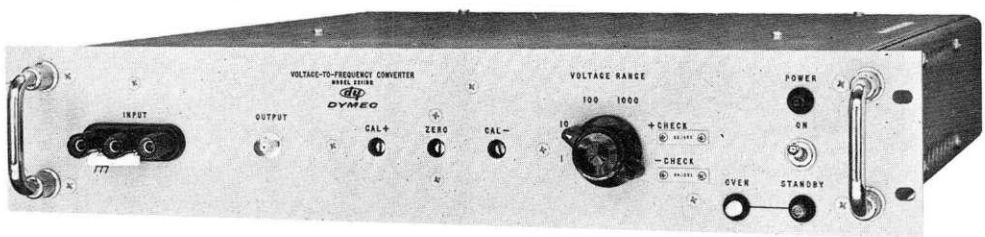
For any assistance contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

HANDBOOK

for

MODELS DY-2211A/B VOLTAGE-TO-FREQUENCY CONVERTERS

(Use For Serial Numbers Indicated On Page ii)



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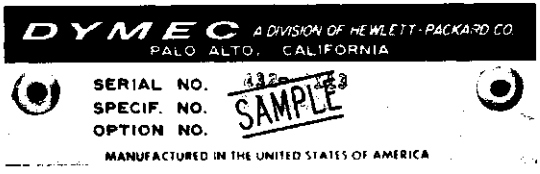
IMPORTANT

THIS HANDBOOK, Stock Number 02211-9002,
APPLIES TO INSTRUMENTS BEARING SERIAL PREFIX 323- **AND**
INCLUDES OPTIONAL MODIFICATIONS:
Within handbook: (none)

At rear of handbook: M2, M3, M4, M6, M7, M10, M17

INSTRUMENT IDENTIFICATION

Each instrument is identified by a two-section, 8-digit Serial Number, stamped on a plate attached to the rear panel (or a side panel).



The first 3 digits are a Serial Prefix (type) Number, the last 5 digits identify each individual instrument. ALL INSTRUMENTS WITH THE SAME SERIAL PREFIX ARE THE SAME. Later instruments (higher Serial Prefixes), are covered by a green "Updating Supplement", at the back of each handbook. Earlier instruments (lower Serial Prefixes), are covered by a blue "Backdating Supplement", also at the rear of the handbook.

Option No(s). identify Modifications made to the basic equipment to meet your particular requirements. Some Optional (standard) Modifications may be described within, or at the rear of the handbook as listed above.

MODIFICATION DESCRIPTIONS

Any special Modifications to the equipment described in this handbook are explained in "Handbook Supplements" added at the rear of this handbook.

READ through Section 2 of the basic handbook and all accompanying "Handbook Supplements" before attempting installation or operation of your equipment, as some special procedures may be necessary.

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SECTION 1
GENERAL DESCRIPTION

1.1 ELECTRICAL DESCRIPTION

The Models 2211A/B Voltage-to-Frequency Converters are highly accurate electronic transducers for automatically converting either positive or negative dc voltages to signals of precisely proportional frequencies.

The output frequency is directly proportional to the dc input voltage and, therefore, by connecting the output to an electronic counter a direct-reading digital display of the input voltage can be obtained. Also a permanent record of the voltage can be obtained by connecting the output of the counter to a compatible digital recorder.

The Model 2211A produces a full-scale output frequency of 10,000 cycles per second, while the Model 2211B produces a full-scale output of 100,000 cycles per second. The higher sensitivity of the 2211B provides a higher degree of resolution for high speed sampling, at the expense of a small loss of linearity. Zero input to the converters produces zero output, while 1 volt produces a full-scale output. The input impedance to both converters is 1 megohm. An optional attenuator provides additional input voltage ranges of 10 volts, 100 volts, and 1000 volts. The two converters feature high accuracy with the simplest type of operation. There is only one operating control. Short duration operational overloads do not damage the instrument or upset its calibration. Input voltage levels are accurately measured despite any accompanying noise and interference, since the input voltage is averaged over the period of the gate time of the indicating counter.

The converters provide internal positive and negative reference voltages for checking the sensitivity of the instruments to within 0.1% accuracy. The reference voltages are derived from temperature controlled silicon Zener diodes, and can be applied to the input of the instruments by means of a front-panel switch.

1.2 PHYSICAL DESCRIPTION

The converters are constructed for rack mounting and enclosed with screen covers for protection. The units are compact, self cooling, and especially suited to systems use. The front panel is normally finished in non-reflecting light grey baked enamel with black-filled engraved control titles.

1.3 SPECIFICATIONS

INPUT (FLOATING):

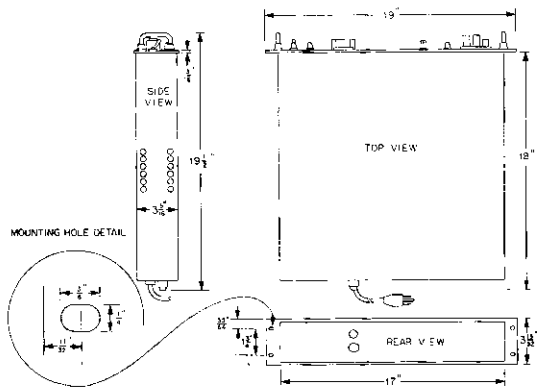
Voltage Range:	0 to 1 vdc. Other ranges on special order. See also Option M6.
Polarity:	Sensitive to positive and negative inputs.
Impedance:	1 megohm shunted by 200 pf.
Connector:	Binding posts (3/4-inch centers).

OUTPUT:

Frequency:	2211A 0 to 10,000 cps 2211B 0 to 100,000 cps (Output of 2211A and B responds to input overload of 20%.)
Accuracy:	Stability (at constant line voltage and temperature) ±.02% of full scale per day. Line voltage effect: less than ±.006% of full scale for ±10% line voltage change. Linearity (referred to straight line through zero and full scale calibration points): DY-2211A: ±.005% of full scale DY-2211B: ±.02% of full scale Temperature coefficient: ± 001% of reading and ±.0005% of full scale per °C (10 to 50°C).

SPECIFICATIONS (Cont'd)

Output Waveform:	Transformer coupled from blocking oscillator. Five volt positive-going pulse, approximately 0.1 microsecond rise time, 2.5 microsecond duration, followed by a negative spike which decays exponentially.
Output Impedance:	Positive pulse virtually unaffected from no load to 500 ohm load. Negative spike decreases from 10v at no load to 4v at 500 ohm load. Load impedances less than 500 ohms progressively deteriorate the output waveform.
Connector:	BNC
SELF-CHECK:	Against internal zener diodes (0.1% accuracy).
POWER REQUIREMENTS:	115/230v ±10%, 60 cps, 120 watts
DIMENSIONS:	



WEIGHT:	Net wt. 26 lbs, shipping wt. 40 lbs approx.
ACCESSORIES SUPPLIED:	Coaxial output cable, BNC-terminated both ends, 4 feet long (part no. 5060-2504).

OPTIONS:

M2. Input Polarity Indication

Two neon indicators are provided on the front panel, indicating positive and negative polarity of input, respectively. In addition, a single-pole double-throw relay contact closure is brought out to a rear MS3102A-10SL-3P connector.

M3. Parallel Rear Connectors

An INPUT connector type XLR-3-32-A95 and an OUTPUT BNC are mounted on the rear panel; these are wired in parallel with the respective front panel connectors. The mating input connector type XLR-3-11C-A95 is also supplied.

M4. Separate Outputs

Two OUTPUT BNC connectors are provided on the rear panel, supplying separate outputs for positive and negative inputs. The standard combined pulse output at the front panel BNC is retained.

M6. Input Attenuator (1 to 1000v)

Input ranges 1, 10, 100, 1000v full scale. Max. division error at 25°C, ±.03%. Max. temperature coefficient, ±.001% per °C.

M7. Rack-Mounting Slides

Instrument is fitted with slides, Chassis-Trak C-300-S-20, permitting easy withdrawal from rack.

M10. Input Attenuator (0.1 to 100v)

Input attenuator provides ranges of 0.1, 1, 10, and 100v full scale.

M17. 0.1 Volt Input Range

Full scale input is 0.1v instead of 1v.

SECTION 2
INSTALLATION AND OPERATING PROCEDURE

2.1 INSTALLATION

The instrument mounts in a standard 19-inch wide rack. The instrument has an internal power supply that is wired at the factory for 115-volt, 50-60 cycle operation, by may be converted for 230-volt operation by rewiring the primary windings of the two power transformers as shown on the schematic diagram of the power supply.

2.2 CONTROLS, TERMINALS, AND INDICATORS

Power (Toggle switch): When in STANDBY position and with the power cord connected, heater power is supplied to the temperature control oven to maintain certain circuits of the instrument at 65°C. When in ON position, line power is supplied to the primary windings of power transformer, T1, which allows the electrical circuits to operate after a short time delay.

Indicator lamps:

Amber: Indicates when the power cord is connected and power switch is in the STANDBY position.

White: Cycles on and off as heat is alternatively applied and removed from the temperature control oven.

Red: Indicates when power switch is in ON position.

Voltage Range Selector (Rotary switch): Selects input voltages to be applied to the converter. Two types are available.

Without attenuator: (standard) Has three positions. One position accepts positive or negative dc input voltages from 0 to 1 volt. Two additional positions, +CHECK and -CHECK, connect internal reference voltages to the input for self-check purposes.

With Option M6 attenuator: (Option M10 attenuator ranges are 0.1, 1, 10, 100v)	Has six positions. Four positions, 1v, 10v, 100v, and 1000v, select positive or negative dc input voltage ranges of 0 to 1, 0 to 10, 0 to 100, and 0 to 1000 volts. Two additional positions, +CHECK and -CHECK, connect internal reference voltages through the 10v range to the input for self-check purposes.

Input (binding post connectors): Receives dc input voltages to be measured. Input may be floated or grounded to chassis.

Output (BNC connector): Provides means for connecting an external instrument to the converter for monitoring the output frequency.

Zero (potentiometer): Screwdriver-adjusted potentiometer, accessible through the front panel, is used to equalize the instrument's ±response.

±Cal (Two screwdriver-adjusted potentiometers): Two potentiometers, accessible through the front panel, are used to calibrate the instrument.

2.3 OPERATING PROCEDURE

To operate the Voltage-to-Frequency Converter proceed as follows:

1) Turn the instrument on and allow to warm up. Readings may be taken after a three-minute warm-up; however, for best accuracy, allow the instrument to warm up for at least 30 minutes. If the instrument was previously in the STANDBY position only a short warm-up period is necessary.

   CAUTION: If the white light, indicating oven heating, should fail to go off after the instrument has reached operating temperature, turn off the instrument. Check the mercury thermostat to see if it is operating properly, as the circuits in the oven can be damaged by too much heat.

2) Connect an electronic counter or other frequency measuring device to the output connector of the converter.

3) Connect the dc voltage to be measured to the input of the converter.

   Note: The converter may be floated at up to 200 volts peak above chassis ground by connecting the input voltage to the red and black input terminals and leaving the chassis ground terminal disconnected. To reference the converter to chassis ground, the black input terminal should be connected to the chassis ground terminal.

Overload input voltages tend to saturate the chopper-stabilized amplifier and make the instrument free-run. However, with the exception of the 1000v range on the 2211A/B with the optional attenuator, input voltages up to approximately 1.2 times the full-scale range switch setting can still be measured to full specified accuracy. Also, except on the 1000v range, brief input voltage overloads up to 10 times the full-scale range switch setting cause no damage or permanent shift in calibration. However, for several seconds after correcting a highly overloaded condition, the amplifier will remain saturated and the instrument will be locked-out, generating an output frequency above the rated full-scale frequency.

2.4 CHECKING CALIBRATION

The +CHECK and -CHECK positions of the front panel selector switch permit easy checking of the instrument's sensitivity against internal zener diode reference voltages.

Calibration of the 2211A/B consists of establishing zero output cycles for zero input volts, and establishing full-scale output (10,000 cps for 2211A, and 100,000 cps for 2211B) for a full scale input of one volt, separately, for each polarity. Check the calibration of the 2211A/B periodically with an electronic counter having a crystal-controlled time base, and if necessary, make calibration adjustments as described below:

1) Zero output for zero input: This adjustment is made with the ZERO potentiometer which equalizes the converter's positive and negative response. To make this adjustment switch the Voltage Range switch to an external input position, short out the input terminals, and adjust the ZERO potentiometer for zero output frequency.

2) Full-scale output for full-scale input: This adjustment is accomplished with the four CAL potentiometers, and establishes the full-scale output for both polarities of dc input. To make this adjustment, proceed as follows after the instrument has been turned on for at least one hour.

    1. Mechanically center the two front-panel CAL potentiometers.

    2. Apply +1 vdc, having an accuracy of 0.01% or better, to the input of the converter.

    3. Adjust the internal +CAL potentiometer for a full-scale output frequency (10,000 cps for 2211A; 100,000 cps for 2211B).

    4. Repeat steps 2 and 3 for -1 vdc input, and adjust the internal -CAL potentiometer for a full-scale output.

Note: The two front-panel potentiometers, CAL+ and CAL-, provide fine adjustments for calibrating.

2.5 TRANSIENT RESPONSE

The Voltage-to-Frequency Converter follows changes of input level virtually instantaneously; the output will be at the proper new frequency within a single period of that frequency. The delay varies from a few milliseconds for signals near zero input level to a fraction of a millisecond for inputs near full scale. However, a small delay may be introduced if the signal crosses through zero, or starts from zero. When crossing through zero, the maximum response time for the 2211A and 2211B is about 10^{-3} volt-seconds and 10^{-4} volt-seconds respectively. That is, in the case of the 2211A the response to a step function of 1 volt may be delayed up to 1 millisecond; at a level of 0.01 volt, it may be delayed 100 milliseconds before a steady state is reached. Another way of stating this is that a maximum possible loss of 10 counts can occur on passing through, or starting from, zero. In cases where maximum speed of response is needed, a small polarizing voltage should be applied to the input. The polarizing voltage should be applied in the same direction as the input signal and should be of sufficient magnitude to provide 2 or 3 counts every 10 seconds. The polarizing voltage can be supplied by offsetting the ZERO control, providing a check is made to see that the polarity is correct (i.e., by inserting a small input voltage and seeing if the count increases).

SECTION 3
DETAILED DESCRIPTION AND THEORY OF OPERATION

3.1 GENERAL

The 2211A/B contains a Voltage Range switch on the front panel for selecting either an external dc voltage or the internal dc reference voltage to be applied to the input circuits of the instrument.

