TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL INCLUDING REPAIR PARTS AND SPECIAL TOOLS LISTS

FOR

IMPEDANCE METER: VECTOR ZM-74/U (HEWLETT-PACKARD MODEL 4800A WITH MODEL 4801 PLUG-IN) (NSN 6625-00-167-9861)

HEADQUARTERS, DEPARTMENT OF THE ARMY

2 SEPTEMBER 1981

TABLE 1-1. SPECIFICATIONS

FREQUENCY CHARACTERISTICS.

RANGE: 5 Hz to 500 kHz in five bands; 5 to 50 Hz, 50 to 500 Hz, 0.5 to 5 kHz, 5 to 50 kHz, and 50 to 500 kHz.

ACCURACY: ±4% from 5 Hz to 50 Hz, ±2% from 50 Hz to 500 kHz, ±1% at 15.92 on FREQUENCY dial from 159.2 Hz to 159.2 kHz, ±2% at 15.92 Hz.

MONITOR OUTPUT: level; 0.2 V rms minimum; source impedance: 600 ohms in series with 50 μF.

IMPEDANCE MEASUREMENT CHARACTERISTICS.

RANGE: 1 ohm to 10 megohms in seven ranges: 10 ohms, 100 ohms, 1 K ohms, 10 K ohms, 100K ohms, 1 megohm and 10 megohms full scale.

ACCURACY: ±5% of reading.

PHASE ANGLE MEASUREMENT CHARACTERISTICS.

RANGE: 0° to $\pm 90^{\circ}$

ACCURACY: $\pm 6^{\circ}$

CALIBRATION: increments of 5°

DIRECT INDUCTANCE MEASUREMENT CAPABILITIES.

RANGE: 1 μH to 100,000 H, direct reading at decades multiples of 15.92 Hz.

ACCURACY: ±7% of reading for Q greater than 10 from 159.2 Hz to 159.2 kHz; ±8% of reading for Q greater than 10 at 15.92 Hz.

DIRECT CAPACITANCE MEASUREMENT CAPABILITIES.

RANGE: 0.1 pF to 10,000 μF, direot reading at decade multiples of 15.92 Hz.

ACCURACY: ±7% of reading for D less than 0.1 from 159.2 Hz to 159.2 kHz, ±8% of reading for D less than 0.1 at 15.92 Hz.

MEASURING TERMINAL SIGNAL CHARACTERISTICS.

WAVESHAPE: Sinusoidal.

SIGNAL LEVEL: 2.7 mV rms 1 ohm to 1 K ohm, approx. 2.7 mV rms 1000 ohms to 10,000 ohms, approx. 27 mV rms 10,000 ohms to 100,000 ohms, approx. 270 mV rms 100,000 ohms to 1 megohm. approx. 2.7 V rms 1 megohm to 10 megohms.

EXTERNAL OSCILLATOR REQUIREMENTS.

LEVEL: 0.8 V rms ±5%

RECORDER OUTPUTS.

FREQUENCY: level; 0 to 1 volt nominal; source impedance, 0 to 1000 ohms nominal, proportional to FREQUENCY dial rotation.

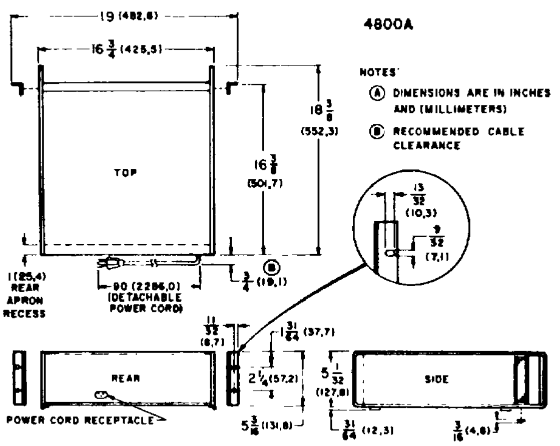
IMPEDANCE: level: 0 to 1 volt nominal; source impedance, 1000 ohms nominal.

PHASE ANGLE: level: 0 to ±0.9 volts nominal; source impedance, 1000 ohms nominal.

GENERAL.

ACCESSORIES FURNISHED: 13525A Calibration Resistor, 00610A Terminal Shield, circuit board extender, rack mounting kit.

DIMENSIONS:



WEIGHT: net 25 lbs (11.3kg), shipping 36 lbs (16.2kg).

POWER: 105 to 125 volts or 210 to 250 volts, 50 to 400 Hz, 27 w.

SECTION III.
OPERATION

3-1. INTRODUCTION

3-2. The4800A Vector Impedance Meter measures impedance directly by injecting a signal into the "unknown" and comparing the ratio of voltage to current. Depending on the impedance range, either the voltage or current is held constant by an automatic leveling control circuit (ALC). Impedance is directly proportional to voltage with the current held constant, and inversely proportional to current with the voltage held constant. Phase angle is measured by comparing the phase relationship between the voltage and current waveforms. Impedance magnitude is measured from 1 ohm to 10 megohms in seven decade ranges; phase angle is indicated from -90 degrees to i90 degrees.

3-3. The Z MAGNITUDE meter has two scales: a direct-reading black scale used with the black engraved Z RANGE positions X1, X10, and X100, and an inverse-reading red scale used with the red engraved Z RANGE positions X1K, X10K, X100K, and X1M. An off-scale reading to the right, with the Z RANGE switch at a black engraved position, indicates the range is too low and the switch should be advanced clockwise. An off-scale reading to the right, with the Z RANGE switch at a red engraved position, indicates the range is too high and the switch should be turned counterclockwise.

NOTE

> After changing ranges, allow a few seconds for circuits to return from an overload condition; if pointer does not indicate on scale, change to the next range.

