523C/D

HEWLETT-PACKARD COMPANY / OPERATING AND SERVICE MANUAL

523C/D

ELECTRONIC COUNTER

522 B

THIS MANUAL COVERS A SPECIAL MODIFICATION OF THE INSTRUMENT. SEE INSIDE COVER

523C/D

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.

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OPERATING AND SERVICE MANUAL

MODELS 523C AND 523D

SERIALS PREFIXED: 139 -

ELECTRONIC COUNTERS

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SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The ⓗⓟ Models 523C and 523D Electronic Counters are precision frequency and time measuring instruments. They measure frequencies from 10 cps to 1.2 mc directly and determine frequencies below 100 kc by period measurement. They measure the time interval between two electrical events with a resolution of 1 microsecond, whether the events occur on the same or different signals. The instruments can also measure phase, frequency ratio, and totalize random or periodic events.

1-3. The Models 523C and 523D are identical except for type of readout. The Model 523C uses six digital display tubes behind a light filter, and can blank the readout during counter time. The Model 523D uses six numbered masks, illuminating one number in each mask; the readout is visible at all times.

1-4. The text throughout this manual refers to the Models 523C/D except as specifically noted.

1-5. INSTRUMENT IDENTIFICATION.

1-6. Hewlett-Packard uses a two-section eight-digit serial number (000-00000). If the first three digits of the serial number on your instrument do not agree with those on the title page of this manual, change sheets supplied with the manual will define differences between your instrument and the Model 523C/D described.

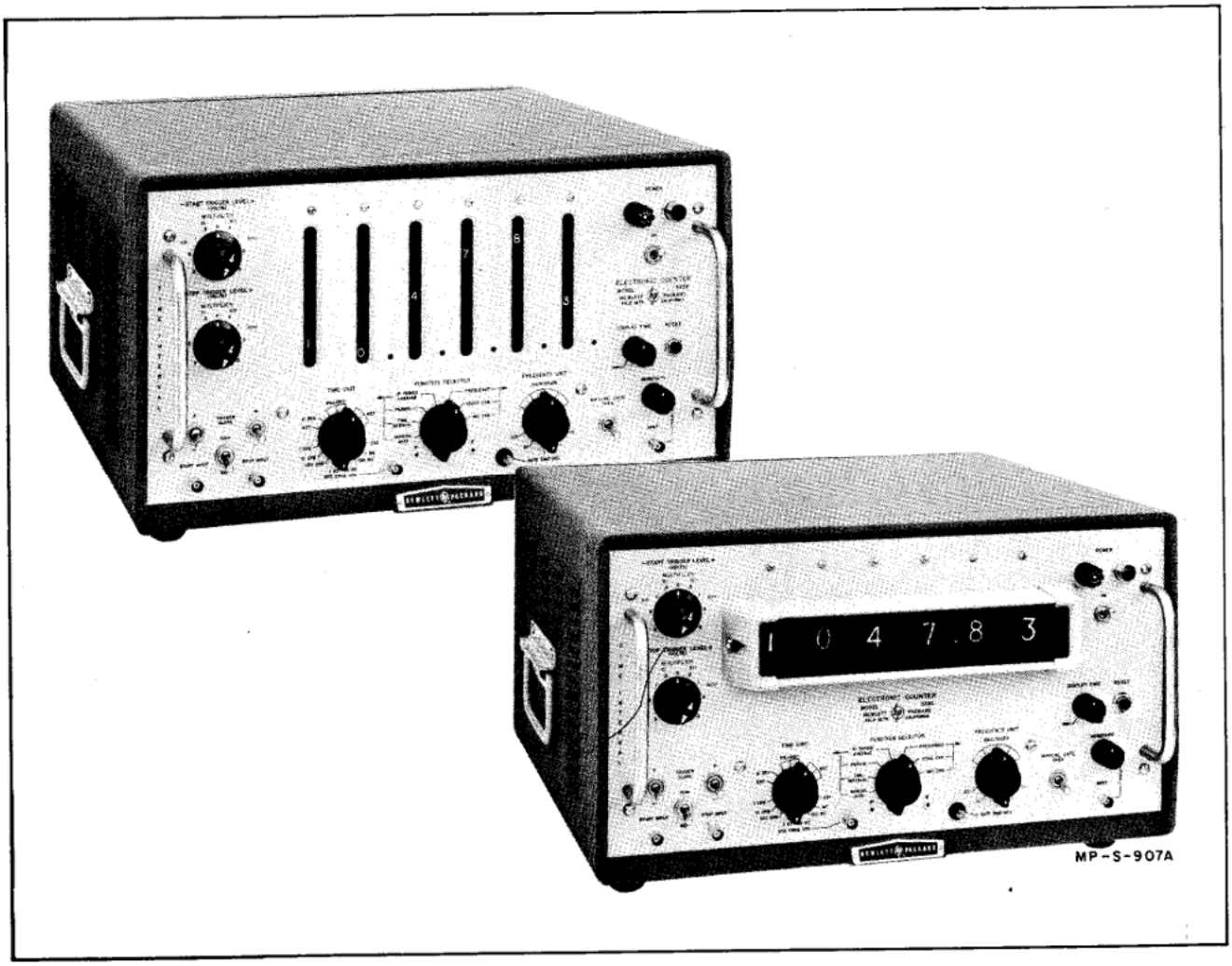

Figure 1-1. ⓗⓟ Models 523C/D Electronic Counters

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Table 1-1. Specifications

FREQUENCY MEASUREMENT

Range:
10 cps to 1.2 mc
cycles per second;

Accuracy:
±1 count ± time base accuracy

Input Sensitivity:
0.1 volt rms, adjustable to 150 volts rms maximum input.
real rms sq-wave

Input Trigger Levels:
Stop channel may be used so that only signals meeting conditions set by trigger level controls are counted. Slope may be + or -, level -300 to +300 volts.

Input Impedance:
Approximately 1 megohm, 50 pf shunt

Gate Time:
.001, .01, .1, 1, 10 seconds

Reads In:
Kilocycles; automatic illuminated decimal point

PERIOD MEASUREMENT

Range:
.00001 cps to 100 kc

Accuracy Measuring Sine Waves*:
10 period: ±0.003% ±1 count ± time base accuracy (at 1 volt rms input), ±0.03% ±1 count ± time base accuracy (at 0.1 volt rms input).

1 period: ±0.03% ±1 count ± time base accuracy (at 1 volt rms input), ±0.3% ±1 count ± time base accuracy (at 0.1 volt rms input).

Input Requirements:
0.1 volt rms minimum; direct coupled

Input Impedance:
Approximately 1 megohm shunted by 50 pf

Measurement Period:
1 or 10 cycles of unknown

PERIOD MEASUREMENT (Cont'd)

Standard Frequency Counted:
1 cps, 10 cps, 100 cps, 1 kc, 10 kc, 100 kc, 1 mc, or externally applied signal, 10 cps to 1.2 mc, 0.1 volt rms minimum.

Reads In:
Seconds, milliseconds, microseconds, automatic illuminated decimal point.

TIME INTERVAL MEASUREMENT

Range:
1 microsecond to 10^6 seconds

Accuracy (Pulse Input)*:
±1 count ± time base accuracy

Input Impedance:
Approximately 1 megohm, 50 pf shunt

Input Requirements:
0.1 volt rms minimum. Direct coupled or ac coupled input.

Start and Stop Input:
Separate channels with independent controls. Separate or common input.

Start and Stop Marker Output:
Separate output pulses, each approximately 5μsec duration and - 20 volts peak, available at rear of instrument for oscilloscope intensity modulation to mark start and stop points on input waveform. May be combined with SEP-COM switch on rear of instrument.

Trigger Slope:
Positive or negative on start and stop channels

Trigger Amplitude:
Continuously adjustable on both input channels from -300 to +300 volts

Standard Frequency Counted:
1 cps, 10 cps, 100 cps, 1 kc, 10 kc, 100 kc, 1 mc; external.

Reads In:
Seconds, milliseconds, microseconds, with automatic illuminated decimal point.

* For any waveshape: Error = $\pm \left(\frac{0.0025}{\text{signal slope (volts}/\mu\text{sec)}}\right)$ μsec ±1 count ± stability; below 0.1 cps maximum error may increase up to 10 fold depending upon line voltage and environmental conditions.

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Table 1-1. Specifications (Cont'd)

PHASE MEASUREMENT

Range:
1 cps to 20 kc, dc coupled; 50 cps to 20 kc, ac coupled.

Input Voltage:
5 to 10 volts rms, pure sinusoidal signal

Accuracy:
$\pm 0.1^{o} \pm f / 360$ where f_c is the counted frequency and f_p is the measured frequency.

RATIO MEASUREMENT

Displays f_1/f_2, or 10 f_1/f_2 as an integer, with accuracy of ±1. f_1: 10 cycles, to 1.2 mc; f_2: 0.00001 cps to 100 kc.

TOTALIZE

Electrical events, periodic or random to 999999 at rates to 1,200,000/sec.

GENERAL

Registration:
523CR: Six digital display tubes, single line.
523DR: Six decimal places each indicated by lighted numbers.

Stability:
2/1,000,000 per week

Answer Display Time:
Variable from approximately 0.1 to 10 seconds; display can be held until manually reset.

Self-Check:
Automatic count of 100 kc and 1 mc frequencies to assure proper operation of counter.

Output Frequencies:
Secondary standard frequencies available at front panel; 1 cps, 10 cps, 100 cps, 1 kc, 10 kc rectangular 100 kc and 1 mc sine wave; 0.5 volt p-p; stability $2/10^6$ per week.

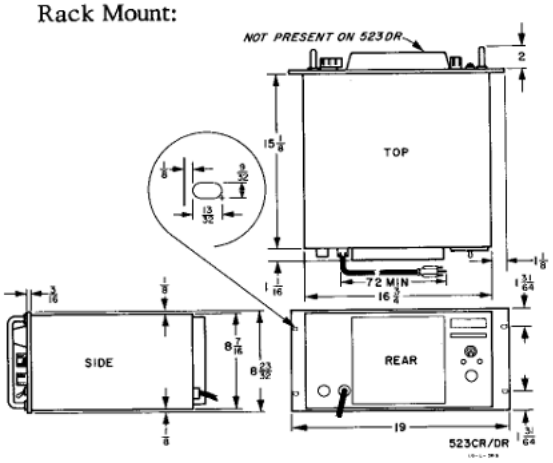
External Standard:
100 kc from external primary standard can be applied to unit for highest accuracy; minimum input: 1 volt rms.

Power Supply:
115 or 230 volts ±10%, 50 to 60 cps, approximately 350 watts.

GENERAL (Cont'd)

Dimensions:
Cabinet Mount: 20-1/2 in. wide, 11-1/4 in. high, 18-3/4 in. deep

Rack Mount:



Weight:
Net 48 lbs, shipping 85 lbs

Accessories Furnished:
Two ⓗⓟ AC-16K Cable Assembly, 4 feet of RG-58/U 50-ohm coaxial cable terminated at each end with UG-88/U Type BNC male connectors.

Accessories Available:
K05-523C Remote Indicator for 523C
K07-523C Cable for K05-523C, specify length (100 ft maximum).

Options:
Ten-line decimal code output for operating ⓗⓟ Model 561B Digital Recorder or K05-523C Remote Indicator, 523C-95B installed (523C/CR only)

Single line decimal code (staircase) for operating ⓗⓟ Model 560A Digital Recorder, 523D-95A installed

Four-line BCD (1-2-2-4) output for Dymec and other instrument, specify by prefixing model number with H80, i.e. H80-523DR.

Digital Recorder Kits for Field Installation:
523D-95A (for 560A Digital Recorder)
523C-95B (for 561B Digital Recorder)

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SECTION II
INSTALLATION

2-1. UNPACKING AND INSPECTION.

2-2. Unpack the instrument upon receipt and inspect it for signs of physical damage such as scratched panel surfaces, broken knobs, etc. If there is any apparent damage, file a claim with the carrier and refer to the warranty page in this manual.

2-3. An electrical inspection should be performed as soon as possible after receipt. To aid in electrical inspection a list of performance checks are in section V, paragraph 5-43. These procedures make a good test as part of incoming quality-control inspection.

2-4. REPACKING FOR SHIPMENT.

2-5. The following list is a general guide for repackaging an instrument for shipment. If you have any questions, contact your authorized Hewlett-Packard sales representative.

a. If possible, use the original container designed for the instrument.

b. Wrap the instrument in heavy paper or plastic before placing it in the shipping container.

c. Use plenty of packing material around all sides of the instrument and protect the panel with cardboard strips.

d. Use heavy cardboard carton or wooden box to house the instrument and use heavy tape or metal bands to seal the container.

e. Mark the packing box with "Fragile", "Delicate Instrument", etc.

Note

If the instrument is to be shipped to Hewlett-Packard Company for service or repair, attach to the instrument a tag identifying the owner and indicating the service or repair to be accomplished. In any correspondence be sure to identify the instrument by model number, serial prefix, and serial number.

2-6. POWER REQUIREMENTS.

2-7. The Model 523C/D requires a power source of 115 or 230 volts ±10%, 50-60 cps, 350 watts.

2-8. POWER CABLE.

2-9. To protect operating personnel, the National Electrical Manufacturers' Association recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground pin.

2-10. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

2-11. 230-VOLT OPERATION.

2-12. The Model 523C/D is normally wired for operation from a nominal 115-volt supply. Operation from a 230-volt source is easily accomplished as follows:

a. Change power transformer and crystal oven connections as shown on figure 5-9, Power Supply. (Thermistor RT202 limits the initial current surge to the power transformer T201 when the instrument is first turned on.)

b. Change crystal oven arc suppressor components R201 to 22 ohms and C201 to .001 μf, and add R229 (20K, 3W) in parallel with the arc suppressor.

c. Change line fuse F202 to the type specified for 230-volt operation in section VI, table 6-2.

2-13. INSTALLATION.

2-14. The standard Model 523C/D Electronic Counter is a cabinet-mounted portable instrument requiring no permanent installation. The instrument is intended to be operated with its front panel in a vertical or near-vertical plane.

2-15. RACK MOUNTING.

2-16. The Rack Mount Models 523CR and 523DR are designed for installation in a 19-inch rack, requiring 8-3/4 inches of vertical space.

2-17. COOLING.

2-18. The Model 523C/D uses forced air cooling. The air intake and filter are located on the rear of the instrument. For proper ventilation, leave at least three inches of clearance behind the air intake. In addition, be certain that no other instruments discharge warm air into the intake of the Model 523C/D.

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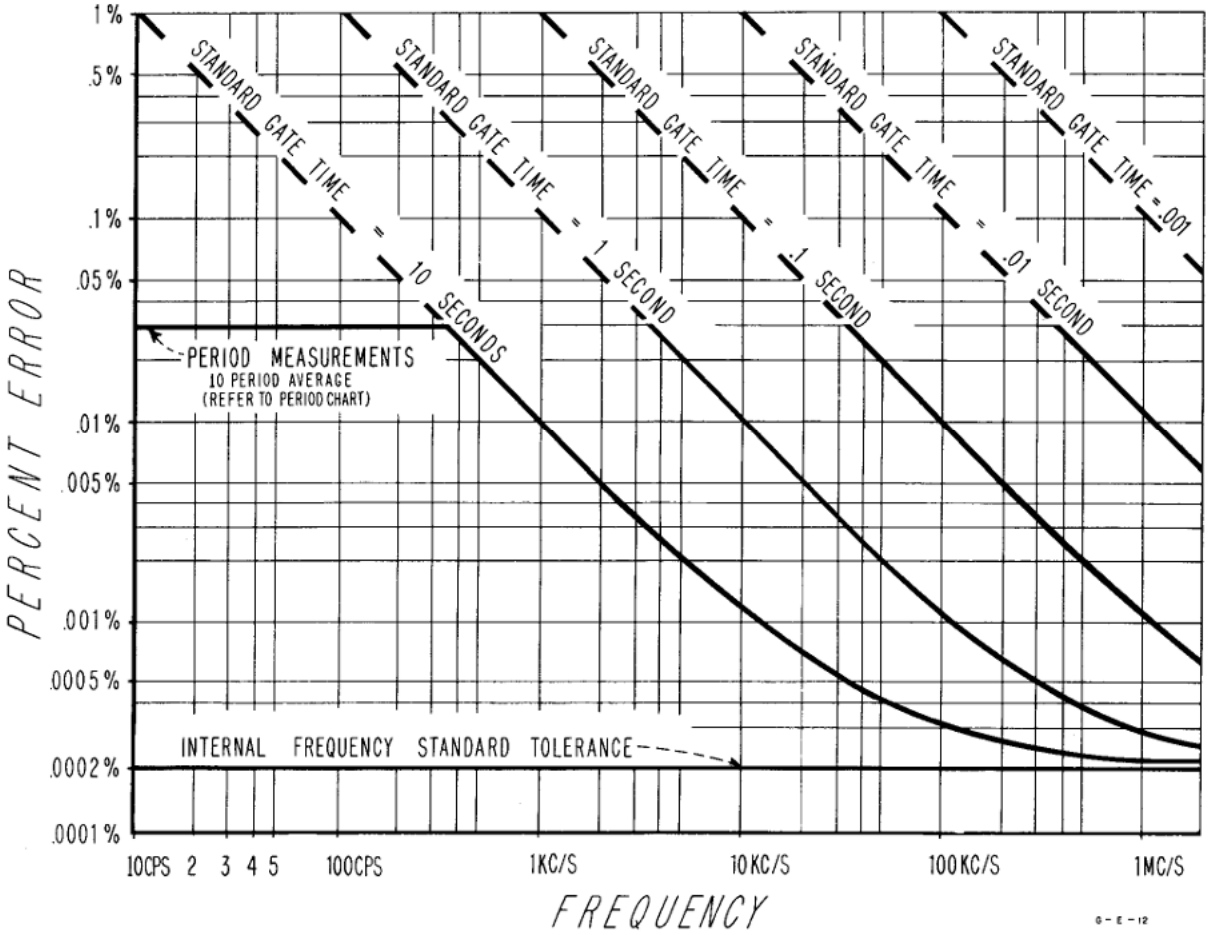

Figure 3-1. Frequency Measurement Accuracy Curves

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SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains operating instructions and general operating information. Instructions covering basic measurements are given in figures 3-12 through 3-18, paragraph 3-31. The remainder of this section is supporting material to give some understanding of the basic operating principles.

3-3. INSTRUMENT WARMUP.

3-4. The crystal oven requires a half hour to reach operating temperature from a cold start. The rest of the instrument requires only a five-minute warmup and should yield proper self-check readings during crystal-oven warmup.

3-5. To maintain the specified crystal stability at all times, keep the instrument connected to the power source. The crystal oven remains in operation even with the power switch off, and the overall warmup time is reduced to five minutes.

3-6. EXTERNAL STANDARD.

3-7. To use an external standard in place of the internal oscillator, set the 100 KC STANDARD switch on the rear of the instrument to EXT, and connect the external standard to the INPUT connector, also on the rear of the instrument. The signal must be at least 1 volt rms.

3-8. FREQUENCY MEASUREMENT.

3-9. For frequency measurements, the Model 523C/D operates as indicated in figure 3-2. The time base controls the opening and closing of the signal gate, and the signal to be measured is totalized for an accurately controlled period of time. The decimal point is automatically positioned to give readings in kilocycles.

3-10. The accuracy of frequency measurements is determined by the stability of the internal oscillator and the ±1 count ambiguity inherent in the counter-type instrument. The graph of figure 3-1 shows the accuracy possible for each of the five standard gate times. Below 100 kc even on the 10-second gate the ±1 count ambiguity is the primary factor in determining the accuracy, and below 1 kc period measurement may or may not be more accurate, depending upon waveform and signal-to-noise ratio (see figure 3-3).

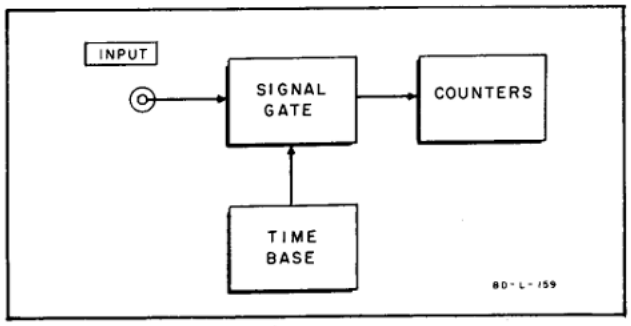

Figure 3-2. Basic Block Diagram of Model 523C/D for Frequency Measurements

3-11. The shorter gate times can provide a greater number of readings per unit time and are useful when the input signal varies. On the two shortest gate times, the display appears to be continuous and to instantly follow any variation in input frequency.

3-12. The Model 523C/D will ordinarily count pulses of either polarity. However, if the signal consists of short, low-amplitude pulses, you may have to adjust the frequency sensitivity to obtain a count. Make the adjustment as follows:

a. Connect signal to INPUT connector.

b. Set:

FUNCTION SELECTOR . . . . . FREQUENCY
FREQUENCY UNIT 1
SENSITIVITY. . . . . maximum clockwise
DISPLAY TIME . . . . . MIN

c. Adjust R406 F (frequency sensitivity) until instrument counts. Figure 5-2 shows location of F control.

Note

To return the frequency sensitivity to its proper adjustment, see section V.

3-13. Complex and noisy signals may produce more than one count per cycle when counted in the normal manner. By using the stop time-interval channel, you can measure the frequency of such signals directly (up to a maximum of 100 kc). The stop channel permits you to select three conditions which the input signal must meet to produce a count. The conditions are voltage level, slope and polarity. (Slope defines a signal as positive-going or negative-going; it does not refer to rate of change.) The STOP TRIGGER LEVEL controls determine the voltage level and polarity; the stop TRIGGER SLOPE switch determines the slope.

3-14. Each time the input signal meets the selected conditions, that is, each time the input signal crosses the selected voltage level with the selected slope, the stop channel produces a negative pulse at the STOP output connector on the rear of the instrument. With this connector connected to the signal INPUT connector the counter will register a count each time the input signal meets the selected conditions. If you select conditions which the input signal meets but once per cycle, the counter readout will be the signal frequency. Proceed as follows:

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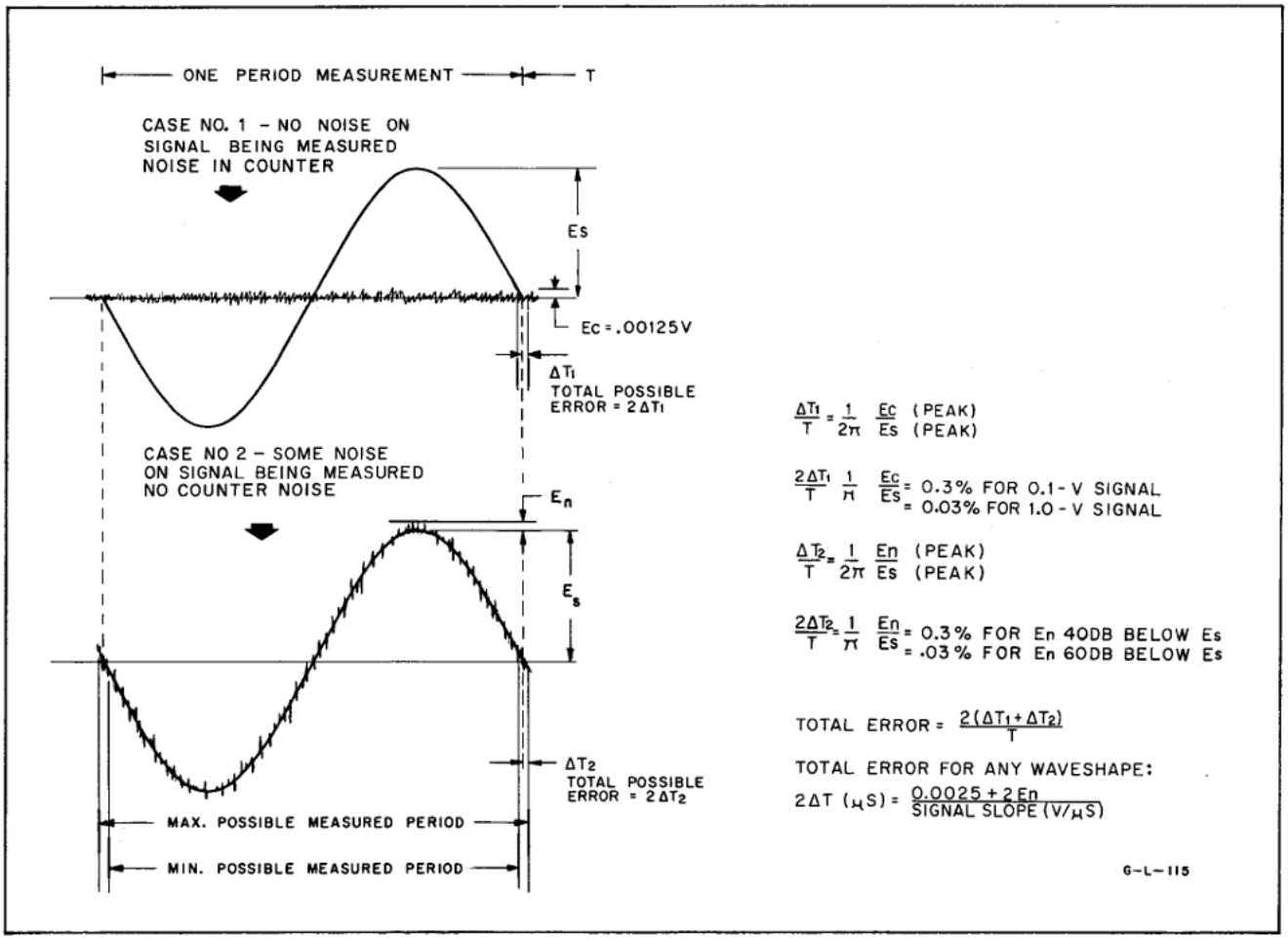

Figure 3-3. Period Measurement Errors due to Noise

a. Set:
FUNCTION SELECTOR . . . . . FREQUENCY
FREQUENCY UNIT . . . . . desired gate time
DISPLAY TIME . . . . . MIN
both COM-SEP switches (front and rear of instrument) to SEP.

b. Connect STOP connector on instrument rear to signal INPUT connector.

c. Set SENSITIVITY control slightly counterclockwise from point where stop-channel noise produces a count.

d. Connect signal to be counted to STOP INPUT connector.

e. Set STOP TRIGGER LEVEL controls and stop TRIGGER SLOPE switch as desired, and read frequency of input signal.

3-15. PERIOD MEASUREMENT.

3-16. For period measurements, the Model 523C/D operates as indicated in figure 3-4. The input signal opens and closes the signal gate, and the counters totalize the time base output. Thus, the readout is the number of time units counted during one period of the input signal. The decimal point is positioned to give readings in μsec, millisec or secs.

3-17. The accuracy of period measurements of sine waves depends primarily on the signal-to-noise ratio (see figure 3-3). However, the measured period of rectangular waveforms and pulses is unaffected by small amounts of noise; thus, the accuracy of period

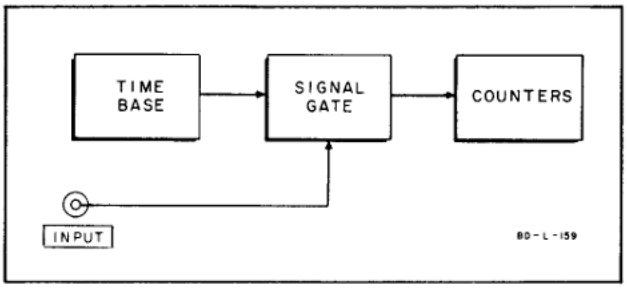

Figure 3-4. Basic Block Diagram of Model 523C/D for Period Measurements

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measurements of such signals depends only on the oscillator stability and the ±1 count ambiguity (see figure 3-5). The period curves of figure 3-5 are for ten period average measurements; for period measurement, multiply the indicated error by ten.

3-18. Period measurement is used to determine low frequencies. However, in the range from 10 cps to 100 kc, both direct frequency measurement and period measurement are possible. The choice of which type of measurement to use depends upon signal waveform, signal-to-noise ratio, degree of accuracy desired, rate at which ratings are to be repeated, and convenience of reading (period readings may be converted into frequency).

3-19. The period measurement input circuits are dc coupled to follow the slow variations of low-frequency signals. The circuits are adjusted so the measurement starts as the input signal crosses zero volts going from positive to negative and stops the next time the signal crosses zero volts going in the same direction. The zero-volt point is used because it is generally the region of maximum slope of a signal and so permits the greatest accuracy. A dc component in the input signal may shift the signal so that the maximum slope no longer occurs at zero volts and so cause a loss of accuracy. The last equation of figure 3-3 shows the relationship between signal slope and accuracy.

3-20. If a signal consists of positive or negative pulses, it may never cross zero volts. To measure the period of such signals, you must adjust the period sensitivity to start and stop the measurement at some other voltage. Proceed as follows:

a. Set:

FUNCTION SELECTOR . . . . . PERIOD
TIME UNIT . . . . . as desired
DISPLAY TIME . . . . . MIN

b. Connect signal to signal INPUT connector.

c. Adjust R416, PERIOD sensitivity control, until instrument gives consistent count. Figure 5-6 shows location of PERIOD sensitivity control.

Note

To return the period sensitivity to its proper adjustment, see section V.

3-21. TIME INTERVAL MEASUREMENT.