The dc input voltage is applied to the Voltage-to-Frequency Converter, which internally generates a train of standard pulses with a frequency proportional to the input voltage. When the input voltage is zero, no pulses are generated. When a voltage other than zero is applied to the input, it is integrated such that a linear voltage is generated with a slope proportional to the input voltage. When the linear voltage reaches a fixed trigger level, a pulse of precise voltage-time characteristics and polarity opposite to that of the input is generated and applied back at the input (see figure 3-1). This pulse is used to restore the linear voltage to a balanced level below that at which the pulse was generated. At the end of the restoring pulse the linear voltage again returns to the trigger level and another restoring pulse is generated. This process continues with restoring pulses being generated at a rate proportional to the slope of the integrated input voltage. Output pulses are generated simultaneously with the restoring pulses and are transformer coupled to a front-panel output connector to be monitored by a frequency measuring device.

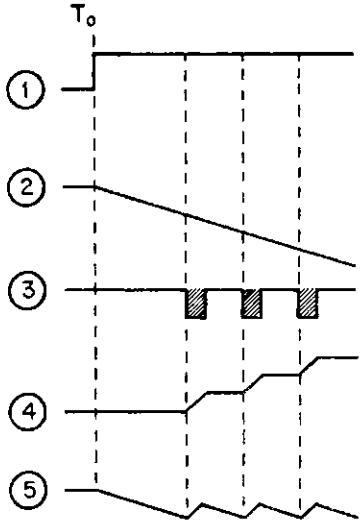
3.2 DETAILED DESCRIPTION

3.2.1 Converter Section

A dc input voltage is applied through a 1 megohm input impedance to an inverting chopper-stabilized amplifier with an external feedback capacitor. The inherent gain of this amplifier is so high that the feedback loop alone determines its operation. The feedback capacitor, together with a series input resistance, causes the dc input voltage to be integrated with respect to time.

To understand the operation of the integrating amplifier circuit, consider the case where a positive dc voltage is applied to the input of the converter. This causes current to flow through the input series resistance and raise the dc voltage level at the input of the amplifier. This lowers the voltage at the amplifier output. The change in the output voltage causes current to flow through a feedback capacitor around the amplifier and oppose the change in voltage at the input. This current charges the capacitor, building up a voltage across it. Since the gain of the amplifier is extremely high, a very small change in the input voltage causes a very large change in the output current. Therefore,

INTEGRATOR WAVEFORMS



1. + D.C. INPUT VOLTAGE.
2. INTEGRATED INPUT VOLTAGE.
3. BALANCING VOLTAGE-TIME PULSES.
4. INTEGRATED VOLTAGE-TIME PULSES.
5. INTEGRATED COMBINATION OF +D.C. INPUT AND BALANCING VOLTAGE-TIME PULSES.

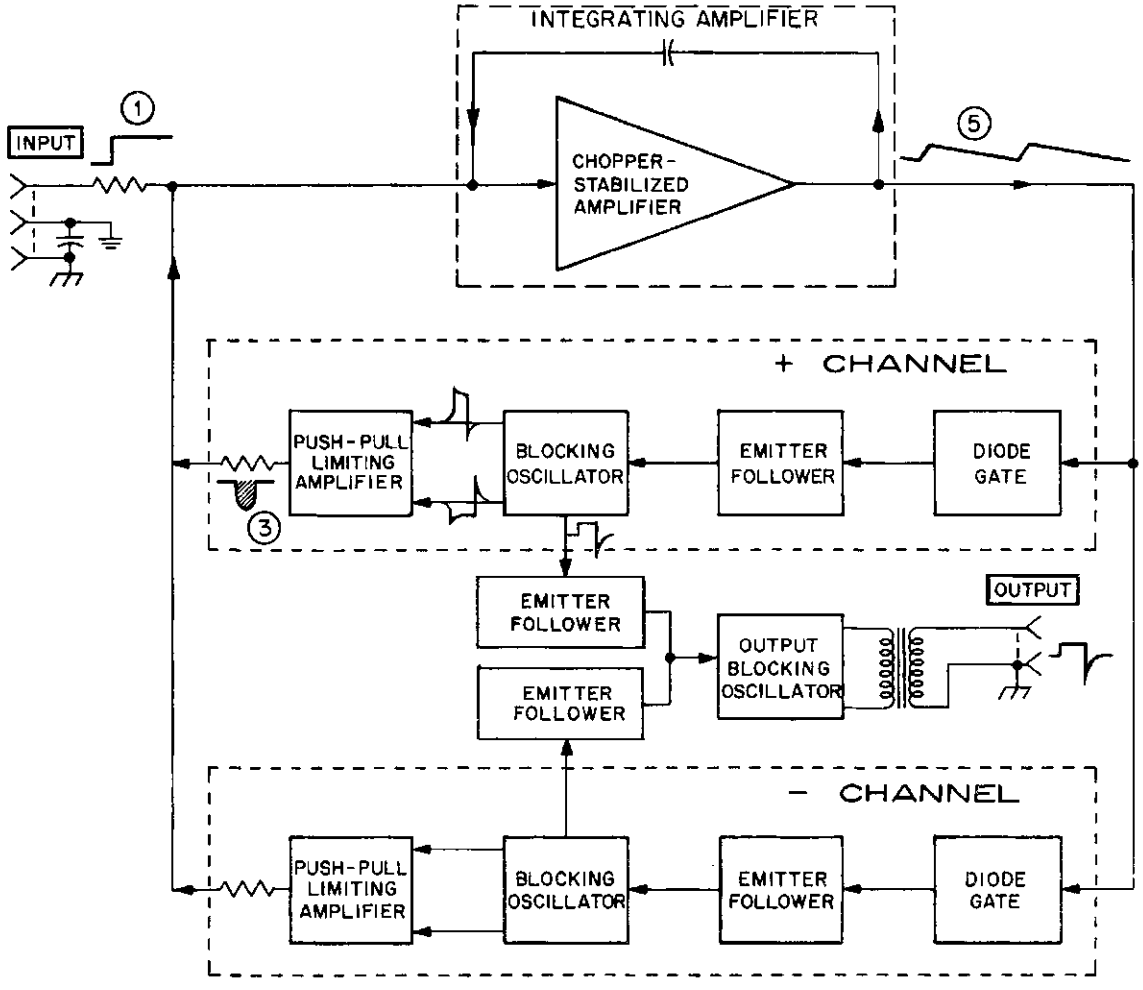
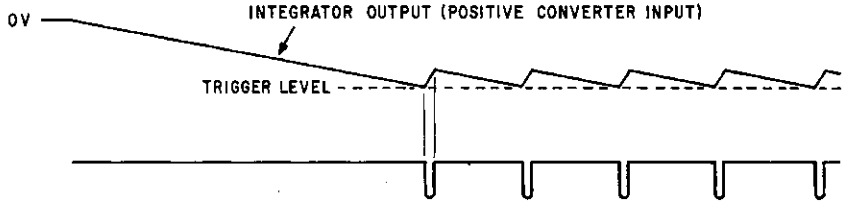


FIGURE 3-1

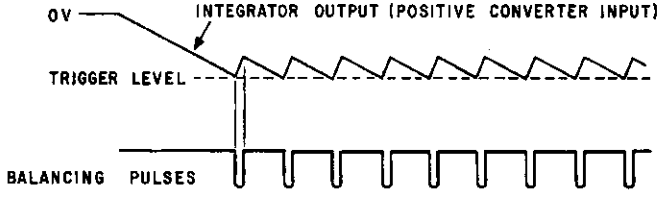
FUNCTIONAL BLOCK DIAGRAM OF VOLTAGE-TO-FREQUENCY CONVERTER

the voltage at the input stays very near ground potential. The current through the capacitor is directly proportional to the voltage applied to the input to the integrating amplifier circuit, and the voltage developed across the capacitor (and amplifier output) is directly proportional to the charge on the capacitor. Since the charge on the capacitor is the integral of the current with respect to time, the voltage at the output of the amplifier is directly proportional to the integral of the input voltage.

There are two transistorized pulse generators in the converter, A5 for positive and A6 for negative inputs, that are triggered by the integrated voltage from the chopper-stabilized amplifier. A5 pulse generator is triggered by a negative going voltage, while A6 is triggered by a positive going voltage. Similarly, the two pulse generators provide balancing pulses of opposite polarities for the converter input circuit. Each consists of a diode gate, an emitter follower, a blocking oscillator, and a push-pull limiting amplifier that drives a saturable core transformer. For convenience, the following description refers to the triggered pulse generator that operates when a positive voltage is applied to the converter input.



(a) OUTPUT PULSE RATE FOR CONVERTER INPUT OF E VOLTS



(b) OUTPUT PULSE RATE FOR CONVERTER INPUT OF (3XE) VOLTS

FIGURE 3.2
TRIGGERING OF BALANCING PULSES

When a positive voltage is applied to the input, the output voltage of the chopper-stabilized amplifier decreases at a linear rate until a definite trigger level is reached, as determined by the biasing network of emitter follower, A5Q2. At this point A5Q2 conducts and the blocking oscillator fires, producing a pulse which is used to drive the push-pull limiting amplifier and is also coupled through emitter follower, A5Q3, to the output blocking oscillator. The output blocking oscillator fires and a pulse is coupled to the output connector.

The push-pull limiting amplifier has a saturable core transformer which first saturates in one direction and then the other, when the blocking oscillator fires. The output of the limiting amplifier consists of pulses with a uniform voltage-time integral rectified to have a polarity opposite to that of the voltage applied to the input of the converter. That is, the positive pulse generator produces negative output pulses; the negative pulse generator channel produces positive output pulses. These pulses are used to return the integrated output of the chopper-stabilized amplifier to a level below that at which a pulse is generated.

It should be noted that the accuracy of the 2211A/B does not depend on the level at which the blocking oscillator is triggered, but only on the voltage-time integral of the standard pulses from the limiting amplifier.

3.2.2 Power Supply

The voltage-to-Frequency Converter contains two highly regulated dc power supplies and one unregulated power supply. One regulated power supply provides +10 and -10 vdc to power the transistorized circuits in the converter. The +10 vdc output is also used to operate the other regulated supply of +150 and -150 vdc, which provides high voltage power for the chopper-stabilized amplifier. The 150 vdc power supply has a free-running multivibrator operating at about 10,000 cps in the primary circuit of its saturable core power transformer. By means of the proper turns ratio on the transformer the multivibrator oscillations are stepped up, so that after being rectified, the output is 150 vdc.

The unregulated power supply provides about 30 vdc to the temperature control oven in the converter. A constant temperature of 65°C is maintained in the oven by thermostat S1.

When the power switch is turned on, the 10 vdc power supply immediately operates to supply power for the transistorized circuits in the converter, and filament power of 10 vdc and 6.3 vac for tubes V1, V2, and V3, V4 respectively, in the chopper-stabilized amplifier. However, the 150 vdc power supply does not go into operation until a 60-second thermal time delay switch is closed. When the time delay switch is closed, relay K1 becomes energized, which removes the bias from the transistors in the 150 vdc power supply multivibrator, and allows the multivibrator to function.

SECTION 4
MAINTENANCE

4.1 INTRODUCTION

This section describes how to maintain the 2211A/B Voltage-to-Frequency Converters. The material in this section is as follows:

4.2 PRECAUTIONS

The high standards of performance of which the Voltage-to-Frequency Converters are capable depend on the accuracy, and the voltage and temperature stabilities of their electrical parts. Careful handling while servicing will maintain this performance. If the instrument should fail, determine the cause of the failure before replacing parts. When replacing parts, use exact duplicates. Do not overheat parts when soldering.

When testing the converter while it is turned on, be careful to avoid momentary shorts within the instrument. Transistors and diodes can be damaged instantly by short-circuit currents.

The converter uses a number of deposited film resistors. Be careful not to scratch the surface of these resistors, as this will affect their accuracy.

The two saturable core transformers in sections A3 of the converter are inside Mu-metal shields. Physical shock may change the magnetic properties of these shields.

4.3 TUBE REPLACEMENT

The tubes in the Voltage-to-Frequency Converter are RETMA types and require no special selection. After changing a tube, check the calibration as described in Section 2; check again after the first 24 hours of operation.

4.4 SEMICONDUCTOR REPLACEMENT

Under normal conditions transistors and diodes can last indefinitely unless damaged. If one fails, replace it with one of the same type. Use the least possible heat when soldering to the transistors and diodes, and allow them to cool before turning the instrument on.

After replacing a transistor or diode, check the calibration as described in Section 2; check again after 24 hours of operation.

4.5 TROUBLE SHOOTING

By making use of the material in this section in conjunction with the schematic diagrams, and waveform and voltage charts provided, the location of most malfunctions occurring in the 2211A/B will be greatly simplified.

For most malfunctions occurring in the Voltage-to-Frequency Converter a visual check and power supply voltage check should be made before doing any other trouble shooting in the instrument.

In making a visual check of the instrument, look for cold tubes, signs of overheating, mechanical damage, and so forth. Observe the precautions described in Para 4.2. If the chopper is operating, a slight vibration can be felt on top of its case.

WARNING: 115 vac is present at several locations in the instrument when the power cord is in an active outlet. To be safe, unplug the power cord when working inside the instrument.

Normal power supply voltages are listed below:

SUPPLY	VOLTAGE AT 115 VAC LINE	RIPPLE	REGULATION 102 - 128v
+10 vdc nom.	+10 ±0.5v	20 mv rms	10 mv
-10 vdc nom.	-10 ±0.5v	10 mv rms	10 mv
+150 vdc nom.	+150 ±3v	30 mv rms	30 mv
-150 vdc nom.	-150 ±3v	30 mv rms	30 mv

The +150v supply and the -150v supply should be within 1-1/2v of each other.

4.5.1 Power Supply Troubles

Symptom	Possible Cause
Poor regulation of ±10v supply	1. Q1, 3, 5, 6, damage due to a momentary short of the power supply output. 2. Absence of -150v in 10v supply.
No ±150v output	1. Failure of the ±150v multivibrator indicated by Q10, 11, heating-up and by a voltage drop in the +10v supply. 2. No +10v output. 3. Malfunction of K2 time delay relay.
Oven lamp fails to cycle on and off	1. DS3 lamp failure. 2. Oven thermostat failure (DS3 should begin to cycle on and off after 30 minutes).

4.5.2 Converter Troubles

The malfunctions most likely to occur in the converter result in an abnormally high output frequency indication, or no output at all. These two conditions are charted below:

Symptom	Range Switch Position	Possible Cause
High Output High Output	+ CHECK - CHECK	1. If output is normal after a few seconds in a CHECK position, the external input voltage overloaded the converter.
High output High output	+ CHECK - CHECK	1. Chopper Amplifier, check for faulty tubes by substitution.
High output Normal output	+ CHECK - CHECK	1. Check + Channel (A5)
High output Normal output	- CHECK + CHECK	1. Check - Channel (A6)
No output No output	+ CHECK - CHECK	1. Output blocking oscillator 2. Check that external counter is operating properly.
No output Normal output	+ CHECK - CHECK	1. A5Q1 (If A5Q1 is faulty check A5CR1, 2, before replacing).
Normal output No output	+ CHECK - CHECK	1. A6Q1 (If A6Q1 is faulty check A6CR1, 2, before replacing).