3-4. The analog outputs on the rear panel provide dc voltages proportional to Z MAGNITUDE meter deflection, PHASE ANGLE meter deflection, and FREQUENCY dial rotation.

3-5. OPERATING CONTROLS

3-6. Figures 3-1 and 3-2 identify and briefly describes the purpose of each panel control, switch, and connector.

3-7. SLIDERULE CALCULATOR

3-8. A slide rule calculator (5952-251 b)has been shipped with the equipment to simplify the more common conversions and calculations that arise with impedance measurements. One side of the slide rule is a Vector Impedance Calculator that resolves the impedance vector Z into its resistive and reactive components. The other side of the slide rule is a Capacitance-Inductance Reactance Calculator that is especially useful for solving resonant frequency problems. The calculator may also be used as a scale factor "nomograph" when direct-reading component measurements are being made with the 4800A (see Paragraph 3-10). The simple instructions necessary to use the calculators are printed on the slide rule (P/N5952-2516),

3-9. MEASUREMENT PROCEDURES

3-10. MEASURING L AND C

3-11. The 4800A provides readings in capacitance and inductance when the FREQUENCY dial is set to the "LC" mark (15.92). Thus, at the frequencies 15.92 Hz, 159.2 Hz, 1.592 kHz, and 159.2 kHz, readings on the Z MAGNITUDE meter scales can be converted to microfarads or microhenries using the "LC" formulas engraved on the front panel, and components may be measured directly. Table 3-1 gives the scale factors that apply when the 4800A is operated in this mode.

Example 1: A coil indicating 800 ohms on the Z MAGNITUDE meter with the FREQUENCY RANGE switch set to X10 (n = 3), has a value of:

LpH = Z x $_{10n}$

L/H = $_{800}$ x 103

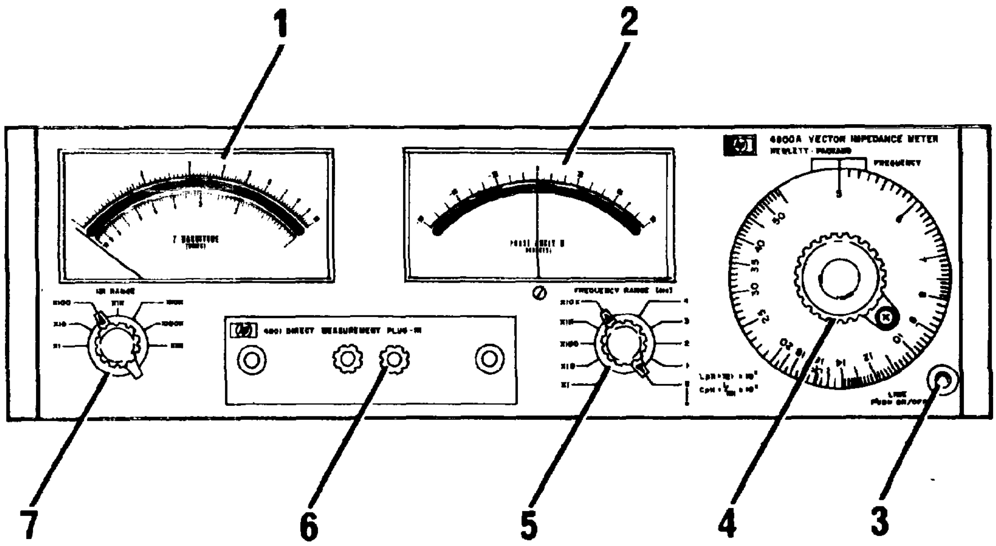
L = 0.8 H

Example 2: A capacitor indicating 30 K ohms on the AGNITUDE meter with the FRE-NCY RANGE switch set to X1K = 1), has a value of:

CUF=1/Z x 10 n

CUF = 1/30K 10 1

C = 333 pF



1. Z MAGNITUDE (OHMS) Meter - indicates impedance magnitude on two scales; a direct-reading black scale used with Z RANGE positions X1, X10, and X100, and an inverse-reading red scale used with Z RANGE positions X1K, X10K, X100K, and X1M.

2. PHASE ANGLE (DEGREES) Meter - indicates impedance phase angle from -90 degrees to +90 degrees.

3. LINE PUSH ON/OFF Switch - combination line power switch and power on indicator; push-button glows when line power is applied.

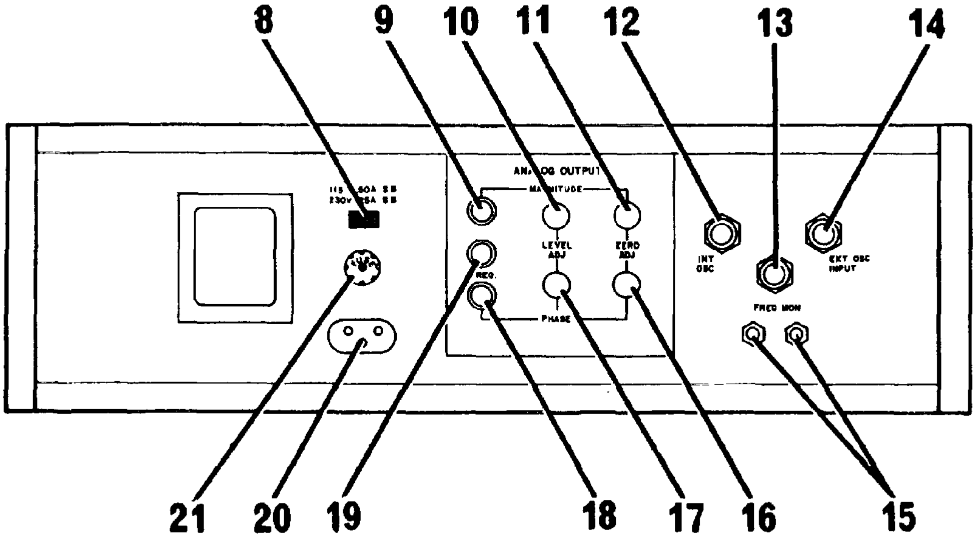
4. FREQUENCY Control - selects test frequency from five available ranges. When dial is set at "LC" mark(15.92), impedance scales on Z MAGNITUDE meter are calibrated in microhenries or microfarads and components may be measured directly.