3-22. For time interval measurements, the 523C/D operates as indicated in figure 3-6. Time interval measurement is similar to period measurement except that you can 1) use separate signals to open and close the signal gate, 2) select the voltage level, polarity, and slope the signals must have to actuate the

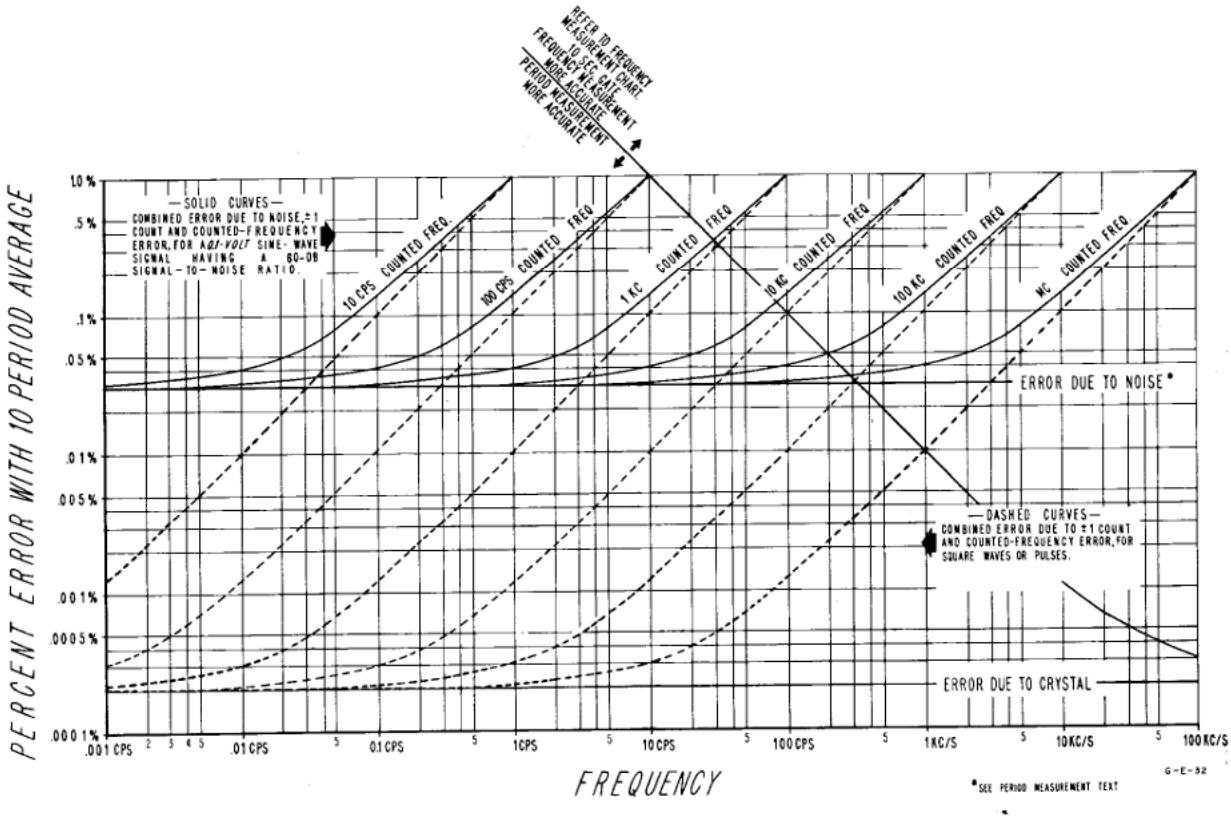

Figure 3-5. Period Measurement Accuracy Curves

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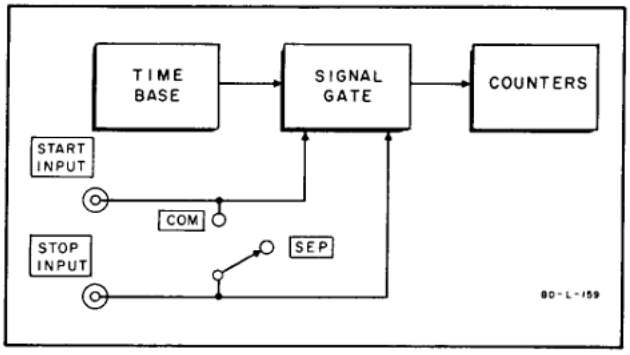

Figure 3-6. Basic Block Diagram of Model 523C/D for Time Interval Measurements

signal gate, and 3) select either dc coupling (to allow slow voltage variations to actuate the signal gate) or ac coupling (to eliminate any dc component).

3-23. To make accurate time interval measurements you may have to pay close attention to the START and STOP TRIGGER LEVEL settings. To measure the interval A-D of figure 3-7, it makes no difference if you actually measure A-C, B-C or B-D. However, to measure A-D of figure 3-8, you must be more careful. To facilitate the proper setting of the TRIGGER LEVEL controls, the 523C/D provides a negative output pulse when the signal gate opens and another when the signal gate closes. These pulses are available at the START and STOP output connectors on the rear of the instrument. To use these pulses, apply the start and/or stop signal to an oscilloscope and intensity modulate the trace with the output pulses from the Model 523C/D. Bright spots will appear on the waveform at the points where the measurement starts and stops. Thus, by watching the oscilloscope as you adjust the start and/or stop controls, you can set the controls exactly.

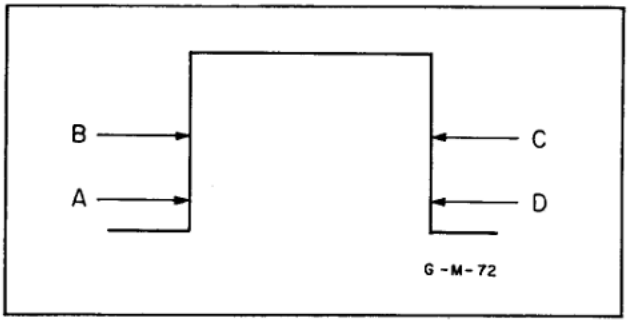

Figure 3-7. Time Interval Measurements on a Simple Waveform

3-24. PHASE MEASUREMENT.

3-25. Phase measurement is actually a special application of time interval measurement. You measure the time interval between like points on two similar waveforms and relate the reading to phase angle. The measurement is made between the points where the signals cross 0 volt going in the same direction. The zero-crossing is the reference point for two reasons: first, it is the easiest point to determine accurately on the counter; and second, it is generally in the region of maximum slope, allowing maximum resolution.

3-26. Phase difference is measured in time units if one of the internal standard frequencies is counted. The following formula converts time to phase:

$$\text{Phase difference in degrees} = \frac{360 \times \text{time interval}}{\text{period of either signal}}$$

If the two signals are not equal in amplitude, use the larger for the period measurement. You can measure phase directly in degrees if you apply the appropriate external frequency (360 x frequency of signals whose phase you are measuring) to the counters in place of an internal standard frequency. However, the external frequency cannot exceed the 1.2 mc maximum counting rate of the instrument.

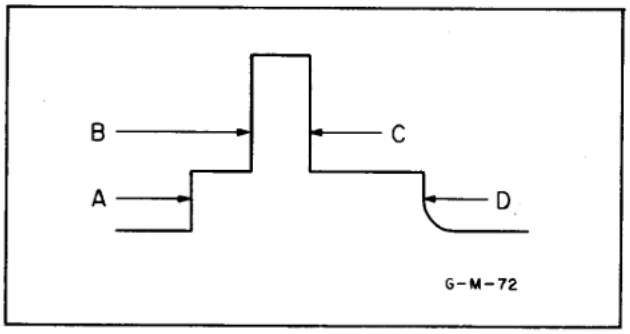

Figure 3-8. Time Interval Measurements on a Complex Waveform

3-27. RATIO MEASUREMENT.

3-28. The Model 523C/D operates as indicated in figure 3-9 when measuring frequency ratio. Ratio measurement is similar to period measurement except that an external signal replaces time base output. The counted frequency must be higher than the signal frequency controlling signal gate. The readout indicates the number of higher-frequency cycles per cycle or per ten cycles of the lower signal. Ratio measurement accuracy is indicated in figure 3-10.

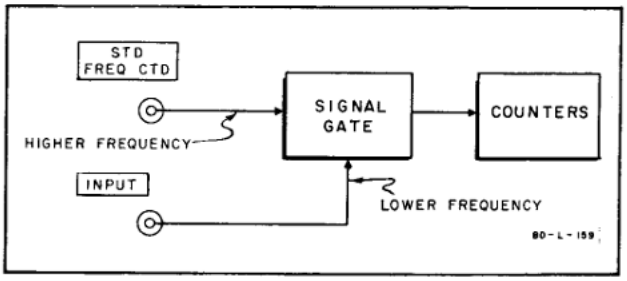

Figure 3-9. Basic Block Diagram of Model 523C/D for Frequency Ratio Measurements

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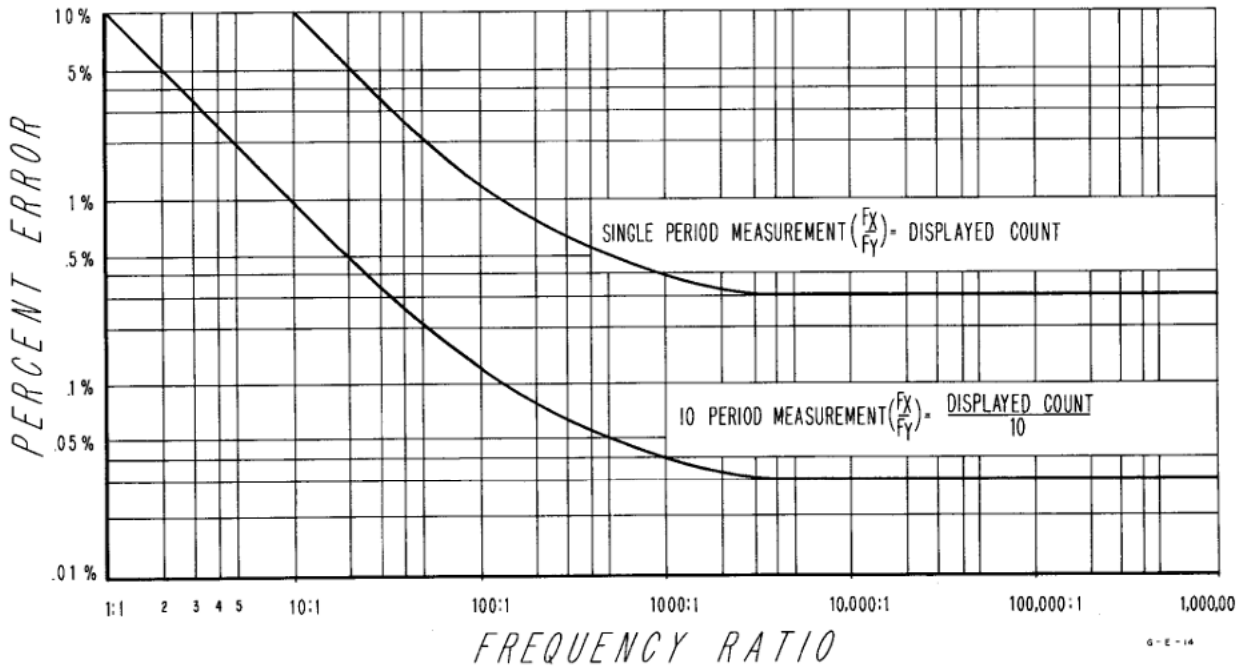

Figure 3-10. Ratio Measurement Accuracy Curves

3-29. TOTALIZING.

3-30. The Model 523C/D operates as indicated in figure 3-11 when totalizing. In this case, MANUAL GATE switch controls the signal gate, and the readout is a running total of electrical events occurring from the time signal gate opens until it closes.

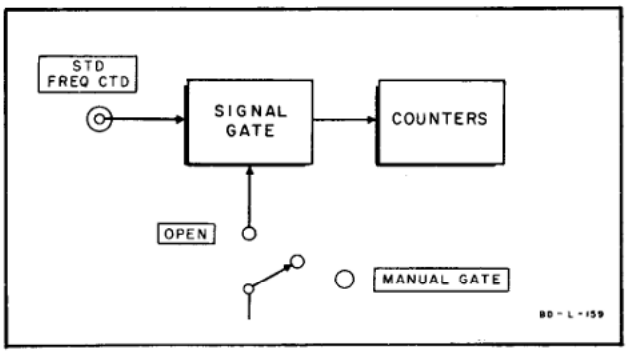

Figure 3-11. Basic Block Diagram of Model 523C/D for Totalizing

3-31. OPERATING INSTRUCTIONS.

3-32. Operating instructions are given on the following pages. If the instrument has been out of operation, make self-check (figure 3-12) before proceeding. Procedures are given for frequency, period, time interval, phase, and ratio measurement, and for totalizing.

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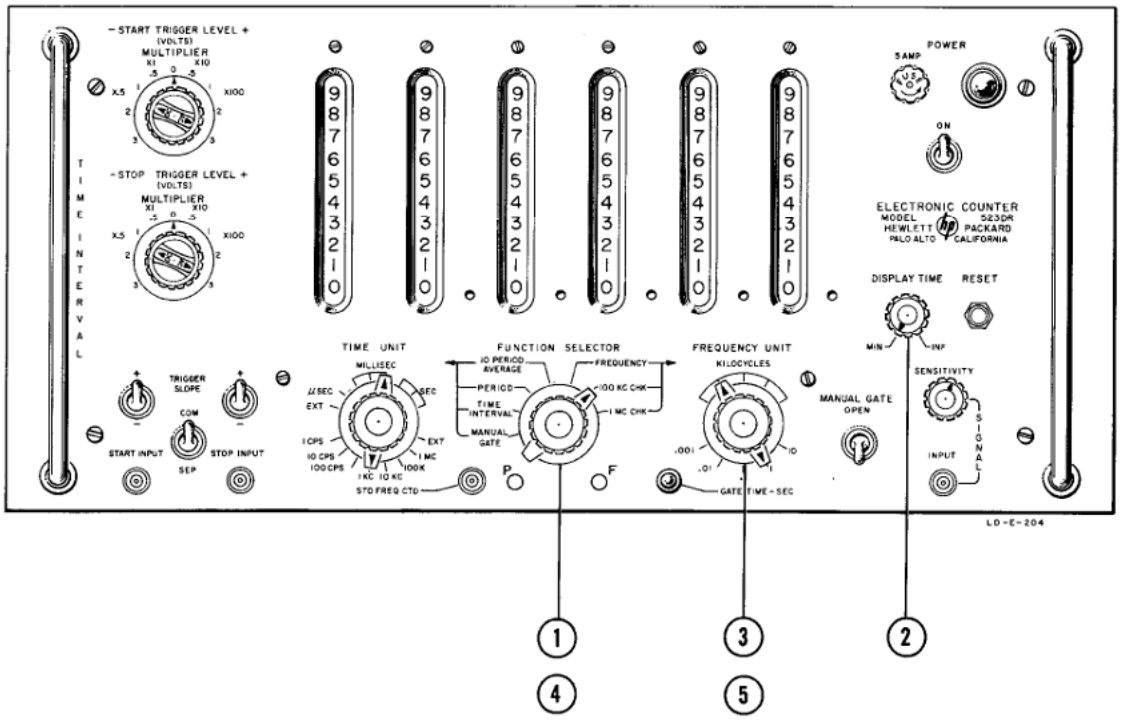

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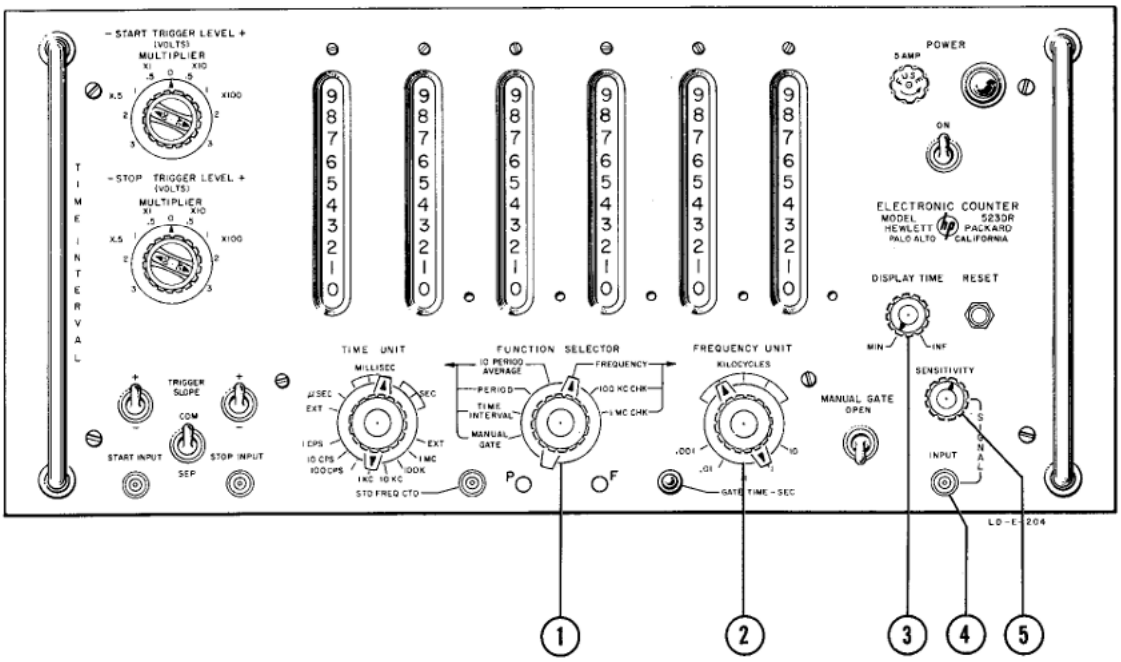
1. Set FUNCTION SELECTOR to 100 KC CHK.
2. Set DISPLAY TIME control to minimum (counterclockwise).
3. Set FREQUENCY UNIT switch to each position and compare counts obtained with corresponding counts on Table below. If counts do not agree, check phantastron adjustments (Section IV).
4. Set FUNCTION SELECTOR to 1 MC CHK.
5. Set FREQUENCY UNIT switch to each position and compare counts obtained with corresponding counts on Table below. If you obtain consistent 2- or 3-count error, check gate length adjust, Section IV.

SELF-CHECK TABLE

Gate Time	100 kc Check	1 mc Check
0.001 sec	000100.	001000. ±1
0.01 sec	00100.0	01000.0 ±.1
0.1 sec	0100.00	1000.00 ±.01
1 sec	100.000	000.000 ±.001
10 sec	00.0000	00.0000 ±.0001

Figure 3-12. Procedure for Self-Check



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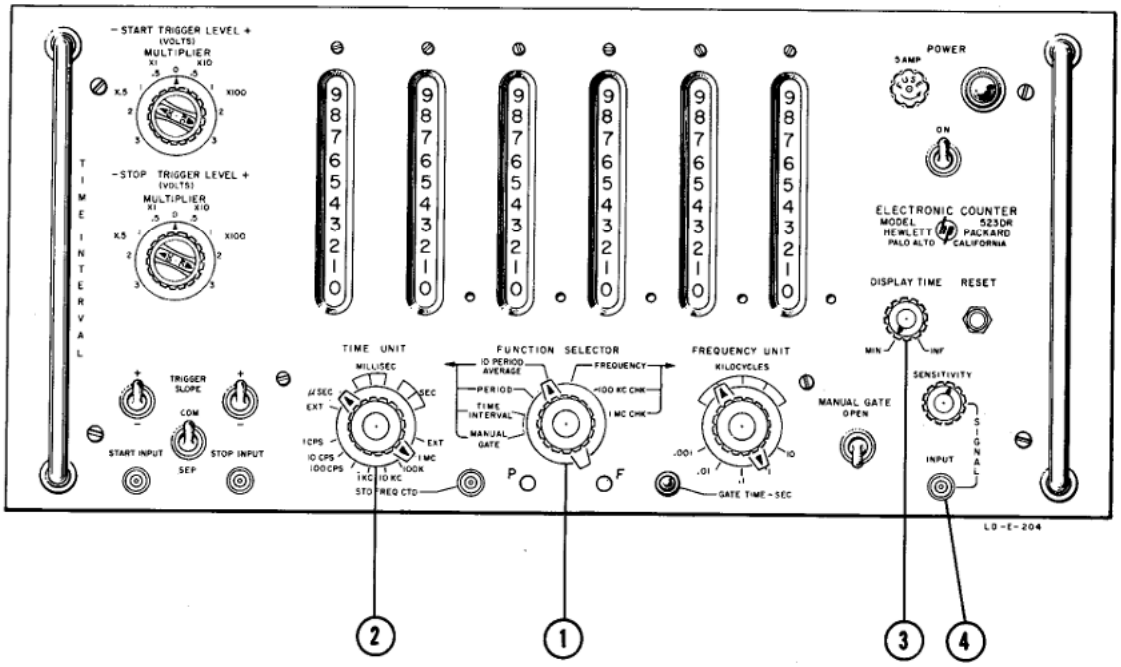
1. Set FUNCTION SELECTOR to FREQUENCY.
2. Set FREQUENCY UNIT switch to desired gate time.
3. Set DISPLAY TIME control to desired display time.
4. Connect signal to INPUT connector.
5. Adjust SENSITIVITY control slightly clockwise from point which just gives reliable count.
6. Read signal frequency in kc.

REFERENCE TABLE

Input signal:	0.1 volt rms to 150 volt rms
Input Impedance:	1 meg. shunted by 40 pf.
Range:	10 cps to 1.2 mc

Figure 3-13. Procedure for Frequency Measurement



1. Set FUNCTION SELECTOR to PERIOD or 10 PERIOD AVERAGE.
2. Set TIME UNIT switch to desired time units.
3. Set DISPLAY TIME control to desired display time.
4. Connect signal to INPUT connector.
5. Read period in time units selected.

REFERENCE TABLE

Input Signal:	0.1 volt to 150 volts rms
Input Impedance:	1 meg. shunted by 50 pf.
Range:	10 μsec to 100,000 sec (100 kc to .00001 cps)

Figure 3-14. Procedure for Period Measurement

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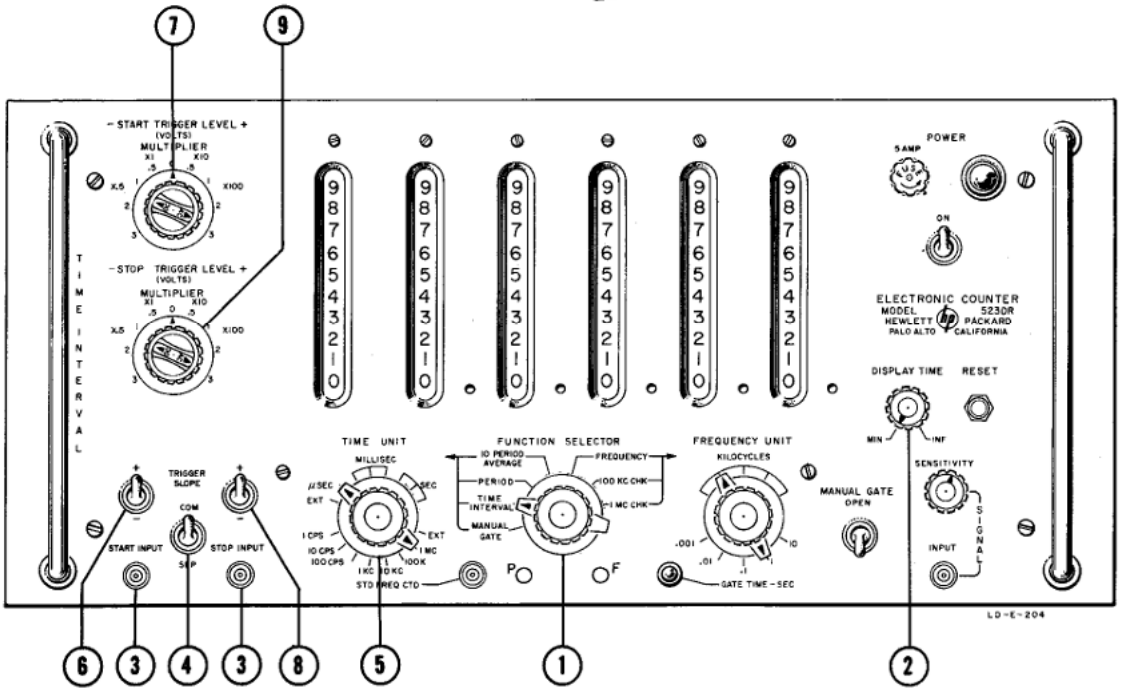


1. Set FUNCTION SELECTOR to TIME INTERVAL.
2. Set DISPLAY TIME control to desired display time.
3. Connect start signal to START INPUT connector and stop signal to STOP INPUT connector.
4. Set COM-SEP switch to SEP. Note: If start and stop signals come from common source, set COM-SEP switch to COM and connect signal to either input connector.
5. Set TIME UNIT switch to desired time units.
6. Set start TRIGGER SLOPE switch to positive to start measurement on positive-going portion of signal; set to negative to start measurement on negative-going portion of signal.
7. Set start TRIGGER LEVEL controls to start measurement at desired voltage level. Select ac or dc coupling when setting MULTIPLIER.
8. Set stop TRIGGER SLOPE switch to positive to stop measurement on positive-going portion of signal; set to negative to stop measurement on negative-going portion of signal.
9. Set stop TRIGGER LEVEL controls to stop measurement at desired voltage level. Select ac or dc coupling when setting MULTIPLIER.

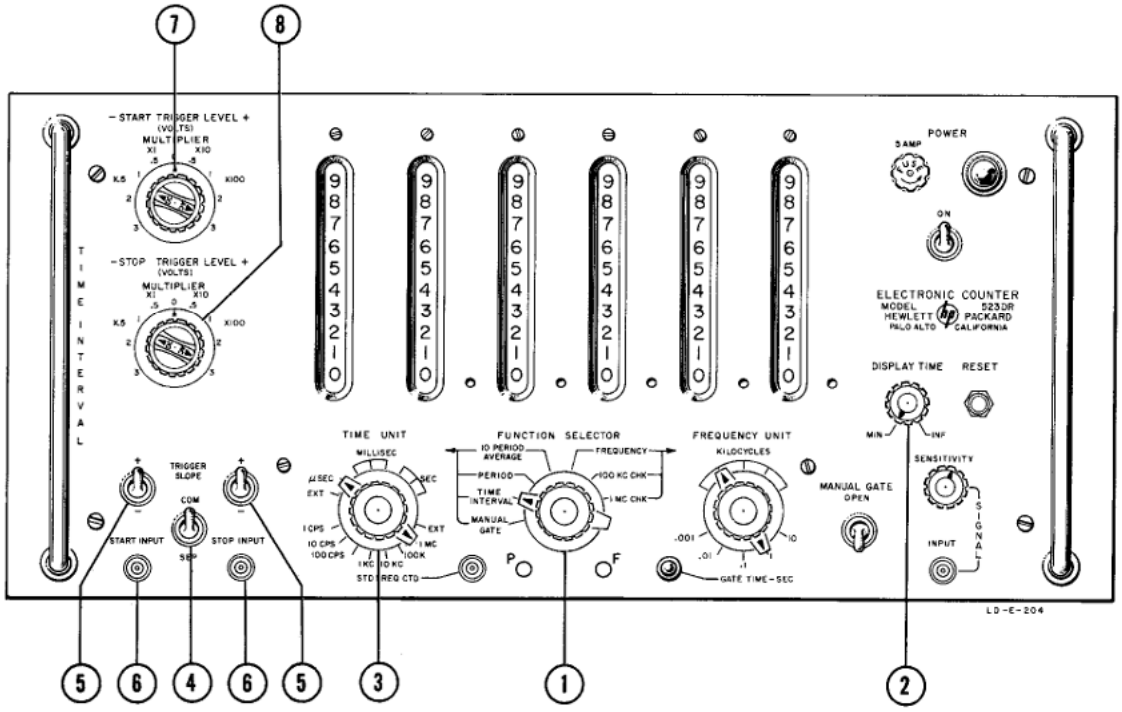
   NOTE: See paragraph 2-6 for using oscilloscope to help set TRIGGER LEVEL controls.

10. Read time interval in units selected by TIME UNIT switch.

REFERENCE TABLE

Input Signal:	±.14 volt to ±300 volt peak
Input Impedance:	1 meg. shunted by 50 pf.
Range:	1 μsec to 100,000 sec

Figure 3-15. Procedure for Time Interval Measurement



1. Set FUNCTION SELECTOR to TIME INTERVAL.
2. Set DISPLAY TIME control to MIN.
3. Set TIME UNIT switch to desired time unit (or to EXT to count external frequency, and connect external frequency to STD FREQ CTD connector).
4. Set COM-SEP switch to SEP.
5. Set start and stop TRIGGER SLOPE switches to same polarity.
6. Connect signals whose phase difference is to be measured to START INPUT and STOP INPUT connectors.
7. Set START TRIGGER LEVEL control for no difference in counter reading as start MULTIPLIER is switched between X.5 and X1. Leave MULTIPLIER switch on X.5. Use DC setting of MULTIPLIER unless start signal has dc component.
8. Set STOP TRIGGER LEVEL control for no difference in counter reading as stop MULTIPLIER is switched between X.5 and X1. Leave MULTIPLIER switch on X.5. Use DC setting of MULTIPLIER unless stop signal has dc component.
9. Read phase difference in units selected by TIME UNIT switch.

REFERENCE TABLE

Input Voltage: 5 to 10 volts rms (sinewave only)

Range: DC: 1 cps to 20 kc; AC: 50 cps to 20 kc.

Accuracy: $\pm 0.1^\circ \pm (f_p/f_c)360$ where f_c is the counted frequency and f_p is the measured frequency.

Figure 3-16. Procedure for Phase Measurement

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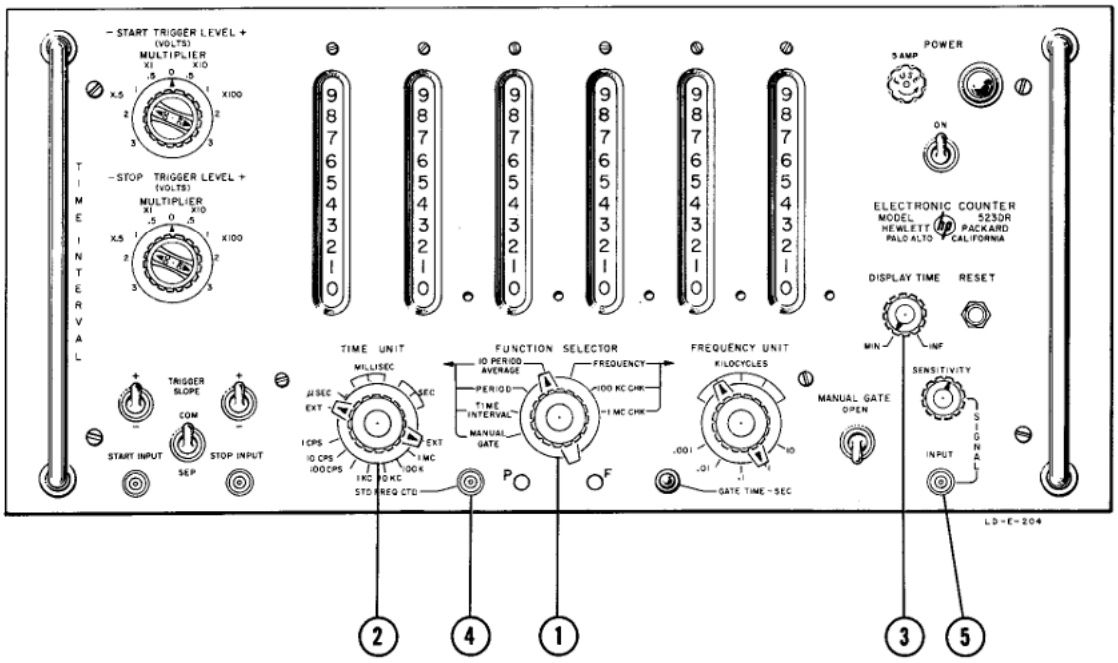

1. Set FUNCTION SELECTOR to PERIOD or 10 PERIOD AVERAGE.
2. Set TIME UNIT switch to EXT.
3. Set DISPLAY TIME control for desired display time.
4. Connect higher frequency to STD FREQ CTD connector.
5. Connect lower frequency to SIGNAL INPUT connector.
6. Readout indicates ratio directly if FUNCTION SELECTOR set to PERIOD; readout indicates ten times ratio if FUNCTION SELECTOR set to 10 PERIOD AVERAGE.