After malfunctions in the instrument have been corrected, check the power supply voltages with the oven at operating temperature (65°C).

With the Voltage Range switch in one of the external input positions, and the input terminals shorted, adjust the ZERO potentiometer for zero output at pin 6 of the chopper-stabilized amplifier. Observe the output frequency indications with the Voltage Range switch in the +CHECK and -CHECK positions. If these indications do not correspond with the calibration tags on the front panel for these positions, then the instrument should be recalibrated using a source voltage with 0.01% accuracy. The covers should be installed and the instruments allowed to heat-run for 24 hours before recalibrating.

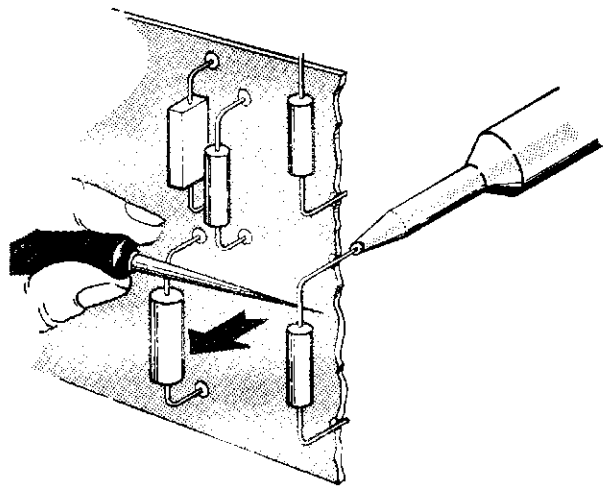
Note: If one of the Zener diodes in the ±10 vdc power supply is changed, a new calibration tag for the front panel must be made. If K1, V3, or V4 in the chopper-amplifier have been replaced follow the procedure in 4.5.3.

4.5.3 AC Filament Hum Adjustment

1. Switch the VOLTAGE RANGE selector to one of its external input positions.
2. Short the input terminal.
3. Connect an oscilloscope to the output terminal of the chopper-stabilized amplifier (pin 6 of A2).
4. Adjust the hum potentiometer (R45) for minimum 50-60-cycle ripple as observed on the oscilloscope.

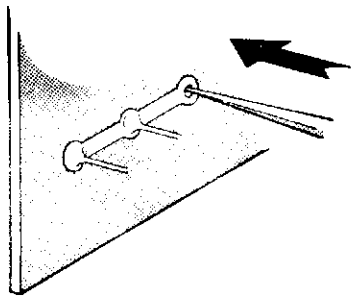
4.5 SERVICING ETCHED CIRCUIT BOARDS

The bond between etched wires and mounting board last indefinitely under normal instrument use. The bond can be broken by excessive heat or pressure. Follow these instructions carefully.



1. Apply heat sparingly to lead of part, not to etched wiring. Use 50-watt iron or smaller; solder quickly.

3. Shape leads of part so they fit easily through mounting holes. Tin leads so further fluxing will not be required.



2. Clean mounting holes by quickly melting solder and inserting awl in direction shown.

4. Being careful not to raise etched wiring from board, insert new part and hold firmly against board. Apply heat to lead of part, solder to junction. If necessary, use rosin flux only; do not use soldering paste. Cut off surplus wire leads. Coat with insulating varnish.

Some components are mounted by soldering their leads in eyelets which are in turn soldered in place on the board. Replace components mounted in this manner by unsoldering and resoldering the leads in the eyelets without disturbing the solder connection between the eyelet and the etched circuit. If necessary resolder this connection.

Additional holes can be drilled with a number 55 (0.052 inch; 1.3 millimeter) drill bit in a high speed electric drill. Start drill on the etched-wire side of the board.

If an etched wire is accidentally partially raised up off of the circuit boards, cement it down with a quick drying acetate-base cement. This cement must have good electrical insulating qualities.

A broken or burned out section of an etched wire can be repaired or replaced by soldering a length of solid copper wire over the damaged section. If possible, overlap approximately 1/2 inch. Use pretinned wire that has a diameter less than the width of the etched wire.

To remove a tube socket or other components attached to the board by more than two wires (such as potentiometers, pulse transformers, etc.) clip the leads between the component and the board and then unsolder the portions of the leads which remain attached to the board. Clean the mounting holes as shown in Fig. 2.

D.C. VOLTAGE CHART

TRANSISTOR	LOCATION	D.C. VOLTS	NOTES
Q1	EMITTER BASE COLLECTOR	-10.3 -10.5 -16.5*	* nominal; 14.2 vdc low line, to 19.3 vdc high line.
Q2	EMITTER BASE COLLECTOR	- 6.0* - 6.2* -10.5	* for 6.2 volt Zener diode; can vary ±0.3 volt depending on particular Zener used.
Q3	EMITTER BASE COLLECTOR	- 0.3 - 0.5 - 5.6*	* nominal; -3.0 vdc low line, to 7.8 vdc high line.
Q4	EMITTER BASE COLLECTOR	+ 6.4* + 6.2* - 0.5	* for 6.2 volt Zener diode; can vary ±0.3 volt depending on particular Zener used.
Q5	EMITTER BASE COLLECTOR	-10.0 -10.3 -16.5*	* nominal; 14.2 vdc low line, to 19.3 vdc high line.
Q6	EMITTER BASE COLLECTOR	0 - 0.3 - 5.6*	* nominal; -3.0 vdc low line, to 7.8 vdc high line.
Q7	EMITTER BASE COLLECTOR	+ 6.4* + 6.2* 0	* for 6.2 volt Zener diode; can vary ±0.3 volt depending on particular Zener used.
Q8	EMITTER BASE COLLECTOR	- 6.0* - 6.2* -10.0	* for 6.2 volt Zener diode; can vary ±0.3 volt depending on particular Zener used.

Circuit Condition: Power switch ON and thermal time delay relay energized.

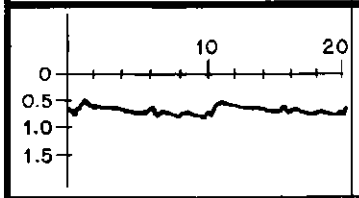
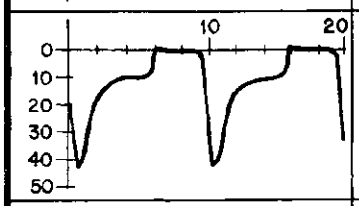
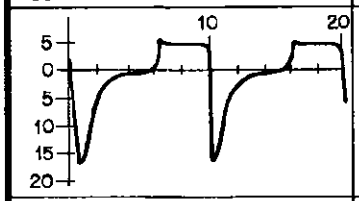
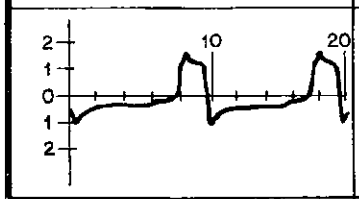
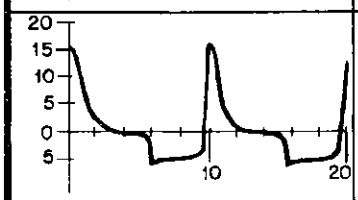
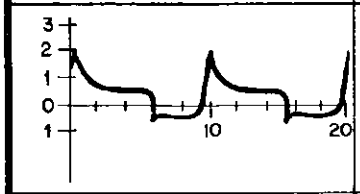
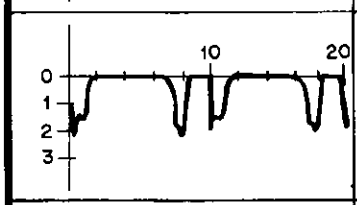
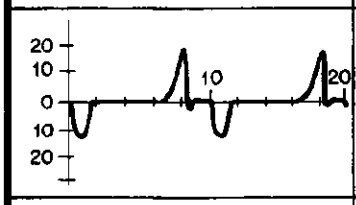
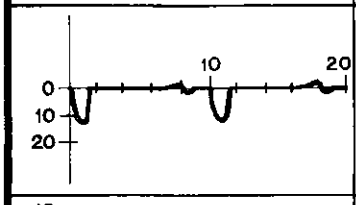
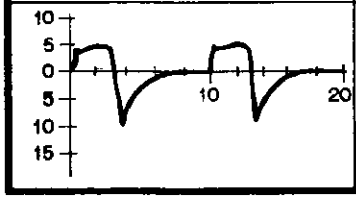
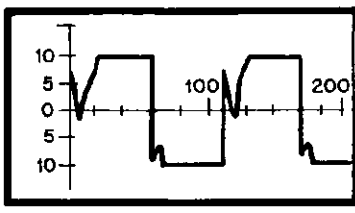
OVEN POWER SUPPLY CIRCUIT POSITION	S1 OPEN		S1 CLOSED	
	Low Line	High Line	Low Line	High Line
Junction R24 and R25	-2.16	-1.68	-0.30	-0.23
Junction R25 and R26	-0.27	-0.21	-0.048	-0.037
Junction R21 and R28	-6.5	-5.0	-0.425	-0.4
Collector of Q12	-2.4	-1.8	-34.0	-26.0
Collector of Q9	-2.5	-2.0	- 0.138	- 0.125

Figure 4-1

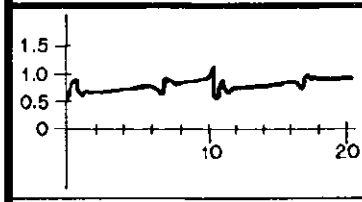
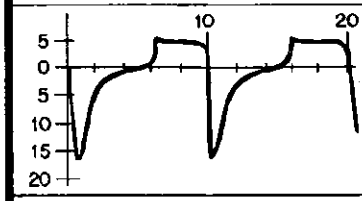
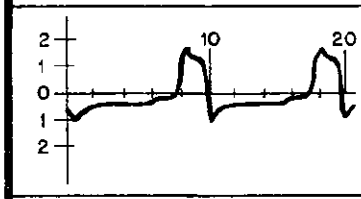
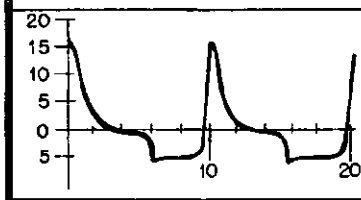
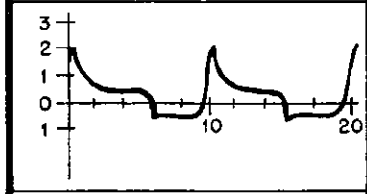
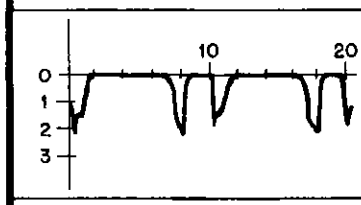
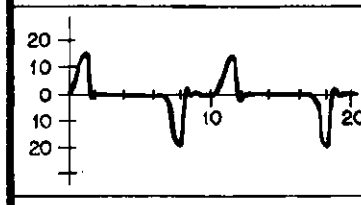
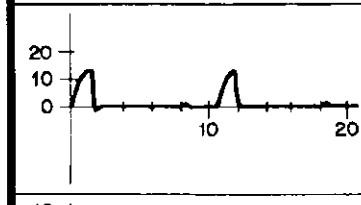
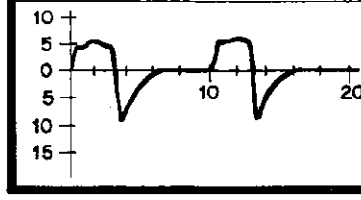
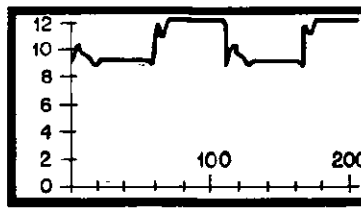
2211B* WAVEFORMS FOR TROUBLESHOOTING

* 2211A WAVEFORMS SIMILAR, BUT WITH TIME BASE EXPANDED 10 TIMES. POWER SUPPLY WAVEFORMS REMAIN THE SAME.

+1 VDC INPUT

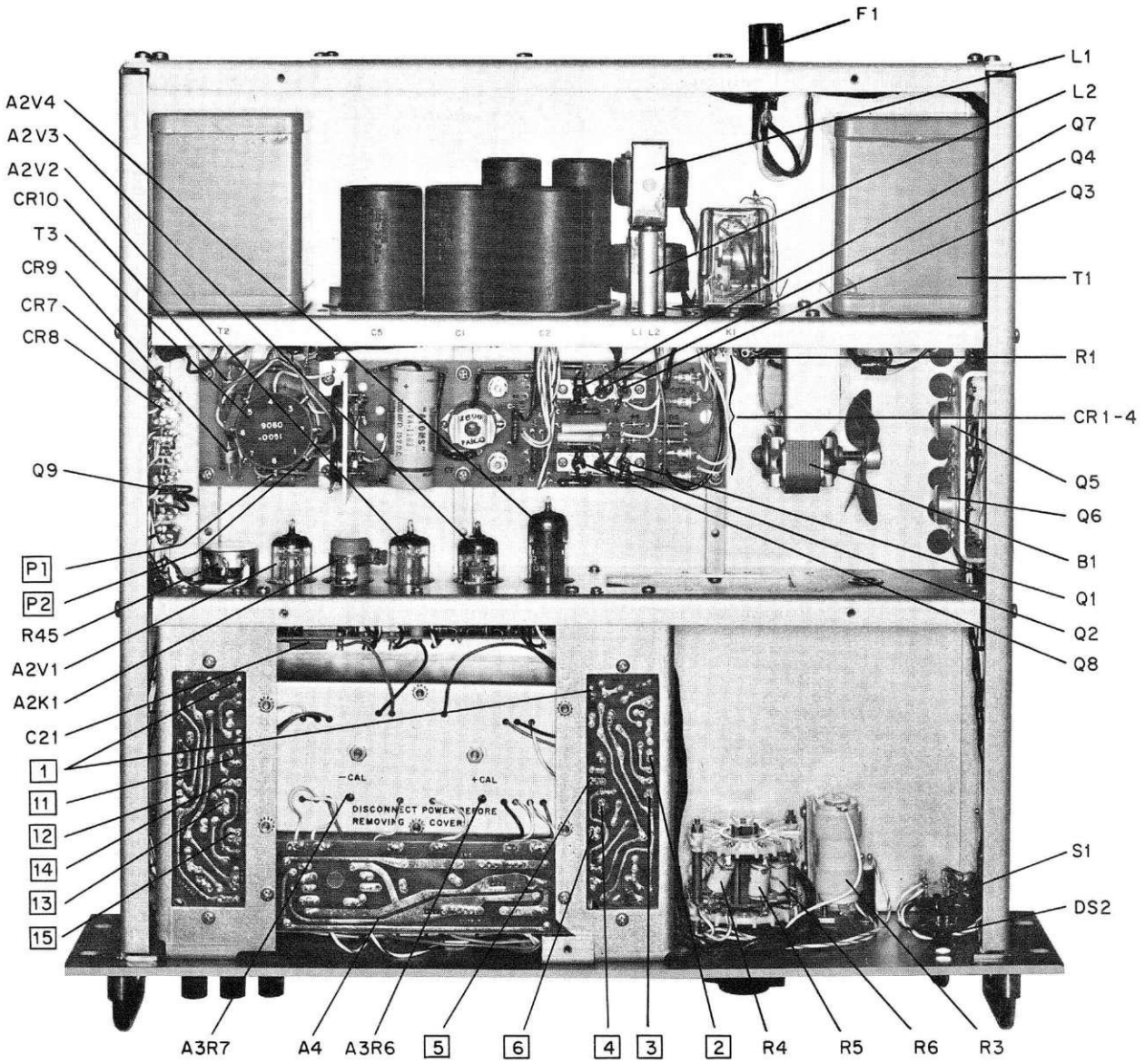
WAVEFORMS	CIRCUIT POSITION & DESCRIPTION
	1 (A2, PIN 6) CHOPPER-STABILIZED AMPLIFIER OUTPUT.
	2 (COLL. A5Q1) BLOCKING OSCILLATOR OUTPUT.
	3 (JCT. A5R2 & A5C2) BLOCKING OSCILLATOR PULSE.
	4 (BASE A3Q1) INPUT, PUSH-PULL LIMITING AMPLIFIER.
	5 (JCT. A5C1 & A5T1) BLOCKING OSCILLATOR PULSE.
	6 (BASE A3Q2) INPUT, PUSH-PULL LIMITING AMPLIFIER.
	7 (A3Z1, PIN 2) CENTER-TAP OUTPUT, PUSH-PULL AMPLIFIER.
	8 (A3Z1, PINS 4 & 5) OUTPUT, PUSH-PULL, AMPLIFIER BEFORE DETECTION.
	9 (A3Z1, PIN 6) BALANCING VOLTAGE-TIME PULSE FROM PUSH-PULL AMPLIFIER.
	10 (J2, OUTPUT BNC) OUTPUT PULSE FROM BLOCKING OSCILLATOR, A4Q1.
	P1 (T3, PIN 8) MULTIVIBRATOR, 150 VDC POWER SUPPLY.