5. FREQUENCY RANGE (Hz) Switch - selects one of five available test frequency ranges: X1, X10, X100, X1K, and X10K. Switch also indicates exponent (0-4) required to compute "LC" formulas.

6. Measuring Terminals - ungrounded terminals used to connect component to be tested.

7. Z RANGE Switch - selects one of seven available impedance magnitude ranges.

Figure 3-1. 4800A Front Panel Operating Controls



8. 115/230 V Slide Switch - matches instrument to nominal line voltage.

9. MAGNITUDE - ANALOG OUTPUT Connector - dc output (0 to 1 V nominal) proportional to Z MAGNITUDE meter deflection. Source impedance for analog voltage is 1 K ohms.

10. MAGNITUDE - LEVEL ADJ - adjusts X-Y plot at full scale deflection of Z MAGNITUDE meter (1 V nominal).

11. MAGNITUDE - ZERO ADJ - adjusts X-Y plot at 1/10 full scale deflection of Z MAGNITUDE meter (0.1 V nominal).

12. INT OSC Connector - output of internal test oscillator.

13. FREQ MON Connector - output of internal test oscillator for counter readout.

14. EXT OSC INPUT Connector - for application of external test oscillator. Input requirements are 0.8 V ±5% into 20 K ohms.

15. Banana jacks for storing 13525A Calibration Resistor.

16. PHASE - ZERO ADJ - adjusts X-Y plot at zero degree deflection of PHASE ANGLE meter.

17. PHASE - LEVEL ADJ - adjusts X-Y plot at +90 degree deflection of PHASE ANGLE meter.

18. PHASE - ANALOG OUTPUT Connector - dc output (0 to ± 0.9 V nominal) proportional to PHASE ANGLE meter deflection. Source impedance for analog voltage is 1 K ohms.

19. FREQ-ANALOG OUTPUT Connector - dc output (0 to 1 V nominal) proportional to FREQUENCY control rotation.

20. Power Connector - provides for connection of ac power line.

21. Line Fuse - correct fuse rating is indicated on rear panel.

Figure 3-2. 3800A Rear Panel Controls

Table 3-1. Scale Factors for Direct L1C Measurements

(Frequency Range)	Direct Reading C Range (n=O) (n=4)	Direct Reading L Range (n=O) (n=4)
Z Range		
X1	0.1AF to 10000pF	1pH to 100mH
X10	0.01IF to 1000pF	10H to 1H
X100	0.001.F to 100pF	100lpH to 10H
X1K	100pF to 10pF	1mH to 100H
X10K	10pF to 1pF	10mH to 1000H
X100K	1pF to 0.1pF	100mH to 10000H
X1M	0.1pF to 0.01pF	1H to 100000H

3-12. Measurements Involving DC Bias

3-13. If it is necessary to make impedance measurements in the presence of dc bias, a blocking capacitor must be used to isolate the de from the 4800A. The impedance of the capacitor must be small compared to that of the device under test. This can be verified with the 4800A. Since the de bias supply appears in parallel , with the unknown, the impedance of this portion of the circuit must be high with relation to the unknown. If this condition cannot be achieved, the bias supply impedance will reduce the impedance of the unknown. This reading can be corrected, however, by making a separate measurement of the bias supply impedance and then correcting the data. The bias supply must be ungrounded unless the regulating resistor is very large. A large resistor with a grounded supply will isolate the 4W00A test signal from ground.

3-14. Transformer Measurements

3-15. The 4800A has the capability to quickly characterize transformers by providing a plot of vector impedance as a function of frequency. Measurements that can be made include the primary inductance, primary resistance, secondary inductance, secondary resistance, and turns ratio.

3-16. Measurements with AC or noise signals present

3-17. Measurements with external ac or noise signals present require the use of careful techniques. The cording. The analog outputs may also be connected to an -hp- Model 3440A Digital Voltmeter, providing a digital readout for greater resolution. In addition, an ideal go-no-go impedance checkout system can be obtained by combining the 4800A with the -hp- Model 3434A Comparator.

3-20. Frequency Analog Output.
To calibrate the X-axis of an X-Y recorder to a given dial frequency, proceed as follows:

NOTE

The FREQ ANALOG OUTPUT has no exact mathematical relationship to the frequency dial but it is approximately logarithmic.

impedance measuring circuits of the 4800A may amplify an unwanted signal to the same order of magnitude as the internal test signal. This situation will result in a completely spurious impedance reading. The condition is generally easy to recognize, however, since it will become difficult to obtain a stable on-scale reading of either impedance or phase, or both. To help eliminate interference from unwanted signals, bandpass filtering is used for each frequency range. Interference can sometimes be effectively filtered by choosing a frequency two decades away from the unwanted signal. In measurements where interfering noise is likely, such as with antennas, electrical isolation is often necessary. In addition, devices which have the property of converting some other parameter to electrical energy must be isolated from excitation. For instance, a piezoelectric transducer will have to be isolated from mechanical vibration to prevent the generation of unwanted signals. In addition to the precautions mentioned, care should be taken not to apply more than 1 volt rms of external ac to the 4801A measurement terminals; otherwise damage may result to protective diodes CR1-4 in the 4801A.