REFERENCE TABLE

STD FREQ CTD connector

Input Signal:	0.1volt rms to 150 volts rms
Input Impedance:	1 meg. shunted by 45 pf.
Range:	10 cps to 1.2 mc

SIGNAL INPUT connector

Input Signal:	0.1volt rms to 150 volts rms
Input Impedance:	1 meg. shunted by 50 pf.
Range:	.00001 cps to 100 kc

Figure 3-17. Procedure for Ratio Measurement

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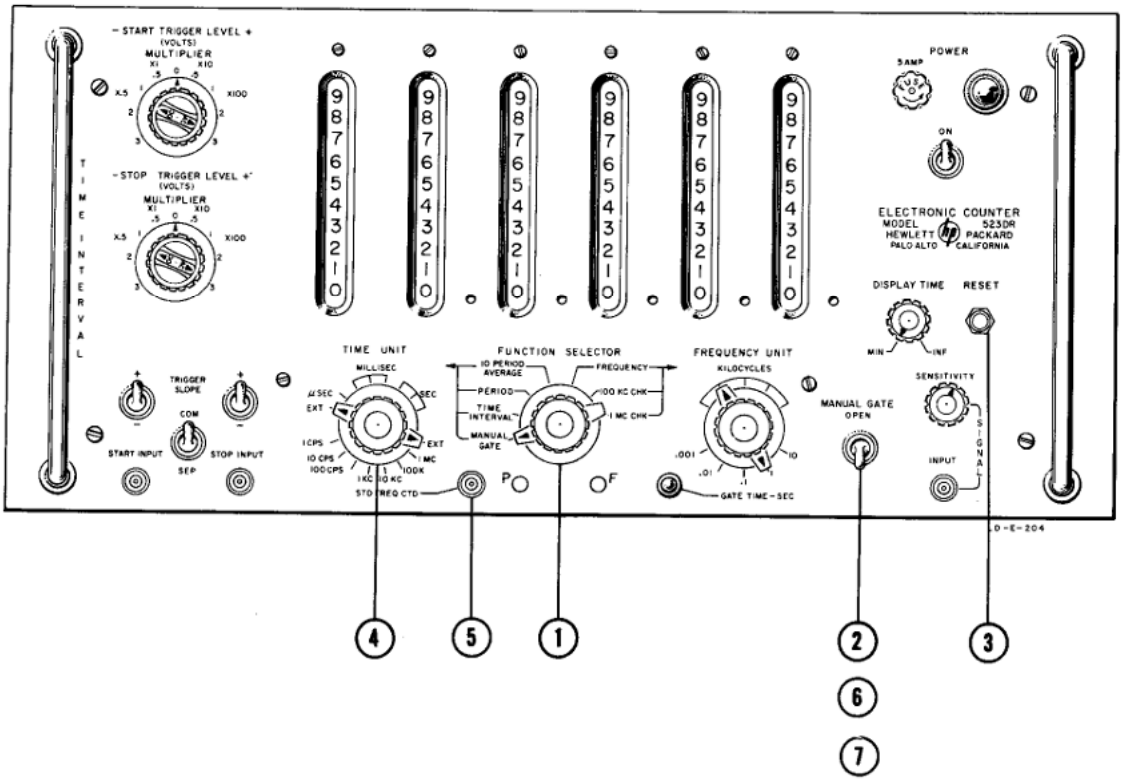

1. Set FUNCTION SELECTOR to MANUAL GATE.
2. Set MANUAL GATE switch to CLOSED.
3. Press RESET switch to set readout to zero.
4. Set TIME UNIT switch to EXT.
5. Connect signal to STD FREQ CTD connector.
6. To start count, set MANUAL GATE switch to OPEN.
7. To end count, set MANUAL GATE switch to down position. Readout indicates number of impulses received.

REFERENCE TABLE

Input Signal:	0.1 volt to 150 volts rms
Input Impedance:	1 meg. shunted by 45 pf.
Range:	10 cps to 1.2 mc

Figure 3-18. Procedure for Totalizing

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SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. The Model 523C/D is basically a totalizing instrument; it counts applied electrical impulses and displays the accumulated total. Six cascaded decade counter units do the actual counting. Other circuits give the count meaning either in terms of frequency (by accurately controlling the opening and closing of a signal gate) or in terms of time (by applying precise frequencies to the counter units). Still other circuits 1) shape the input waveform to allow a variety of waveforms to register on the counters; 2) return the counters to zero prior to each new count, 3) control the time the count is displayed, and 4) (Model 523C/CR only) blank the readout during count time.

4-3. TIME BASE SECTION.

4-4. The time base section provides the timing signals used by the instrument. Either the internal 100-kc oscillator (V301) or an external 100-kc standard may be used as the time reference. If an external standard is used, the 100 KC STANDARD switch is set to EXT, in which position it converts V301 into an amplifier.

4-5. Figure 4-1 is the time base block diagram. The 100-kc trigger (V302) is a Schmitt trigger (see paragraph 4-4) and converts the sine waves from V301 to pulses suitable for driving the X10 multiplier and phantastrons (see paragraph 4-20). The X10 multiplier multiplies the 100-kc signal to 1 mc, and the five cascaded phantastron frequency dividers divide the 100-kc signal to provide the five frequencies shown.

4-6. The 1-mc and 100-kc signals are used to self-check the instrument; the 10-kc through 1 cps signals are used to time the opening and closing of the signal gate for frequency measurements; and all signals plus any external signal connected to the STD FREQ CTD connector are used as time units for measuring time or period. Any frequency selected by the TIME UNIT switch is applied to the STD FREQ CTD connector.

4-7. GATE SECTION.

4-8. The gate section contains the counting and control circuits (see figure 4-2). The FUNCTION SELECTOR connects the signal to be counted to the frequency trigger unit, an amplifier followed by a Schmitt trigger. While maintaining the frequency of the input signal, the frequency trigger unit produces the fast-rise, constant-amplitude waveform required to drive the units counter. The output of the trigger unit is applied to signal gate V402. Plug-in counter units totalize the signal gate output and display the count.

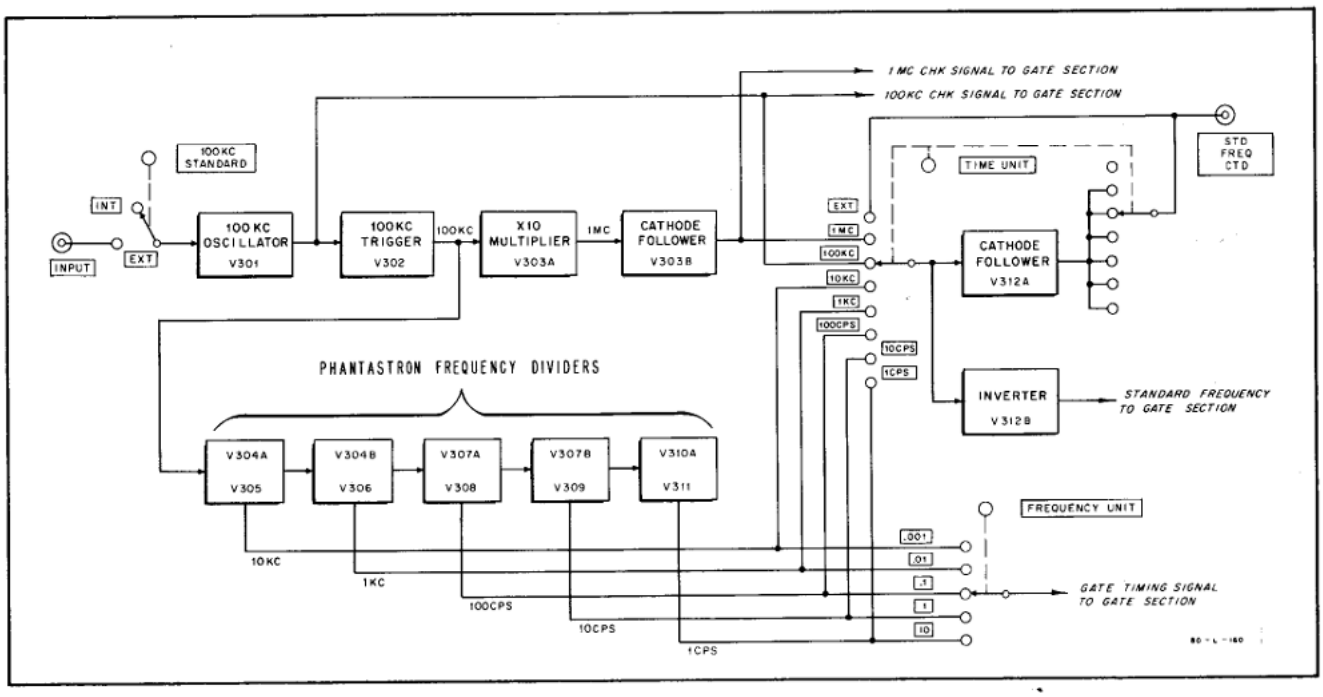

Figure 4-1. Time Base Section

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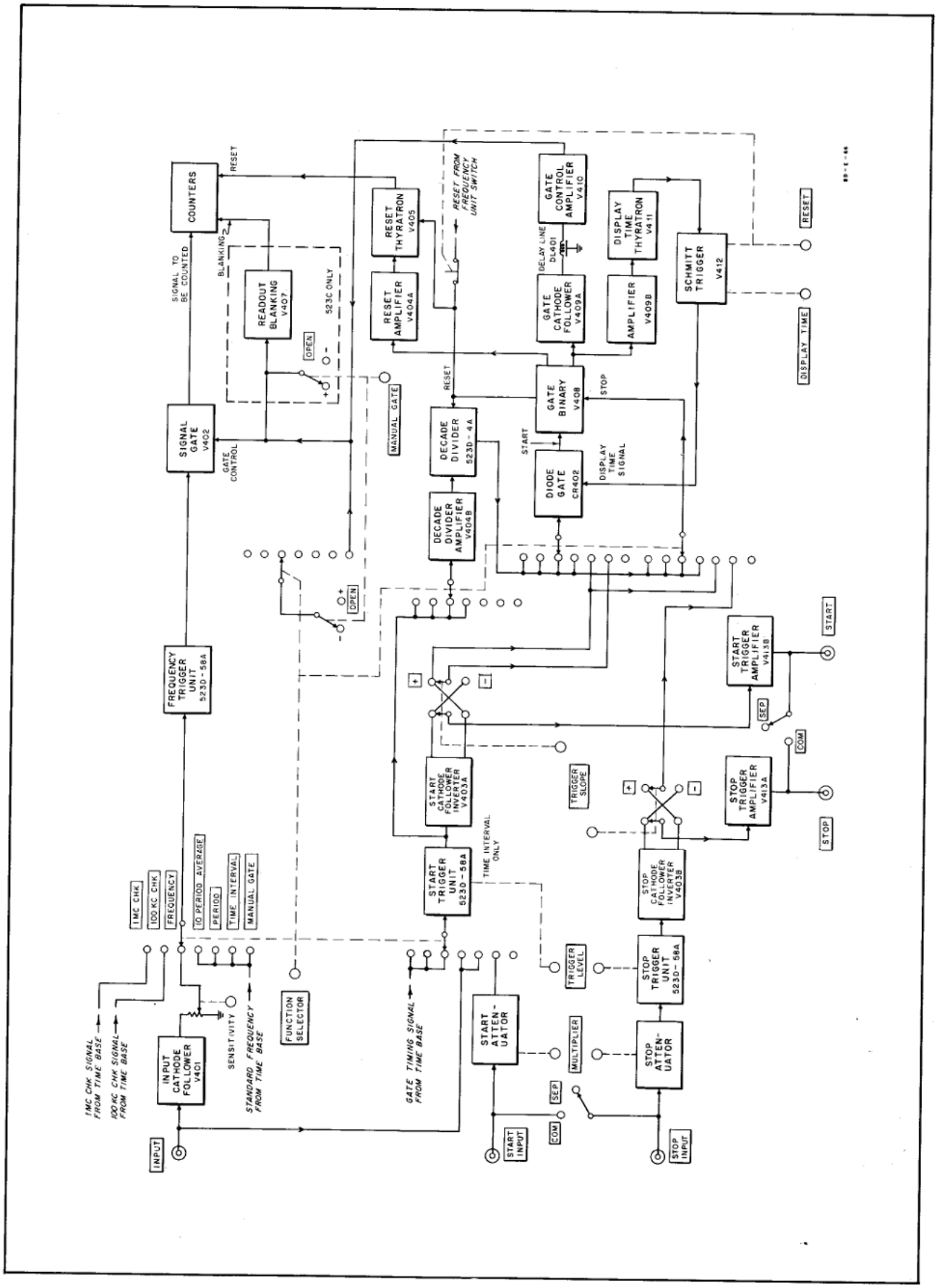

Figure 4-2. Gate Section

4-9. Gate binary V408, a bi-stable multivibrator, controls signal gate V402. Gate cathode follower V409A, delay line DL401, and gate control amplifier V410 apply the gate binary output to the signal gate. In the Model 523C, the gate control signal also controls readout blanking circuit V407, which blanks the readout during count time. The delay line gives reset thyratron V405, fired by the gate binary through reset amplifier V404A, time to set the counters to zero before the signal gate opens.

4-10. All start or gate-opening pulses must pass through diode gate CR402 to the gate binary; all stop or gate-closing pulses are applied directly to the gate binary. When a stop pulse causes the gate binary to close the signal gate, the gate binary fires display time thyratron V411. The display time thyratron in turn triggers Schmitt trigger V412. The Schmitt trigger then holds the diode gate closed for a time determined by the DISPLAY TIME control and prevents any start pulses from reaching the gate binary.

4-11. On 1-mc check, 100-kc check, frequency, and ten period average measurements, the start trigger unit output is applied to the decade divider through decade divider amplifier V404B. The decade divider which provides one output pulse for each ten input pulses, actuates gate binary V408. On period measurements, the start trigger unit, identical to the frequency trigger unit, actuates gate binary V408 directly through start cathode follower inverter V403A, which is a cathode follower in this case.

4-12. On time interval measurements, the start trigger unit provides only the start pulse; the stop trigger unit, also identical to the frequency trigger unit, provides the stop pulse. Signals applied to the START INPUT and/or STOP INPUT connectors are attenuated according to the setting of the MULTIPLIER switches. These switches control the start and stop attenuators and select either ac or dc coupling from the input connectors to the attenuators. The attenuated signals are applied to the trigger units.

4-13. The TRIGGER LEVEL controls control the bias of the Schmitt triggers of the trigger units, thus setting the voltage levels the attenuated input signals must cross to actuate the Schmitt triggers. The output signals of the Schmitt triggers (and the trigger units) are positive or negative voltage steps depending upon whether the input signals are positive-going or negative-going. Circuit components differentiate these voltage steps into pulses, and the pulses are applied to gate binary V408 through the cathode follower inverters (V403A and V403B) and the TRIGGER SLOPE and FUNCTION SELECTOR switches. Since only negative pulses actuate the gate binary, the pulses may or may not require inversion. The TRIGGER SLOPE switches select either the plate or cathode of cathode follower inverters V403A and V403B, as required, to obtain negative pulses when the input signals cross the predetermined voltage levels in the desired directions.

4-14. With the FUNCTION SELECTOR set to MANUAL GATE, the MANUAL GATE switch controls the signal gate. In the Model 523C, the MANUAL GATE switch prevents readout blanking when set to OPEN regardless of the FUNCTION SELECTOR setting.

4-15. The RESET switch provides manual reset control. When pressed, it 1) fires the reset thyratron, 2) sets the decade divider to a count of eight, 3) sets the gate binary to the gate-closed condition, and 4) resets Schmitt trigger V412 to open the diode gate and terminate display. The FREQUENCY UNIT switch (figure 4-1) also fires the reset thyratron, sets the decade divider to a count of eight, and sets the gate binary to the gate-closed condition when switched from one position to another.

4-16. SCHMITT TRIGGER.

4-17. The Schmitt trigger (figure 4-3) is a type of bi-stable multivibrator. It is used where fast-rise waveforms are needed for reliable circuit operation.

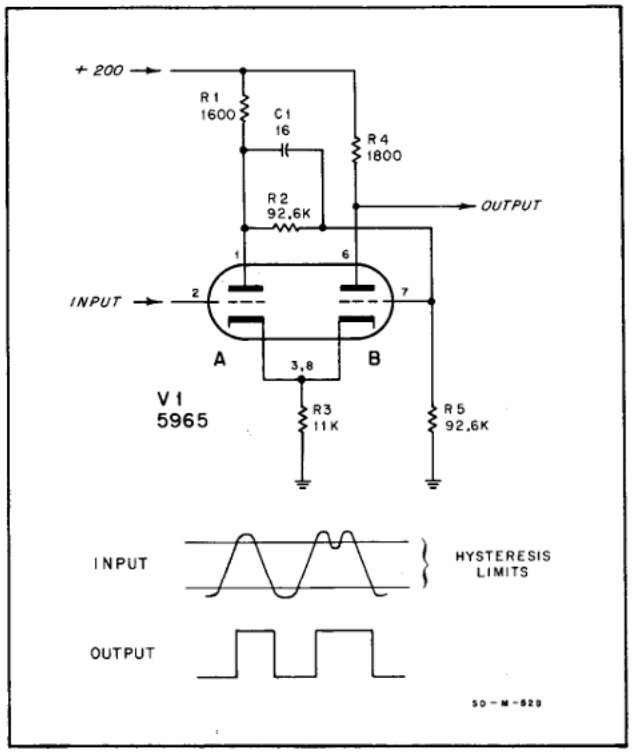

Figure 4-3. Schmitt Trigger

4-18. If the input voltage is such that section A is cut off, section B conducts. As the input voltage becomes more positive, it will eventually reach a predetermined level at which the circuit changes state. Section A conducts and section B is quickly cut off. If the input voltage then goes in a negative direction, the common cathode potential decreases and section B grid goes in a positive direction. When the input voltage reaches a second predetermined level, section B conducts and section A is quickly cut off. Thus, the output is a voltage step, either positive or negative depending upon the slope polarity of the input. In the Model 523C/D, components in following circuits differentiate the voltage step into a sharp trigger pulse.

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4-19. The input voltage levels at which a Schmitt switches are the hysteresis limits. Note that there is no output if the input fails to cross both limits. In the Model 523CD, the hysteresis limits are about 100 mv apart.

4-20. PHANTASTRON.

4-21. The phantastron frequency divider is shown in figure 4-4. The heart of this phantastron is the 6AS6/5725, a special tube with two control grids, G1 and G3. Grid G1 controls total cathode current, and G3 controls the division of current between G2 and the plate. Initially, G1 and the cathode are about 25 volts positive, and G3 is sufficiently negative with respect to the cathode to hold plate current to zero. The cathode current flows mainly to G2; some flows to G1.

4-22. A negative trigger applied to the input is coupled through C1, V1 and C2 to G1 of V2. The negative pulse on G1 reduces cathode current and thus reduces cathode potential. If the pulse is large enough, the potential difference between G3 and the cathode decreases to the point where plate current flows. When plate current starts flowing, plate potential decreases; this decrease is coupled through C2 to G1, further decreasing cathode potential and increasing plate current. Grid G1 quickly reaches a voltage level where any further decrease also decreases plate current; here G1 potential stops dropping. As C2 discharges, G1 potential rises, increasing cathode current. Most of the increasing cathode current goes to the plate, decreasing plate potential further. The plate signal, coupled to G1, slows the rise of G1 caused by the discharge of C2. Eventually plate potential approaches cathode potential, and plate current stops increasing. Now G1 potential increases more rapidly. Cathode potential follows G1 potential and becomes sufficiently positive with respect to G3 to cut off plate current. As C2 recharges, the circuit returns to its initial condition.

4-23. The cathode of V1 is biased very close to the supply voltage; thus V1 is open and blocks the input signal as long as the plate voltage of V2 is below its initial value.

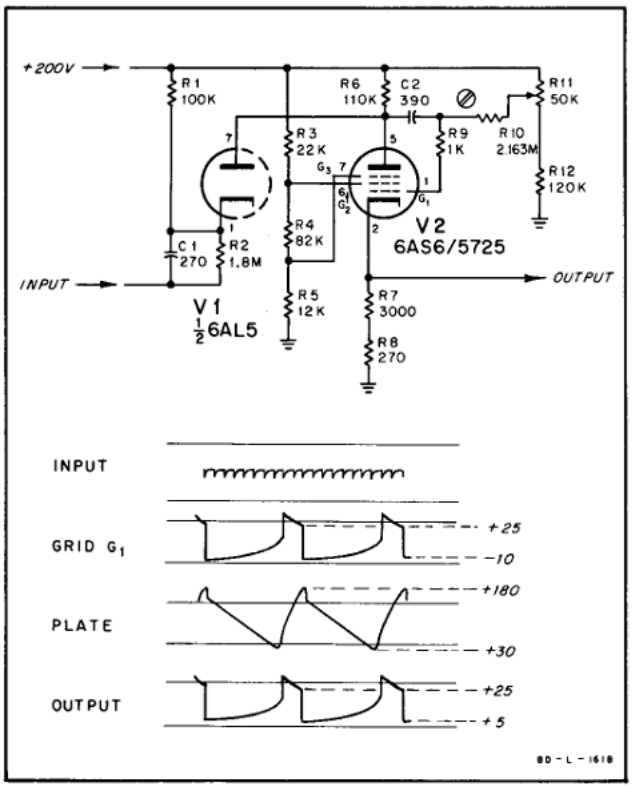

Figure 4-4. Phantastron

4-24. The time required for the phantastron to complete a cycle is determined primarily by the values of C2 and R10. Potentiometer R11 permits some adjustment of the cycle time. In the Model 523C/D, each phantastron is adjusted to respond to every tenth input trigger to provide the required 10:1 division ratio.

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SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides maintenance and service information for Model 523C/D Electronic Counter. Included in this section is a performance check which verifies proper instrument operation. The section also includes recommended test equipment, troubleshooting, repair and adjustment procedures.

5-3. A separate AC-4 Decade Counters Manual contains operating and servicing information on the plug-in counter units.

5-4. PERIODIC MAINTENANCE.

5-5. CLEANING THE AIR FILTER.

5-6. Inspect the air filter regularly, and clean it before it becomes dirty enough to restrict the air flow.

a. Remove filter from instrument rear, and wash it in warm water and detergent.

b. Dry filter thoroughly and coat it with filter adhesive. We recommend Filter Coat No. 3 from Research Products Company, Inc. This adhesive comes in "Handi-Koter" sprayer cans and is available from most heating supply stores or from authorized Hewlett-Packard sales representatives.

5-7. SELF-CHECK.

5-8. The Self-Check (figure 3-12) should be performed each time before using instrument.

5-9. OSCILLATOR ACCURACY.

5-10. The Oscillator Accuracy (paragraph 5-31), should be performed once each week.

5-11. TEST EQUIPMENT.

5-12. Test equipment recommended for use in maintaining and servicing the Model 523C/D is listed in table 5-1. Equipment having similar characteristics can be substituted for the equipment listed.

5-13. TROUBLESHOOTING.

5-14. The following section gives information to aid in the localizing of troubles in the Model 523C/D. Study the block diagrams of section IV. This counter is logical in its operation so that many troubles can be located by systematically checking the instrument from the front panel. Use the following procedure as a guide.

a. Check the power supply (paragraph 5-25). Proceed to step b only if the power supply operates properly.

Table 5-1. Recommended Test Equipment

Instrument Type	Required Characteristics	Use	Model
DC Voltmeter	Input Impedance: ≧ 100 megohms Voltage accuracy: 3%	General voltage measurements	ⓗⓟModel 410B ⓗⓟModel 412A
Test Oscillator	Frequency Range: 10 cps - 1 mc	Performance check Adjustment procedure	ⓗⓟModel 650A
Oscilloscope	Passband: dc to 1 mc Sensitivity: .05 to 100 volt/div Input impedance: 100 megohms (with probe)	Observations of waveforms	ⓗⓟModel 150A ⓗⓟModel 170A
Variable Transformer	Output voltage: 103-127 volts (207-254 if instrument wired for 230-volt operation) Output current: 5 amps (2.5 amps for 230-volt operation)	Vary line voltage	Powerstat type 116
Amplifier	Frequency: ≧ 1 mc Gain: 40 db	Comparison with WWV Standard	ⓗⓟModel 450A
Communications Receiver	20 mc receiver	Comparison with WWV Standard	
Frequency Standard	Frequency: 100 kc	Comparison with Local Frequency Standard	ⓗⓟModel 100E

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b. Self check instrument (figure 3-12). By so doing you check a maximum number of circuits and will save time if the trouble is external to the counter. Also, if the trouble is in the X10 multiplier or any phantastron but the 10-kc phantastron, self-check procedure shows it. Self check tests instrument operation but not sensitivity; if the instrument self checks properly, check performance (paragraph 5-43). If instrument does not self check, proceed to step c.

c. Check instrument reactions to specific front-panel control settings and compare reactions with those of table 5-2. When you have isolated the trouble to as few circuits as possible, proceed to step d.

d. Compare waveforms throughout suspected circuits with those of table 5-3. The waveforms in the table were viewed on a hp Model 150A Oscilloscope using a 152B Dual Trace Amplifier and an AC-21C Oscilloscope Probe. If waveform analysis does not pinpoint the faulty component, proceed to step e.

e. Check tubes, voltages and resistances within faulty circuits.

5-15. Voltages are shown throughout the schematic diagrams; these voltages are typical and may vary some from instrument to instrument. If you replace a part in any of the circuits listed in paragraph 5-19, make the indicated adjustment. Should you have to replace a part on a printed circuit board, see paragraph 5-21.

5-16. REPAIR AND REPLACEMENT.

5-17. CABINET REMOVAL.

a. Remove the rear cover. Four screws hold it in place.

b. Turn the instrument on its back and unscrew the two recessed screws in the bottom of the bezel about 1/4 inch.

c. Lift the cabinet towards the top of the instrument and off.

5-18. The Models 523CR and 523DR have a cabinet that consists of top and bottom dust covers. Each cover slides in place and is held by two screws at the rear.

5-19. TUBE REPLACEMENT.

5-20. Electron tubes are best checked by replacement. Results obtained from an external tube tester can sometimes be misleading. Mark the tubes for identification as you remove them so you can return them to their original sockets if they are still good. Table 5-4 lists the electron tubes used in the Model 523C/D, their function, and the adjustment to be made when a tube is replaced.

CAUTION

Do not remove V601 from any trigger unit while the instrument is turned on. Heater current to these three tubes is regulated, and if you remove one, the others will draw excessive current.