-1 VDC INPUT

WAVEFORMS	CIRCUIT POSITION & DESCRIPTION
	1 (A2, PIN 6) CHOPPER-STABILIZED AMPLIFIER OUTPUT.
	11 (COLL. A6Q1) BLOCKING OSCILLATOR OUTPUT.
	12 (JCT. A6R2 & A6C2) BLOCKING OSCILLATOR PULSE.
	13 (BASE A3Q3) INPUT, PUSH-PULL LIMITING AMPLIFIER.
	14 (JCT. A6C1 & A6T1) BLOCKING OSCILLATOR PULSE.
	15 (BASE A3Q4) INPUT, PUSH-PULL LIMITING AMPLIFIER.
	16 (A3Z2, PIN 2) CENTER-TAP OUTPUT, PUSH-PULL AMPLIFIER.
	17 (A3Z2, PINS 5 & 6) OUTPUT, PUSH-PULL, AMPLIFIER BEFORE DETECTION.
	18 (A3Z2, PIN 4) BALANCING VOLTAGE-TIME PULSE FROM PUSH-PULL AMPLIFIER.
	10 (J2, OUTPUT BNC) OUTPUT PULSE FROM BLOCKING OSCILLATOR, A4Q1.
	P2 (T3, PIN 1) MULTIVIBRATOR, 150 VDC POWER SUPPLY.

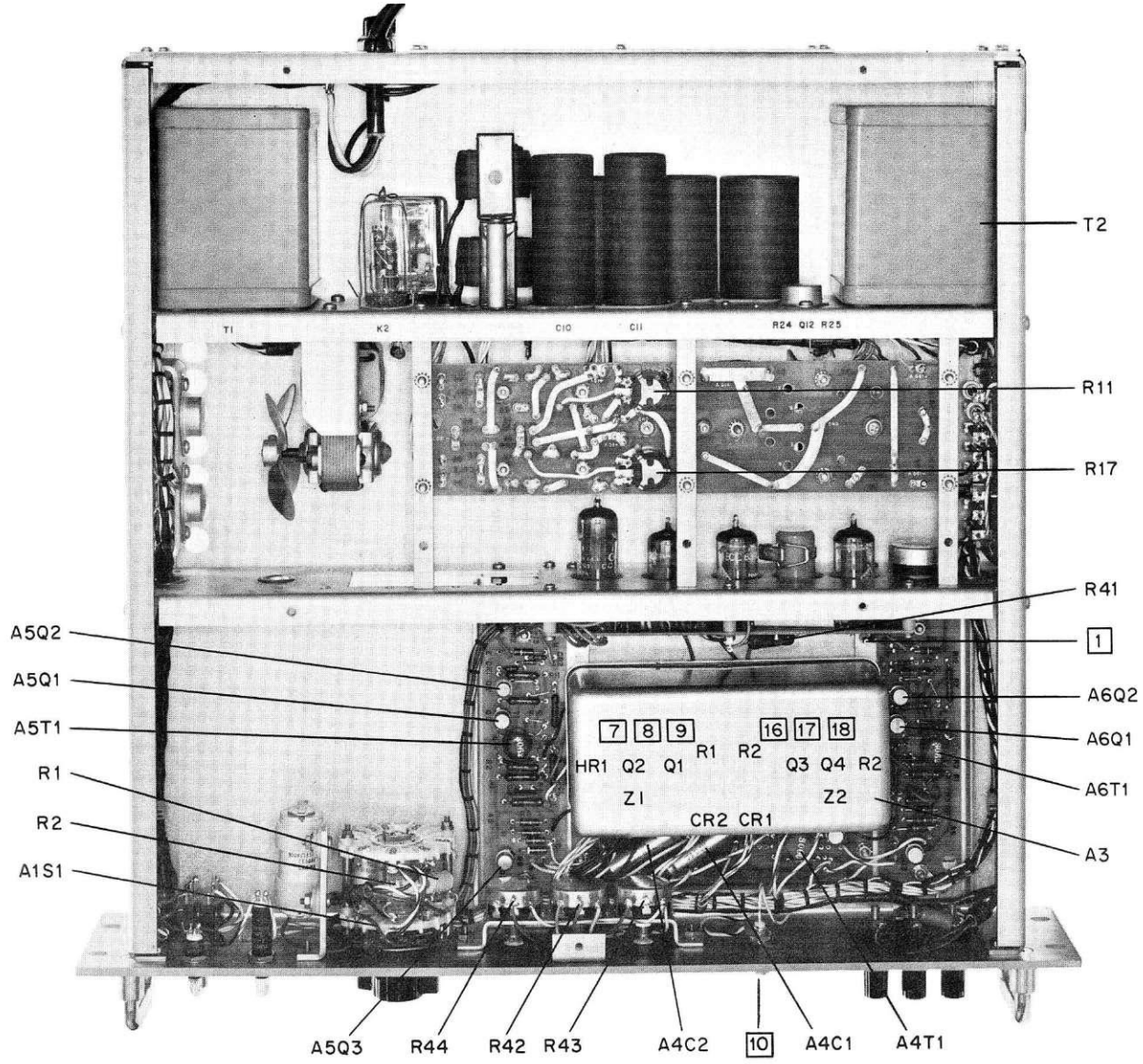
NOTE: VERTICAL SCALE IN VOLTS, HORIZONTAL SCALE IN MICROSECONDS.

FIGURE 4-2



TOP INTERNAL VIEW OF MODEL DY-2211

FIGURE 4-3



BOTTOM INTERNAL VIEW OF MODEL DY-2211

FIGURE 4-4

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SECTION 5
TABLE OF REPLACEABLE PARTS

5.1 INTRODUCTION

This section contains identification and ordering information for replacement parts. Any changes to the Table of Replaceable Parts will be listed on a Change Sheet at the front of this handbook. Note that Dymec uses ℌ stock numbers. A part described as ℌ only is a special part that can be obtained only from the Hewlett-Packard Co. If another manufacturer's stock (part) number is listed, the part may be obtained directly from that manufacturer. A list of manufacturers' code numbers will be found in the Appendix at the end of the Table. In general, parts available from manufacturers other than those listed may be used if the part has equivalent electrical and physical characteristics and quality.

As noted on schematic diagrams, the optimum electrical value of certain components may be selected at the factory to compensate for variations in other components, wiring capacitance, etc. In some instruments, a selected part may be omitted (e.g., a selected resistor might be a wire or an open circuit). The nominal (or average) value of the part is indicated on the schematic diagram. When replacing, use the original value of the part installed in your instrument.

The Table lists parts in alpha-numerical order of their reference designation and provides the following information on each part:

1. Description (see list of abbreviations used, paragraph 5.3).
2. ℌ stock number or Dymec drawing number.
3. Typical manufacturer of the part in a five-digit code (see list of manufacturers in Appendix).
4. Manufacturer's part, stock, or drawing number.
5. Total quantity used in instrument.
6. Recommended spare part quantity for complete maintenance during one year of isolated service.

Miscellaneous and mechanical parts not indexed by reference designation are listed at the end of the Table.

5.2 ORDERING INFORMATION

To order a replacement part, address your order or inquiry either to your local Hewlett-Packard/Dymec field office (listed on last page of this handbook) or to:

United States
CUSTOMER SERVICE
Hewlett-Packard Co.
395 Page Mill Road
Palo Alto, California

Western Europe
Hewlett-Packard S.A.
54 Route des Acacias
Geneva, Switzerland

Specify the following information on each part:

1. Dymec model number and complete serial number of instrument.
2. hp stock number.
3. Circuit reference designation.
4. Description.

To order a part not listed in the Table, give complete description and include function and location of the part in the instrument and/or system.

5.3 ABBREVIATIONS USED

Reference Designation Column

A	= assembly	MP	= mechanical part
B	= motor	P	= plug
C	= capacitor	Q	= transistor
CR	= diode	R	= resistor
DL	= delay line	RT	= thermistor
DS	= device signaling (lamp)	RV	= varistor
E	= misc electronic part	S	= switch
F	= fuse	T	= transformer
FL	= filter	V	= vacuum tube, neon bulb, photocell, etc.
J	= jack		
K	= relay	W	= cable
L	= inductor	X	= socket
M	= meter	Z	= network

Description Column

a	= amperes	pos	= position(s)
c	= carbon	poly	= polystyrene
cer	= ceramic	pot	= potentiometer
comp	= composition	rect	= rectifier
depc	= deposited carbon	rot	= rotary
elect	= electrolytic	s-b	= slow-blow
f	= farads	Se	= selenium
f-a	= fast acting	sect	= section(s)
fxd	= fixed	Si	= silicon
Ge	= germanium	SPL	= special
incd	= incandescent	Ta	= tantalum
metflm	= metal film	Ti	= titanium dioxide
MFR	= manufacturer	tog	= toggle
my	= mylar	tol	= tolerance
NC	= normally closed	v	= volts
Ne	= neon	var	= variable
NFR	= not field replaceable	w/	= with
NO	= normally open	w	= watts
NPO	= zero temp coeff	ww	= wirewound
NSN	= no stock number	w/o	= without
NSR	= not separately replaceable	*	= optimum value selected, nominal value shown (component may be omitted)
OBD	= order by description		
pc	= printed circuit board		
piv	= peak inverse voltage		

REFERENCE DESIGNATION	DESCRIPTION		ℎ STOCK NO.	MFR. CODE NO.	MFR. PART NO.	QTY.	1-YR. SPA.
A1	Assembly, input-switch w/o attenuator		OBD	28480		1	0
	w attenuator		5060-2417	04404		1	0
A2	Amplifier, Chopper-stabilized		0950-0033	28480		1	0
A3	Assembly, oven		5060-2376	04404		1	0
A4	Board, output		5060-2157	04404		1	0
A5	Board, + Channel		5060-2215	04404		1	0
A6	Board, - Channel		5060-2216	04404		1	0
B1	Motor: fan		3140-0010	73793	G5-CW ER-6667	1	1
	Blade: fan		3160-0038	06812	0-327-4	1	1
C1, 2, 5	C: fxd, elect, 500 μf, 75v		0180-0047	56289	D27345-852-J	3	1
C3, 4	C: fxd, my, 0.1 μf, 20%, 150 vdcw		0170-0055	72928	33SY104M	2	1
C7	C: fxd, elect, 1000 μf, 15v		0180-0174	56289	TVA-1163	1	1
C8, 12	C: fxd, my, .1 μf, 10%, 200v		0160-0168	56289	192P10492	2	1
C9	C: fxd, mica, .001 μf, 5%, 500 vdcw		0140-0018	00853	KK-1210	1	1
C10, 11	C: fxd, elect, 40 μf, 450 vdcw		0180-0208	56289	D16653	2	1
C21	C: fxd, mica, 5%, 500v	2211A: 470 pf	0140-0085	56289	KR-1347	1	1
		2211B: 47 pf	0140-0039	56289	KR-1210	1	1
C22A, B	C: fxd, cer, 2 × 0.01 μf, 20%, 250v		0150-0119	56289	41C159A	1	1
CR1-4	Diode: Si, SD-91		1901-0069	81483		4	4
CR5, 6	Diode: Ge, 1N90		1901-0016	73293		2	2
CR7, 8	Diode: Si, SD-91A		1901-0026	81483		2	2
CR9, 10	Diode: Si, SD-94		1901-0028	81483		2	2
DS1	Lamp: Ne, amber		1450-0084	03797		1	1

REFERENCE DESIGNATION	DESCRIPTION	STOCK NO.	MFR. CODE NO.	MFR. PART NO.	QTY.	1-YR. SPA.
DS2	Lamp: Ne, red	1450-0085	03797		1	1
DS3	Lamp: incd, white, 28v	1450-0086	03797		1	1
F1	Fuse: cartridge, 1.6a, s-b	2110-0005	75915	31301.6	1	10
	Fuseholder for above	1400-0084	75915	342012	1	1
J2	Receptacle: female, BNC, UG-1094/U	1250-0118	91737	UG-1094/U	1	1
J3	Connector: power, 3 pin, male	1251-0148	87930	H-1061 1G-3L	1	1
K1	Relay: 2.5K coil, 3 PDT	0490-0071	77342	KCP14	1	1
K2	Relay: thermal time delay, 60 sec	0490-0051	94197	117-60-G	1	1
L1, 2	Inductor: 225 mh at 400 ma	9110-0065	98734	1639	2	1
L3	Inductor: .18 mh, .025Ω	9110-0066	98734	1696	1	1
Q1, 3-9	Transistor: Ge, 2N404	1850-0032	72699		8	2
Q2, 4, 7, 8	Transistor: Ge, 2N650	1850-0048	04713		4	1
Q5, 6, 12	Transistor: Ge, 2N301	1850-0126	02735		3	1
Q10, 11	Transistor: 2N627 (Purchase without solder lugs on emitter and base pins.)	1850-0120	04713		2	1
R1	R: fxd, comp, 2.2K, 5%, 1w	0689-2225	01121	GB2225	1	1
R2, 3	R: fxd, comp, 120K, 5%, 1/2w	0686-1245	01121	EB1245	2	1
R4, 6	R: fxd, comp, 100K, 5%, 1/2w	0686-1045	01121	EB1045	2	1
R5	R: fxd, comp, 47K, 5%, 1/2w	0686-4735	01121	EB4735	1	1
R7, 21	R: fxd, comp, 12K, 5%, 1/2w	0686-1235	01121	EB1235	2	1
R8	R: fxd, cflm, 100Ω, 1%, 1/2w	0727-0864	19701	Type DC-1/2	1	1
R9, 19	R: fxd, ww, 500Ω, 1%, 3w	0811-0229	91637	RS2B	2	1
R10, 18	R: fxd, cflm, 82.5Ω, 1%, 1/2w	0727-0716	19701	Type DC-1/2A	2	1