3-18. Analog Output Measurements

3-19. The 4800A analog outputs may be used to drive the -hp- Model 136A Two-Pen X-Y Recorder. This will provide a continuous record of impedance and phase as a function of various parameters, such as frequency or bias current. Paragraphs 3-20 through 3-22 describe the analog output adjustment procedures for X-Y re-

a. Connect FREQ output to the recorder X-axis input.

b. With recorder pens raised, rotate 4800A FREQUENCY dial from "5" to "50" and mark desired frequency points on the recorder paper.

NOTE

Once this frequency calibration has been accomplished, it need not be repeated for subsequent plots. The original calibration may be transferred from one plot to the next.

3-21. Magnitude Analog Output. This procedure adjusts the MAGNITUDE ZERO ADJ and LEVEL ADJ for proper X-Y recorder operation. Proceed as follows:

a. Set 4800A controls as follows:

Z RANGE	X10
FREQUENCY RANGE	X1K
FREQUENCY dial	"LC" (15.92)

b. Connect dc voltmeter to MAGNITUDE output and a 0.1 uF capacitor to measurement terminals.

c. Adjust FREQUENCY dial for a reading of 10.0 on the Z MAGNITUDE meter black scale.

d. Adjust MAGNITUDE LEVEL ADJ for 1.0 V on voltmeter.

e. Change Z RANGE to X100.

f. Adjust FREQUENCY dial for a reading of 1.0 on the Z MAGNITUDE meter black scale.

g. Adjust MAGNITUDE ZERO ADJ for 0.1 V on voltmeter; due to interaction between controls, this procedure must be repeated until desired accuracy is achieved.

NOTE

The MAGNITUDE output voltage is directly proportional to readings on the black meter scale ranges and inversely proportional to readings on the red meter scale ranges.

3-22. PHASE ANALOG OUTPUT. This procedure adjusts the PHASE LEVEL ADJ and ZERO ADJ for proper X-Y recorder operation. Proceed as follows:

a. Set 4800A controls as follows:

Z RANGE X1K
FREQUENCY RANGE X100
FREQUENCY dial "LC" (15.92)

b. Connect dc voltmeter to PHASE output and 1 KQ Calibration resistor to measurement terminals.

c. Adjust PHASE ZERO ADJ for O V on voltmeter.

d. Connect a 0.1 IF capacitor to measurement terminals.

e. Adjust PHASE LEVEL ADJ for -0.9 V on voltmeter; due to interaction between controls, this procedure must be repeated until desired accuracy is achieved.