Table 5-2. Troubleshooting Aid

Control Setting	Normal Counter Reaction	Circuits Checked
FUNCTION SELECTOR to MANUAL GATE	GATE light lights when MANUAL GATE switch set to OPEN, goes off when MANUAL GATE switch set to down position.	MANUAL GATE switch GATE light
FUNCTION SELECTOR to MANUAL GATE MANUAL GATE switch to OPEN TIME UNIT switch to 100 KC	Counter counts continuously at 100-kc rate (watch hundred-thousands counter unit for low-speed operation; it should have ten stable conditions and light only one number at a time).	100-kc oscillator V301 Inverter V312B Signal trigger unit Signal gate V402 Counter Units
FUNCTION SELECTOR to MANUAL GATE MANUAL GATE switch to OPEN TIME UNIT switch to 10 KC	Counter counts continuously at 10-kc rate (watch ten-thousands counter for low-speed operation).	100-kc trigger V302 10-kc phantastron V304A, V305
FUNCTION SELECTOR to MANUAL GATE MANUAL GATE switch to OPEN TIME UNIT switch to 1 KC	Counter counts continuously at 1-kc rate (watch one-thousands counter for low-speed operation).	1-kc phantastron V304B, V306
FUNCTION SELECTOR to MANUAL GATE MANUAL GATE switch to OPEN TIME UNIT switch to 100 CPS	Counter counts continuously at 100 cps rate (watch hundreds counter for low-speed operation).	100-cps phantastron V307A, V308

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Table 5-2. Troubleshooting Aid (Cont'd)

Control Setting	Normal Counter Reaction	Circuits Checked
FUNCTION SELECTOR to MANUAL GATE MANUAL GATE to OPEN TIME UNIT to 10 CPS	Counter counts continuously at 10-cps rate (watch tens counter for low-speed operation).	10-cps phantastron V310A, V309
FUNCTION SELECTOR to MANUAL GATE MANUAL GATE to OPEN TIME UNIT to 1 CPS	Counter counts continuously at 1-cps rate (watch units counter for low-speed operation).	1-cps phantastron V310B, V311
FUNCTION SELECTOR to MANUAL GATE MANUAL GATE to OPEN TIME UNIT to 1 MC	Counter counts continuously at 1-mc rate.	100-kc trigger V302 X10 multiplier V303A Cathode follower V303B
FUNCTION SELECTOR to TIME INTERVAL TIME UNIT to 100 KC Start MULTIPLIER to X. 5 Start TRIGGER SLOPE to + MANUAL GATE to down position	Model 523DR: Counter starts counting at 100-kc rate as START TRIGGER LEVEL control rotated from +3 to -3. Model 523CR: Readout blanks as START TRIGGER LEVEL rotated from +3 to -3.	Start trigger unit Cathode follower inverter V403A Gate binary V408 Cathode follower V409A Gate control amplifier V410 Readout blanking V407
FUNCTION SELECTOR to TIME INTERVAL TIME UNIT to 100 KC Stop MULTIPLIER to X. 5 Stop TRIGGER SLOPE to +	Model 523DR: Counter stops counting as STOP TRIGGER LEVEL control rotated from +3 to -3. Model 523CR: Readout becomes visible as STOP TRIGGER LEVEL control rotated from +3 to -3.	Stop trigger unit Cathode follower inverter V403B
FUNCTION SELECTOR to 100 KC CHK FREQUENCY UNIT to 1 SEC DISPLAY TIME to MIN	Counter counts for one second, displays for one second; readout is 100. 000; counter units reset prior to each new count .	Decade divider amplifier V404B Decade divider Reset amplifier V404A Reset thyratron V405
FUNCTION SELECTOR to 100 KC CHK FREQUENCY UNIT to 1 SEC DISPLAY TIME to max but not INF	Counter counts for one second, displays for about 10 seconds.	Amplifier V409B Display thyratron V410 Schmitt trigger V412
FUNCTION SELECTOR to FREQUENCY FREQUENCY UNIT to 1 SEC DISPLAY TIME to MIN TIME UNIT to 100 KC Connect STD FREQ CTD connector to INPUT connector SENSITIVITY to maximum	Counter consistently displays 100. 000.	Cathode follower V312A Cathode follower V401
FUNCTION SELECTOR to 100 KC CHK FREQUENCY UNIT to 10 SEC DISPLAY TIME to max but not INF Press RESET switch during count time	Counter stops counting; counter units reset to zero; and counter starts counting again after about two seconds.	RESET switch S409

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Table 5-2. Troubleshooting Aid (Cont'd)

Control Setting	Normal Counter Reaction	Circuits Checked
FUNCTION SELECTOR to 100 KC CHK FREQUENCY UNIT to 1 SEC DISPLAY TIME to MIN Change FREQUENCY UNIT to 10 SEC during count time	Counter stops counting; counter units reset to zero; and counter starts counting again after about two seconds.	Reset from FREQUENCY UNIT switch
FUNCTION SELECTOR to 1 MC CHK FREQUENCY UNIT to 10 DISPLAY TIME to MIN	Counter consistently displays 00.0000 ± 0001	Units and tens counters (checked for high-speed operation)

Table 5-3. Waveforms

Unless otherwise noted, set front-panel controls as follows:

FUNCTION SELECTOR . . . . . 100 KC CHK
FREQUENCY UNIT 001
TIME UNIT . . . . . 1 MC
SENSITIVITY . . . . . .maximum clockwise
DISPLAY TIME . . . . . MIN

START AND STOP TRIGGER LEVEL 0
Start and Stop MULTIPLIER . . . . . AC X. 5
Start and Stop TRIGGER SLOPE. . . . . +
COM - SEP . . . . . SEP
MANUAL GATE . . . . . down position

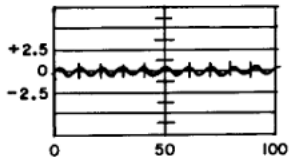
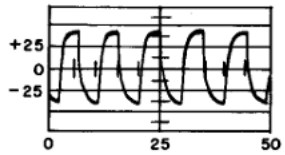
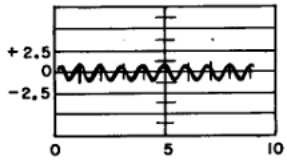
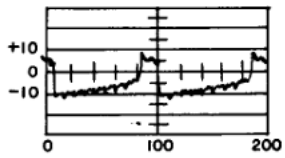
Waveform Number	Test Point	Oscilloscope Sweep Speed	Normal Indication
1	Junction C301 and C302	10 μsec/cm	
2	Pin 6, V302	5 μsec/cm	
3	Pin 3, V303	1 μsec/cm	
4	Pin 2, V305	20 μsec/cm	

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Table 5-3. Waveforms (Cont'd)

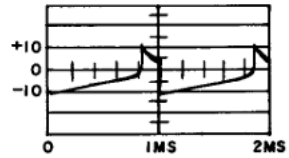
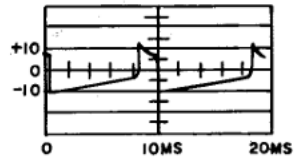
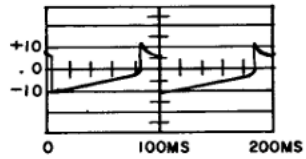
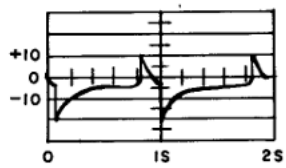
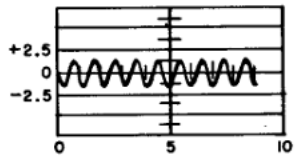
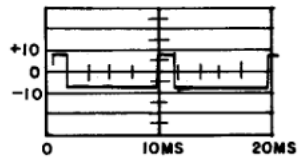
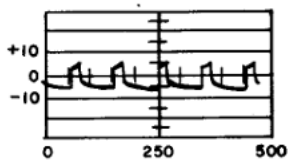
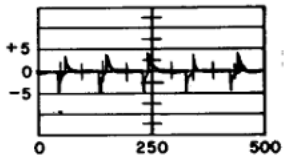
Waveform Number	Test Point	Oscilloscope Sweep Speed	Normal Indication
5	Pin 2, V306	2 ms/cm	
6	Pin 2, V308	2 ms/cm	
7	Pin 2, V309	20 ms/cm	
8	Pin 2, V311	0.2 s/cm	
9	Pin 1, V312	1 μsec/cm	
10	Pin 2, Start Trig Unit (FREQUENCY UNIT to .1)	2 ms/cm	
11	Pin 2, Start Trig Unit	50 μsec/cm	
12	Pin 1, V403	50 μsec/cm	

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Table 5-3. Waveforms (Cont'd)

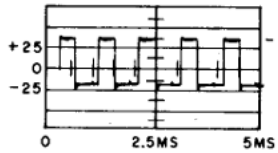
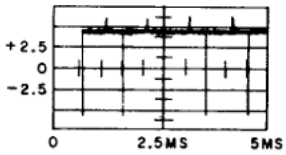
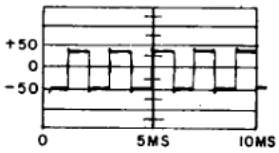
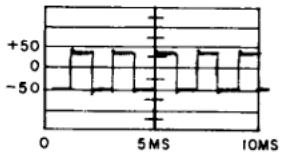
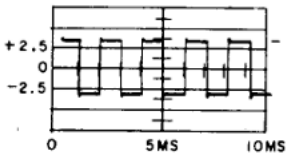
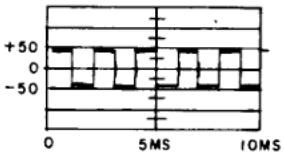
Waveform Number	Test Point	Oscilloscope Sweep Speed	Normal Indication
13	Pin 1, Decade Divider	50 μsec/cm	
14	Pin 2, Decade Divider	0.5 ms/cm	
15	Junction C419 or C420 and S401B	0.5 ms/cm	
16	Pin 6, V408 (V411 removed)	1 ms/cm	
17	Pin 1, V408 (V411 removed)	1 ms/cm	
18	Pin 3, V409 (V411 removed)	1 ms/cm	
19	Pin 5, V410 (V411 removed)	1 ms/cm	
20	Pin 7, V402 (V411 removed	1 ms/cm	

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Table 5-3. Waveforms (Cont'd)

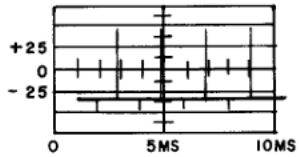
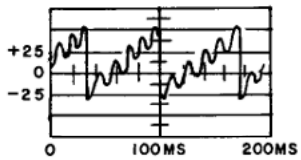
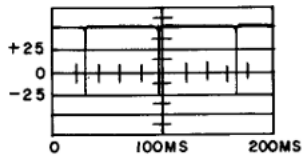
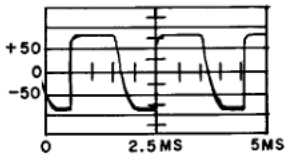
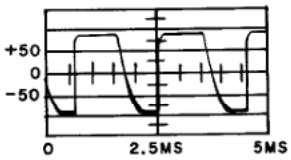
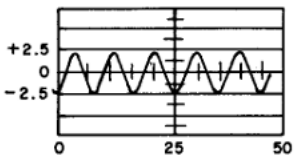
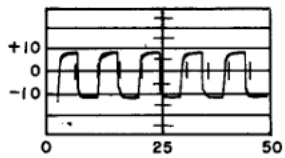
Waveform Number	Test Point	Oscilloscope Sweep Speed	Normal Indication
21	Pin 6, V409 (V411 removed)	1 ms/cm	
22	Pin 6, V411 (replace V411)	20 ms/cm	
23	Pin 6, V412	20 ms/cm	
24	Pin 3, V407	0.5 ms/cm	
25	Pin 6, V407	0.5 ms/cm	
	FUNCTION SELECTOR to FREQUENCY		
26	Pin 7, V401 (input: 100 kc at 2 volts rms)	5 μsec/cm	
27	Pin 2, Frequency Trig Unit (input: 100 kc at 2 volts rms)	5 μsec/cm	

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Table 5-3. Waveforms (Cont'd)

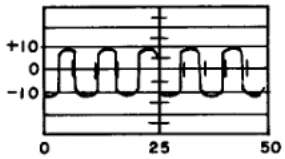
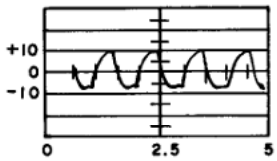
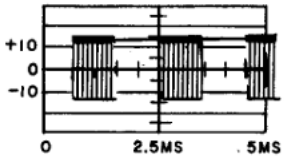
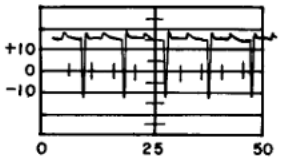
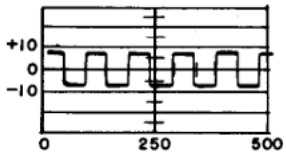
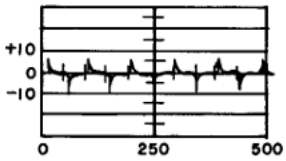
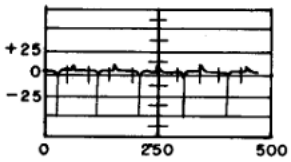
Waveform Number	Test Point	Oscilloscope Sweep Speed	Normal Indication
28	Pin 2, Frequency Trig Unit (input: 100 kc at 0.1 volt rms)	5 μsec/cm	
29	Pin 2, Frequency Trig Unit (input: 1 mc at 2 volts rms)	0.5 μsec/cm	
30	Pin 5, V402 (remove V411) (input: 100 kc at 2 volts rms)	0.5 ms/cm	
31	Pin 5, V402 (remove V411 (input: 100 kc at 2 volts rms)	5 μsec/cm	
	FUNCTION SELECTOR to TIME INTERVAL		
32	Pin 2, Start, Stop Trig Units (input: 10 kc at 2 volts rms)	50 μsec/cm	
33	Pins 1 and 6, V403 (input: 10 kc at 2 volts rms)	50 μsec/cm	
34	Pins 1 and 6, V413 (input: 10 kc at 2 volts rms)	50 μsec/cm	

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Table 5-4. Tube Replacement/Adjustment

Tube No. and Type		Function	Adjustment
V201	5Y3	Rectifier	Power supply (paragraph 5-25)
V202	6CB6	Control tube	Power supply (paragraph 5-25)
V203	6AS7GA	Series regulator	Power supply (paragraph 5-25)
V204	6AU5	Series regulator	Power supply (paragraph 5-25)
V205	6CB6	Control tube	Power supply (paragraph 5-25)
V206	5651/OG3	Reference tube	Power supply (paragraph 5-25)
V301	6AU6	Oscillator	Oscillator output (paragraph 5-32) and frequency (paragraph 5-28)
V303	5963	X10 multiplier	X10 multiplier (paragraph 5-34)
V305 V306 V308 V309 V311	6AS6/5725	Phantastrons	Phantastrons (paragraph 5-35)
V409(A)	5963	Cathode follower	Gate length (paragraph 5-42)
V410	6AU6	Gate control amplifier	Gate length (paragraph 5-42)
Frequency Trigger Unit			
V601	7308	Amplifier	Frequency sensitivity (paragraph 5-46)
V602	5965	Schmitt trigger	Frequency sensitivity (paragraph 5-46)
Start Trigger Unit			
V601	7308	Amplifier	Period sensitivity (paragraph 5-47) Time interval sensitivity (paragraph 5-48) Phase input (paragraph 5-40)
V602	5965	Schmitt trigger	Period sensitivity (paragraph 5-47) Time interval sensitivity (paragraph 5-48)
Stop Trigger Unit			
V601	7308	Amplifier	Time interval sensitivity (paragraph 5-48) Phase input (paragraph 5-40)
V602	5965	Schmitt trigger	Time interval sensitivity (paragraph 5-48)

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5-21. SERVICING ETCHED CIRCUIT BOARDS.

Note

Excessive heat or pressure can lift copper conductors from etched circuit boards.

5-22. To remove components from board, clip leads on component side of board. New components can then be soldered to the leads extending from the board or the leads can be removed. If leads are removed, clean holes with a toothpick (metal awls or soldering aids may destroy plating in the hole) before inserting leads.

5-23. ADJUSTMENTS.

5-24. The following section is a complete adjustment procedure and should be made only if it has been definitely determined that the Model 523C/D is out of adjustment.

5-25. POWER SUPPLY.

5-26. Check the power supply voltages and regulation before making adjustments elsewhere in the instrument and as a first troubleshooting step, but avoid unnecessary adjustment. If the voltages are essentially correct and properly regulated, there is no reason to adjust them.

5-27. The regulated voltages normally vary less than 1% when line voltage varies from 103 to 127 volts. When you do adjust the supply voltages, use a meter which is accurate within 3% of full scale. Adjust the -115 volt supply first, for it is independent of the other voltages. Adjust the +200 volt supply second; it uses -115 volts as a reference.

5-28. OSCILLATOR FREQUENCY.

5-29. This section gives two oscillator frequency checks. The first procedure checks the oscillator against WWV. The second procedure checks the oscillator frequency against a local frequency standard. The first procedure is preferred unless the local standard has better short-term stability than the Model 523C/D.

Note

Make any necessary adjustments in the instrument before checking oscillator frequency.

5-30. CHECKING THE OSCILLATOR AGAINST WWV.

a. Turn Model 523C/D on. Allow 1 hour warmup if instrument has been disconnected from power source; allow five-minute warmup if instrument has been connected to power source for at least 1 hour.

b. Connect equipment as shown in figure 5-1. Use unshielded wire to connect the 5 to 20 pf capacitors between the antenna and Model 450A output. The Model 450A is overdriven to provide adequate harmonics.

c. Set 100 KC STANDARD switch on instrument rear to INT, and set TIME UNIT switch to 1 MC.

d. Tune communications receiver to strongest WWV signal 20 mc or below. For best zero-beat indication, coupled 1-mc harmonic should be as strong as WWV signal.

e. Adjust frequency ADJ. C304 on rear of Model 523C/D for exact zero beat. As you approach zero beat, pitch of beat note will decrease below audible range. At about this point the beat will be indicated by oscillations of the "S" meter pointer. At exact zero beat,

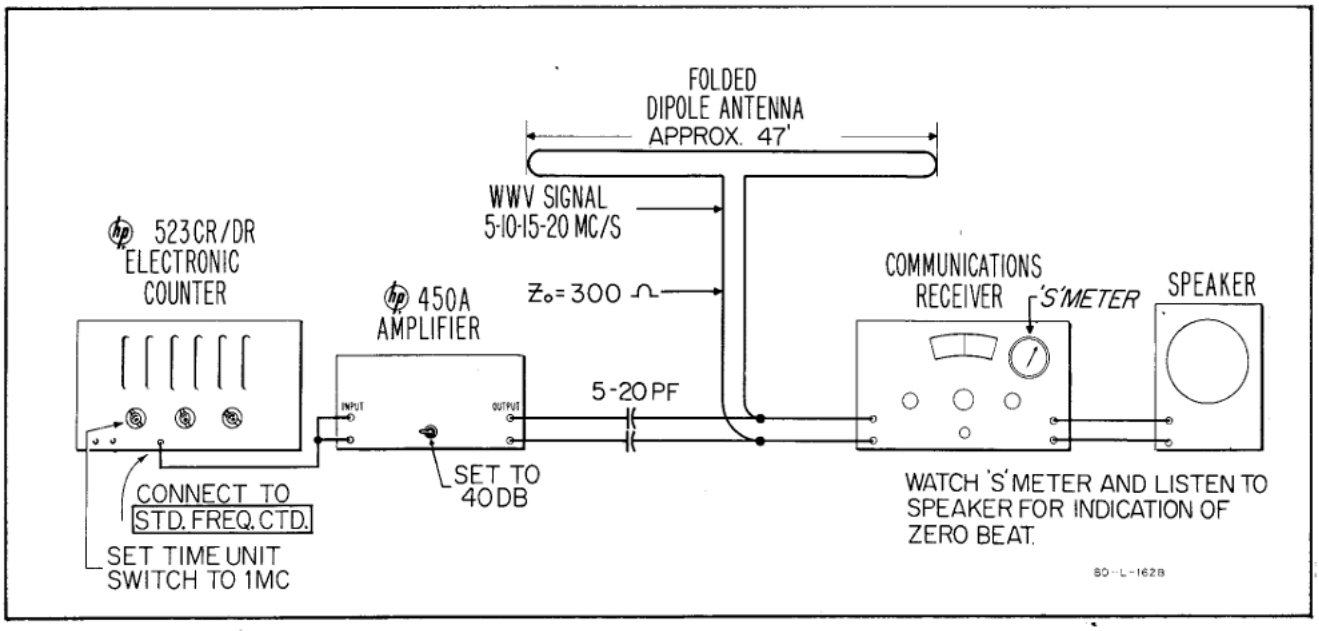

Figure 5-1. Equipment Setup for Checking Oscillator against WWV

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"S" meter pointer will be stationary. WWV broadcasts an audio tone three minutes out of every five; adjust for zero beat during the two-minute intervals between audio tones when only the carrier is present.

f. If C304 does not have enough range to obtain a zero beat, set it to mid-range and adjust 100 KC ADJ. C305 for zero beat. C305 is located on the main deck next to the power transformer (see figure 5-2).

5-31. CHECKING THE OSCILLATOR AGAINST A LOCAL STANDARD.

a. Turn the instrument on. Allow a 1-hour warmup if it has been disconnected from power source; allow a five-minute warmup if it has been connected to power source for at least 1 hour.

b. Set TIME UNIT switch to 100 KC and 100 KC STANDARD switch on instrument rear to INT.

c. Connect equipment as shown in figure 5-3. Any hp oscilloscope will do.

d. Adjust frequency ADJ. C304 on rear of Model 523C/D to hold oscilloscope pattern absolutely still.

e. If C304 does not have enough range to stop oscilloscope pattern, set it to mid-range and adjust 100 KC ADJ. (C305) to stop pattern. C305 is located on the main deck next to the power transformer (see figure 5-2).

5-32. ADJUSTING 100 KC OSCILLATOR OUTPUT.

5-33. This adjustment affects oscillator frequency. Thus, adjust oscillator output before adjusting oscillator frequency, and check oscillator frequency whenever you adjust oscillator output.

a. Connect oscilloscope to pin 2 of V302.

b. Adjust L301 for maximum 100-kc signal on the oscilloscope.

5-34. ADJUSTING X10 MULTIPLIER.

a. Set:
FUNCTION SELECTOR . . . . . 1 MC CHK
TIME UNIT . . . . . 1 MC
FREQUENCY UNIT 1
DISPLAY TIME . . . . . MIN

b. Connect oscilloscope to STD FREQ CTD connector.

c. Adjust 1-mc tune capacitors C317 and C319 for maximum 1-mc signal on oscilloscope. Observe counter readout to be sure signal is actually 1 mc.

5-35. ADJUSTING PHANTASTRONS.

5-36. A phantastron needs adjusting if 100-kc self-check yields counts of 80, 90, 110 or 120 kc on one gate time and correct counts on all shorter gate times. Always adjust the phantastrons in the order given below. The adjustment controls are located just behind the counter units.

a. Set:
FUNCTION SELECTOR . . . . . 100 KC CHK
DISPLAY TIME . . . . . MIN

b. Set FREQUENCY UNIT switch to .001 and adjust 10 KC phantastron control R326 to center of range which yields readout of 000100.

c. Set FREQUENCY UNIT switch to .01 and adjust 1 KC phantastron control R341 to center of range which yields readout of 00100.0.

d. Set FREQUENCY UNIT switch to .1 and adjust 100 CPS phantastron control R353 to center of range which yields readout of 0100.00.

e. Set FREQUENCY UNIT switch to 1 and adjust 10 CPS phantastron control R379 to center of range which yields readout of 100.000.

f. Set FREQUENCY UNIT switch to 10 and adjust 1 CPS phantastron control R379 to center of range which yields readout of 00.0000.

5-37. ADJUSTING FREQUENCY SENSITIVITY.

a. Set line voltage to 115 volts.

b. Set:
FUNCTION SELECTOR . . . . . FREQUENCY
SENSITIVITY . . . . . maximum clockwise
DISPLAY TIME . . . . . MIN

c. Connect sine-wave signal about 1 kc to INPUT connector; adjust signal amplitude until counter counts consistently.

d. Set "F" control R454 (Screwdriver Adj.) to mid-position. Gradually reduce signal amplitude while adjusting FREQ sensitivity control R406 to maintain consistent counting. Maximum sensitivity is 0.1 volt rms.

e. Check for 0.1 volt rms sensitivity at line voltages of 103 and 127 volts. If necessary, readjust "F" control R454.

5-38. ADJUSTING PERIOD SENSITIVITY.

a. Set line voltage to 115 volts.

b. Set:
FUNCTION SELECTOR . . . . . PERIOD
TIME UNIT . . . . . 1 MC
DISPLAY TIME . . . . . MIN

c. Connect sine-wave signal about 1 kc to INPUT connector; adjust signal amplitude to give consistent counter operation.

d. Set "P" control R475 (Screwdriver Adj.) to mid-position. Gradually reduce signal amplitude while adjusting PERIOD sensitivity control R416 to maintain consistent counter operation. Maximum sensitivity is 0.1 volt rms.

e. Check for 0.1 volt rms sensitivity at line voltages of 103 and 127 volts. If necessary, readjust "P" control R475.

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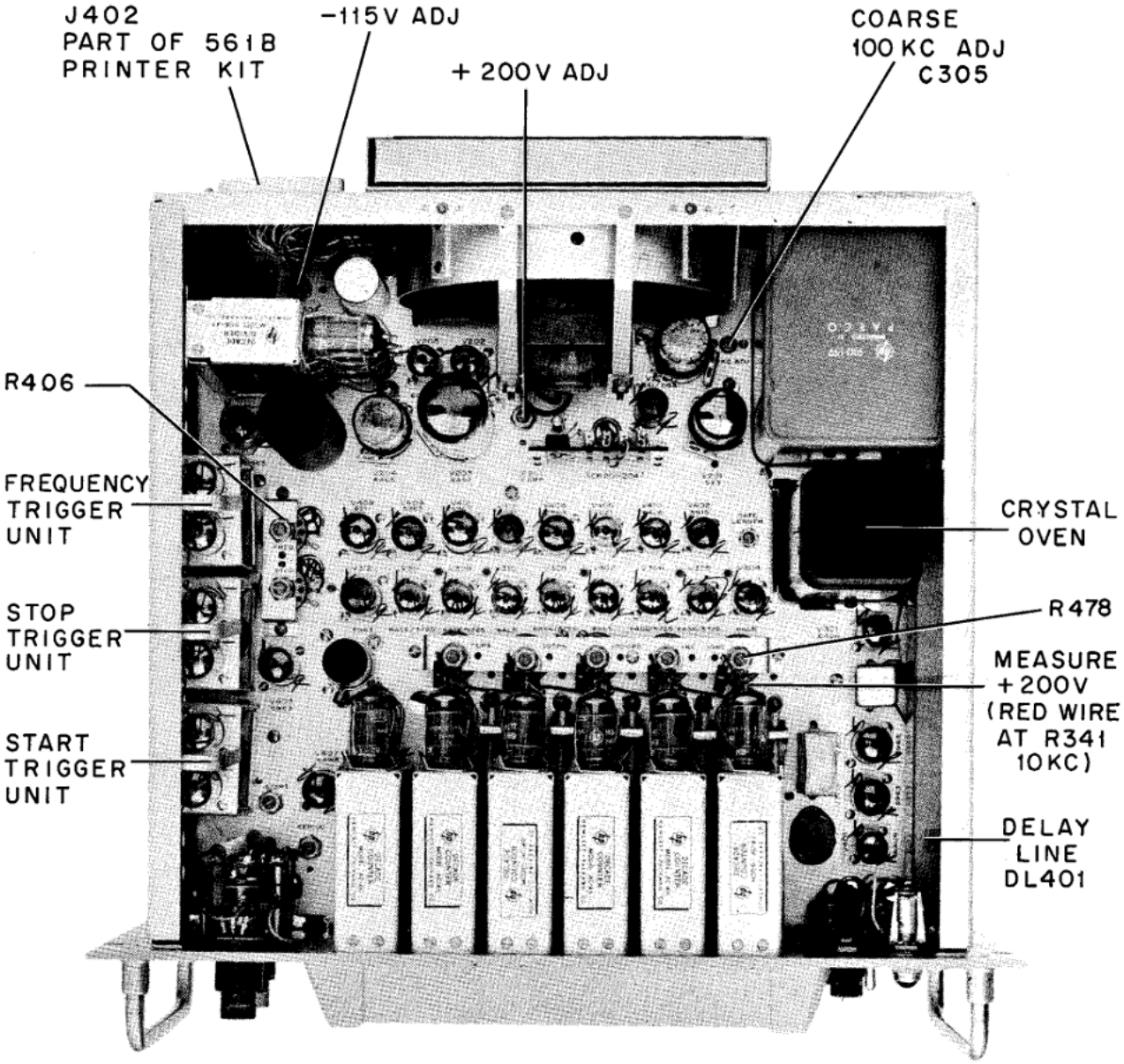

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MP-S-494BC

Figure 5-2. Model 523C Top Internal View

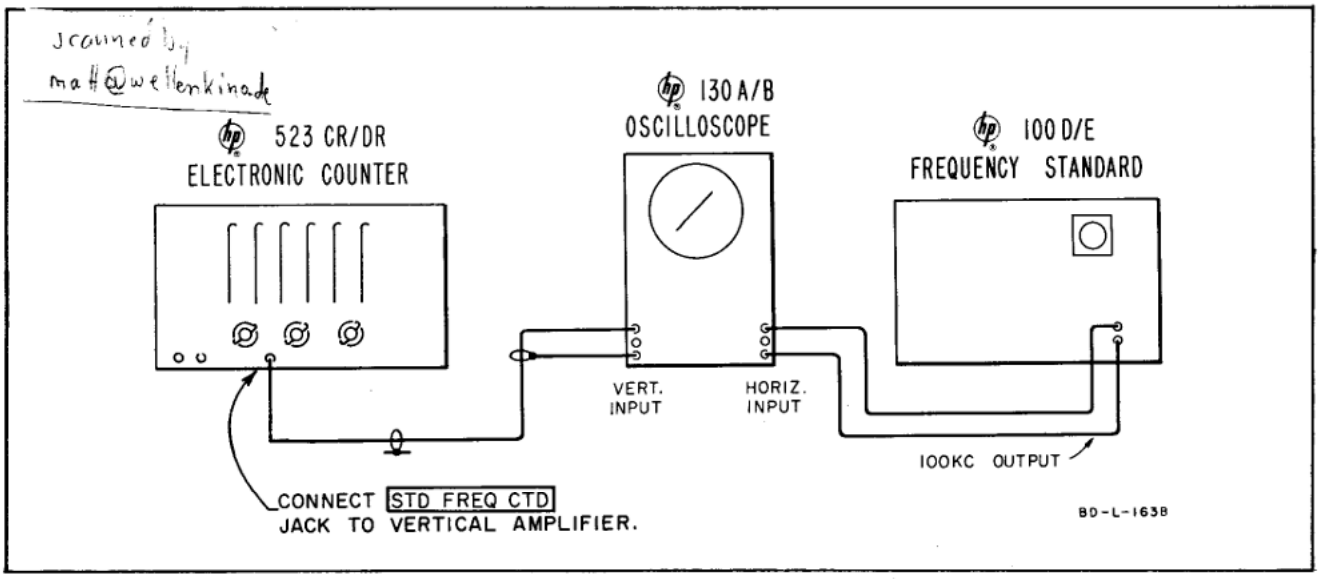


Figure 5-3. Equipment Setup for Checking Oscillator against Local Standards

5-39. ADJUSTING TIME INTERVAL SENSITIVITY.

a. Set line voltage to 115 volts.

b. Set:

FUNCTION SELECTOR . . . . . TIME INTERVAL
START TRIGGER LEVEL 0
STOP TRIGGER LEVEL 0
Start and stop MULTIPLIER . . . . . AC X. 5
Front-panel COM-SEP . . . . . COM

c. Connect oscilloscope to pin 2 of start trigger unit and adjust sweep speed to about 0. 2 millisec/cm.

d. Connect sine-wave signal about 1 kc to START INPUT connector and adjust signal amplitude to obtain an output from trigger unit.

e. Reduce signal amplitude to 0. 1 volt rms and adjust START sensitivity control R423 to make start trigger unit output a square wave.

f. Connect oscilloscope to pin 2 of stop trigger unit and adjust signal amplitude to obtain output from trigger unit.

g. Reduce signal amplitude to 0. 1 volt rms and adjust STOP sensitivity control R508 to make stop trigger unit output a square wave.

h. Check trigger-units for 0. 1 volt rms sensitivity at line voltages of 103 and 127 volts.

5-40. ADJUSTING PHASE INPUT.

5-41. The phase input adjustment equalizes the phase shift in the input circuits of the start and stop channels.

a. Set:

FUNCTION SELECTOR . . . . . TIME INTERVAL
FREQUENCY UNIT . . . . . 1 MC
Start and stop MULTIPLIER . . . . . DC X. 5
Front-panel COM-SEP . . . . . SEP
DISPLAY TIME . . . . . MIN

b. Connect low-impedance, 2:1 attenuator such as that shown in figure 5-4 to test oscillator. Connect attenuator output to START INPUT and test oscillator output directly to STOP INPUT.

c. Adjust test oscillator output to 50 cps at 5 volts rms and set attenuator switch to apply full signal to START INPUT.

d. Set START TRIGGER LEVEL to 0 and STOP TRIGGER LEVEL to obtain a readout of about 100 on counter.

e. Switch attenuator switch back and forth between full-signal and half-signal positions and set START TRIGGER LEVEL control so counter readout remains constant. Note readout.

f. Set attenuator switch to full-signal position.

g. Set start MULTIPLIER to DC X1 (be sure you do not move START TRIGGER LEVEL control) and adjust C415 (figure 5-5) to give same readout as noted in step e above.