REFERENCE DESIGNATION	DESCRIPTION	STOCK NO.	MFR. CODE NO.	MFR. PART NO.	QTY.	1-YR. SPA.
R11, 17	R: var, ww, 25Ω, 10%, 1.5w	2100-0494	12697	49M9-25Ω	2	1
R12, 15, 16	R: fxd, cflm, 147Ω, 1%, 1/2w	0727-0720	19701	Type DC-1/2A	3	1
R13	R: fxd, comp, 2K, 5%, 1/2w	0686-2025	01121	EB2025	1	1
R14	R: fxd, comp, 3K, 5%, 1/2w	0686-3025	01121	EB3025	1	1
R20	R: fxd, comp, 820Ω, 5%, 2w	0692-8215	01121	HB8215	1	1
R22	R: fxd, comp, 82Ω, 5%, 1/2w	0686-8205	01121	EB8205	1	1
R23, 27	R: fxd, comp, 1K, 5%, 1/2w	0686-1025	01121	EB1025	2	1
R24	R: fxd, ww, 270Ω, 10%, 10w	0816-0035	91637	Type B-10	1	1
R25	R: fxd, ww, 2.2Ω, 5%, 3w	0812-0039	91637	Type RS-2B	1	1
R26	R: fxd, ww, 0.27Ω, 5%, 1/2w	0812-0040	75042	Type BW-1/2	1	1
R28	R: fxd, comp, 3600Ω, 5%, 1/2w	0686-3625	01121	EB3625	1	1
R41	R: fxd, cflm, 10M, 1%, 1w	0730-0168	19701	Type DC-1	1	1
R42	R: var, ww, 10K, 10%, 2w	2100-0702	12697	43-162	1	1
R43, 44	R: var, ww, 4Ω, 10%, 2w	2100-0007	12697	43-4	2	1
R45	R: var, ww, 50Ω, 10%, 3w	2100-0709	12697	43-50	1	1
S1	Switch: tog, DPDT	3101-0005	04009	81027CE	1	1
T1	Transformer: power	9100-0203	98734	9166	1	1
T2	Transformer: power	9100-0202	98734	9084	1	1
T3	Transformer: toroidal	5080-1458	81095	67441	1	1
W1	Cable: power, NEMA	8120-0078	70903	KH-4147	1	1
A1	**Input Switch Assembly W/O Attenuator**					
R1	R: fxd, ww, 31.6K, 1%, ±15 ppm/°C, 1/4w	0811-0180	71471	Type CE522E	1	1

REFERENCE DESIGNATION	DESCRIPTION	STOCK NO.	MFR. CODE NO.	MFR. PART NO.	QTY.	1-YR. SPA.
	Input Switch Assembly W/O Attenuator (Continued)					
R2	R: fxd, ww, 5.62K, 1%, ±15 ppm/°C, 1/4w	0811-0179	71471	Type CE522E	1	1
S1	Switch: rot, 1 sect, 3 pos	3100-0455	76854	102990-H1	1	1
A1	Input Switch Assembly W Attenuator	5060-2157	04404		1	
R1	R: fxd, ww, 9K, 0.25%, ±30 ppm/°C, 1/2w	0811-0156	71471	Type CE526	1	1
R2	R: fxd, ww, 90K, .01%, ±10 ppm/°C, 1/2w	0811-0152	71471	Type CE526	1	1
R3	R: fxd, ww, 900K, .01%, ±2.5 ppm/°C, 2w	0811-0204	71471	Type CE504	1	1
R4	R: fxd, ww, 111,111Ω, .01%, ±5 ppm/°C, 1/2w	0811-0149	71471	Type CE526	1	1
R5	R: fxd, ww, 10101Ω, .01%, ±5 ppm/°C, 1/2w	0811-0153	71471	Type CE526	1	1
R6	R: fxd, ww, 1001Ω, .01%, ±5 ppm/°C, 1/2w	0811-0158	71471	Type CE526	1	1
S1	Switch: rot, 2 sect, 6 pos	3100-0451	76854	205673-DL2	1	1
A2	**Chopper-Stabilized Amplifier**	0950-0033	28480		1	
C1	C: fxd, my, 0.1 μf, 5%, 100v	0170-0019	84411	Type 663 UW	1	1
C2,3,5	C: fxd, my, 0.01 μf, 5%, 400v	0160-0371	84411	Type 663-UW	3	1
C4	C: fxd, cer, 1000 pf, +100 -0%, 600v	0150-0050	84411	Type B	1	1
C6	C: fxd, my, 1.0 μf, 5%, 100v	0160-0293	84411	HEW-4	1	1
C7	C: fxd, cer, 10 pf, 10%, 600v	0160-0270	72982	Type GP1K	1	1
C8	C: fxd, cer, 0.1 μf, +100 -0%, 600v	OBD	28480		1	1
C9	C: fxd, cer, 7.5 pf, 5%, 600v	0160-0272	14655	Type C(NPO)	1	1
C10	C: fxd, cer, 100 pf, +100 -0%, 600v	0160-0273	14655	Type BYA	1	1
C11,13	C: fxd, cer, 15 pf, 5%, 600v	0160-0274	14655	Type C(NPO)	2	1
C12	C: fxd, cer, 270 pf, +100 -0%, 600v	OBD	28480		1	1

REFERENCE DESIGNATION	DESCRIPTION	STOCK NO.	MFR. CODE NO.	MFR. PART NO.	QTY.	1-YR. SPA.
	Chopper-Stabilized Amplifier (Continued)					
K1	Chopper: SPDT, 6.3v, 60 cps	0490-0106	76854	660	1	1
R1, 5, 7, 13, 21	R: fxd, comp, 1M, 5%, 1/2w	0686-1055	01121	EB1055	5	2
R2, 6, 8	R: fxd, comp, 22M, 5%, 1/2w	0686-2265	01121	EB2265	3	1
R3	R: fxd, comp, 470K, 5%, 1/2w	0686-4745	01121	EB4745	1	1
R4, 10	R: fxd, comp, 270K, 5%, 1/2w	0686-2745	01121	EB2745	2	1
R9, 11	R: fxd, comp, 120K, 5%, 1/2w	0686-1245	01121	EB1245	2	1
R12	R: fxd, comp, 5.6M, 5%, 1/2w	0686-5655	01121	EB5655	1	1
R14, 19	R: fxd, comp, 510K, 5%, 1/2w	0686-5145	01121	EB5145	2	1
R15	R: fxd, comp, 36K, 5%, 2w	0692-3635	01121	HB3635	1	1
R16	R: fxd, comp, 150K, 5%, 2w	0692-1545	01121	HB1545	1	1
R17	R: fxd, comp, 100K, 5%, 1/2w	0686-1045	01121	EB1045	1	1
R18	R: fxd, comp, 47Ω, 5%, 1/2w	0686-4705	01121	EB4705	1	1
R22	R: fxd, comp, 18M, 5%, 1/2w	0686-1865	01121	EB1865	1	1
R23	R: fxd, comp, 1.5K, 5%, 1/2w	0686-1525	01121	EB1525	1	1
R24	R: fxd, comp, 1.5M, 5%, 1/2w	0686-1555	01121	EB1555	1	1
R25	R: fxd, comp, 4.7M, 5%, 1/2w	0686-4755	01121	EB4755	1	1
R26	R: fxd, ww, 2.5K, 5%, 10w	0815-0024	09746	10X2500	1	1
R27, 28	R: fxd, comp, 68K, 5%, 2w	0692-6835	01121	HB1045	2	1
V1, 2	Tube: electron, 12AX7	1932-0030	F0009		2	2
V3	Tube: electron, 6U8A	1933-0004	02735		1	1
V4	Tube: electron, 6S4A	1921-0023	02735		1	1

REFERENCE DESIGNATION	DESCRIPTION		STOCK NO.	MFR. CODE NO.	MFR. PART NO.	QTY.	1-YR. SPA.
A3	**Oven Assembly**		5060-2376	04404		1	
Z1, 2	Transformer Assembly	2211A	5080-1416	04404		2	1
		2211B	5080-1415	04404		2	1
CR1, 2	Diode: Si, Zener, 1N823		1902-0033	03877		2	2
CR3, 4	Diode: Si		1901-0081	28480		2	2
HR1, 2	R: fxd, ww, 70Ω, 3%, 10w		0815-0025	91637	NH-10	2	1
Q1-4	Transistor: Ge, 2N404		1850-0032	72699		4	1
R1	R: fxd, ww, 1M, .01%, ±5 ppm/°C		0811-0203	71471	Type C501	1	1
R2, 5	R: fxd, mtflm, 1.15M, 1%, 1/2w, 25 ppm/°C, *		0757-0292	65092	9852	2	1
R3, 4	R: fxd, cflm, 9.09K, 1%, 1/2w		0727-0896	19701	Type DC-1/2A	2	1
R6, 7	R: var, mtflm, 1K, 10%		2100-0739	73138	Type 50	2	1
R8, 9	R: fxd, cflm, 14.7K, 1%, 1/2w		0727-0785	19701	Type DC-1/2A	2	1
R10, 11	R: fxd, cflm, 619Ω, 1%, 1/2w		0727-0744	19701	Type DC-1/2A	2	1
R12, 13	R: fxd, mtflm, 200Ω, 1%, 1w, 50 ppm/°C		0757-0233	65092	Type 9854	2	1
S1	Thermometer: contact, 65°C		0440-0002	48620	Type 40	1	1
A4	**Output Board**		5060-2157	04404		1	
C1, 2	C: fxd, elect, 200 μv, 15v		0180-0173	56289	TE1164	2	1
Q1	Transistor: Ge, 2N404		1850-0032	72699		1	1
R1, 2	R: fxd, cflm, 2.87K, 1%, 1/2w		0727-0766	19701	Type DC-1/2A	2	1
R3	R: fxd, comp, 560Ω, 5%, 1/2w		0686-5615	01121	EB5615	1	1
R4	R: fxd, comp, 150Ω, 5%, 1/2w		0686-1515	01121	EB1515	1	1
T1	Transformer: pulse, 2.5 mh, 4:1:2:2		9130-0026	98734	3060	1	1

REFERENCE DESIGNATION	DESCRIPTION		STOCK NO.	MFR. CODE NO.	MFR. PART NO.	QTY.	1-YR. SPA.
A5	**+Channel, Printed Circuit**		5060-2215	04404		1	
C1	C: fxd, mica, 150 pf, 5%, 500 vdcw		0140-0067	00853	RR-1315	1	1
C2	C: fxd, cer, .01 μf, 20%, 1000 vdcw		0150-0012	56289	H-1038	1	1
CR1, 2	Diode: Si, 1N628		1901-0058	03877		2	2
Q1, 3	Transistor: Ge, 2N404		1850-0032	72699		2	1
Q2	Transistor: Ge, 2N604		1850-0110	72699		1	1
R1	R: fxd, cflm, 5K, 1%, 1/2w		0727-0774	19701	Type DC-1/2A	1	1
R2, 4	R: fxd, cflm, 1.47K, 1%, 1/2w		0727-0881	19701	Type DC-1/2A	2	1
R3, 11	R: fxd, cflm, 10K, 1%, 1/2w		0727-0891	19701	Type DC-1/2A	2	1
R5	R: fxd, comp, 2.7K, 5%, 1/2w		0686-2725	01121	EB2725	1	1
R6	R: fxd, comp, 10K, 5%, 1/2w		0686-1035	01121	EB1035	1	1
R7	R: fxd, cflm, 100Ω, 1%, 1/2w		0727-0864	01121	Type DC-1/2	1	1
R8	R: fxd, comp, 1K, 5%, 1/2w		0686-1025	01121	EB1025	1	1
R9	R: fxd, comp, 9.1K, 5%, 1/2w		0686-9125	01121	EB9125	1	1
R10	R: fxd, cflm, 2.15K, 1%, 1/2w		0727-0763	19701	Type DC-1/2A	1	1
R12	R: fxd, comp, 120K, 5%, 1/2w		0686-2145	01121	EB2145	1	1
R13	R: fxd, comp, 180Ω, 5%, 1/4w		0683-1815	01121	CB1815	1	1
T1	Transformer: pulse, 4:1:2:2	2211A: 7.5 mh 2211B: 2.5 mh	9130-0027 9130-0026	98734 98734	3062 3060	1 1	1 1
A6	**-Channel, Printed Circuit**		5060-2216			1	
C1	C: fxd, mica, 150 μμf, 5%, 500v		0140-0067	00853	RR-1315	1	1
C2	C: fxd, cer, .01 μf, 20%, 1000 vdcw		0150-0012	56289	H-1038	1	1
CR1, 2	Diode: Si, 1N628		1901-0058	03877		2	2
Q1, 2	Transistor: 2N446A		1851-0028	72699		2	1

REFERENCE DESIGNATION	DESCRIPTION		STOCK NO.	MFR. CODE NO.	MFR. PART NO.	QTY.	1-YR. SPA.
	-Channel, Printed Circuit (Continued)						
Q3	Transistor: Ge, 2N404		1850-0032	72699		1	1
R1	R: fxd, cflm, 5K, 1%, 1/2w		0727-0774	19701	Type DC-1/2A	1	1
R2, 4	R: fxd, cflm, 1.47K, 1%, 1/2w		0727-0881	19701	Type DC-1/2A	2	1
R3, 10	R: fxd, cflm, 10K, 1%, 1/2w		0727-0891	19701	Type DC-1/2A	2	1
R5	R: fxd, comp, 2.7K, 5%, 1/2w		0686-2725	01121	EB2725	1	1
R6	R: fxd, comp, 10K, 5%, 1/2w		0686-1035	01121	EB1035	1	1
R7	R: fxd, cflm, 100Ω, 1%, 1/2w		0727-0864	19701	Type DC-1/2A	1	1
R8	R: fxd, comp, 1K, 5%, 1/2w		0686-1025	01121	EB1025	1	1
R9	R: fxd, cflm, 2.15K, 1%, 1/2w		0727-0763	19701	Type DC-1/2A	1	1
R11	R: fxd, comp, 140K, 1%, 1/2w		0727-0887	19701	Type DC-1/2A	1	1
R12	R: fxd, comp, 390Ω, 5%, 1/4w		0683-3915	01121	CB3915	1	1
T1	Transformer: pulse, 4:1:2:2	2211A: 7.5 mh	9130-0027	98734	3062	1	1
		2211B: 2.5 mh	9130-0026	98734	3060	1	1

HANDBOOK
UPDATING SUPPLEMENT

for

MODEL DY-2211A/B
VOLTAGE-TO-FREQUENCY CONVERTER

ITEM DESCRIPTION

Serial number 323-00578 and above.