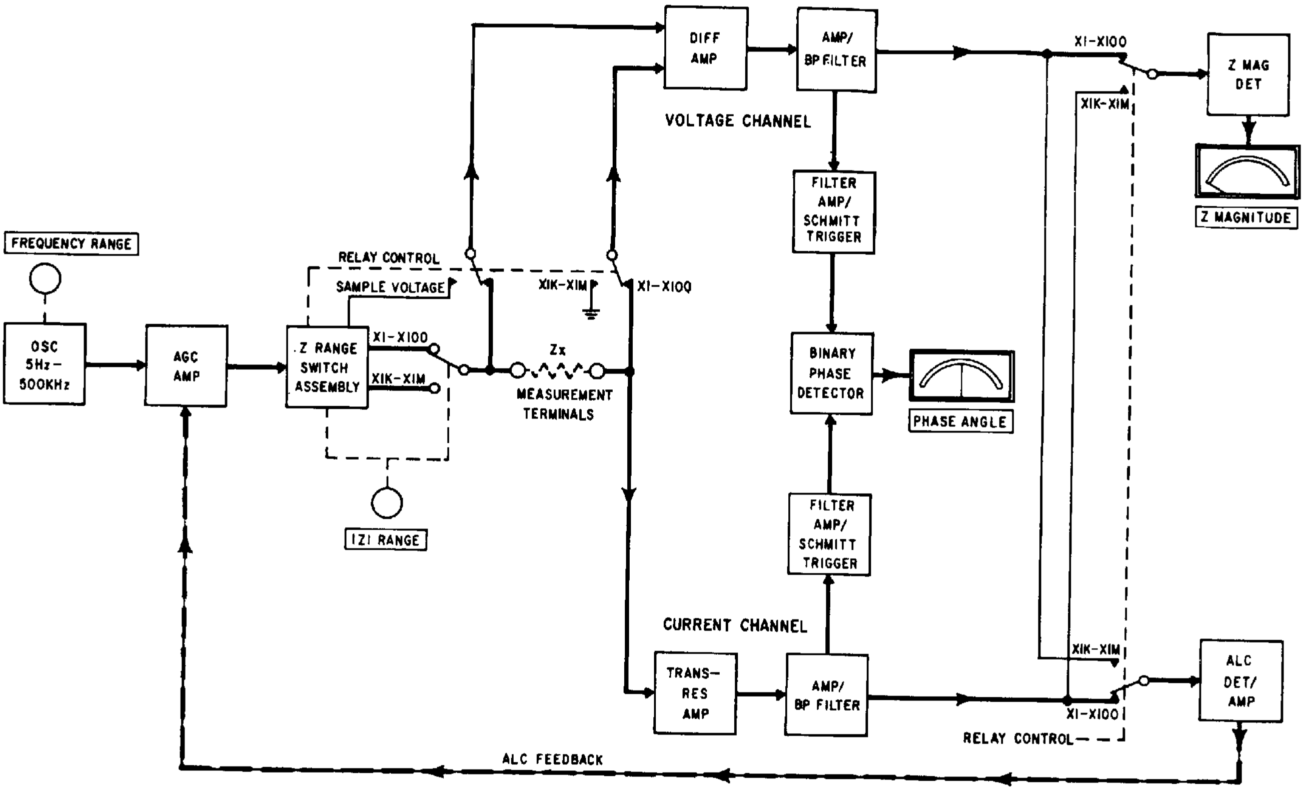


Figure 4-1. 4800A Block Diagram

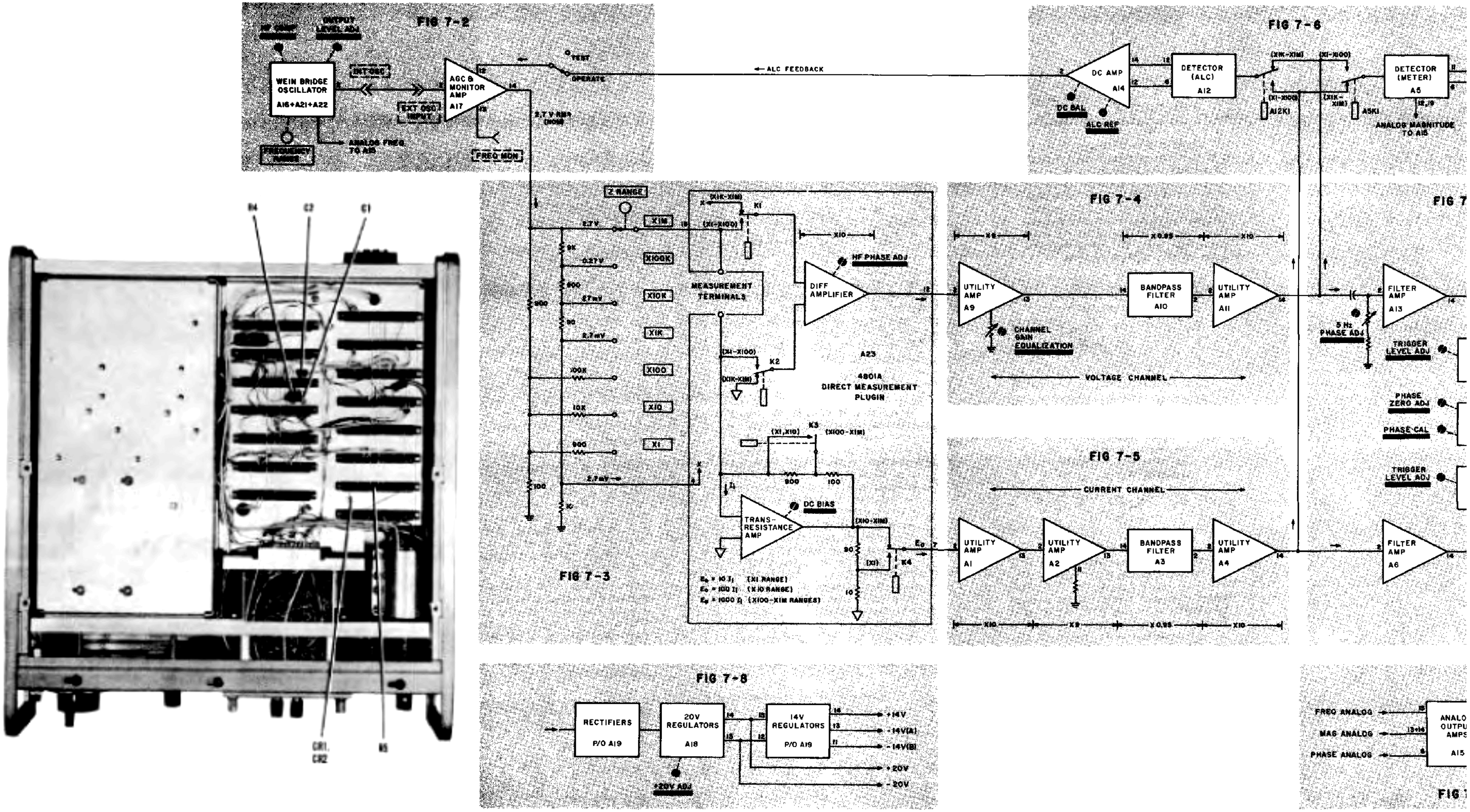


Figure 7-1. FUNCTIONAL BLOCK DIAGRAM

P/O A21 OSCILLATOR RANGE SW

To obtain a low frequency limit of 5 Hz with a practical sized tuning capacitors, resistance in the frequency selective network must be high - 50 MΩ in the 4800A. The high input impedance of an FET source follower (A22Q1) minimizes amplifier loading. All possible leakage paths from the FET gate to ground must be very high resistance.

The test signal oscillator is a resistance-capacitance type (Wein bridge). The circuit consists of a feedback amplifier having both positive and negative feedback loops. The positive loop includes the R-C frequency selective network and causes the circuit to oscillate. Resistance is selected by the FREQUENCY RANGE (Hz) switch and capacitance by the setting of the FREQUENCY tuning capacitor (A22C1A/B).

Phase shift which occurs near the high and low frequency extremes causes errors in dial calibration. Low frequency phase shift caused by C5 and C6 in the feedback path is compensated by the network C3 and R7. High frequency phase shift caused by delay through the amplifier is compensated by C1-C2 and R1. A16C1 is adjusted for dial calibration at a high frequency point (159.2 kHz).

Oscillator circuits are decoupled from the +20 V supplies through +17 V regulators which perform as active filters.

The regulator pass transistor, Q5 (Q7), is protected against failure (short circuits) of +20 V (-20 V) by CR6 (CR8) which prevents emitter-base reverse breakage and by CR7 (CR9) which prevents damage caused by a forward bias of the collector-base junction. The protection is against large current pulses that develop due to the discharge of capacitors in the regulator load.