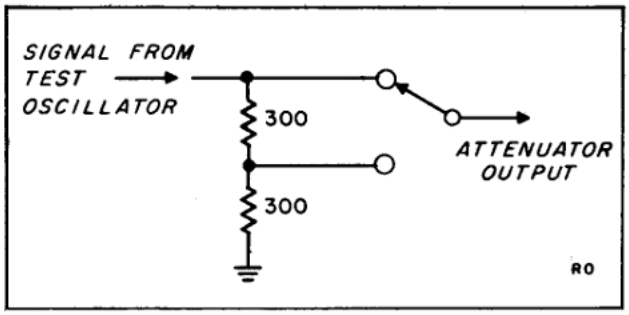
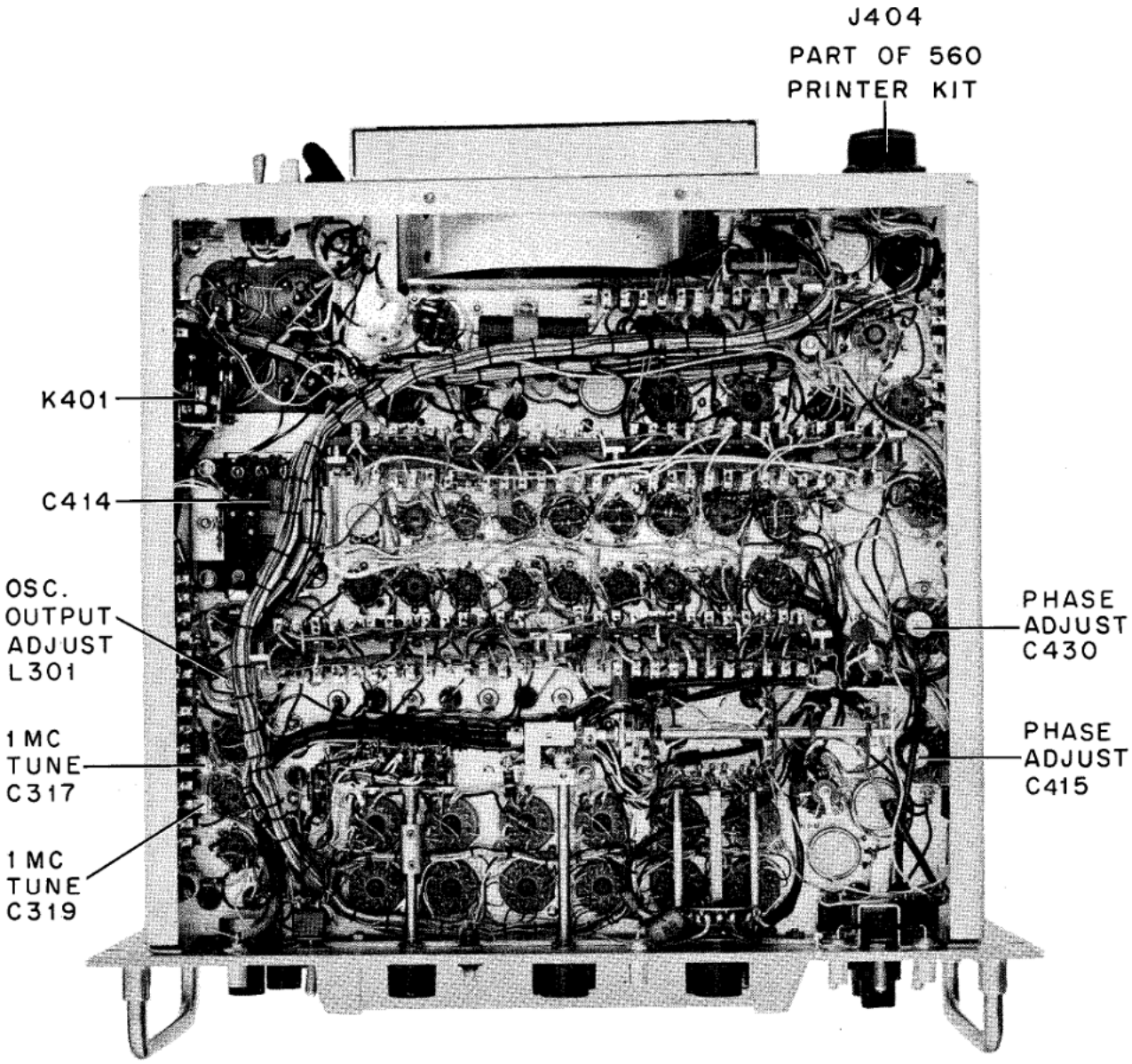


Figure 5-4. 2:1 Attenuator for Phase Input Adjustment



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MP-S-495C

Figure 5-5. Model 523C Bottom Internal View

h. Switch connections to START INPUT and STOP INPUT and repeat steps c through g for stop channel. Adjust C430 (figure 5-5).

5-42. ADJUSTING GATE LENGTH.

a. Set:

FUNCTION SELECTOR . . . . . 1 MC CHK
FREQUENCY UNIT . . . . . 0.1 sec gate
DISPLAY TIME . . . . . MIN

b. Adjust GATE LENGTH control R478 to middle of range that produces readout of 1000.00 ±.01.

5-43. PERFORMANCE CHECK.

5-44. The following is a quick check of the instrument against its specifications. You can make the check with the instrument in its cabinet. Proceed as follows:

5-45. SELF-CHECK.

a. Set line voltage to 115 volts, turn instrument on, and allow five-minute warmup.

b. Self-check instrument as directed in figure 3-12.

5-46. FREQUENCY SENSITIVITY CHECK.

a. Set:

FUNCTION SELECTOR . . . . . FREQUENCY
SENSITIVITY. . . . . maximum clockwise
FREQUENCY UNIT 1
DISPLAY TIME. . . . . MIN

b. Connect test oscillator to INPUT connector as shown in figure 5-6.

c. Adjust test oscillator output to about 1 kc at 0.1 volt rms; counter should consistently indicate signal frequency.

d. Adjust test oscillator output to about 1 mc at 0.1 volt rms; counter should consistently indicate signal frequency.

5-47. PERIOD SENSITIVITY CHECK.

a. Set:

FUNCTION SELECTOR . . . . . PERIOD
TIME UNIT . . . . . 1 MC
DISPLAY TIME . . . . . MIN

b. Connect test oscillator to INPUT connector as shown in figure 5-6.

c. Adjust test oscillator output to about 1 kc at 0.1 volt rms; counter should consistently indicate signal period ±0.3%.

5-48. TIME INTERVAL SENSITIVITY CHECK.

a. Set:

FUNCTION SELECTOR. . . . . TIME INTERVAL
TIME UNIT . . . . . 1 MC
DISPLAY TIME . . . . . MIN
Start and stop MULTIPLIER . . . . . AC X.5
START and STOP TRIGGER LEVEL 0
Start and stop TRIGGER SLOPE . . . . . +
COM-SEP. . . . . SEP
MANUAL GATE . . . OPEN on Model 523C, OPEN or CLOSED on Model 523D

b. Adjust test oscillator output to about 1 kc at less than 0.05 volt rms and connect it to START INPUT connector.

c. Gradually increase signal amplitude; counter should start counting as or before signal amplitude reaches 0.1 volt rms.

d. Reduce test oscillator output to less than 0.05 volt rms and connect it to STOP INPUT connector.

e. Gradually increase signal amplitude; counter should stop counting as or before signal amplitude reaches 0.1 volt rms.

f. Repeat procedure at line voltages of 103 and 127 volts.

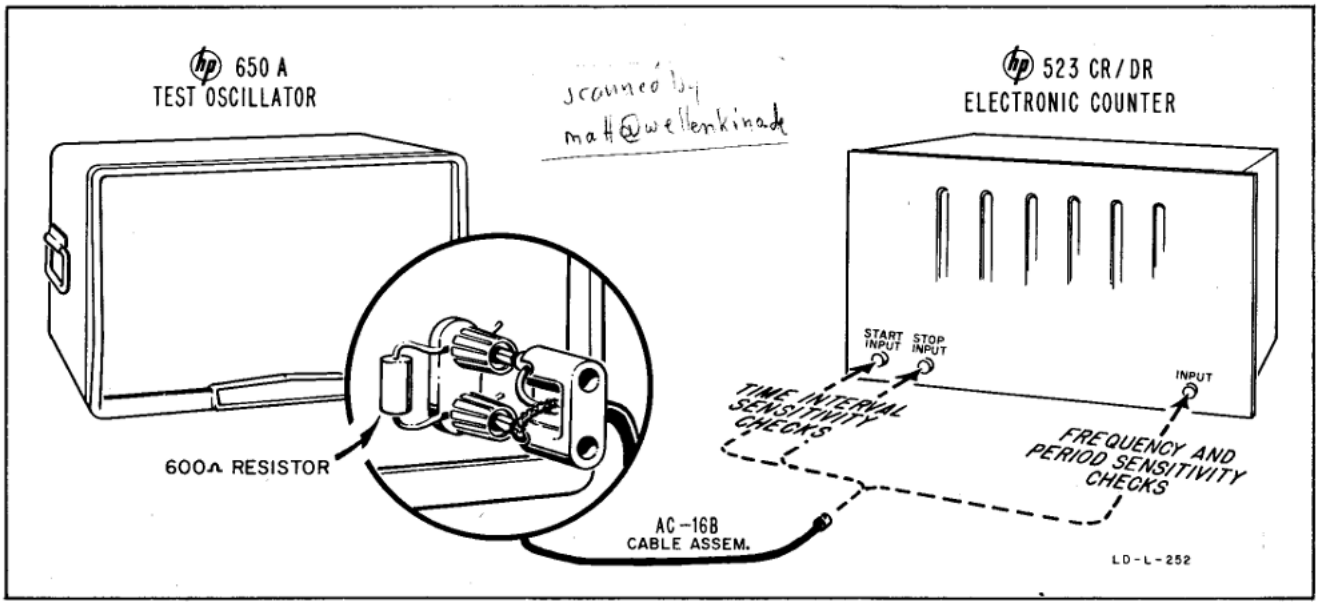

Figure 5-6. Equipment Setup for Performance Check

SCHEMATIC DIAGRAM NOTES

1. Heavy box around control titles indicates front-panel or rear-panel engraving; light box indicates chassis marking.

2. Arrows on potentiometers indicate clockwise rotation as viewed from the shaft side.

3. Heavy solid lines indicate main signal paths; heavy dashed lines indicate secondary or feedback signal paths.

4. Resistance is given in ohms, inductance in microhenries, and capacitance in pico-farads unless otherwise noted.

5. Voltages were measured with a vacuum tube voltmeter having an input resistance greater than 100 megohms; values may vary some from those shown due to tube aging or normal differences between instruments. Voltages were measured under the following conditions:

   FUNCTION SELECTOR set to 1 MC CHK
   FREQUENCY UNIT set to .001
   TIME UNIT set to 1 MC
   DISPLAY TIME set to MIN
   START and STOP TRIGGER LEVEL set to 0

6. * indicates part value adjusted at the factory; schematic shows average value.

7. Relay shown in de-energized position.

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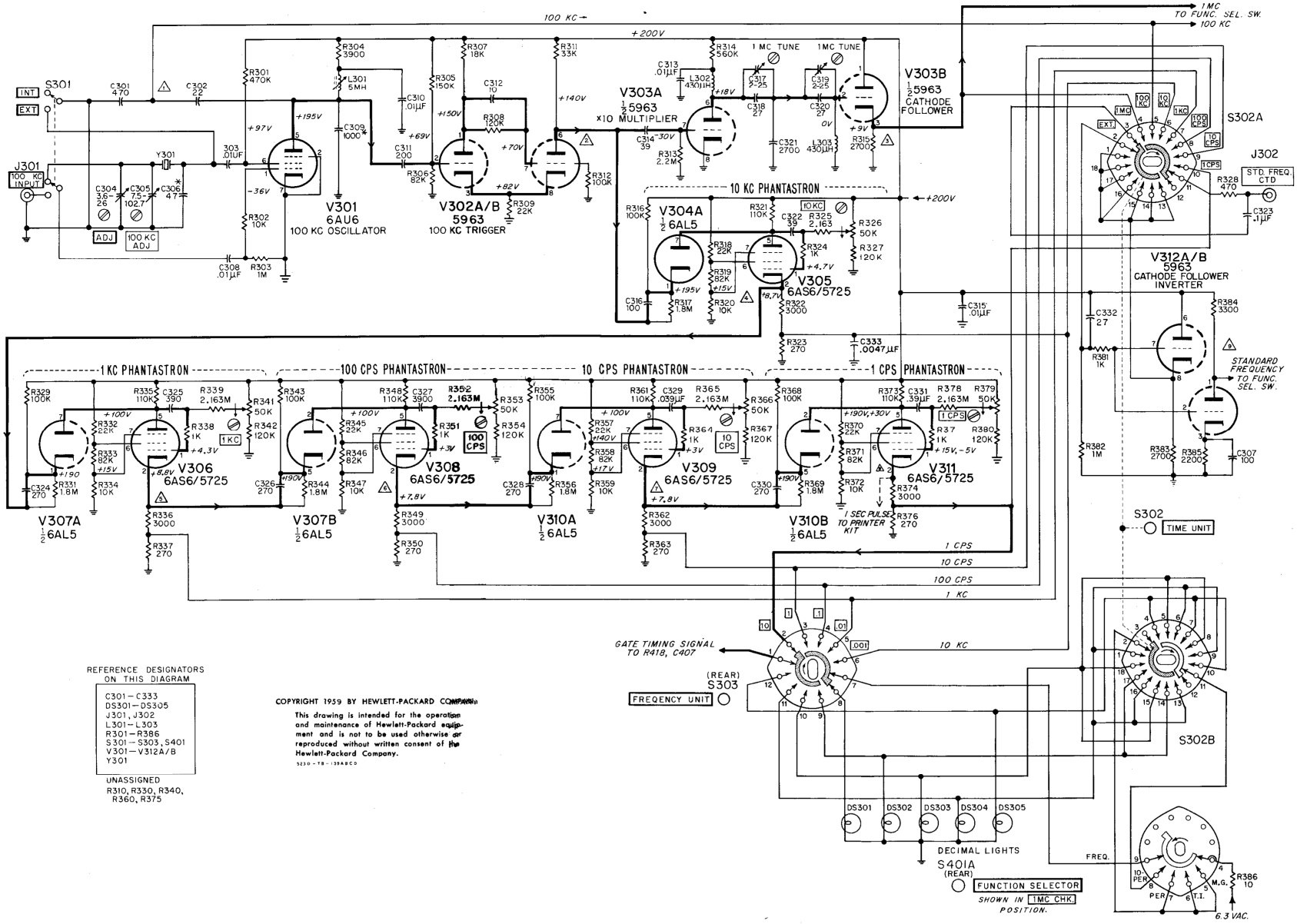

REFERENCE DESIGNATORS ON THIS DIAGRAM

C301 – C333
DS301 – DS305
J301, J302
L301 – L303
R301 – R386
S301 – S303, S401
V301 – V312A/B
Y301

UNASSIGNED
R310, R330, R340, R360, R375

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5230 - TB - 135A&C D

Figure 5-7. Time Base Section

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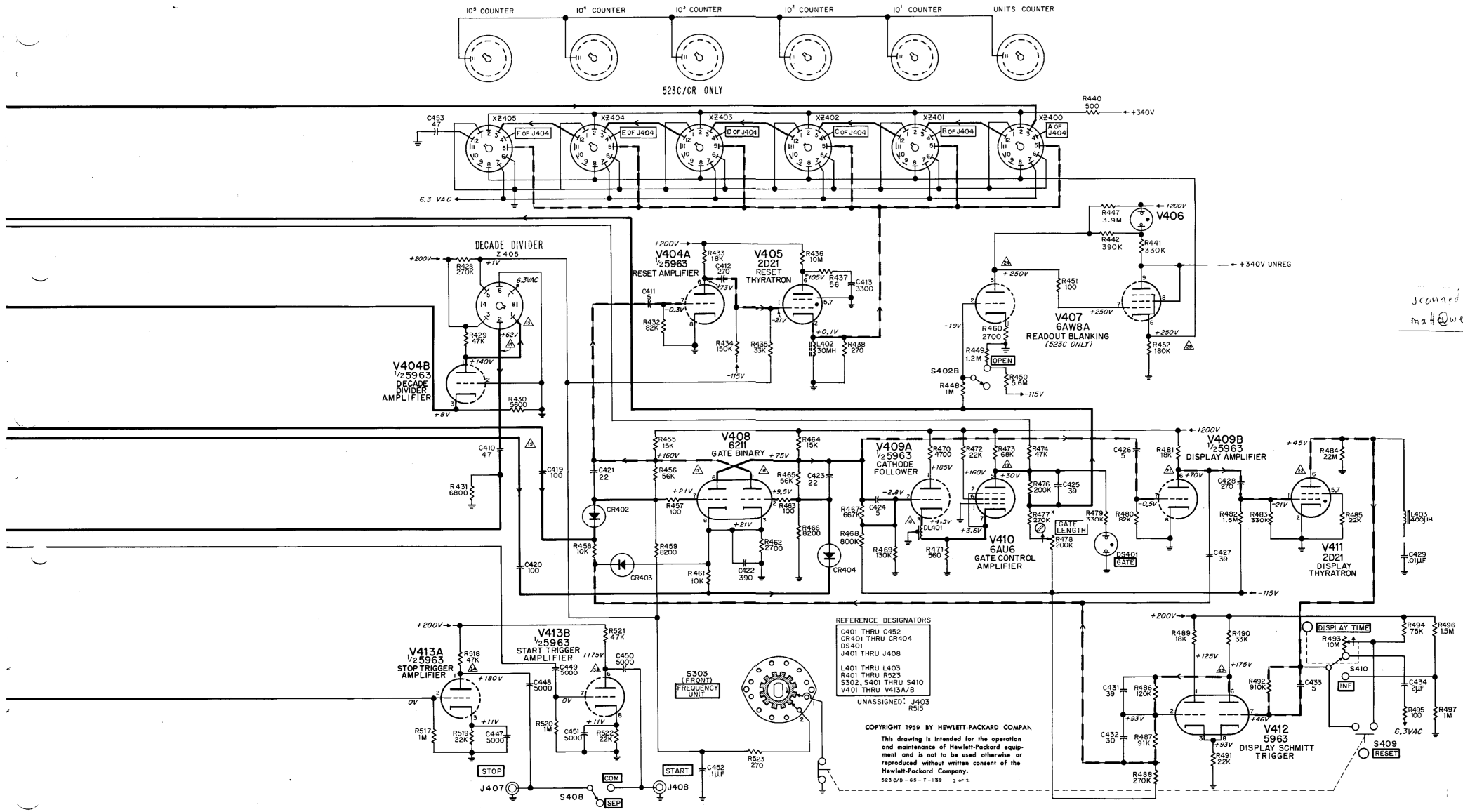

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Figure 5-8. Gate Section (sheet 2 of 2)

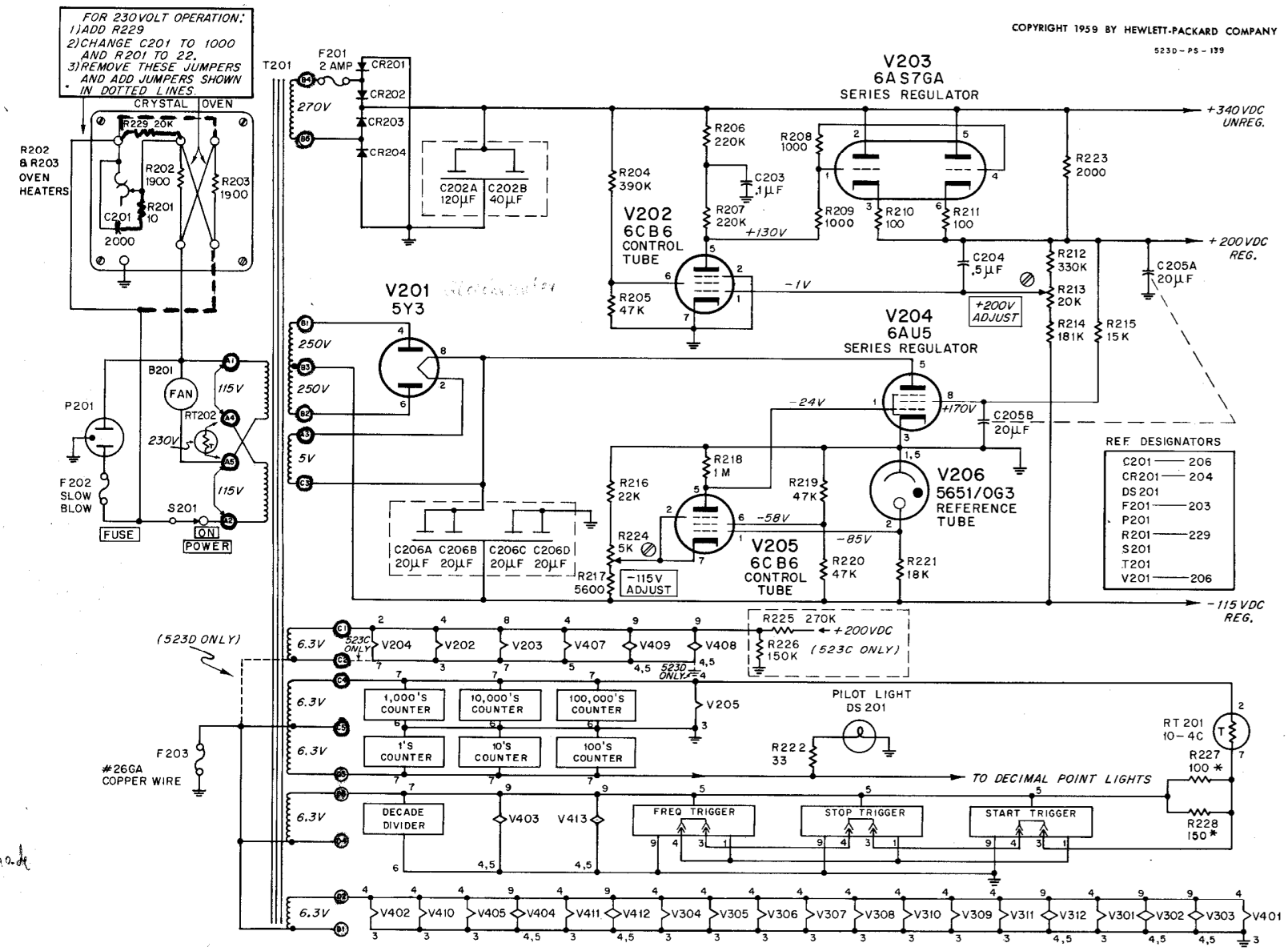

Figure 5-9. Power Supply

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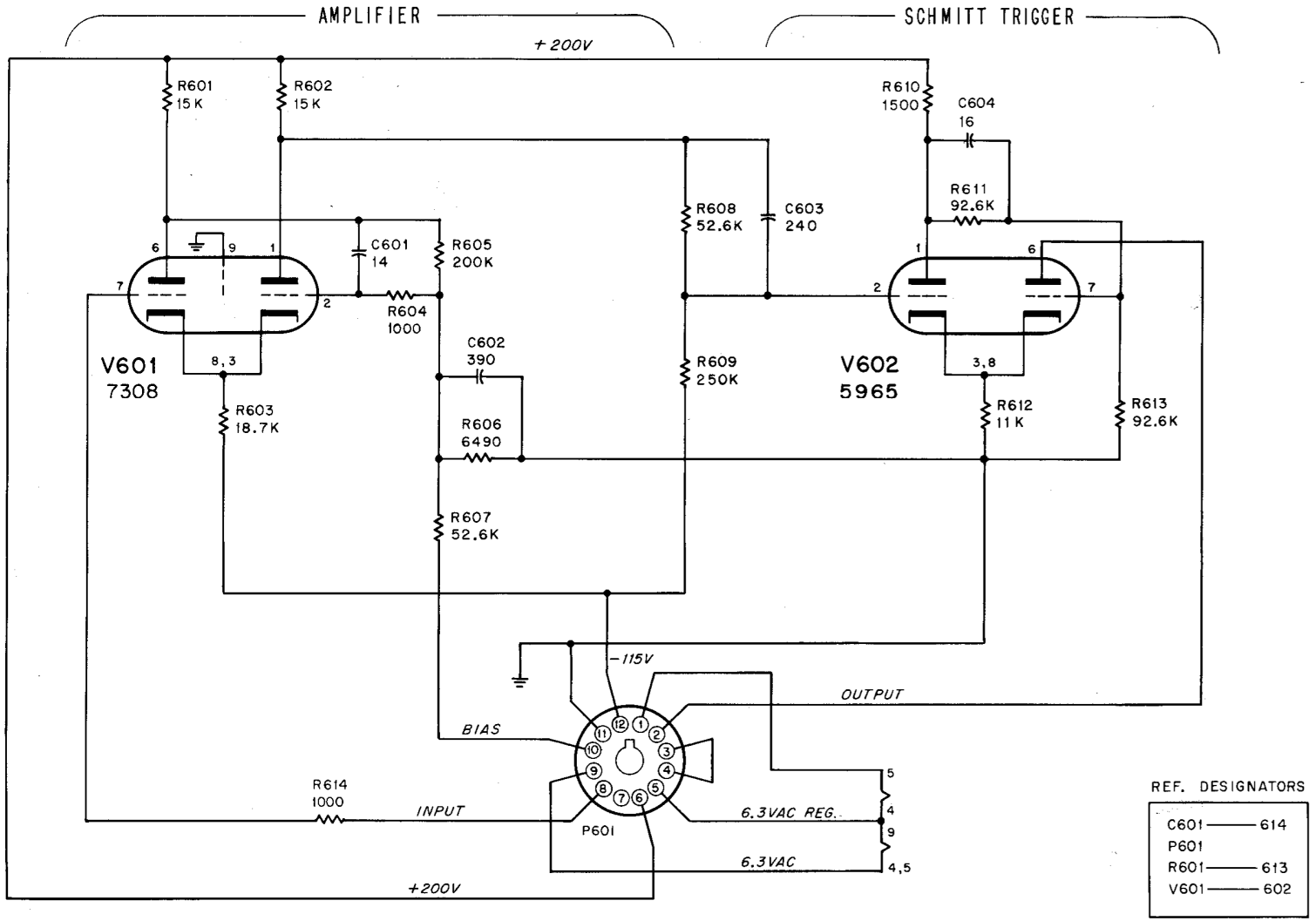

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Figure 5-10. Trigger Unit

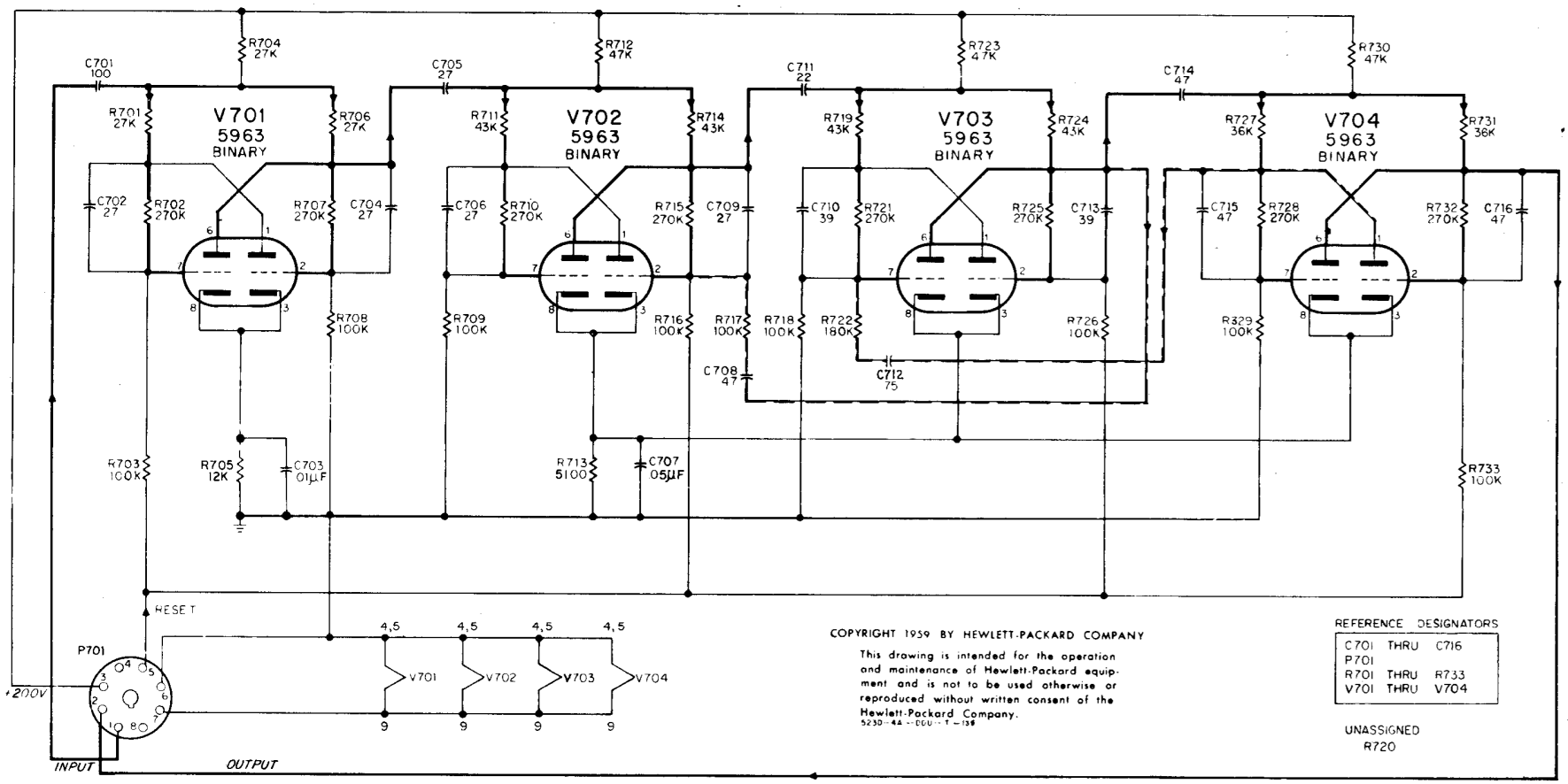

Figure 5-11. Decade Divider

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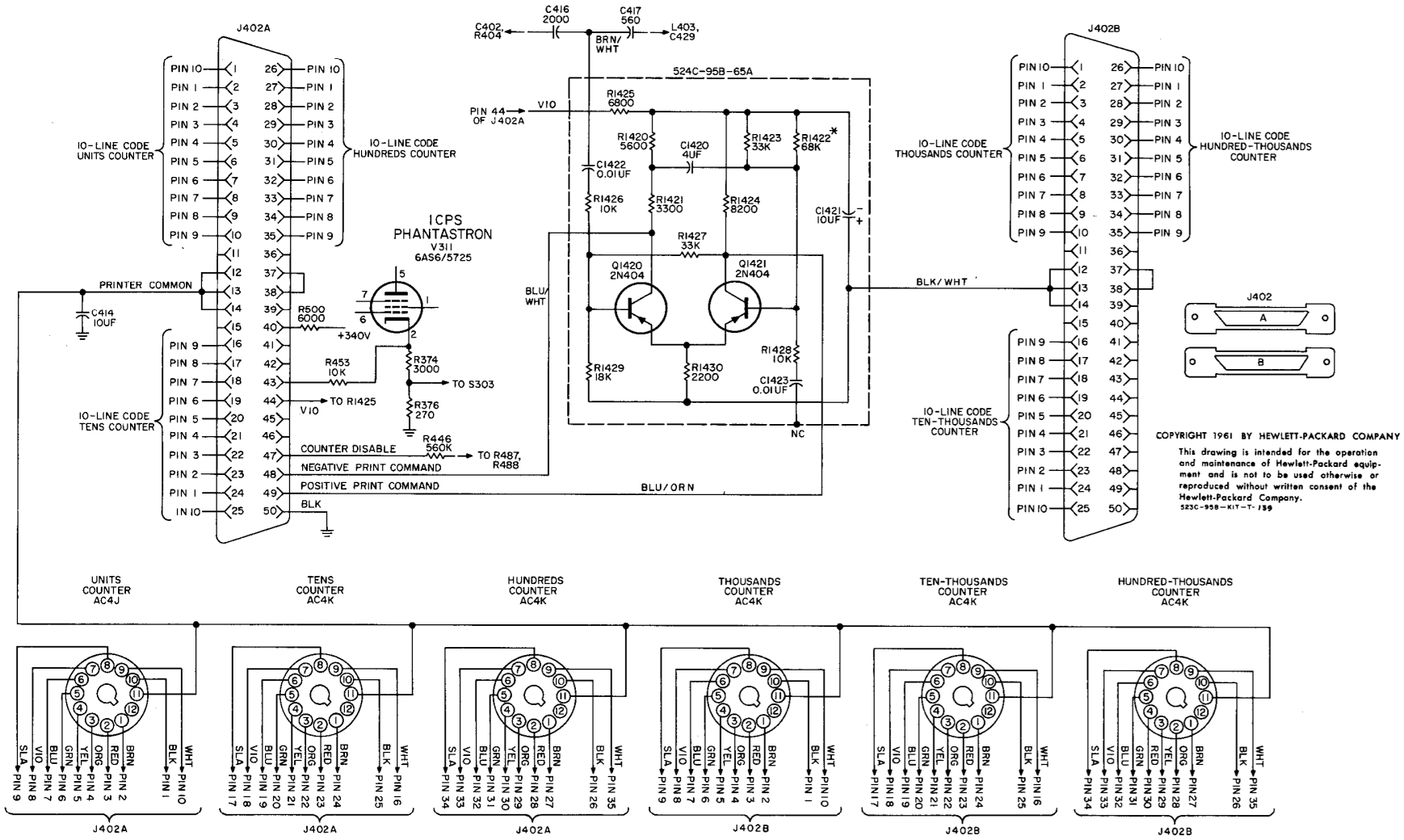