1 Page 2-3, 1st paragraph, in the 2nd and 3rd sentences, delete the phrases "-- with the exception of the 1000v range on the 2211A/B with the optional attenuator, --" and "-- except on the 1000v range, --".

2 Page 2-3, 1st paragraph (the last one of Section 2.3), change the last sentence to read:

"Recovery time from such overloads is less than 10 milliseconds.

NOTE: During that recovery time the amplifier will remain saturated. This will cause the output frequency to then be erroneous and higher than the rated full-scale value."

3 Page 3-4, between the 3rd paragraph and Section 3.2.2, add the following:

"When an overload voltage is present the output of the chopper-stabilized amplifier becomes high enough to cause one of the two Zener diodes CR15 or CR16 to pass breakdown current and produce a voltage drop across resistor R47. The overload voltage also establishes a voltage at the opposite end of the network made up of diodes CR11 through CR14 and resistor R46. Thus a conductive path is established to feed the chopper-stabilized amplifier's output back to its input, effectively cancelling the input current.

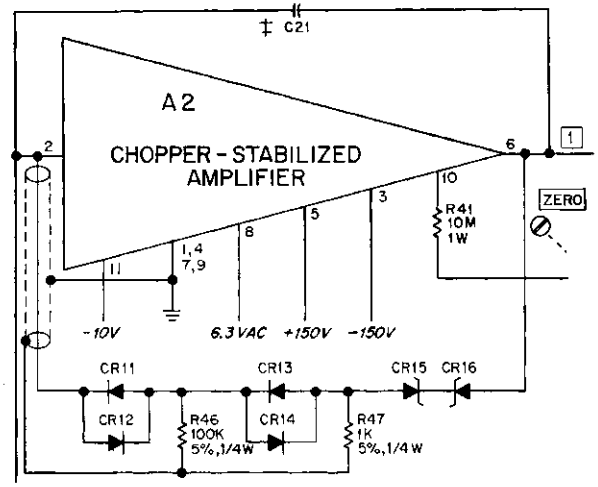
4 Page 5-3, between listings for CR9, 10 and DS1, add the following:

CR11-14; Diode: Si, HD4479; Stk. No. 1901-0156; Mfr. Code 73293; -; 4; 4.

CR15, 16; Diode: Si, HV-0211; Stk. No. 1902-0099; Mfr. Code 73293; -; 2; 2.

ITEM DESCRIPTION

5 Page 4-11, in Figure 4-6, add two resistors and 4 diodes as follows:



6 Page 5-5, between listings for R45 and S1, add the following:

R46; R: fxd, comp, 100K, 5%, 1/4w; Stk. No. 0683-1045; Mrf. Code 01121; CB1045; 1; 1.

R47; R: fxd, comp, 1K, 5%, 1/4w; Stk. No. 0683-1025; Mfr. Code 01121; CB1025; 1; 1.

Serial number 323-00857 and above for the DY-2211A; 323-00877 and above for the DY-2211B.

7 Page 5-3, change listing for CR1-4 to read:

"CR1-4; Diode: Si, -; Stk. No. 1901-0045; 28480; -; 4; 4."

8 Page 5-3, change listing for CR9, 10 to read:

"CR9, 10; Diode: Si, 1N647; Stk. No. 1901-0129; 01295; -; 2; 2.

9 Page 4-12, Figure 4-7. Delete the notations "SD91" from diodes CR1-4, "SD91A" from CR7 and 8, "1N90" from CR5 and 6, "1N823" from A3 diodes CR1 and 2, and "SD94" from CR9 and 10.

11/65

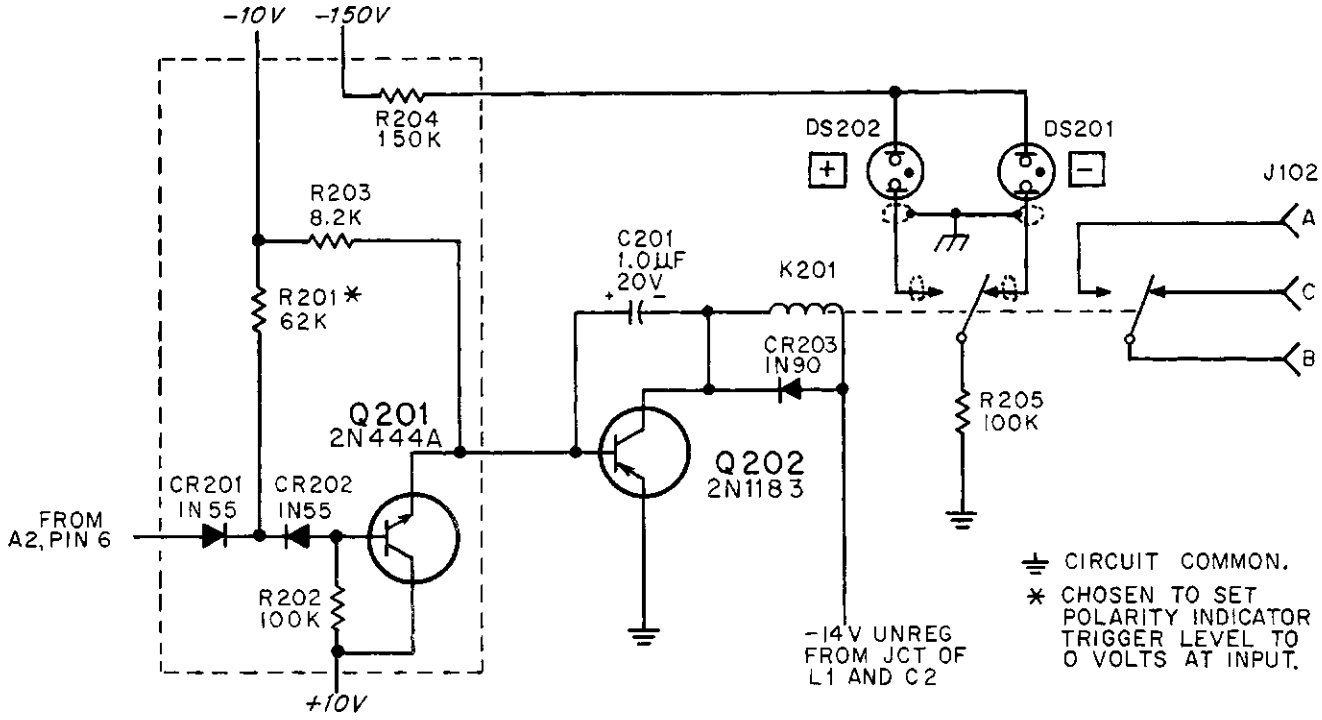
Models DY-2211A/B
Voltage-to-Frequency Converters
(Serials 82 thru 146, and serials prefixed 115-, 125-, 132-, 223- (or 217-) 307-, 323-)

Optional Modification M2

INPUT POLARITY INDICATION

Two neon lamps are provided on the front panel for indicating the polarity of the dc voltage applied to the DY-2211. In addition, contact closures are provided at pins A, B, and C of a rear connector J102 for polarity indication on a digital recorder or other external device. The schematic is shown overleaf.

The sensitivity of the polarity indicating circuit is such that the neons will light with a signal applied to the DY-2211 of only a few microvolts. Therefore, if it is desired to avoid the transient response delay of the DY-2211 (see para. 2.5 of DY-2211 manual) when measuring signals of one polarity, the ZERO potentiometer can be offset very slightly (with zero volts applied to the converter) so that the neon corresponding to the polarity to be measured is lit.



MODELS DY-2211A/B
VOLTAGE-TO-FREQUENCY CONVERTERS

(Serials 82 thru 146, and serials prefixed 115-, 125-, 132-, 223- (or 217-), 307-, 323-)

A2211-1100

OPTIONAL MODIFICATION M2
INPUT POLARITY INDICATION

RS 11-17-61 A2211-1100

DY-2211A/B-M2 Input Polarity Indication

REFERENCE DESIGNATION	DESCRIPTION	hp STOCK NO.	MFR. CODE NO.	MFR. PART NO.	QTY.	1-YR. SPA.
C201	C: fxd, Ta, 1 μf, 20%, 20v	0180-0192	82376	TES-1M-20	1	1
CR201, 202	Rectifier: crystal	1910-0003	08792	1N55	2	2
CR203	Diode: Ge	1910-0004	73293	1N90	1	1
DS201, 202	Indicator: Ne, clear	OBD	28480		2	1
J102	Receptacle: male, 3-pin	1251-0039	71468	MS3102A-10SL-3P	1	1
	Mating connector for above:	1251-0257	71468	MS3106B-10SL-3S		
K201	Relay: 300Ω coil, 2 form C	0490-0073	04777	Type EQA	1	1
Q201	Transistor: Ge	1851-0029	72699	2N444A	1	1
Q202	Transistor: Ge	1850-0064	02735	2N1183	1	1
R201	R: fxd, comp, 62K, 5%, 1/2w, *	0686-6235	01121	EB6235	1	1
R202	R: fxd, comp, 100K, 5%, 1/2w	0686-1045	01121	EB1045	1	1
R203	R: fxd, comp, 8.2K, 5%, 1/2w	0686-8225	01121	EB8225	1	1
R204	R: fxd, comp, 150K, 5%, 1/2w	0686-1545	01121	EB1545	1	1
R205	R: fxd, comp, 100K, 5%, 1/2w	0686-1045	01121	EB1045	1	1

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Models DY-2211A/B
Voltage-to-Frequency Converters
(Serials prefixed 125-, 132-, 223- (or 217-) 307-, 323-)

Optional Modification M3

PARALLEL REAR CONNECTORS

Additional **INPUT** and **OUTPUT** connectors are provided on the rear panel, wired in parallel with the standard connectors on the front panel.

The additional input receptacle is a 3-pin male Cannon XLR-3-32-A95 (Dymec Stk. No. 2535-0056); the mating connector is an XLR-3-11C-A95 (Dymec Stk. No. 2535-0057). Pin 3 of this connector is the high side of the input voltage; pin 2 is the low side; pin 1 is chassis ground.

The additional output receptacle, J302, is a Gremar UG-1094A/U (Dymec Stk. No. 2536-0016), which will mate with any male BNC-type connector such as UG-88/U (Dymec Stk. No. 2536-0004).

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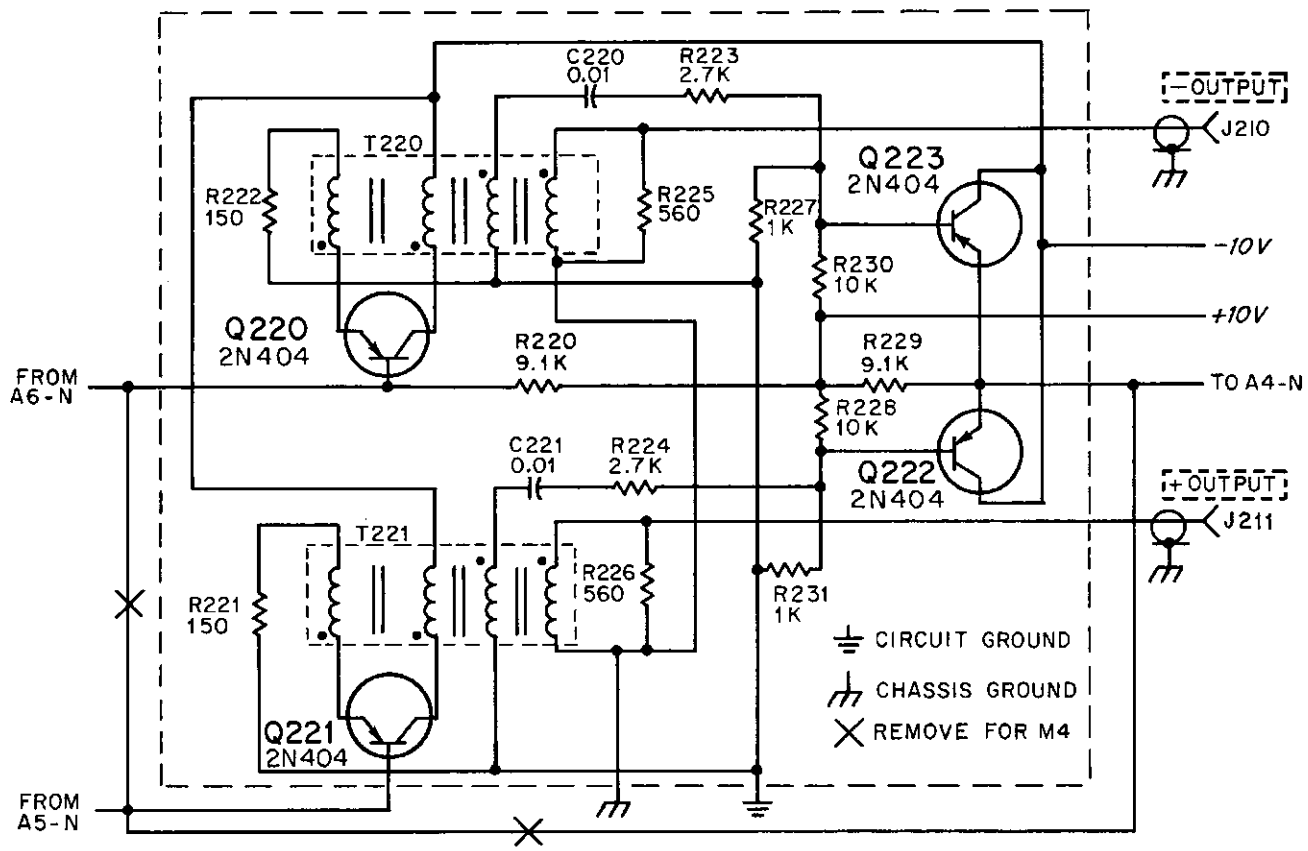
Models DY-2211A/B
Voltage-to-Frequency Converters
(Serials 82 thru 146, &
serials prefixed 115-, 125-, 132-, 223- (or 217-) 307-, 323-)

Optional Modification M4

SEPARATE OUTPUTS

Modification M4 consists of the provision of separate outputs for positive and negative inputs to the DY-2211A/B. These outputs are brought out to rear BNC connectors. The standard combined pulse output at the front panel BNC is retained.