The negative feedback loop, which reduces distortion, contains a nonlinear resistance (A16R17 and R18, two small 3 V incandescent lamps) which limit the amplitude of oscillation. The lamps, with positive temperature coefficients, adjust their resistance higher or lower to compensate for any tendency of the oscillations to vary in amplitude. Because lamp characteristics vary widely, output amplitude is normalized to 0.8 V, approximately, before being applied to following circuits. Output level changes due to ambient temperature changes, are reduced by R16, a tungsten filament resistor (positive temperature coefficient) of approximately 100 ohms.

REFERENCE DESIGNATORS

A16	A17	A21	A22	CHASSIS
C1-10 CR1-10 E1 Q1-8 R1-30	C1-8 CR1-8 DS1 E1 L1,2 Q1-6 R1-23 V1	R1-10 S1	C1-3 Q1 R1	CP1-3 J1,6,7 R1 S1

DELETED: A17R13, A17R14, A17R16, R1 (CHASSIS)

A17 AGC & MONITOR AMP

Complementary emitter followers Q5 and Q6 decouple the AGC amplifier output from external monitoring equipment.

Amplifier stage Q1-Q4 comprise a feedback stabilized amplifier. One element of the negative feedback path is V1/DS1, a photocell lamp modulator. Lamp current is supplied as leveling feedback from DC Amplifier, A14. As lamp current is increased, photocell resistance decreases; the resulting decrease in feedback causes an increase in output voltage.

The amplifier is the controlled element in the overall leveling loop that supplies the measurement terminals with a constant test current (or voltage) depending on Z MAGNITUDE switch position. Complementary emitter followers are used to give low impedance.

S1 permits breaking of the leveling loop for troubleshooting purposes. In the TEST position there is no current through DS1; V1 resistance is very high, resulting in total feedback around the Q1-4 amplifier and thus a gain of unity.

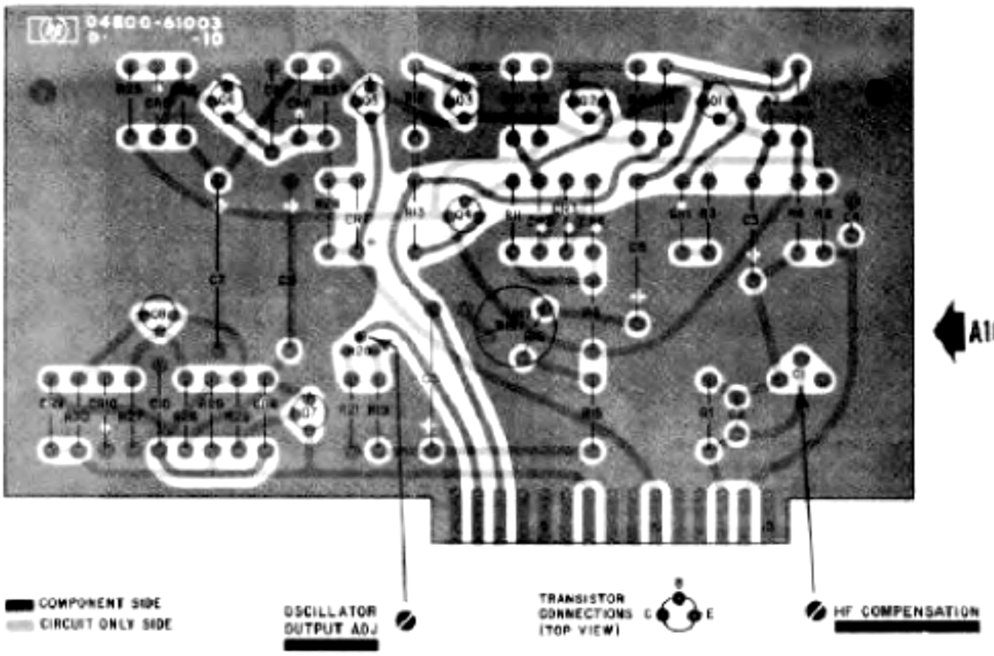
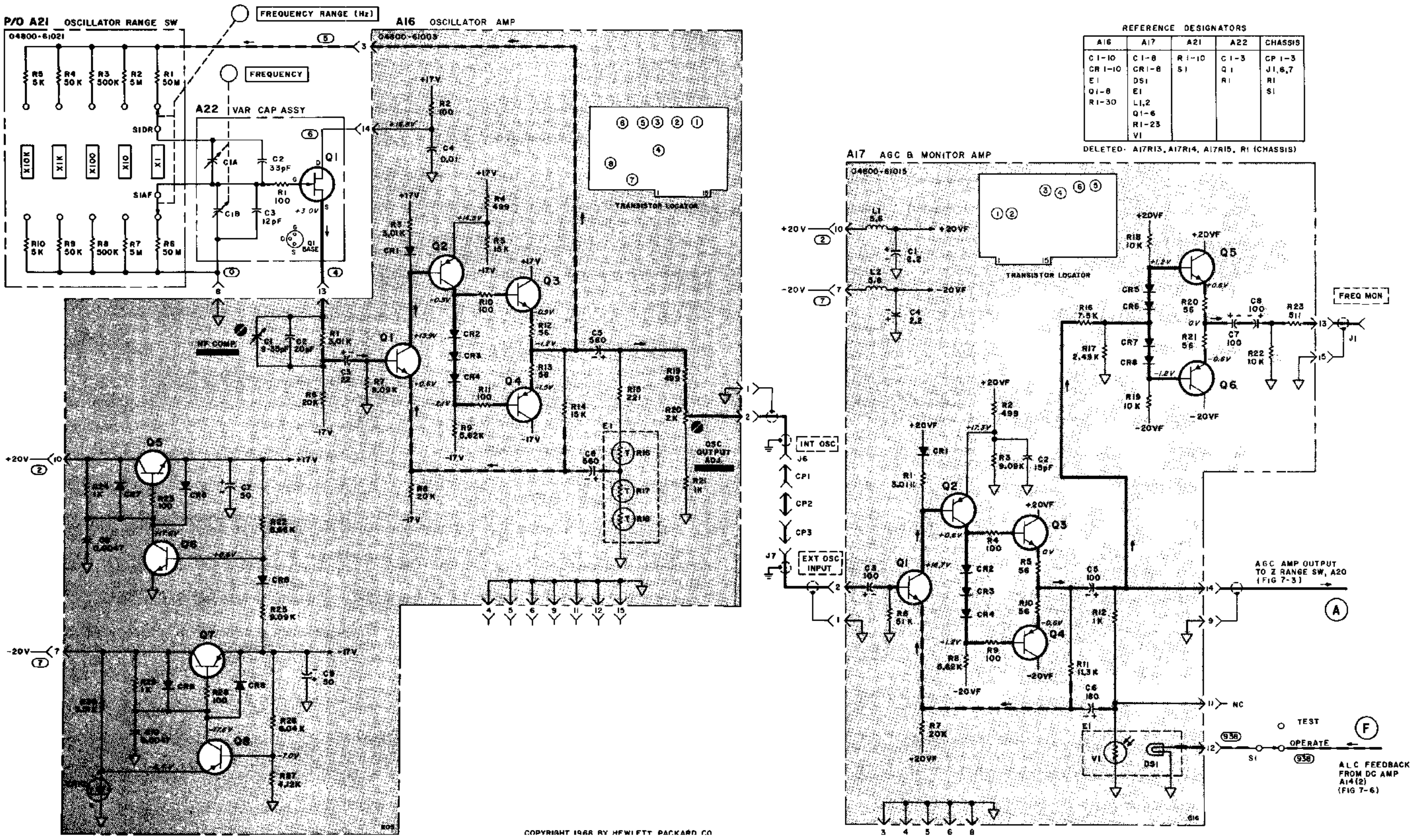