Figure 5-12. 523C-95B Digital Recorder Kit

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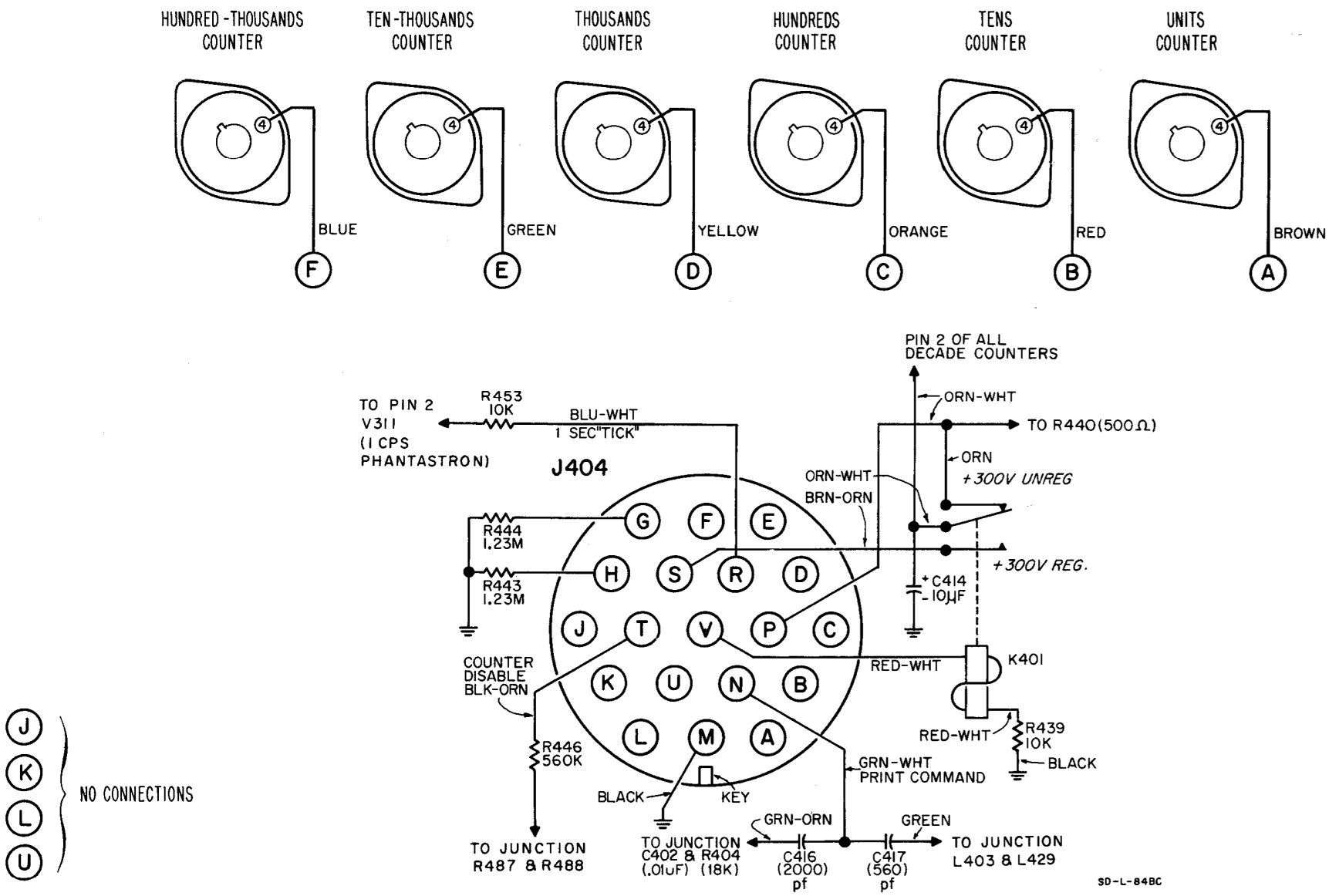

Figure 5-13. 523D-95A Digital Recorder Kit

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SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical order of their reference designators and indicates the description and ⓗⓟ stock number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their ⓗⓟ stock numbers and provides the following information on each part:

a. Description of the part (see list of abbreviations below).

b. Typical manufacturer of the part in a five-digit code; see list of manufacturers in appendix.

c. Manufacturer's stock number.

d. Total quantity used in the instrument (TQ col.).

e. Recommended spare part quantity for complete maintenance during one year of isolated service (RS column).

6-3. Miscellaneous parts not indexed in table 6-1 are listed at the end of table 6-2.

6-4. ORDERING INFORMATION.

6-5. To order a replacement part, address order or inquiry either to your authorized Hewlett-Packard sales representative or to

CUSTOMER SERVICE
Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California

or, in Western Europe, to

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

6-6. Specify the following information for each part:

a. Model and complete serial number of instrument.

b. Hewlett-Packard stock number.

c. Circuit reference designator.

d. Description.

6-7. To order a part not listed in tables 6-1 and 6-2, give a complete description of the part and include its function and location.

REFERENCE DESIGNATORS

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

ABBREVIATIONS

A = amperes
BP = bandpass
BWO = backward wave oscillator
CER = ceramic
CMO = cabinet mount only
COEF = coefficient
COM = common
COMP = composition
CONN = connection
CRT = cathode-ray tube
DEPC = deposited carbon
EIA = Tubes or transistors meeting Electronic Industries' Association standards will normally result in instrument operating within specifications; tubes and transistors selected for best performance will be supplied if ordered by ⓗⓟ stock numbers.
ELECT = electrolytic
ENCAP = encapsulated
F = farads
FXD = fixed
GE = germanium
GL = glass
GRD = ground(ed)
H = henries
HG = mercury
HR = hour(s)
IMPG = impregnated
INCD = incandescent
INS = insulation (ed)
K = kilo = 1000
LIN = linear taper
LOG = logarithmic taper
M = meg = 10^6
MA = milliamperes
MINAT = miniature
METFLM = metal film
MFR = manufacturer
MTG = mounting
MY = mylar
NC = normally closed
NE = neon
NO = normally open
NPO = negative positive zero (zero temperature coefficient)
NSR = not separately replaceable
OBD = order by description
P = peak
PC = printed circuit board
PF = picofarads = 10^{-12} farads
PP = peak-to-peak
PIV = peak inverse voltage
POR = porcelain
POS = position(s)
POLY = polystyrene
POT = potentiometer
RECT = rectifier
ROT = rotary
RMS = root-mean-square
RMO = rack mount only
S-B = slow-blow
SE = selenium
SECT = section(s)
SI = silicon
SIL = silver
SL = slide
TA = tantalum
TD = time delay
TI = titanium dioxide
TOG = toggle
TOL = tolerance
TRIM = trimmer
TWT = traveling wave tube
U = micro = 10^{-6}
VAC = vacuum
VAR = variable
W/ = with
W = watts
WW = wirewound
W/O = without
* = optimum value selected at factory, average value shown (part may be omitted)
# = number

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Table 6-1. Reference Designation Index

Circuit Reference	Stock No.	Description	Note
B 201	3140-0006	MOTOR:FAN 115VAC 60 CYCLES	
C 201		NOT ASSIGNED	
C 202	0180-0030	C:FXD ELECT 120 X40 UF 450VDCW	
C 203	0160-0013	C:FXD MY 0.1UF 10% 400VDCW	
C 204	0160-0024	C:FXD PAPER 5UF +/-10% 400VDCW	
C 205	0180-0012	C:FXD ELECT 2X20 UF 450VDCW	
C 206	0180-0125	C:FXD ELECT 4X20UF -10+30% 450VDCW	
C 207-		NOT ASSIGNED	
C 300		NOT ASSIGNED	
C 301	0140-0027	C:FXD MICA 470 PF 10% 500 VDCW	
C 302	0140-0026	C:FXD MICA 22 PF 10% 500 VDCW	
C 303	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C 304	0121-0006	C:VAR AIR 3.6-26PF	
C 305	0121-0008	C:VAR AIR 7.5-102.7PF	
C 306	0150-0010	C:FXD CER 47PF 5% NPO 500VDCW	
C 307	0140-0041	C:FXD MICA 100 PF 5% 500 VDCW	
C 308	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C 309	0140-0003	C:FXD MICA 1000 PF 10% 500VDCW	
C 310	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C 311	0140-0056	C:FXD MICA 200 PF 10% 500 VDCW	
C 312	0140-0002	C:FXD MICA 10 PF 10% VDCW	
C 313	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C 314	0140-0035	C:FXD MICA 39 PF 5% 500 VDCW	
C 315	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C 316	0140-0054	C:FXD MICA 100 PF 10% 500 VDCW	
C 317	0131-0005	C:VAR MICA 2-25 PF 175 V	
C 318	0140-0042	C:FXD MICA 27 PF 5% 500 VDCW	
C 319	0131-0005	C:VAR MICA 2-25 PF 175 V	
C 320	0140-0042	C:FXD MICA 27 PF 5% 500 VDCW	
C 321	0160-0044	C:FXD PAPER 2700 PF 10% 600VDCW	
C 322	0140-0116	C:FXD MICA 39 PF 2% 500 VDCW	
C 323	0170-0022	C:FXD MY 0.1UF 20% 600VDCW	
C 324	0140-0015	C:FXD MICA 270 PF 10% 500VDCW	
C 325	0140-0114	C:FXD MICA 390 PF 2% 500 VDCW	
C 326	0140-0015	C:FXD MICA 270 PF 10% 500VDCW	
C 327	0140-0115	C:FXD MICA 3900PF 500VDCW	
C 328	0140-0015	C:FXD MICA 270 PF 10% 500VDCW	
C 329	0170-0032	C:FXD POLY 0.039UF 2% 400VDCW	
C 330	0140-0015	C:FXD MICA 270 PF 10% 500VDCW	
C 331	0170-0031	C:FXD POLY 0.39 UF 2% 400VDCW	
C 332	0140-0042	C:FXD MICA 27 PF 5% 500 VDCW	
C 333	0150-0086	C:FXD CER 4700 PF 20% 500 VDCW	
C 334-		NOT ASSIGNED	
C 400		NOT ASSIGNED	
C 401	0160-0013	C:FXD MY 0.1UF 10% 400VDCW	
C 402	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C 403	0160-0013	C:FXD MY 0.1UF 10% 400VDCW	
C 404	0140-0110	C:FXD MICA SIL 127 PF 2% 300 VDCW	
C 405	0140-0030	C:FXD MICA 390 PF 10% 500 VDCW	
C 406	0160-0018	C:FXD MY 0.22UF 10% 400VDCW	
C 407	0160-0007	C:FXD MY 0.0022UF 10% 600VDCW	
C 408	0140-0039	C:FXD MICA 47 PF 5% 500 VDCW	
C 409	0150-0014	C:FXD CER 5000PF MIN 500VDCW	
C 410	0140-0039	C:FXD MICA 47 PF 5% 500 VDCW	
C 411	0140-0001	C:FXD MICA 5 PF 500 VDCW	
C 412	0140-0015	C:FXD MICA 270 PF 10% 500VDCW	

See introduction to this section

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Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
C 413	0140-0029	C:FXD MICA 3300 PF 10% 500 VDCW	
C 414	0180-0005	C:FXD ELECT 10UF 50% 450VDCW	
C 415	0130-0012	C:VAR CER 5-25 PF NPO	
C 416	0150-0023	C:FXD CER 2000PF 20% 1000VDCW	
C 417	0140-0044	C:FXD MICA 560 PF 10% 500 VDCW	
C 418		NOT ASSIGNED	
C 419	0140-0041	C:FXD MICA 100 PF 5% 500 VDCW	
C 420	0140-0041	C:FXD MICA 100 PF 5% 500 VDCW	
C 421	0140-0034	C:FXD MICA 22 PF 5% 500 VDCW	
C 422	0140-0037	C:FXD MICA 390 PF 5% 500 VDCW	
C 423	0140-0034	C:FXD MICA 22 PF 5% 500 VDCW	
C 424	0140-0033	C:FXD MICA 5 PF 20% 500 VDCW	
C 425	0140-0035	C:FXD MICA 39 PF 5% 500 VDCW	
C 426	0140-0001	C:FXD MICA 5 PF 500 VDCW	
C 427	0140-0021	C:FXD MICA 39 PF 10% 500 VDCW	
C 428	0140-0015	C:FXD MICA 270 PF 10% 500VDCW	
C 429	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C 430	0130-0008	C:VAR CER 8-50 N750	
C 431	0140-0035	C:FXD MICA 39 PF 5% 500 VDCW	
C 432	0140-0105	C:FXD MICA 30 PF 5% 500 VDCW	
C 433	0140-0033	C:FXD MICA 5 PF 20% 500 VDCW	
C 434	0160-0103	C:FXD PAPER 2UF 10% 400VDCW	
C 435	0170-0033	C:FXD MY 0.18UF 2% 600VDCW	
C 436	0140-0020	C:FXD MICA 1800 PF 10% 500 VDCW	
C 437	0140-0041	C:FXD MICA 100 PF 5% 500 VDCW	
C 438	0150-0031	C:FXD TI 2PF 5% 500VDCW	
C 439	0140-0081	C:FXD MICA 56 PF 1% 500 VDCW	
C 440	0170-0033	C:FXD MY 0.18UF 2% 600VDCW	
C 441	0140-0020	C:FXD MICA 1800 PF 10% 500 VDCW	
C 442	0140-0041	C:FXD MICA 100 PF 5% 500 VDCW	
C 443	0150-0031	C:FXD TI 2PF 5% 500VDCW	
C 444	0140-0081	C:FXD MICA 56 PF 1% 500 VDCW	
C 445	0150-0014	C:FXD CER 5000PF MIN 500VDCW	
C 446	0140-0039	C:FXD MICA 47PF 5% 300VDCW	
C 447	0150-0014	C:FXD CER 5000PF MIN 500VDCW	
C 448	0150-0014	C:FXD CER 5000PF MIN 500VDCW	
C 449	0150-0014	C:FXD CER 5000PF MIN 500VDCW	
C 450	0150-0014	C:FXD CER 5000PF MIN 500VDCW	
C 451	0150-0014	C:FXD CER 5000PF MIN 500VDCW	
C 452	0170-0022	C:FXD MY 0.1UF 20% 600VDCW	
C 453	0140-0039	C:FXD MICA 47PF 5% 300VDCW	
C 454		NOT ASSIGNED	
C 600-		NOT ASSIGNED	
C 601	0150-0056	C:FXD CER 14 PF 3% NPO 500 VDCW	
C 602	0140-0037	C:FXD MICA 390 PF 5% 500 VDCW	
C 603	0140-0092	C:FXD MICA 240 PF 5% 500 VDCW	
C 604	0150-0057	C:FXD CER 16 PF 3% NPO 500 VDCW	
C 605-		NOT ASSIGNED	
C 700		NOT ASSIGNED	
C 701	0140-0041	C:FXD MICA 100 PF 5% 500 VDCW	
C 702	0140-0042	C:FXD MICA 27 PF 5% 500 VDCW	
C 703	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C 704	0140-0042	C:FXD MICA 27 PF 5% 500 VDCW	
C 705	0140-0042	C:FXD MICA 27 PF 5% 500 VDCW	
C 706	0140-0042	C:FXD MICA 27 PF 5% 500 VDCW	

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Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
C 707	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C 708	0140-0039	C:FXD MICA 47PF 5% 300VDCW	
C 709	0140-0042	C:FXD MICA 27 PF 5% 500 VDCW	
C 710	0140-0035	C:FXD MICA 39 PF 5% 500 VDCW	
C 711	0140-0034	C:FXD MICA 22 PF 5% 500 VDCW	
C 712	0140-0040	C:FXD MICA 75 PF 5% 500 VDCW	
C 713	0140-0035	C:FXD MICA 39 PF 5% 500 VDCW	
C 714	0140-0039	C:FXD MICA 47PF 5% 300VDCW	
C 715	0140-0039	C:FXD MICA 47PF 5% 300VDCW	
C 716	0140-0039	C:FXD MICA 47PF 5% 300VDCW	
CR201	1901-0029	DIODE SILICON PIV 600V I AVG 0.75A	
CR202	1901-0029	DIODE SILICON PIV 600V I AVG 0.75A	
CR203	1901-0029	DIODE SILICON PIV 600V I AVG 0.75A	
CR204	1901-0029	DIODE SILICON PIV 600V I AVG 0.75A	
CR205-		NOT ASSIGNED	
CR400		NOT ASSIGNED	
CR401	1910-0011	DIODE GERMANIUM 5MA AT 1V 60 PIV	
CR402	1910-0011	DIODE GERMANIUM 5MA AT 1V 60 PIV	
CR403	1910-0011	DIODE GERMANIUM 5MA AT 1V 60 PIV	
CR404	1910-0011	DIODE GERMANIUM 5MA AT 1V 60 PIV	
DL401	9190-0001	DELAY LINE ASSEMBLY	
DS201	2140-0009	LAMP:INCANDESCENT 6-8V TYPE 47	
DS202		NOT ASSIGNED	
DS300		NOT ASSIGNED	
DS301	2140-0009	LAMP:INCANDESCENT 6-8V TYPE 47	
DS301	2140-0009	LAMP:INCANDESCENT 6-8V TYPE 47	
DS303	2140-0009	LAMP:INCANDESCENT 6-8V TYPE 47	
DS304	2140-0009	LAMP:INCANDESCENT 6-8V TYPE 47	
DS305	2140-0009	LAMP:INCANDESCENT 6-8V TYPE 47	
DS306-		NOT ASSIGNED	
DS400		NOT ASSIGNED	
DS 401	1450-0025	LAMP:NEON	
F 201	2110-0002	FUSE:CARTRIDGE 2 AMP 3 AG	
F 202	2110-0030	FUSE:CARTRIDGE 5 AMP 125V SLOW BLOW	
J 301	1250-0083	CONNECTOR:BNC	
J 302	1250-0001	CONNECTOR:BNC	
J 303-		NOT ASSIGNED	
J 400		NOT ASSIGNED	
J 401	1250-0001	CONNECTOR:BNC	
J 402-		NOT ASSIGNED	
J 404		NOT ASSIGNED	
J 405	1250-0001	CONNECTOR:BNC	
J 406	1250-0001	CONNECTOR:BNC	
J 407	1250-0083	CONNECTOR:BNC	
J 408	1250-0083	CONNECTOR:BNC	
K 401	0490-0017	RELAY:DPDT 110VDC	
L 301	9140-0016	COIL VAR RF 3.5-5 MHY	
L 302	9140-0021	COIL:FXD RF 430OH	
L 303	9140-0021	COIL:FXD RF 430OH	
L 304-		NOT ASSIGNED	
L 400		NOT ASSIGNED	
L 401	9140-0022	COIL:FXD RF 5000H	
L 402	9130-0001	COIL:PULSE 30MH	
L 403	9140-0020	COIL FXD RF 400 UHY	

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Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
P 201	8120-0015	POWER CABLE	
P 202-		NOT ASSIGNED	
P 600		NOT ASSIGNED	
P 601	1251-0114	CONNECTOR:12-PIN MALE	
P 602	1251-0114	CONNECTOR:12-PIN MALE	
P 603	1251-0114	CONNECTOR:12-PIN MALE	
P 604-		NOT ASSIGNED	
P 700		NOT ASSIGNED	
P 701	1200-0027	SOCKET:9-PIN	
R 201	0687-1001	R:FXD COMP 10 OHMS 10% 1/2W (FOR 115-VOLT OPERATION)	
R 201	0687-2201	R:FXD COMP 22 OHMS 10% 1/2W (FOR 230-VOLT OPERATION)	
R 202		HEATER:CRYSTAL OVEN HOUSING ASSY.	
R 202		NOT SEPARATELY REPLACEABLE	
R 203		HEATER:CRYSTAL OVEN HOUSING ASSY.	
R 204	0687-3941	R:FXD COMP 390K OHMS 10% 1/2W	
R 205	0687-4731	R:FXD COMP 47K OHMS 10% 1/2W	
R 206	0687-2241	R:FXD COMP 220K OHMS 10% 1/2W	
R 207	0687-2241	R:FXD COMP 220K OHMS 10% 1/2W	
R 208	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R 209	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R 210	0690-1011	R:FXD COMP 100 OHMS 10% 1W	
R 211	0690-1011	R:FXD COMP 100 OHMS 10% 1W	
R 212	0730-0086	R:FXD DEPC 330K OHMS 1% 1W	
R 213	2100-0060	R:VAR 20K OHMS 20% 2W LIN	
R 214	0730-0077	R:FXD DEPC 181K OHMS 1% 1W	
R 215	0690-1531	R:FXD COMP 15K OHMS 10% 1W	
R 216	0690-2231	R:FXD COMP 22K OHMS 10% 1W	
R 217	0687-5621	R:FXD COMP 5600 OHMS 10% 1/2W	
R 218	0687-1051	R:FXD COMP 1M OHMS 10% 1/2W	
R 219	0687-4731	R:FXD COMP 47K OHMS 10% 1/2W	
R 220	0687-4731	R:FXD COMP 47K OHMS 10% 1/2W	
R 221	0687-1831	R:FXD COMP 18K OHMS 10% 1/2W	
R 222	0690-3301	R:FXD COMP 33 OHMS 10% 1W	
R 223	0818-0010	R:FXD WW 2000 OHMS 5% 30W	
R 224	2100-0026	R:VAR COMP 5000 OHM 10% LIN 2W	
R 225	0687-2741	R:FXD COMP 270K OHMS 10% 1/2W	
R 226	0687-1541	R:FXD COMP 150K OHMS 10% 1/2W	
R 227	0693-1011	R:FXD COMP 100 OHMS 10% 2W	
R 228	0690-1511	R:FXD COMP 150 OHMS 10% 1W	
R 229	0767-0011	R:FXD 20K OHMS 5% 3W	
R 230-		NOT ASSIGNED	
R 300		NOT ASSIGNED	
R 301	0687-4741	R:FXD COMP 470K OHMS 10% 1/2W	
R 302	0687-1031	R:FXD COMP 10K OHMS 10% 1/2W	
R 303	0687-1051	R:FXD COMP 1M OHMS 10% 1/2W	
R 304	0690-3921	R:FXD COMP 3900 OHMS 10% 1W	
R 305	0687-1541	R:FXD COMP 150K OHMS 10% 1/2W	
R 306	0687-8231	R:FXD COMP 82K OHMS 10% 1/2W	
R 307	0690-1831	R:FXD COMP 18K OHMS 10% 1W	
R 308	0687-1241	R:FXD COMP 120K OHMS 10% 1/2W	
R 309	0690-2231	R:FXD COMP 22K OHMS 10% 1W	
R 310		NOT ASSIGNED	
R 311	0687-3331	R:FXD COMP 33K OHMS 10% 1/2W	

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Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
R 312	0687-1041	R:FXD COMP 100K OHMS 10% 1/2W	
R 313	0687-2251	R:FXD COMP 2.2M OHMS 10% 1/2W	
R 314	0687-5641	R:FXD COMP 560K OHMS 10% 1/2W	
R 315	0687-2721	R:FXD COMP 2700 OHMS 10% 1/2W	
R 316	0690-1041	R:FXD COMP 100K OHMS 10% 1W	
R 317	0687-1851	R:FXD COMP 1.8M OHMS 10% 1/2W	
R 318	0693-2231	R:FXD COMP 22K OHMS 10% 2W	
R 319	0689-8235	R:FXD COMP 82K OHMS 5% 1W	
R 320	0686-1035	R:FXD COMP 10K OHMS 5%1/2W	
R 321	0689-1145	R:FXD COMP 110K OHMS 5% 1W	
R 322	0689-3025	R:FXD COMP 3000 OHMS 5% 1W	
R 323	0687-2711	R:FXD COMP 270 OHMS +/-10% 1/2W	
R 324	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R 325	0730-0113	R:FXD DEPC 2.163MEGOHMS 1% 1W	
R 326	2100-0028	R:VAR COMP 50K OHM 10% LIN 2W	
R 327	0690-1241	R:FXD COMP 120K OHMS 10% 1W	
R 328	0687-4711	R:FXD COMP 470 OHMS 10% 1/2W	
R 329	0690-1041	R:FXD COMP 100K OHMS 10% 1W	
R 330		NOT ASSIGNED	
R 331	0687-1851	R:FXD COMP 1.8M OHMS 10% 1/2W	
R 332	0693-2231	R:FXD COMP 22K OHMS 10% 2W	
R 333	0689-8235	R:FXD COMP 82K OHMS 5% 1W	
R 334	0686-1035	R:FXD COMP 10K OHMS 5%1/2W	
R 335	0689-1145	R:FXD COMP 110K OHMS 5% 1W	
R 336	0689-3025	R:FXD COMP 3000 OHMS 5% 1W	
R 337	0687-2711	R:FXD COMP 270 OHMS +/-10% 1/2W	
R 338	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R 339	0730-0113	R:FXD DEPC 2.163MEGOHMS 1% 1W	
R 340		NOT ASSIGNED	
R 341	2100-0028	R:VAR COMP 50K OHM 10% LIN 2W	
R 342	0690-1241	R:FXD COMP 120K OHMS 10% 1W	
R 343	0690-1041	R:FXD COMP 100K OHMS 10% 1W	
R 344	0687-1851	R:FXD COMP 1.8M OHMS 10% 1/2W	
R 345	0693-2231	R:FXD COMP 22K OHMS 10% 2W	
R 346	0689-8235	R:FXD COMP 82K OHMS 5% 1W	
R 347	0686-1035	R:FXD COMP 10K OHMS 5%1/2W	
R 348	0689-1145	R:FXD COMP 110K OHMS 5% 1W	
R 349	0689-3025	R:FXD COMP 3000 OHMS 5% 1W	
R 350	0687-2711	R:FXD COMP 270 OHMS +/-10% 1/2W	
R 351	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R 352	0730-0113	R:FXD DEPC 2.163MEGOHMS 1% 1W	
R 353	2100-0028	R:VAR COMP 50K OHM 10% LIN 2W	
R 354	0690-1241	R:FXD COMP 120K OHMS 10% 1W	
R 355	0690-1041	R:FXD COMP 100K OHMS 10% 1W	
R 356	0687-1851	R:FXD COMP 1.8M OHMS 10% 1/2W	
R 357	0693-2231	R:FXD COMP 22K OHMS 10% 2W	
R 358	0689-8235	R:FXD COMP 82K OHMS 5% 1W	
R 359	0686-1035	R:FXD COMP 10K OHMS 5%1/2W	
R 360		NOT ASSIGNED	
R 361	0689-1145	R:FXD COMP 110K OHMS 5% 1W	
R 362	0689-3025	R:FXD COMP 3000 OHMS 5% 1W	
R 363	0687-2711	R:FXD COMP 270 OHMS +/-10% 1/2W	
R 364	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R 365	0730-0113	R:FXD DEPC 2.163MEGOHMS 1% 1W	
R 366	2100-0028	R:VAR COMP 50K OHM 10% LIN 2W	