The schematic is shown on the following page. The output for positive inputs, designated "+ OUTPUT", is obtained from pin N of A5 through blocking oscillator Q221. Similarly, the output for negative inputs, "-OUTPUT" is obtained from pin N of A6 through blocking oscillator Q220. The standard combined output, through blocking oscillator A4Q1 in the Model 2211, is obtained from one of two emitter-followers, Q222 or Q223, depending on whether the input to the Model 2211 is positive or negative.



MODELS DY-2211A/B
VOLTAGE-TO-FREQUENCY CONVERTERS

(Serials 82 thru 146, and serials prefixed 115-, 125-, 132-, 223- (or 217-), 307-, 323-)

MODIFICATION M4 – SEPARATE OUTPUTS

A2211-1101

RS 11-17-61 A2211-1101

DY-2211A/B-M4 Separate Outputs

REFERENCE DESIGNATION	DESCRIPTION	STOCK NO.	MFR. CODE NO.	MFR. PART NO.	QTY.	1-YR. SPA.
C220, 221	C: fxd, cer, .01 μf, 20%, 1000v	0150-0012	56289	H-1038	2	1
J210, 211	Connector: receptacle, female, BNC	1250-0075	91737	UG-291/U	2	1
Q220-223	Transistor: Ge	1850-0032	72699	2N404	4	1
R220, 229	R: fxd, comp, 9.1K, 5%, 1/2w	0686-9125	01121	EB9125	2	1
R221, 222	R: fxd, comp, 150Ω, 5%, 1/2w	0686-1515	01121	EB1515	2	1
R223, 224	R: fxd, comp, 2.7K, 5%, 1/2w	0686-2725	01121	EB2725	2	1
R225, 226	R: fxd, comp, 560Ω, 5%, 1/2w	0686-5615	01121	EB5615	2	1
R227, 231	R: fxd, comp, 1K, 5%, 1/2w	0686-1025	01121	EB1025	2	1
R228, 230	R: fxd, comp, 10K, 5%, 1/2w	0686-1035	01121	EB1035	2	1
T220, 221	Transformer: pulse, 2.5 mh	9130-0026	98734	3060	2	1

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Models DY-2211A/B
Voltage-to-Frequency Converters
(Serials prefixed 125-, 132-, 223- (or 217-) 307-, 323-)

Optional Modification M6

INPUT ATTENUATOR (1 to 1000v)

Modification M6 consists of the addition of a front panel attenuator providing input ranges of 10v, 100v and 1000v full scale in addition to the 1v range of the standard instrument. The instrument will respond to input overloads of up to 20% (except on the 1000v range) with no loss of accuracy. Brief overloads up to 10 times the input range (except on 1000v range) will not damage the instrument nor cause a shift in calibration. However, for several seconds after correcting a highly overloaded condition, the amplifier will remain saturated such that the instrument will generate an output frequency above the full-scale frequency.

The input impedance and accuracy specifications of the basic instrument are not affected by the addition of the attenuator. The attenuator specifications are:

Division Error:	±0.03% max. at 25°C
Temperature Coefficient:	±0.001% per °C max.

The schematic and the parts list in the standard manual describe the instrument both with and without the optional input attenuator.

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Models DY-2211A/B
Voltage-to-Frequency Converters
(Serials 11 thru 146, &
serials prefixed 115-, 125-, 132-, 223- (or 217-) 307-, 323-)

Optional Modification M7

RACK-MOUNTING SLIDES

With Modification M7 the instrument is fitted with Chassis-Trak C-300-S-20 slides for mounting in racks having 10-32 holes spaced 5/8", 5/8", 1/2".

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Models DY-2211A/B
Voltage-to-Frequency Converters
(Serials prefixed 125-, 132-, 223- (or 217-) 307-, 323-)

Optional Modification M10

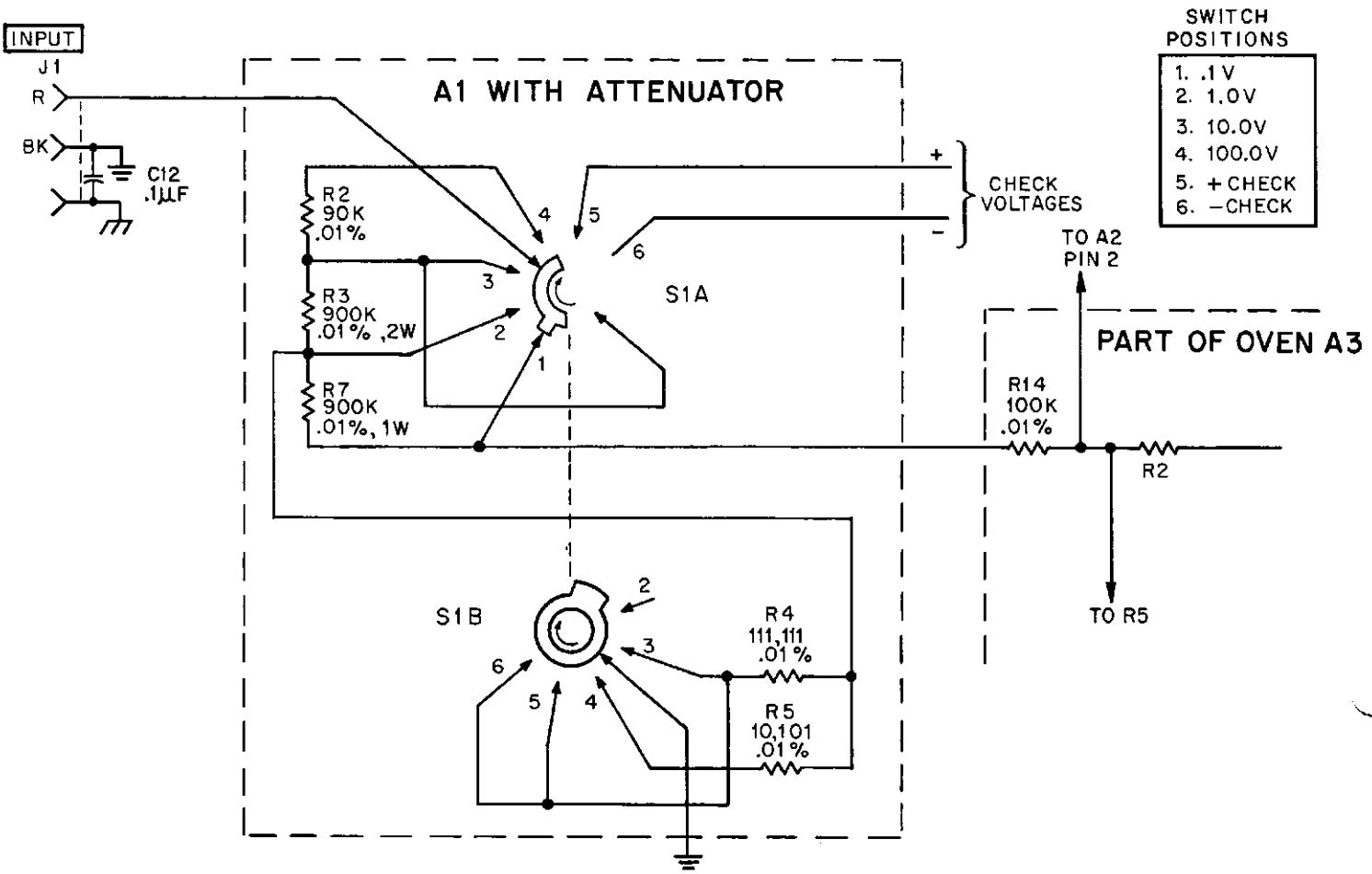
INPUT ATTENUATOR (0.1 to 100v)

An input attenuator providing input ranges of 1, 10, 100, and 1000v full scale may be installed in the Model DY-2211 as Modification M6. For Modification M10 the attenuator is modified to provide instead ranges 0.1, 1, 10, and 100v full scale. The performance specifications for the instrument are unchanged on the 1, 10 and 100v ranges. On the 0.1v range the following specifications apply:

Input Impedance:	100K shunted by 200 pf.
Stability:	±0.07% of full scale per day (at constant line voltage and temperature).
Line Voltage Effect:	±0.02% for ±10% line voltage change.
Linearity:	DY-2211A: ±.01% of full scale. DY-2211B: ±.03% of full scale.
Attenuator:	Division error ±0.03% max, at 25°C. Temperature coefficient ±0.001% per °C max.

The ZERO preset control is adjusted at the factory with the instrument switched to the 1v range. It may sometimes be found that an improvement in accuracy on the 0.1v range can be obtained by slight readjustment of the ZERO control with the instrument switched to that range.

The schematic of the modified attenuator is shown on the following page.



MODELS DY-2211A/B
VOLTAGE - TO - FREQUENCY CONVERTERS

(Serials prefixed 125-, 132-, 223-(or 217-), 307-, 323-)

MODIFICATION M10 0.1V INPUT RANGE

B2211-1103

DY-2211A/B-M10 0.1v Input Range

REFERENCE DESIGNATION	DESCRIPTION	STOCK NO.	MFR. CODE NO.	MFR. PART NO.	QTY.	1-YR. SPA.
	From the Table of Replaceable Parts of DY-2211 (Input Switch W Attenuator) delete the following: R1, R6 Also delete A3R1. Add the following:					
R7	R: fxd, ww, 900K, .01%, 1w, 2.5 ppm/°C	0811-0201	71471	Type CE527	1	1
R14	R: fxd, ww, 100K, .01%, 1/2w, 2.5 ppm/°C	0811-0191	71471	Type CE506	1	1

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Models DY-2211A/B
Voltage-to-Frequency Converters
(Serials prefixed 223- (or 217-) 307-, 323-)

Optional Modification M17

0.1 VOLT INPUT RANGE

An input voltage range of ±0.1 volt full scale is provided instead of 1 volt. Instrument specifications which are changed are:

Input Impedance:	100K shunted by 200 pf.
Stability:	±0.07% of full scale per day (at constant line voltage and temperature).
Line Voltage Effect:	±0.02% for ±10% line voltage change.
Linearity:	DY-2211A: ±.01% of full scale. DY-2211B: ±.03% of full scale.
Attenuator:	Division error ±0.03% max, at 25°C. Temperature coefficient ±0.001% per °C max.

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MANUAL
UPDATING SUPPLEMENT

for

MODELS DY-2211A/B
VOLTAGE-TO-FREQUENCY
CONVERTERS

ITEM	DESCRIPTION
1	Page 5-3, parts listing for A3. Add "(DY-2211A only)" behind "A3". Then add another listing immediately below that line: "A3 (DY-2211B only)"; Assembly, oven; 5060-2375; 04404; ——; 1;0.
2	Page 5-3, parts listings for A3. For each of these add this note behind the Description "Assembly, Oven": "(Requires two factory-selected resistors. Contact local Service office.)".
3	Page 5-8, Title for A3. Change the Description, ℗ Stock No., Mfr. Code No. and Qty. column entries to two lines as follows: (1st line) "Oven Assembly (DY-2211A only); 5060-2376; 04404; 1. (2nd line) "Oven Assembly (DY-2211B only); 5060-2375; 04404; 1.

Use with DY-2211A/B manual, Stk. No. 02211-9002, dated 3/66

TABLE 6-3.
CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Microtron Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc., Electronics Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
00929	Microlab Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div. Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Chicago, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05397	Union Carbide Corp., Linde Div., Kemet Dept.	Cleveland, Ohio
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., The	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Calif.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Semcor Div. Components Inc.	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Varian Assoc. Eimac Div.	San Carlos, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07261	Avnet Corp.	Culver City, Calif.
07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp., The	Monterey Park, Calif.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Calif.
07700	Technical Wire Products Inc.	Cranford, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Calif.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08792	CBS Electronics Semiconductor Operations, Div of C.B.S. Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Atohm Electronics	Sun Valley, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
11534	Duncan Electronics Inc.	Costa Mesa, Calif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc., CG Elect. Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp.	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermalloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dublier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	So. Pasadena, Calif.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Calif.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15558	Micron Electronics	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15818	Amelco Inc.	Mt. View, Calif.
15909	Daven Div. Thomas A. Edison Ind. McGraw-Edison Co.	Long Island City, N.Y.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N.J.
16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokoma, Ind.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Calif.
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	Bendix Corp., The Eclipse-Poineer Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19589	Concoa	Baldwin Park, Calif.
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.

From: FSC. Handbook Supplements
H4-1 Dated AUGUST 1966
H4-2 Dated NOV 1962

TABLE 6-3.
CODE LIST OF MANUFACTURERS (Cont'd)

Code No.	Manufacturer	Address
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Revere Wollansak Div. Minn. Mining & Mfg. Co.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif
71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A.O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72354	John E. Fast Co., Div. Victoreen Instr. Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Chicago, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Philips Co., Inc.	Hicksville, N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
73734	Federal Screw Products Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Calif.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75378	CTS Knights Inc.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Corp., The Bendix Pacific Div.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Any brand Tube meeting EIA Standards-Washington, DC.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Adhesive Label Corp.	Monrovia, Calif.
80583	Hammarlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Calif.
81541	Airpax Electronics, Inc.	Cambridge, Mass.
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp., Defense Prod. Division	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.