Figure 7-1. FUNCTIONAL BLOCK PROGRAM



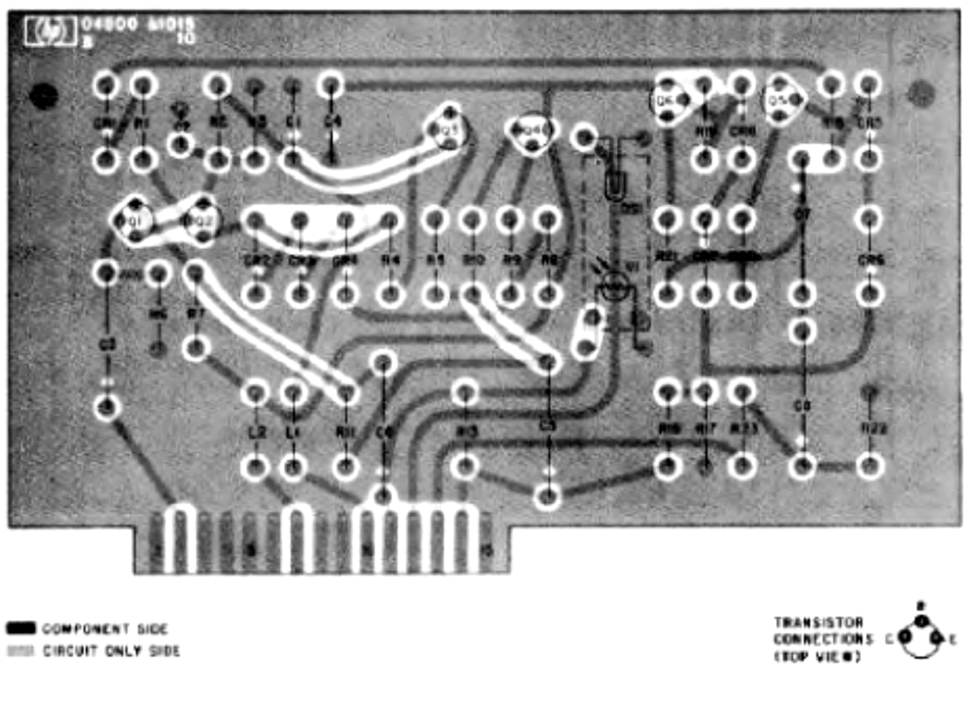
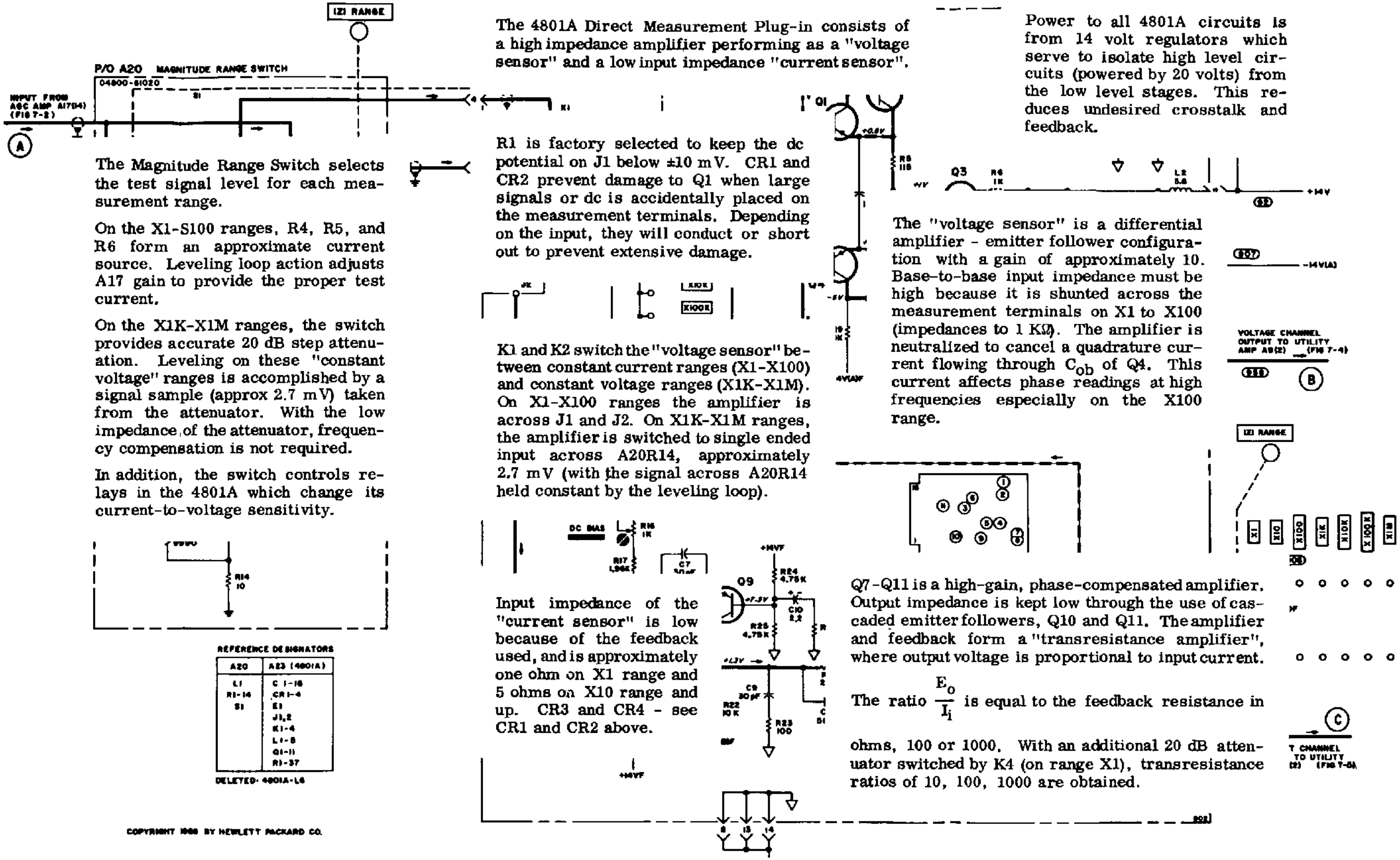