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Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
R 367	0690-1241	R:FXD COMP 120K OHMS 10% 1W	
R 368	0690-1041	R:FXD COMP 100K OHMS 10% 1W	
R 369	0687-1851	R:FXD COMP 1.8M OHMS 10% 1/2W	
R 370	0693-2231	R:FXD COMP 22K OHMS 10% 2W	
R 371	0689-8235	R:FXD COMP 82K OHMS 5% 1W	
R 372	0686-1035	R:FXD COMP 10K OHMS 5%1/2W	
R 373	0689-1145	R:FXD COMP 110K OHMS 5% 1W	
R 374	0689-3025	R:FXD COMP 3000 OHMS 5% 1W	
R 375		NOT ASSIGNED	
R 376	0687-2711	R:FXD COMP 270 OHMS 10% 1/2W	
R 377	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R 378	0730-0113	R:FXD DEPC 2.163MEGOHMS 1% 1W	
R 379	2100-0028	R:VAR COMP 50K OHM 10% LIN 2W	
R 380	0690-1241	R:FXD COMP 120K OHMS 10% 1W	
R 381	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R 382	0687-1051	R:FXD COMP 1M OHMS 10% 1/2W	
R 383	0687-2721	R:FXD COMP 2700 OHMS 10% 1/2W	
R 384	0687-3321	R:FXD COMP 3300 OHMS 10% 1/2W	
R 385	0687-2221	R:FXD COMP 2200 OHMS 10% 1/2W	
R 386	0687-1001	R:FXD COMP 10 OHMS 10% 1/2W	
R 387-		NOT ASSIGNED	
R 400		NOT ASSIGNED	
R 401	0687-1051	R:FXD COMP 1M OHMS 10% 1/2W	
R 402	0693-1831	R:FXD COMP 18K OHMS 10% 2W	
R 403	2100-0010	R:VAR COMP 2000 OHM 20% 1/4W	
R 404	0687-1831	R:FXD COMP 18K OHMS 10% 1/2W	
R 405	0687-1051	R:FXD COMP 1M OHMS 10% 1/2W	
R 406	2100-0028	R:VAR COMP 50K OHM 10% LIN 2W	
R 407	0687-1821	R:FXD COMP 1800 OHMS 10% 1/2W	
R 408	0727-0203	R:FXD DEPC 90K OHM 1% 1/2W	
R 409	0686-1345	R:FXD COMP 130K OHMS 5% 1/2W	
R 410	0686-1035	R:FXD COMP 10K OHMS 5%1/2W	
R 411	0687-1821	R:FXD COMP 1800 OHMS 10% 1/2W	
R 412	0690-2731	R:FXD COMP 27K OHMS 10% 1W	
R 413	0690-3931	R:FXD COMP 39K OHMS 10% 1W	
R 414	0687-1821	R:FXD COMP 1800 OHMS 10% 1/2W	
R 415	0687-1051	R:FXD COMP 1M OHMS 10% 1/2W	
R 416	2100-0028	R:VAR COMP 50K OHM 10% LIN 2W	
R 417	0727-0203	R:FXD DEPC 90K OHM 1% 1/2W	
R 418	0686-2735	R:FXD COMP 27K OHM 5% 1/2W	
R 419	0687-2751	R:FXD COMP 2.7M OHMS 10% 1/2W	
R 420		NOT ASSIGNED	
R 421	0686-8235	R:FXD COMP82K 5% 1/2W	
R 422	0727-0203	R:FXD DEPC 90K OHM 1% 1/2W	
R 423	2100-0028	R:VAR COMP 50K OHM 10% LIN 2W	
R 424	0687-1251	R:FXD COMP 1.2M OHMS 10% 1/2W	
R 425	0687-4731	R:FXD COMP 47K OHMS +/-10% 1/2W	
R 426	0687-3321	R:FXD COMP 3300 OHMS 10% 1/2W	
R 427	0687-3321	R:FXD COMP 3300 OHMS 10% 1/2W	
R 428	0687-2741	R:FXD COMP 270K OHMS 10% 1/2W	
R 429	0687-4731	R:FXD COMP 47K OHMS 10% 1/2W	
R 430	0687-5621	R:FXD COMP 5600 OHMS 10% 1/2W	
R 431	0687-6821	R:FXD COMP 6800 OHMS 10% 1/2W	
R 432	0687-8231	R:FXD COMP 82K OHMS 10% 1/2W	
R 433	0693-1831	R:FXD COMP 18K OHMS 10% 2W	

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Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
R 434	0687-1541	R:FXD COMP 150K OHMS 10% 1/2W	
R 435	0687-3331	R:FXD COMP 33K OHMS 10% 1/2W	
R 436	0687-1061	R:FXD COMP 10M OHMS 10% 1/2W	
R 437	0687-5601	R:FXD COMP 56 OHMS 10% 1/2W	
R 438	0687-2711	R:FXD COMP 270 OHMS 10% 1/2W	
R 439	0693-1031	R:FXD COMP 10K OHMS 10% 2W	
R 440	0816-0003	R:FXD WW 500 OHMS 10% 10W	
R 441	0687-3341	R:FXD COMP 330K OHMS 10% 1/2W	
R 442	0687-3941	R:FXD COMP 390K OHMS 10% 1/2W	
R 442		(523C/CR ONLY)	
R 443	0730-0108	R:FXD DEPC 1.23M OHMS 1% 1W	
R 444	0730-0108	R:FXD DEPC 1.23M OHMS 1% 1W	
R 445	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R 446	0687-5641	R:FXD COMP 560K OHMS 10% 1/2W	
R 447	0687-3951	R:FXD COMP 3.9M OHMS 10% 1/2W	
R 448	0687-1051	R:FXD COMP 1M OHMS 10% 1/2W	
R 448		(523C/CR ONLY)	
R 449	0687-1251	R:FXD COMP 1.2M OHMS 10% 1/2W	
R 449		(523C/CR ONLY)	
R 450	0687-5651	R:FXD COMP 5.6M OHMS 10% 1/2W	
R 450		(523C/CR ONLY)	
R 451	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R 452	0687-1841	R:FXD COMP 180K OHMS 10% 1/2W	
R 453	0687-1031	R:FXD COMP 10K OHMS 10% 1/2W	
R 454	2100-0169	R:VAR COMP 20K OHM 30% LIN 0.2W	
R 455	0767-0010	R:FXD MET FLM 15K OHMS 5% 3W	
R 456	0686-5635	R:FXD COMP 56K OHMS 5% 1/2W	
R 457	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R 458	0687-1031	R:FXD COMP 10K OHMS 10% 1/2W	
R 459	0686-8225	R:FXD COMP 8200 OHMS 5% 1/2W	
R 460	0687-2721	R:FXD COMP 2700 OHMS 10% 1/2W	
R 461	0687-1031	R:FXD COMP 10K OHMS 10% 1/2W	
R 462	0686-2725	R:FXD COMP 2700 OHM 5% 1/2W	
R 463	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R 464	0767-0010	R:FXD MET FLM 15K OHMS 5% 3W	
R 465	0686-5635	R:FXD COMP 56K OHMS 5% 1/2W	
R 466	0686-8225	R:FXD COMP 8200 OHMS 5% 1/2W	
R 467	0727-0249	R:FXD DEPC 667K OHM 1% 1/2W	
R 468	0727-0255	R:FXD DEPC 800K OHM 1% 1/2W	
R 469	0686-1345	R:FXD COMP 130K OHMS 5% 1/2W	
R 470	0693-4721	R:FXD COMP 4700 OHMS 10% 2W	
R 471	0687-5611	R:FXD COMP 560 OHMS 10% 1/2W	
R 472	0687-2231	R:FXD COMP 22K OHMS 10% 1/2W	
R 473	0693-6831	R:FXD COMP 68K OHMS 10% 2W	
R 474	0687-4731	R:FXD COMP 47K OHMS 10% 1/2W	
R 475	2100-0169	R:VAR COMP 20K OHM 30% LIN 0.2W	
R 476	0727-0221	R:FXD DEPC 200K OHM 1% 1/2W	
R 477	0690-2741	R:FXD COMP 270K OHMS 10% 1W	
R 478	2100-0164	R:VAR COMP 200K OHM 30% LIN 0.2W	
R 479	0687-3341	R:FXD COMP 330K OHMS 10% 1/2W	
R 480	0687-8231	R:FXD COMP 82K OHMS 10% 1/2W	
R 481	0693-1831	R:FXD COMP 18K OHMS 10% 2W	
R 482	0687-1551	R:FXD COMP 1.5M OHMS 10% 1/2W	
R 483	0687-3341	R:FXD COMP 330K OHMS 10% 1/2W	
R 484	0687-2261	R:FXD COMP 22M OHMS 10% 1/2W	
R 485	0687-2231	R:FXD COMP 22K OHMS 10% 1/2W	

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Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
R 486	0686-1245	R:FXD COMP 120K OHMS 5%1/2W	
R 487	0686-9135	R:FXD COMP 91K OHMS 5% 1/2W	
R 488	0686-2745	R:FXD COMP 270K OHM 5% 1/2W	
R 489	0690-1831	R:FXD COMP 18K OHMS 10% 1W	
R 490	0690-3331	R:FXD COMP 33K OHMS 10% 1W	
R 491	0690-2231	R:FXD COMP 22K OHMS 10% 1W	
R 492	0686-9145	R:FXD COMP 910K OHMS 5% 1/2W	
R 493	2100-0152	R:VAR COMP 10MEGOHM 30% LIN 1/4W	
R 494	0686-7535	R:FXD COMP 75K OHMS 5% 1/2W	
R 495	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R 496	0686-1555	R:FXD COMP 1.5M OHMS 5% 1/2W	
R 497	0686-1055	R:FXD COMP 1M OHMS 5%1/2W	
R 498	0686-4725	R:FXD COMP 4700 OHMS 5% 1/2W	
R 499	0686-5145	R:FXD COMP 510K OHMS 5% 1/2W	
R 500	0819-0020	R:FXD WW 6000 OHMS 10% 20W	
R 501	0686-4345	R:FXD COMP 430K OHMS 5% 1/2W	
R 502	0686-4735	R:FXD COMP 47K OHM 5% 1/2W	
R 503	0686-5145	R:FXD COMP 510K OHMS 5% 1/2W	
R 504	0686-4345	R:FXD COMP 430K OHMS 5% 1/2W	
R 505	0686-4735	R:FXD COMP 47K OHM 5% 1/2W	
R 506	0686-4725	R:FXD COMP 4700 OHMS 5% 1/2W	
R 507	0727-0203	R:FXD DEPC 90K OHM 1% 1/2W	
R 508	2100-0028	R:VAR COMP 50K OHM 10% LIN 2W	
R 509	0686-8235	R:FXD COMP 82K OHMS 5% 1/2W	
R 510		NOT ASSIGNED	
R 511	0687-1821	R:FXD COMP 1800 OHMS 10% 1/2W	
R 512	0687-1251	R:FXD COMP 1.2M OHMS 10% 1/2W	
R 513	0687-4731	R:FXD COMP 47K OHMS +/-10% 1/2W	
R 514	0687-3321	R:FXD COMP 3300 OHMS 10% 1/2W	
R 515		NOT ASSIGNED	
R 516	0687-3321	R:FXD COMP 3300 OHMS 10% 1/2W	
R 517	0687-1051	R:FXD COMP 1M OHMS 10% 1/2W	
R 518	0687-4731	R:FXD COMP 47K OHMS +/-10% 1/2W	
R 519	0687-2231	R:FXD COMP 22K OHMS 10% 1/2W	
R 520	0687-1051	R:FXD COMP 1M OHMS 10% 1/2W	
R 521	0687-4731	R:FXD COMP 47K OHMS +/-10% 1/2W	
R 522	0687-2231	R:FXD COMP 22K OHMS 10% 1/2W	
R 523	0687-2711	R:FXD COMP 270 OHMS +/-10% 1/2W	
R 524-		NOT ASSIGNED	
R 600		NOT ASSIGNED	
R 601	0767-0010	R:FXD MET FLM 15K OHMS 5% 3W	
R 602	0767-0010	R:FXD MET FLM 15K OHMS 5% 3W	
R 603	0760-0003	R:FXD MET FLM 18.7K OHM 2% 1W	
R 604	0686-1025	R:FXD COMP 1000 OHMS 5%1/5W	
R 605	0727-0221	R:FXD DEPC 200K OHM 1% 1/2W	
R 606	0727-0143	R:FXD DEPC 6.49K OHMS 1% 1/2W	
R 607	0727-0196	R:FXD DEPC 52.6K OHMS 1% 1/2W	
R 608	0727-0196	R:FXD DEPC 52.6K OHMS 1% 1/2W	
R 609	0727-0226	R:FXD DEPC 250K OHM 1% 1/2W	
R 610	0686-1525	R:FXD COMP 1500 OHMS 5% 1/2W	
R 611	0727-0205	R:FXD DEPC 92.6K OHM 1% 1/2W	
R 612	0692-1135	R:FXD COMP 11K OHMS 5% 2W	
R 613	0727-0205	R:FXD DEPC 92.6K OHM 1% 1/2W	
R 614	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R 615-		NOT ASSIGNED	
R 700		NOT ASSIGNED	

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Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
R 701	0686-2735	R:FXD COMP 27K OHM 5% 1/2W	
R 702	0686-2745	R:FXD COMP 270K OHM 5% 1/2W	
R 703	0686-1045	R:FXD COMP 100K OHMS 5%1/2W	
R 704	0690-2731	R:FXD COMP 27K OHMS 10% 1W	
R 705	0686-1235	R:FXD COMP 12K OHMS 5%1/2W	
R 706	0686-2735	R:FXD COMP 27K OHM 5% 1/2W	
R 707	0686-2745	R:FXD COMP 270K OHM 5% 1/2W	
R 708	0686-1045	R:FXD COMP 100K OHMS 5%1/2W	
R 709	0686-1045	R:FXD COMP 100K OHMS 5%1/2W	
R 710	0686-2745	R:FXD COMP 270K OHM 5% 1/2W	
R 711	0686-4335	R:FXD COMP 43K OHMS 5% 1/2W	
R 712	0690-4731	R:FXD COMP 47K OHMS 10% 1W	
R 713	0689-5125	R:FXD COMP 5100 OHMS 5% 1W	
R 714	0686-4335	R:FXD COMP 43K OHMS 5% 1/2W	
R 715	0686-2745	R:FXD COMP 270K OHM 5% 1/2W	
R 716	0686-1045	R:FXD COMP 100K OHMS 5%1/2W	
R 717	0686-1045	R:FXD COMP 100K OHMS 5%1/2W	
R 718	0686-1045	R:FXD COMP 100K OHMS 5%1/2W	
R 719	0686-4335	R:FXD COMP 43K OHMS 5% 1/2W	
R 720		NOT ASSIGNED	
R 721	0686-2745	R:FXD COMP 270K OHM 5% 1/2W	
R 722	0687-1841	R:FXD COMP 180K OHMS 10% 1/2W	
R 723	0690-4731	R:FXD COMP 47K OHMS 10% 1W	
R 724	0686-4335	R:FXD COMP 43K OHMS 5% 1/2W	
R 725	0686-2745	R:FXD COMP 270K OHM 5% 1/2W	
R 726	0686-1045	R:FXD COMP 100K OHMS 5%1/2W	
R 727	0686-3635	R:FXD COMP 36K OHMS 5% 1/2W	
R 728	0686-2745	R:FXD COMP 270K OHM 5% 1/2W	
R 729	0686-1045	R:FXD COMP 100K OHMS 5%1/2W	
R 730	0690-4731	R:FXD COMP 47K OHMS 10% 1W	
R 731	0686-3635	R:FXD COMP 36K OHMS 5% 1/2W	
R 732	0686-2745	R:FXD COMP 270K OHM 5% 1/2W	
R 733	0686-1045	R:FXD COMP 100K OHMS 5%1/2W	
RT201	0852-0004	TUBE:BALLAST 10-4C	
RT202	0839-0006	RT:10 OHMS 10% AT 25C (FOR 230 ONLY)	
S 201	3101-0002	SWITCH TOG SPDT 125 V 3 AMP	
S 202-		NOT ASSIGNED	
S 300		NOT ASSIGNED	
S 301	3101-0005	SWITCH TOG DPDT JAN #ST22N	
S 302	523D-19D	SWITCH ASSEMBLY:TIME UNIT	
S 303	523D-19C	SWITCH ASSEMBLY:FREQ UNIT	
S 304-		NOT ASSIGNED	
S 400		NOT ASSIGNED	
S 401	523D-19B	SWITCH:ASSEMBLY FUNCTION	
S 402	3101-0005	SWITCH TOG DPDT JAN #ST22N	
S 403	3101-0002	SWITCH TOG SPDT 125 V 3 AMP	
S 404	523D-19A	SWITCH ASSEMBLY:TRIGGER LEVEL	
S 405	523D-19A	SWITCH:ASSEMBLY TRIGGER LEVEL	
S 406	3101-0005	SWITCH TOG DPDT JAN #ST22N	
S 407	3101-0005	SWITCH TOG DPDT JAN #ST22N	
S 408	3101-0002	SWITCH TOG SPDT 125 V 3 AMP	
S 409	3101-0010	SWITCH PUSHBUTTON DPDT MOM ACTION	
S 410	3101-0002	SWITCH TOG SPDT 125 V 3 AMP	
T 201	9100-0089	TRANSFORMER:POWER	

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Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
V 201	1930-0010	ELECTRON TUBE: 5Y3GT FULL WAVE RECT	
V 202	1923-0028	ELECTRON TUBE: 6CB6A PENTODE	
V 203	1932-0019	ELECTRON TUBE: 6AS7GA DUO-TRIODE	
V 204	1923-0020	ELECTRON TUBE: 6AU5GT BEAM PENTODE	
V 205	1923-0028	ELECTRON TUBE: 6CB6A PENTODE	
V 206	1940-0001	ELECTRON TUBE: 5651 VOLTAGE REFEREN	
V 207-		NOT ASSIGNED	
V 300		NOT ASSIGNED	
V 301	1923-0021	ELECTRON TUBE: 6AU6 MIN PENTODE	
V 302	1932-0008	ELECTRON TUBE: DUAL TRIODE	
V 303	1932-0008	ELECTRON TUBE: TWIN TRIODE 9 PIN MINAT	
V 304	1930-0013	ELECTRON TUBE: 6AL5 TWIN DIODE	
V 305	1923-0002	ELECTRON TUBE: 5725 PENTODE	
V 306	1923-0002	ELECTRON TUBE: 5725 PENTODE	
V 307	1930-0013	ELECTRON TUBE: 6AL5 TWIN DIODE	
V 308	1923-0002	ELECTRON TUBE: 5725 PENTODE	
V 309	1923-0002	ELECTRON TUBE: 5725 PENTODE	
V 310	1930-0013	ELECTRON TUBE: 6AL5 TWIN DIODE	
V 311	1923-0002	ELECTRON TUBE: 5725 PENTODE	
V 312	1932-0008	ELECTRON TUBE: TWIN TRIODE 9 PIN MINAT	
V 313-		NOT ASSIGNED	
V 400		NOT ASSIGNED	
V 401	1923-0021	ELECTRON TUBE: 6AU6 MIN 7 PIN PENTODE	
V 402	1924-0001	ELECTRON TUBE: 5915 PENTAGRID	
V 403	1932-0008	ELECTRON TUBE: TWIN TRIODE 9 PIN MINAT	
V 404	1932-0008	ELECTRON TUBE: TWIN TRIODE 9 PIN MINAT	
V 405	1941-0005	ELECTRON TUBE: 2D21 TETRODE THY 7 PIN	
V 406	G-84D	LAMP NEON	
V 406		(523C/CR ONLY)	
V 407	1933-0002	ELECTRON TUBE: 6AW8 TRIODE PENTODE	
V 407		(523C/CR ONLY)	
V 408	1932-0012	ELECTRON TUBE: 6211DUAL TRIODE	
V 409	1932-0008	ELECTRON TUBE: TWIN TRIODE 9 PIN MI	
V 410	1923-0021	ELECTRON TUBE: 6AU6 MIN 7 PIN PENTODE	
V 411	1941-0005	ELECTRON TUBE: 2D21 TETRODE THY 7 PIN	
V 412	1932-0008	ELECTRON TUBE: TWIN TRIODE 9 PIN MINAT	
V 413	1932-0008	ELECTRON TUBE: TWIN TRIODE 9 PIN MINAT	
V 414-		NOT ASSIGNED	
V 600		NOT ASSIGNED	
V 601	1932-0032	ELECTRON TUBE: 7308 DUAL TRIODE	
V 602	1932-0009	ELECTRON TUBE: 5965 DUAL TRIODE	
V 603-		NOT ASSIGNED	
V 700		NOT ASSIGNED	
V 701	1932-0008	ELECTRON TUBE: TWIN TRIODE 9 PIN MINAT	
V 702	1932-0008	ELECTRON TUBE: TWIN TRIODE 9 PIN MINAT	
V 703	1932-0008	ELECTRON TUBE: TWIN TRIODE 9 PIN MINAT	
V 704	1932-0008	ELECTRON TUBE: TWIN TRIODE 9 PIN MINAT	
XF201	1400-0084	FUSEHOLDER EXTRACTOR POST TYPE	
XV201	1400-0033	CLAMP:TUBE	
XV202	1200-0009	SOCKET:TUBE 7-PIN MINAT	
XV203	1400-0019	CLAMP:TUBE	
XV204	1400-0033	CLAMP:TUBE	
XV205	1200-0009	SOCKET:TUBE 7-PIN MINAT	
XV206	1200-0009	SOCKET:TUBE 7-PIN MINAT	
XV207-		NOT ASSIGNED	
XV300		NOT ASSIGNED	
XV301	1200-0009	SOCKET:TUBE 7-PIN MINAT	

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Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
XV302	1200-0008	SOCKET:TUBE 9-PIN	
XV303	1200-0008	SOCKET:TUBE 9-PIN	
XV304	1200-0009	SOCKET:TUBE 7-PIN MINAT	
XV305		NOT ASSIGNED	
XV306		NOT ASSIGNED	
XV307	1200-0009	SOCKET:TUBE 7-PIN MINAT	
XV308		NOT ASSIGNED	
XV309		NOT ASSIGNED	
XV310	1200-0009	SOCKET:TUBE 7-PIN MINAT	
XV312	1200-0008	SOCKET:TUBE 9-PIN	
XV313-		NOT ASSIGNED	
XV400		NOT ASSIGNED	
XV401	1200-0009	SOCKET:TUBE 7-PIN MINAT	
XV402	1200-0009	SOCKET:TUBE 7-PIN MINAT	
XV403	1200-0008	SOCKET:TUBE 9-PIN	
XV404	1200-0008	SOCKET:TUBE 9-PIN	
XV405	1200-0009	SOCKET:TUBE 7-PIN MINAT	
XV406		NOT ASSIGNED	
XV407	1200-0008	SOCKET:TUBE 9-PIN	
XV408	1200-0008	SOCKET:TUBE 9-PIN	
XV409	1200-0008	SOCKET:TUBE 9-PIN	
XV410	1200-0009	SOCKET:TUBE 7-PIN MINAT	
XV411	1200-0009	SOCKET:TUBE 7-PIN MINAT	
XV412	1200-0008	SOCKET:TUBE 9-PIN	
XV413	1200-0008	SOCKET:TUBE 9-PIN	
XV414-		NOT ASSIGNED	
XV600		NOT ASSIGNED	
XV601	1200-0008	SOCKET:TUBE 9-PIN	
XV602	1200-0008	SOCKET:TUBE 9-PIN	
XV603-		NOT ASSIGNED	
XV700		NOT ASSIGNED	
XV701	1200-0008	SOCKET:TUBE 9-PIN	
XV702	1200-0008	SOCKET:TUBE 9-PIN	
XV703	1200-0008	SOCKET:TUBE 9-PIN	
XV704	1200-0008	SOCKET:TUBE 9-PIN	
XZ400	1200-0038	SOCKET:12-PIN MICA	
XZ401	1200-0038	SOCKET:12-PIN MICA	
XZ402	1200-0038	SOCKET:12-PIN MICA	
XZ403	1200-0038	SOCKET:12-PIN MICA	
XZ404	1200-0038	SOCKET:12-PIN MICA	
XZ405	1200-0038	SOCKET:12-PIN MICA	
XZ406	1200-0020	SOCKET:OCTAL BASE	
XZ407	1200-0038	SOCKET:12-PIN MICA	
XZ408	1200-0038	SOCKET:12-PIN MICA	
XZ409	1200-0038	SOCKET:12-PIN MICA	
Y 301	G-69B-2C	CRYSTAL:100KC AGED	
Z 400	AC-4J	DECIMAL COUNTER UNIT	
Z 400		(523C/CR ONLY)	
Z 400	AC-4E	DECIMAL COUNTER UNIT	
Z 400		(523D/DR ONLY)	
Z 401	AC-4K	DECIMAL COUNTER UNIT	
Z 401		(523C/CR ONLY)	
Z 401	AC-4G	DECIMAL COUNTER UNIT	
Z 401		(523D/DR ONLY)	
Z 402	AC-4K	DECIMAL COUNTER UNIT	
Z 402		(523C/CR ONLY)	
Z 402	AC-4G	DECIMAL COUNTER UNIT	
Z 402		(523D/DR ONLY)	

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Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
Z 403	AC-4K	DECIMAL COUNTER UNIT	
Z 403		(523C/CR ONLY)	
Z 403	AC-4G	DECIMAL COUNTER UNIT	
Z 403		(523D/DR ONLY)	
Z 404	AC-4K	DECIMAL COUNTER UNIT	
Z 404		(523C/CR ONLY)	
Z 404	AC-4G	DECIMAL COUNTER UNIT	
Z 404		(523D/DR ONLY)	
Z 405	AC-4K	DECIMAL COUNTER UNIT	
Z 405		(523C/CR ONLY)	
Z 405	AC-4G	DECIMAL COUNTER UNIT	
Z 405		(523D/DR ONLY)	
Z 406	523D-4A	DECADE DIVIDER	
Z 407	523D-58B	TRIGGER UNIT PLUG-IN ASSY.	
Z 408	523D-58B	TRIGGER UNIT PLUG-IN ASSY.	
Z 409	523D-58B	TRIGGER UNIT PLUG-IN ASSY.	