TABLE 6-3.
CODE LIST OF MANUFACTURERS (Cont'd)

Code No.	Manufacturer	Address
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfg. Co.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Calif.
83186	Victory Eng. Corp.	Springfield, N.J.
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Slough, Bucks, England
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SWEDEN
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SWITZERLAND
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TURKEY
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Istanbul
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UNITED KINGDOM
Hewlett-Packard Ltd.
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Edmonton
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TWX: 610-831-2431

BRITISH COLUMBIA
Hewlett-Packard (Canada) Ltd.
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Vancouver
Tel: (604) 738-7520
TWX: 610-922-5050

NOVA SCOTIA
7001 Mumford Road
Suite 356
Halifax
Tel: (902) 455-0511
TWX: 610-271-4482

ONTARIO
Hewlett-Packard (Canada) Ltd.
880 Lady Ellen Place
Ottawa 3
Tel: (613) 722-4223
TWX: 610-562-1952

Hewlett-Packard (Canada) Ltd.
1415 Lawrence Avenue West
Toronto
Tel: (416) 249-9196
TWX: 610-492-2382

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Tel: (514) 697-4232
TWX: 610-422-3022
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ARGENTINA
Mauricio A. Suárez
Telecomunicaciones
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Buenos Aires
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BRAZIL
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Avenida 13 de Maio, 13-22° andar
Rio de Janeiro G.B.
Tel: 42-9483

Ciental, Importacao e
Comércio Ltda.
Rua Des. Eliseu Guilherme, 62
Sao Paulo 8
Tel: 70-2318
Cable: CIENTALCO, Sao Paulo

CHILE
Héctor Calcagni
Casilla 13942
Santiago
Tel: 490.505, 393.119

COLOMBIA
Instrumentacion
Henrik A. Langebaek & Cia. Ltda.
Cra. 7A N° 48-51/59
Apartado Aereo 6287
Bogota, 1 D.E.
Tel: 45-78-06, 45-55-46
Cable: AARIS Bogota

COSTA RICA
Lic. Alfredo Gallegos Gurdián
Apartado 3243
San José
Tel: 21-86-13
Cable: GALGUR San José

ECUADOR
Laboratorios de Radio-Ingenieria
Calle Guayaquil 1246
Post Office Box 3199
Quito
Tel: 12496
Cable: HORVATH Quito

EL SALVADOR
Electrónica
27 Avenida Norte 1133
Apartado Postal 1589
San Salvador
Tel: 25-74-50
Cable: ELECTRONICA
San Salvador

GUATEMALA
Olander Associates Latin America
Apartado 1226
7a. Calle, 0-22, Zona 1
Guatemala City
Tel: 22812
Cable: OLALA Guatemala City

MEXICO
Hewlett-Packard Mexicana,
S.A. de C.V.
Eugenia 408, Dept. 1
Mexico 12, D.F.
Tel: 43-03-79

NICARAGUA
Roberto Terán G.
Edificio Terán
Apartado Postal 689
Managua
Tel: 3451, 3452
Cable: ROTERAN Managua

PANAMA
Electrónica Balboa, S.A.
P.O. Box 4929
Ave. Manuel Espinosa No. 13-50
Bldg. Alina
Panama City
Tel: 30833
Cable: ELECTRON Panama City

PERU
Fernando Ezeta B.
Av. Petit Thouars 4719
Miraflores
Casilla 3061
Lima
Tel: 50346
Cable: FEPERU Lima

PUERTO RICO
San Juan Electronics, Inc.
P.O. Box 5167
Ponce de León 150, Stop 3
Puerta de Tierra Santa
San Juan 00906
Tel: (809) 725-3342
Cable: SATRONICS San Juan

URUGUAY
Pablo Ferrando
S.A. Comercial e Industrial
Avenida Italia 2877
Casilla de Correo 370
Montevideo
Tel: 40-3102
Cable: RADIUM Montevideo

VENEZUELA
Citec, C.A.
Edif. Arisan-Of. #4
Avda. Francisco de Miranda
Apartado del Este 10934 Chacaito
Caracas
Tel: 71.88.05
Cable: CITECAL Caracas

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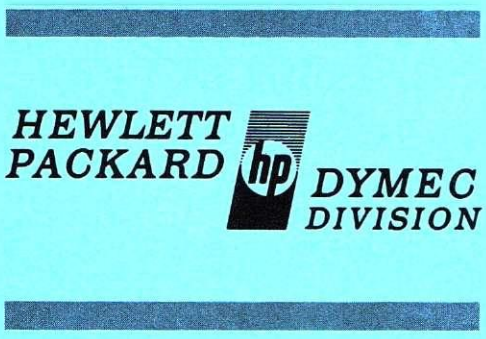
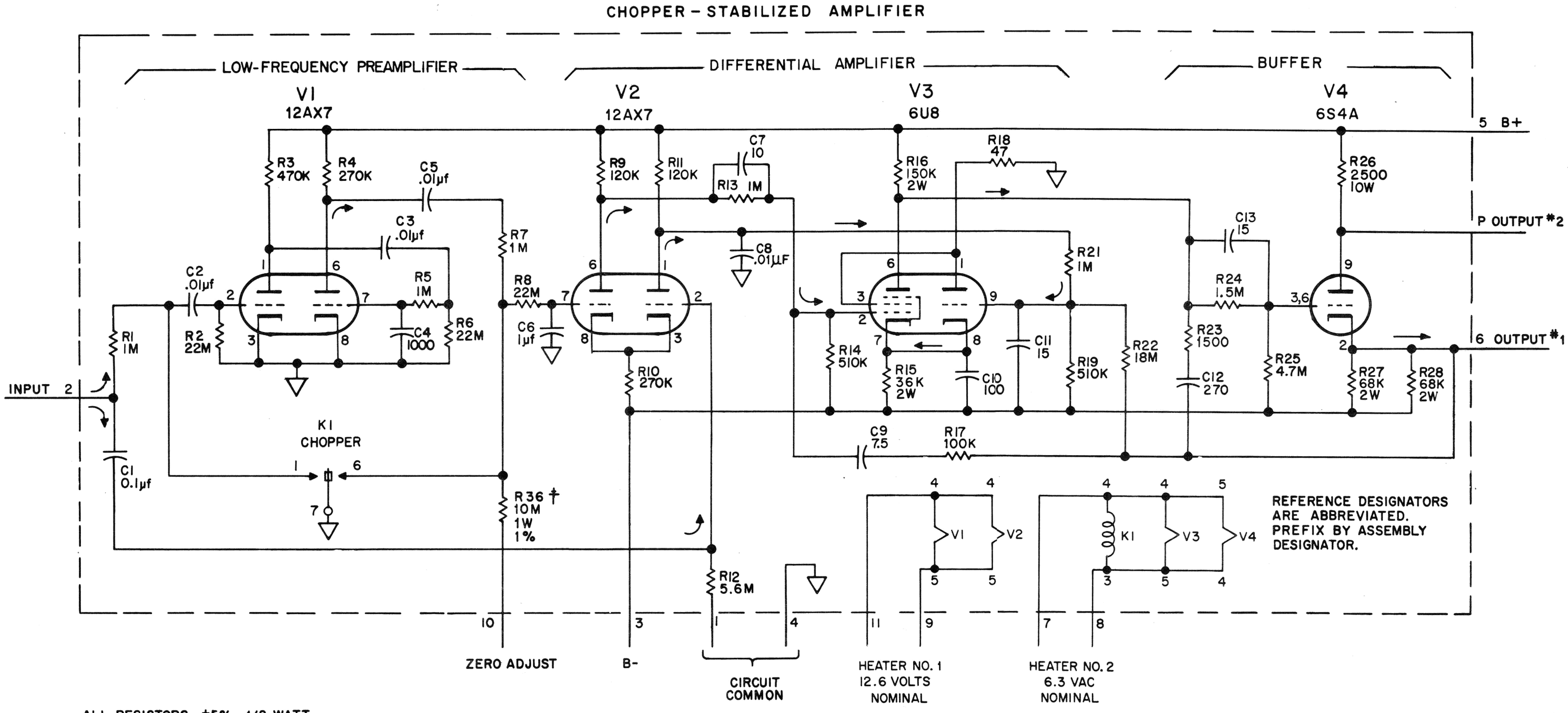

HEWLETT
PACKARD
hp
DYMEC
DIVISION



ALL RESISTORS ±5%, 1/2 WATT UNLESS OTHERWISE NOTED.

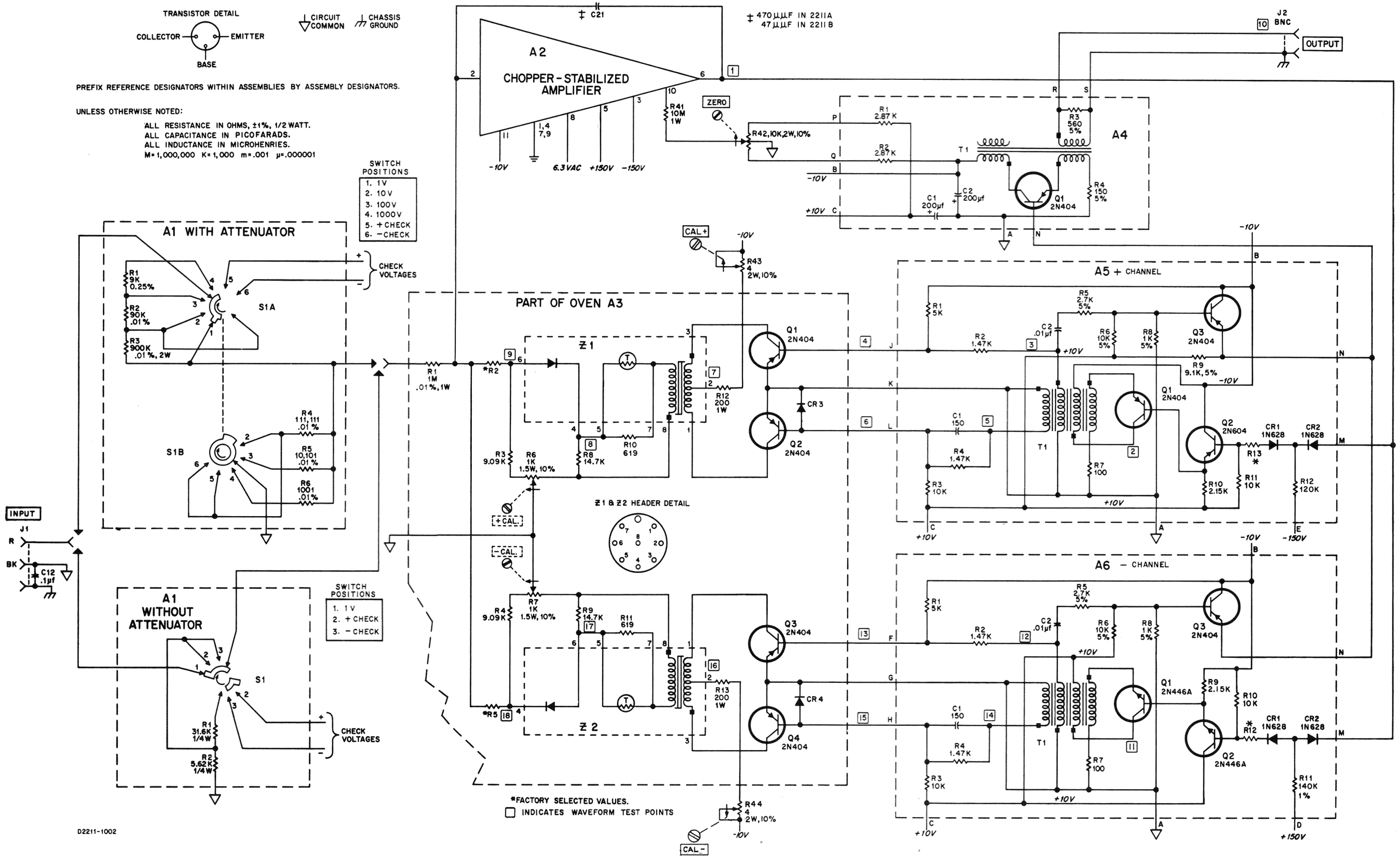
† R36 ADDED TO AMPLIFIER CARD FOR DY-2410B USE.

⏚ = CIRCUIT COMMON

C 2410-1008

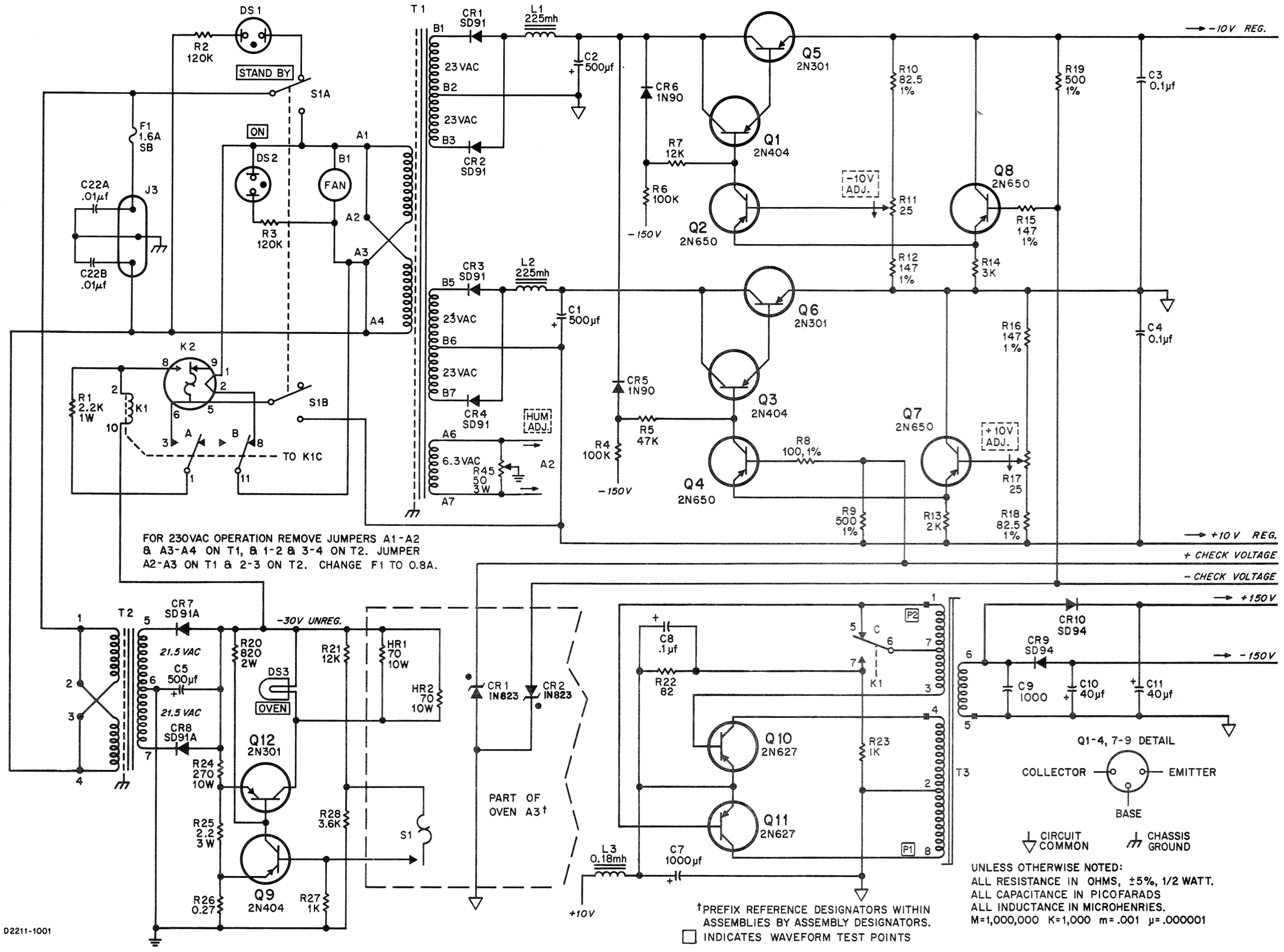
CHOPPER-STABILIZED AMPLIFIER

FIGURE 4-5



DY-2211A/B VOLTAGE-TO-FREQUENCY CONVERTER
(LESS POWER SUPPLY)
SERIALS PREF. 323-

FIGURE 4-6



DY-2211A/B VOLTAGE-TO-FREQUENCY CONVERTER

POWER SUPPLY

SERIALS PREFIXED 323-

FIGURE 4-7