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Table 6-2. Replaceable Parts

Stock No.	Description	Mfr.	Mfr. Part No.	TQ	RS		
0121-0006	C:VAR AIR 3J6-26PF	84970	A 25L	1	1		
0121-0008	C:VAR AIR 7.5-102.7PF	84970	A 103L	1	1		
0130-0008	C:VAR CER 8-50 N750	72982	557-023 U2PO 34R	1	1		
0130-0012	C:VAR CER M 5-25 PF NPO	72982	557-023-COPO-39R	1	1		
0131-0005	C:VAR MICA 2-25 PF 175 V	72136	T5111D REN D	2	1		
0140-0001	C:FXD MICA 5 PF 500 VDCW	00853	TYPE DR DR1550B20	2	1		
0140-0002	C:FXD MICA 10 PF 10% VDCW	00853	TYPE KR B CHAR.	1	1		
0140-0003	C:FXD MICA 1000 PF 10% 500VDCW	76433	RCM30B102K	1	1		
0140-0015	C:FXD MICA 270 PF 10% 500VDCW	00853	TYPE K K1327 B10	6	2		
0140-0020	C:FXD MICA 1800 PF 10% 500 VDCW	00853	TYPE C C1218 B10	2	1		
0140-0021	C:FXD MICA 39 PF 10% 500 VDCW	00853	TYPE DR DR1438 B10	1	1		
0140-0026	C:FXD MICA 22 PF 10% 500 VDCW	76433	RCM20B220K	1	1		
0140-0027	C:FXD MICA 470 PF 10% 500 VDCW	00853	TYPE K K1347 B10	1	1		
0140-0029	C:FXD MICA 3300 PF 10% 500 VDCW	04062	CM30B332K	1	1		
0140-0030	C:FXD MICA 390 PF 10% 500 VDCW	00853	TYPE K K1339 B10	1	1		
0140-0033	C:FXD MICA 5 PF 20% 500 VDCW	00853	TYPE DR DR1550 E20	2	1		
0140-0034	C:FXD MICA 22 PF 5% 500 VDCW	76433	RCM15E220J	1	1		
0140-0035	C:FXD MICA 39 PF 5% 500 VDCW	76433	RCM15E390J	5	1		
0140-0037	C:FXD MICA 390 PF 5% 500 VDCW	00853	TYPE RR RR1339E5	2	1		
0140-0039	C:FXD MICA 47 PF 5% 500 VDCW	14655	CM15E470J	8	2		
0140-0040	C:FXD MICA 75 PF 5% 500 VDCW	00853	TYPE DR DR1475 E5	1	1		
0140-0041	C:FXD MICA 100 PF 5% 500 VDCW	00853	TYPE DR DR1310E5	6	2		
0140-0042	C:FXD MICA 27 PF 5% 500 VDCW	00853	TYPE DR DR1427 E5	8	2		
0140-0044	C:FXD MICA 560 PF 10% 500 VDCW	00853	TYPE K K1356 E10	1	1		
0140-0054	C:FXD MICA 100 PF 10% 500 VDCW	00853	TYPE K K1310 B10	1	1		
0140-0056	C:FXD MICA 200 PF 10% 500 VDCW	11711	RCM20B201K	1	1		
0140-0081	C:FXD MICA 56 PF 1% 500 VDCW	00853	TYPE DR DR1456E	2	1		
0140-0092	C:FXD MICA 240 PF 5% 500 VDCW	00853	TYPE DR DR1324 E5	1	1		
0140-0105	C:FXD MICA 30 PF 5% 500 VDCW	00853	TYPE DR DR1430E5	1	1		
0140-0110	C:FXD MICA SIL 127 PF 2% 300 VDCW	11711	MCM 15E(127)G	1	1		
0140-0114	C:FXD MICA 390 PF 2% 500 VDCW	04062	RCM20E391G	1	1		
0140-0115	C:FXD MICA 3900PF 500VDCW	14655	CM30E392G	1	1		
0140-0116	C:FXD MICA 39 PF 2% 500 VDCW	04062	RCM15E390G	1	1		
0150-0010	C:FXD CER 47PF 5% NPO 500VDCW	04222	SI 47 PF 5% NPO	1	1		
0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	56289	H 1038	8	2		
0150-0014	C:FXD CER 5000PF MIN 500VDCW	04222	D1 4	7	2		
0150-0023	C:FXD CER 2000PF 20% 1000VDCW	91418	TYPE JF .002 20%	1	1		
0150-0031	C:FXD TI 2PF 5% 500VDCW	78488	TYPE GA 2PF 5%	2	1		
0150-0052	C:FXD 0.05 UF 20% 400 VDCW	05729	20X503MC4	1	1		
0150-0056	C:FXD CER 14 PF 3% NPO 500 VDCW	72982	315 000 COGO 140 H	1	1		
0150-0057	C:FXD CER 16 PF 3% NPO 500 VDCW	72982	315 000 COGO 160H	1	1		
0150-0086	C:FXD CER 4700 PF 20% 500 VDCW	56289	CK2AW472M	1	1		
0160-0007	C:FXD MY 0.0022UF 10% 600VDCW	56289	160P22296	1	1		
0160-0013	C:FXD MY 0.1UF 10% 400VDCW	56289	160P10494	3	1		
0160-0018	C:FXD MY 0.22UF 10% 400VDCW	56289	160P22494	1	1		
0160-0024	C:FXD PAPER 5UF +/-10% 400VDCW	14655	PKM4P5	1	1		
0160-0044	C:FXD PAPER 2700 PF 10% 600VDCW	56289	TYPE 160P27296	1	1		
0160-0103	C:FXD PAPER 2UF 10% 400VDCW	56289	S55271	1	1		
0170-0022	C:FXD MY 0.1UF 20% 600VDCW	09134	TYPE 27	2	1		
0170-0031	C:FXD POLY 0.39 UF 2% 400VDCW	02777	BN1P4394	1	1		
0170-0032	C:FXD POLY 0.039UF 2% 400VDCW	02777	BN1P4393E	1	1		
0170-0033	C:FXD MY 0.18UF 2% 600VDCW	09134	TYPE 27	2	1		
01A0-0005	C:FXD ELECT 10UF 50% 450VDCW	37942	#TC72	1	1		

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Table 6-2. Replaceable Parts (Cont'd)

Stock No.	Description	Mfr.	Mfr. Part No.	TQ	RS		
01R0-0012	C:FXD ELECT 2X20 UF 450VDCW	56289	D32440	1	1		
01R0-0030	C:FXD ELECT 120 X40 UF 450VDCW	28480	0180 0030	1	1		
01R0-0125	C:FXD ELECT 4X20UF -10+30% 450VDCW	56289		1	1		
0490-0017	RELAY:DPDT 110VDC	77342	KA11D	1	1		
06R6-1025	R:FXD COMP 1000 OHMS 5%1/5W	01121	EB-1025	1	1		
06R6-1035	R:FXD COMP 10K OHMS 5%1/2W	01121	EB-1035	6	2		
06R6-1045	R:FXD COMP 100K OHMS 5%1/2W	01121	EB-1045	9	2		
06R6-1055	R:FXD COMP 1M OHMS 5%1/2W	01121	EB-1055	1	1		
06R6-1235	R:FXD COMP 12K OHMS 5%1/2W	01121	EB-1235	1	1		
06R6-1245	R:FXD COMP 120K OHMS 5%1/2W	01121	EB-1245	1	1		
06R6-1345	R:FXD COMP 130K OHMS 5% 1/2W	01121	EB1345	2	1		
06R6-1525	R:FXD COMP 1500 OHMS 5% 1/2W	01121	EB1525	1	1		
06R6-1555	R:FXD COMP 1.5M OHMS 5% 1/2W	01121	EB1555	1	1		
06R6-2725	R:FXD COMP 2700 OHM 5% 1/2W	01121	EB 2725	1	1		
06R6-2735	R:FXD COMP 27K OHM 5% 1/2W	01121	EB 2735	3	1		
06R6-2745	R:FXD COMP 270K OHM 5% 1/2W	01121	EB 2745	9	2		
06R6-3635	R:FXD COMP 36K OHMS 5% 1/2W	01121	EB 3635	2	1		
06R6-4335	R:FXD COMP 43K OHMS 5% 1/2W	01121	EB 4335	4	1		
06R6-4345	R:FXD COMP 430K OHMS 5% 1/2W	01121	EB 4345	2	1		
06R6-4725	R:FXD COMP 4700 OHMS 5% 1/2W	01121	EB 4725	2	1		
06R6-4735	R:FXD COMP 47K OHM 5% 1/2W	01121	EB 4735	2	1		
06R6-5145	R:FXD COMP 510K OHMS 5% 1/2W	01121	EB 5145	2	1		
06R6-5635	R:FXD COMP 56K OHMS 5% 1/2W	01121	EB 5635	2	1		
06R6-7535	R:FXD COMP 75K OHMS 5% 1/2W	01121	EB 7535	1	1		
06R6-8225	R:FXD COMP 8200 OHMS 5% 1/2W	01121	EB 8225	2	1		
06R6-8235	R:FXD COMP 82K OHMS 5% 1/2W	01121	EB 8235	1	1		
06R6-9135	R:FXD COMP 91K OHMS 5% 1/2W	01121	EB 9135	1	1		
06R6-9145	R:FXD COMP 910K OHMS 5% 1/2W	01121	EB 9145	1	1		
06R7-1001	R:FXD COMP 10 OHMS 10% 1/2W (FOR 115-VOLT OPERATION)	01121	EB 1001	2	1		
06R7-1011	R:FXD COMP 100 OHMS 10% 1/2W	01121	EB 1011	4	1		
06R7-1021	R:FXD COMP 1000 OHMS 10% 1/2W	01121	EB 1021	10	2		
06R7-1031	R:FXD COMP 10K OHMS 10% 1/2W	01121	EB 1031	4	1		
06R7-1041	R:FXD COMP 100K OHMS 10% 1/2W	01121	EB 1041	1	1		
06R7-1051	R:FXD COMP 1M OHMS 10% 1/2W (523C/CR ONLY)	01121	EB 1051	1	1		
06R7-1051	R:FXD COMP 1M OHMS 10% 1/2W	01121	EB 1051	8	2		
06R7-1061	R:FXD COMP 10M OHMS 10% 1/2W	01121	EB 1061	1	1		
06R7-1241	R:FXD COMP 120K OHMS 10% 1/2W	01121	EB 1241	1	1		
06R7-1251	R:FXD COMP 1.2M OHMS 10% 1/2W (523C/CR ONLY)	01121	EB 1251	1	1		
06R7-1251	R:FXD COMP 1.2M OHMS 10% 1/2W	01121	EB 1251	2	1		
06R7-1541	R:FXD COMP 150K OHMS 10% 1/2W	01121	EB 1541	3	1		
06R7-1551	R:FXD COMP 1.5M OHMS 10% 1/2W	01121	EB 1551	1	1		
06R7-1821	R:FXD COMP 1800 OHMS 10% 1/2W	01121	EB 1821	4	1		
06R7-1831	R:FXD COMP 18K OHMS 10% 1/2W	01121	EB 1831	2	1		
06R7-1841	R:FXD COMP 180K OHMS 10% 1/2W	01121	EB 1841	2	1		
06R7-1851	R:FXD COMP 1.8M OHMS 10% 1/2W	01121	EB 1851	5	1		
06R7-2201	R:FXD COMP 22 OHMS 10% 1/2W (FOR 230-VOLT OPERATION)	01121	EB 2201	1	1		
06R7-2221	R:FXD COMP 2200 OHMS 10% 1/2W	01121	EB 2221	1	1		
06R7-2231	R:FXD COMP 22K OHMS 10% 1/2W	01121	EB 2231	4	1		
06R7-2241	R:FXD COMP 220K OHMS 10% 1/2W	01121	EB 2241	2	1		
06R7-2251	R:FXD COMP 2.2M OHMS 10% 1/2W	01121	EB 2251	1	1		
06R7-2261	R:FXD COMP 22M OHMS 10% 1/2W	01121	EB 2261	1	1		
06R7-2711	R:FXD COMP 270 OHMS +/-10% 1/2W	01121	EB2711	4	1		
06R7-2711	R:FXD COMP 270 OHMS 10% 1/2W	01121	EB 2711	2	1		
06R7-2711	R:FXD COMP 270 OHMS +/-10% 1/2W	01121	EB2711	1	1		

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Table 6-2. Replaceable Parts (Cont'd)

Stock No.	Description	Mfr.	Mfr. Part No.	TQ	RS		
06A7-2721	R:FXD COMP 2700 OHMS 10% 1/2W	01121	EB 2721	3	1		
06A7-2741	R:FXD COMP 270K OHMS 10% 1/2W	01121	741	2	1		
06A7-2751	R:FXD COMP 2.7M OHMS 10% 1/2W	01121	EB 2751	1	1		
06A7-3321	R:FXD COMP 3300 OHMS 10% 1/2W	01121	EB 3321	5	1		
06A7-3331	R:FXD COMP 33K OHMS 10% 1/2W	01121	EB 3331	2	1		
06A7-3341	R:FXD COMP 330K OHMS 10% 1/2W	01121	EB 3341	3	1		
06A7-3941	R:FXD COMP 390K OHMS 10% 1/2W (523C/CR ONLY)	01121	EB 3941	1	1		
06B7-3941	R:FXD COMP 390K OHMS 10% 1/2W	01121	EB 3941	1	1		
06A7-3951	R:FXD COMP 3.9M OHMS 10% 1/2W	01121	EB 3951	1	1		
06A7-4711	R:FXD COMP 470 OHMS 10% 1/2W	01121	EB 4711	1	1		
06A7-4731	R:FXD COMP 47K OHMS 10% 1/2W	01121	EB 4731	3	1		
06A7-4731	R:FXD COMP 47K OHMS +/-10% 1/2W	01121	EB4731	1	1		
06A7-4731	R:FXD COMP 47K OHMS 10% 1/2W	01121	EB 4731	2	1		
06A7-4731	R:FXD COMP 47K OHMS +/-10% 1/2W	01121	EB4731	3	1		
06B7-4741	R:FXD COMP 470K OHMS 10% 1/2W	01121	EB 4741	1	1		
06A7-5601	R:FXD COMP 56 OHMS 10% 1/2W	01121	EB 5601	1	1		
06A7-5611	R:FXD COMP 560 OHMS 10% 1/2W	01121	EB 5611	1	1		
06A7-5621	R:FXD COMP 5600 OHMS 10% 1/2W	01121	EB 5621	2	1		
06A7-5641	R:FXD COMP 560K OHMS 10% 1/2W	01121	EB 5641	2	1		
06A7-5651	R:FXD COMP 5.6M OHMS 10% 1/2W	01121	EB 5651	1	1		
06A7-6821	R:FXD COMP 6800 OHMS 10% 1/2W	01121	EB 6821	1	1		
06A7-8231	R:FXD COMP 82K OHMS 10% 1/2W	01121	EB 8231	3	1		
06A9-1145	R:FXD COMP 110K OHMS 5% 1W	01121	GB 1145	5	1		
06A9-3025	R:FXD COMP 3000 OHMS 5% 1W	01121	GB 3025	5	1		
06A9-5125	R:FXD COMP 5100 OHMS 5% 1W	01121	GB 5125	1	1		
06A9-8235	R:FXD COMP 82K OHMS 5% 1W	01121	GB 8235	5	1		
0690-1011	R:FXD COMP 100 OHMS 10% 1W	01121	GB 1001	2	1		
0690-1041	R:FXD COMP 100K OHMS 10% 1W	01121	GB 1041	5	1		
0690-1241	R:FXD COMP 120K OHMS 10% 1W	01121	GB 1241	5	1		
0690-1511	R:FXD COMP 150 OHMS 10% 1W	01121	GB 1511	1	1		
0690-1531	R:FXD COMP 15K OHMS 10% 1W	01121	GB 1531	1	1		
0690-1831	R:FXD COMP 18K OHMS 10% 1W	01121	GB 1831	2	1		
0690-2231	R:FXD COMP 22K OHMS 10% 1W	01121	GB 2231	3	1		
0690-2731	R:FXD COMP 27K OHMS 10% 1W	01121	GB 2731	2	1		
0690-2741	R:FXD COMP 270K OHMS 10% 1W	01121	GB 2741	1	1		
0690-3301	R:FXD COMP 33 OHMS 10% 1W	01121	GB 3301	1	1		
0690-3331	R:FXD COMP 33K OHMS 10% 1W	01121	GB 3331	1	1		
0690-3921	R:FXD COMP 3900 OHMS 10% 1W	01121	GB 3921	1	1		
0690-3931	R:FXD COMP 39K OHMS 10% 1W	01121	GB 3931	1	1		
0690-4731	R:FXD COMP 47K OHMS 10% 1W	01121	GB 4731	3	1		
0692-1135	R:FXD COMP 11K OHMS 5% 2W	01121	HB 1135	1	1		
0693-1011	R:FXD COMP 100 OHMS 10% 2W	01121	HB 1011	1	1		
0693-1031	R:FXD COMP 10K OHMS 10% 2W	01121	HB 1031	1	1		
0693-1831	R:FXD COMP 18K OHMS 10% 2W	01121	HB 1831	3	1		
0693-2231	R:FXD COMP 22K OHMS 10% 2W	01121	HB 2231	5	1		
0693-4721	R:FXD COMP 4700 OHMS 10% 2W	01121	HB 4721	1	1		
0693-6831	R:FXD COMP 68K OHMS 10% 2W	01121	HB 6831	1	1		
0727-0143	R:FXD DEPC 6.49K OHMS 1% 1/2W	19701	DC 1/2CR5	1	1		
0727-0196	R:FXD DEPC 52.6K OHMS 1% 1/2W	19701	DC 1/2CR5	2	1		
0727-0203	R:FXD DEPC 90K OHM 1% 1/2W	19701	DC 1/2B R5	4	1		
0727-0205	R:FXD DEPC 92.6K OHM 1% 1/2W	19701	DC 1/2C R5	2	1		
0727-0221	R:FXD DEPC 200K OHM 1% 1/2W	19701	DC 1/2A R5	2	1		
0727-0226	R:FXD DEPC 250K OHM 1% 1/2W	19701	DC 1/2C R5	1	1		
0727-0249	R:FXD DEPC 667K OHM 1% 1/2W	19701	DC 1/2C R5	1	1		
0727-0255	R:FXD DEPC 800K OHM 1% 1/2W	19701	DC 1/2A R5	1	1		

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Table 6-2. Replaceable Parts (Cont'd)

Stock No.	Description	Mfr.	Mfr. Part No.	TQ	RS		
0730-0077	R:FXD DEPC 181K OHMS 1% 1W	19701	DC1 R5	1	1		
0730-0086	R:FXD DEPC 330K OHMS 1% 1W	19701	DC1 R5	1	1		
0730-0108	R:FXD DEPC 1.23M OHMS 1% 1W	19701	DC1 R5	2	1		
0730-0113	R:FXD DEPC 2.163MEGOHMS 1% 1W	19701	DC1 R5	5	1		
0760-0003	R:FXD MET FLM 18.7K OHM 2% 1W	07115	S 25	1	1		
0767-0010	R:FXD MET FLM 15K OHMS 5% 3W	07115	LPI 3	4	1		
0767-0011	R:FXD 20K OHMS 5% 3W	07115	LPI-3	1	1		
0816-0003	R:FXD WW 500 OHMS 10% 10W	35434	TYPE C 10	1	1		
0818-0010	R:FXD WW 2000 OHMS 5% 30W	94310	OR 30	1	1		
0819-0020	R:FXD WW 6000 OHMS 10% 20W	35434	C 20	1	1		
0839-0006	RT:10 OHMS 10% AT 25C (FOR 230 ONLY)	24446	D-754	1	1		
0852-0004	TUBE:BALLAST 10-4C	70563	0852-0004	1	1		
1200-0008	SOCKET:TUBE 9-PIN	91662	377PHSPTD.125-3905	16	4		
1200-0009	SOCKET:TUBE 7-PIN MINAT	91662	316PH-3702	12	3		
1200-0020	SOCKET:OCTAL BASE	02660	1200-0020	1	1		
1200-0027	SOCKET:9-PIN	82893	8-N-9T	1	1		
1200-0038	SOCKET:12-PIN MICA	02660	77-MIP-12TM-1003	9	2		
1250-0001	CONNECTOR:BNC	91737	5126	4	1		
1250-0083	CONNECTOR:BNC	91737	UG-1094/U	3	1		
1251-0114	CONNECTOR:12-PIN MALE	02660	86-CP12T-041-2	3	1		
1400-0019	CLAMP:TUBE	91506	120F5-63A	1	1		
1400-0033	CLAMP:TUBE	91506	120D5-63AHS	2	1		
1400-0084	FUSEHOLDER EXTRACTOR POST TYPE	75915	342014	2	1		
1450-0003	LENS CAP:LAMP RED	28480	1450-0003	1	1		
1450-0010	LAMPHOLDER:MINIAT BAYONET	28480	1450-0010	1	1		
1450-0025	LAMP:NEON	03797	ELITE1AG1-1369	1	1		
1901-0029	DIODE SILICON PIV 600V I AVG 0.75A	28480	1901 0029	4	4		
1910-0011	DIODE GERMANIUM 5MA AT 1V 60 PIV	28480	1910 0011	4	4		
1923-0002	ELECTRON TUBE: 5725 PENTODE	33173		5	5		
1923-0020	ELECTRON TUBE: 6AU5GT BEAM PENTODE	33173	6AU5GT	1	1		
1923-0021	ELECTRON TUBE: 6AU6 MIN PENTODE	33173	6AU6	3	3		
1923-0028	ELECTRON TUBE: 6CB6A PENTODE	86684	6CB6A	2	2		
1924-0001	ELECTRON TUBE: 5915 PENTAGRIDE	86684		1	1		
1930-0010	ELECTRON TUBE: 5Y3GT FULL WAVE RECT	86684	5Y3GT	1	1		
1930-0013	ELECTRON TUBE: 6AL5 TWIN DIODE	33173		3	3		
1932-0008	ELECTRON TUBE: DUAL TRIODE	28480	1932 0008	12	12		
1932-0009	ELECTRON TUBE: 5965 DUAL TRIODE	33173	5965	1	1		
1932-0012	ELECTRON TUBE: 6211DUAL TRIODE	33173		1	1		
1932-0019	ELECTRON TUBE: 6AS7GA DUO-TRIODE	33173		1	1		
1932-0032	ELECTRON TUBE: 7308 DUAL TRIODE	73445	7308	1	1		
1933-0002	ELECTRON TUBE: 6AW8 TRIODE PENTODE (523C/CR ONLY)	93332	S/B 6AW8A	1	1		
1940-0001	ELECTRON TUBE: 5651 VOLTAGE REFEREN	86684	5651	1	1		
1941-0005	ELECTRON TUBE: 2D21 TETRODE THY 7 PIN	86684		2	2		
2100-0010	R:VAR COMP 2000 OHM 20% 1/4W	28480	2100 0010	1	1		
2100-0026	R:VAR COMP 5000 OHM 10% LIN 2W	28480	2100 0026	1	1		
2100-0028	R:VAR COMP 50K OHM 10% LIN 2W	28480	2100 0028	9	2		
2100-0060	R:VAR 20K OHMS 20% 2W LIN	28480	2100 0060	1	1		
2100-0152	R:VAR COMP 10MEGOHM 30% LIN 1/4W	28480	02100-0152	1	1		
2100-0164	R:VAR COMP 200K OHM 30% LIN 0.2W	28480	2100 0164	1	1		
2100-0169	R:VAR COMP 20K OHM 30% LIN 0.2W	28480	2100 0169	2	1		
2110-0002	FUSE:CARTRIDGE 2 AMP 3 AG	75915	312.002	1	10		
2110-0030	FUSE:CARTRIDGE 5 AMP 125V SLOW BLOW	75915	31300Z	1	10		
2140-0009	LAMP:INCANDESCENT 6-8V TYPE 47	24455	47	6	6		
3101-0002	SWITCH TOG SPDT 125 V 3 AMP	88140	8908K433	4	1		
3101-0005	SWITCH TOG DPDT JAN #ST22N	04009	95691	4	1		

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Table 6-2. Replaceable Parts (Cont'd)

Stock No.	Description	Mfr.	Mfr. Part No.	TQ	RS		
3101-0010	SWITCH PUSHBUTTON DPDT MOM ACTION	82389	3S-1407	1	1		
3140-0006	MOTOR:FAN 115VAC 60 CYCLES	83821	103-1465	1	1		
3150-0002	OIL:SOLUBLE, FOR AIR FILTER	82866	SN 411	1	1		
3150-0016	FL AIR 7 1/2 X 7 1/2 X 1	28480	3150 0016	1	1		
3160-0019	BLADE FAN 5 BLADES	06812	OUH 731 5	1	1		
8120-0015	POWER CABLE	70903	KH3981/PH70/7.5FT	1	1		
9100-0089	TRANSFORMER:POWER	28480	9100-0089	1	1		
9130-0001	COIL:PULSE 30MH	28480	9130-0001	1	1		
9140-0016	COIL VAR RF 3.5-5 MHY	28480	9140 0016	1	1		
9140-0020	COIL FXD RF 400 UHY	28480	9140 0020	1	1		
9140-0021	COIL:FXD RF 430UH	99848	3430-15-431	2	1		
9140-0022	COIL:FXD RF 5000H	28480	9140-0022	1	1		
9190-0001	DELAY LINE ASSEMBLY	28480	9190-0001	1	1		
AC-4E	DECIMAL COUNTER UNIT (523D/DR ONLY)	28480	AC-4E	1	1		
AC-4G	DECIMAL COUNTER UNIT (523D/DR ONLY)	28480	AC-4G	5	1		
AC-4J	DECIMAL COUNTER UNIT (523C/CR ONLY)	28480	AC-4J	1	1		
AC-4K	DECIMAL COUNTER UNIT (523C/CR ONLY)	28480	AC-4K	5	1		
G-69B-2C	CRYSTAL:100KC AGED	28480	G-69B-2C	1	1		
G-84D	LAMP NEON (523C/CR ONLY)	28480	G-84D	1	1		
523D-4A	DECADE DIVIDER	28480	523D-4A	1	1		
523D-58B	TRIGGER UNIT PLUG-IN ASSY.	28480	523D-58B	3	1		
	MISCELLANEOUS						
G-69G-1	CRYSTAL OVEN BASE ASSY.	28480	G-69G-1	1	1		
G-69G-2	CRYSTAL OVEN HOUSING ASSY.	28480	G-69G-2	1	1		
G-74BW	KNOB:AC-DC MULTIPLIER	28480	OBD#	2	1		
G-74D	KNOB:DISPLAY TIME,SENSITIVITY	28480	G-74D	2	1		
G-74L	KNOB:START-STOP TRIGGER LEVEL	28480	G-74L	2	1		
G-74N	KNOB:FUNCTION SELECTOR	28480	OBD#	1	1		
G-74P	KNOB:TIME UNIT FREQ UNIT	28480	OBD#	2	1		
1400-0084	FUSEHOLDER EXTRACTOR POST TYPE	75915	342014	1	1		
1450-0010	LAMPHOLDER:MINIAT BAYONET	28480	1450-0010	5	0		
1450-0003	LENS CAP:LAMP RED	28480	1450-0003	1	0		
3160-0019	BLADE FAN 5 BLADES	06812	OUH 731 5	1	1		
3150-0016	FL AIR 7 1/2 X 7 1/2 X 1	28480	3150 0016	1	1		
3150-0005	OIL:SOLUBLE, FOR AIR FILTER	82866	SN 411	1	0		
523C-99	DIGITAL DISPLAY TUBE:HOUSING ASSY.	28480	523C-99	1	0		
523C-99C	SUPPORT:LIGHT FILTER	28480	523C-99C	1	0		
523C-901	OPERATING-SERVICE MANUAL	28480	523C-901	1	0		

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APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 1 of 2)

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
00334	Humidial Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic 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 Company, Ordill Division (Capacitors)	Marion, Ill.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	Pacific Semiconductors, Inc.	Culver City, Calif.
01295	Texas Instruments, Inc. Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Ind.
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.
02286	Cole Mfg. Co.	Palo Alto, 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 Products Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co., Electronics Division	Burbank, Calif.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prods., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Division	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire & Cable Company	Redwood City, Calif.
04870	P. M. Motor Co.	Chicago 44, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp., Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05624	Barber Colman Co.	Rockford, Ill.
05729	Metropolitan Telecommunications Corp., Metro Cap. Div.	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
06004	The Bassick Co.	Bridgeport, Conn.
06136	Ward Leonard Electric	Los Angeles, Calif.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
07115	Corning Glass Works Electronic Components Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08717	Sloan Company	Burbank, Calif.
08718	Cannon Electric Co. Phoenix Div.	Phoenix, Ariz.
08792	CBS Electronics Semiconductor Operations, Div. of C.B.S. Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
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.
11312	Microwave Electronics Corp.	Palo Alto, Calif.
11534	Duncan Electronics, Inc.	Santa Ana, Calif.
11711	General Instrument Corporation Semiconductor Division	Newark, N.J.
11717	Imperial Electronics, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12697	Clarostat Mfg. Co.	Dover, N.H.
14655	Cornell Dubilier Elec. Corp.	So. Plainfield, N.J.
15909	The Daven Co.	Livingston, N.J.
16688	De Jur-Amsco Corporation	Long Island City 1, N.Y.
16758	Delco Radio Div. of G. M. Corp.	Kokomo, Ind.
18873	E. I. DuPont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E., Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
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.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer and Inst. Co.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson & Co., Inc.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Owosso, Mich.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Div. of Daystrom, Inc.	Newark, N.J.
66295	Wittek Manufacturing Co.	Chicago 23, Ill.
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	New York, N.Y.
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.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Electronic Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C. P. Clare & Co.	Chicago, Ill.
71528	Standard-Thomson Corp., Clifford Mfg. Co. Div.	Waltham, Mass.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A. O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72354	John E. Fast & Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72758	Girard-Hopkins	Oakland, Calif.
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 Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Phillips Co., Inc.	Hicksville, N.Y.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.

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APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 2 of 2)

CODE NO.	MANUFACTURER	ADDRESS
73734	Federal Screw Products Co.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
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.
75173	Jones, Howard B., Division of Cinch Mfg. Corp.	Chicago, Ill.
75378	James Knights Co.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littelfuse Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C. W. Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp.	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J. W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Pacific Division of Bendix Corp.	No. Hollywood, Calif.
77221	Phaostron Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine and Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
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	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Association Any brand tube meeting EIA standards	Washington, D.C.
80207	Unimax Switch, Div. of W. L. Maxson Corp.	Wallingford, Conn.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Fulton Controls Co.	Columbus 16, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81312	Winchester Electronics Co., Inc.	Norwalk, Conn.
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Ill.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Allen B. DuMont Labs., Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc., Electronic Tube Div.	Emporium, Pa.
82376	Astron Co.	East Newark, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods.	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Manufacturing Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Union, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronics, Inc.	New York, N.Y.
84396	A. J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A. B. Boyd Co.	San Francisco, Calif.
85474	R. M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86197	Clifton Precision Products	Clifton Heights, Pa.
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corp. (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baler Co.	Chicago, Ill.
89665	United Transformer Co.	Chicago, Ill.
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Brothers, Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Philadelphia, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91921	Minneapolis-Honeywell Regulator Co., Micro-Switch Division	Freeport, Ill.
92196	Universal Metal Products, Inc.	Bassett Puente, Calif.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94144	Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div., California Street Plant	Newton, Mass.
94148	Scientific Radio Products, Inc.	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Paterson, N.J.
94310	Tru Ohm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95354	Methode Mfg. Co.	Chicago, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Division of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner Div. of Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic and Precision Mfg. Co.	Yonkers, N.Y.
97966	CBS Electronics, Div. of C.B.S., Inc.	Danvers, Mass.
98141	Axel Brothers Inc.	Jamaica, N.Y.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98734	Palo Alto Engineering Co., Inc.	Palo Alto, Calif.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. of Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Ill.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000I	Telefunken (c/o American Elite)	New York, N.Y.
0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
0000N	Nahm-Bros. Spring Co.	San Leandro, Calif.
0000P	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
0000T	Texas Instruments, Inc. Metals and Controls Div.	Versailles, Ky.
0000U	Tower Mfg. Corp.	Providence, R.I.
0000W	Webster Electronics Co. Inc.	New York, N.Y.
0000X	Spruce Pine Mica Co.	Spruce Pine, N.C.
0000Y	Midland Mfg. Co. Inc.	Kansas City, Kans.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AA	British Radio Electronics Ltd.	Washington, D.C.
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CC	Computer Diode Corp.	Lodi, N.J.
000EE	A. Williams Manufacturing Co.	San Jose, Calif.
000FF	Carmichael Corrugated Specialties	Richmond, Calif.
000GG	Goshen Die Cutting Service	Goshen, Ind.
000HH	Rubbercraft Corp.	Torrance, Calif.
000II	Birtcher Corporation, Industrial Division	Monterey Park, Calif.
000KK	Amatom	New Rochelle, N.Y.
000LL	Avery Label	Monrovia, Calif.
000MM	Rubber Eng. & Development	Hayward, Calif.
000NNA	"N" D Manufacturing Co.	San Jose 27, Calif.
000PP	Atohm Electronics,	Sun Valley, Calif.
000QQ	Cooltron	Oakland, Calif.
000RR	Radio Industries	Des Plaines, Ill.
000SS	Control of Elgin Watch Co.	Burbank, Calif.
000TT	Thomas & Betts Co., The	Elizabeth 1, N.J.

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WARRANTY

All our products are warranted against defects in materials and workmanship for one year from the date of shipment. Our obligation is limited to repairing or replacing products (except tubes) which prove to be defective during the warranty period. We are not liable for consequential damages.

For assistance of any kind, including help with instruments under warranty, contact your authorized hp Sales Representative for instructions. Give full details of the difficulty and include the instrument model and serial numbers. Service data or shipping instructions will be promptly sent to you. There will be no charge for repair of instruments under warranty, *except transportation charges*. Estimates of charges for non-warranty or other service work will always be supplied, if requested, before work begins.

CLAIM FOR DAMAGE IN SHIPMENT

Your instrument should be inspected and tested as soon as it is received. The instrument is insured for safe delivery. If the instrument is damaged in any way or fails to operate properly, file a claim with the carrier or, if insured separately, with the insurance company.

SHIPPING

On receipt of shipping instructions, forward the instrument prepaid to the destination indicated. You may use the original shipping carton or any strong container. Wrap the instrument in heavy paper or a plastic bag and surround it with three or four inches of shock-absorbing material to cushion it firmly and prevent movement inside the container.

GENERAL

Your authorized hp Sales Representative is ready to assist you in any situation, and you are always welcome to get directly in touch with Hewlett-Packard service departments:

CUSTOMER SERVICE

Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California, U.S.A.
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TWX No. PAL AL 117-U
Cable: "HEWPACK"

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