Figure 7-2. OSCILLATOR-AGC AMPLIFIER



The 4801A Direct Measurement Plug-in consists of a high impedance amplifier performing as a "voltage sensor" and a low input impedance "current sensor".

The Magnitude Range Switch selects the test signal level for each measurement range.

On the X1-S100 ranges, R4, R5, and R6 form an approximate current source. Leveling loop action adjusts A17 gain to provide the proper test current.

On the X1K-X1M ranges, the switch provides accurate 20 dB step attenuation. Leveling on these "constant voltage" ranges is accomplished by a signal sample (approx 2.7 mV) taken from the attenuator. With the low impedance of the attenuator, frequency compensation is not required.

In addition, the switch controls relays in the 4801A which change its current-to-voltage sensitivity.

R1 is factory selected to keep the dc potential on J1 below ±10 mV. CR1 and CR2 prevent damage to Q1 when large signals or dc is accidentally placed on the measurement terminals. Depending on the input, they will conduct or short out to prevent extensive damage.

K1 and K2 switch the "voltage sensor" between constant current ranges (X1-X100) and constant voltage ranges (X1K-X1M). On X1-X100 ranges the amplifier is across J1 and J2. On X1K-X1M ranges, the amplifier is switched to single ended input across A20R14, approximately 2.7 mV (with the signal across A20R14 held constant by the leveling loop).

Input impedance of the "current sensor" is low because of the feedback used, and is approximately one ohm on X1 range and 5 ohms on X10 range and up. CR3 and CR4 - see CR1 and CR2 above.

Power to all 4801A circuits is from 14 volt regulators which serve to isolate high level circuits (powered by 20 volts) from the low level stages. This reduces undesired crosstalk and feedback.

The "voltage sensor" is a differential amplifier - emitter follower configuration with a gain of approximately 10. Base-to-base input impedance must be high because it is shunted across the measurement terminals on X1 to X100 (impedances to 1 KΩ). The amplifier is neutralized to cancel a quadrature current flowing through C_{ob} of Q4. This current affects phase readings at high frequencies especially on the X100 range.

Q7-Q11 is a high-gain, phase-compensated amplifier. Output impedance is kept low through the use of cascaded emitter followers, Q10 and Q11. The amplifier and feedback form a "transresistance amplifier", where output voltage is proportional to input current.

The ratio $\frac{E_o}{I_i}$ is equal to the feedback resistance in ohms, 100 or 1000. With an additional 20 dB attenuator switched by K4 (on range X1), transresistance ratios of 10, 100, 1000 are obtained.

REFERENCE DESIGNATORS

A20	A23 (4801A)
L1 R1-14 S1	C1-16 CR1-4 E1 J1,2 K1-4 L1-8 Q1-11 R1-37

DELETED: 4801A-L6

Figure 7-2. OSCILLATOR-AGC AMPLIFIER

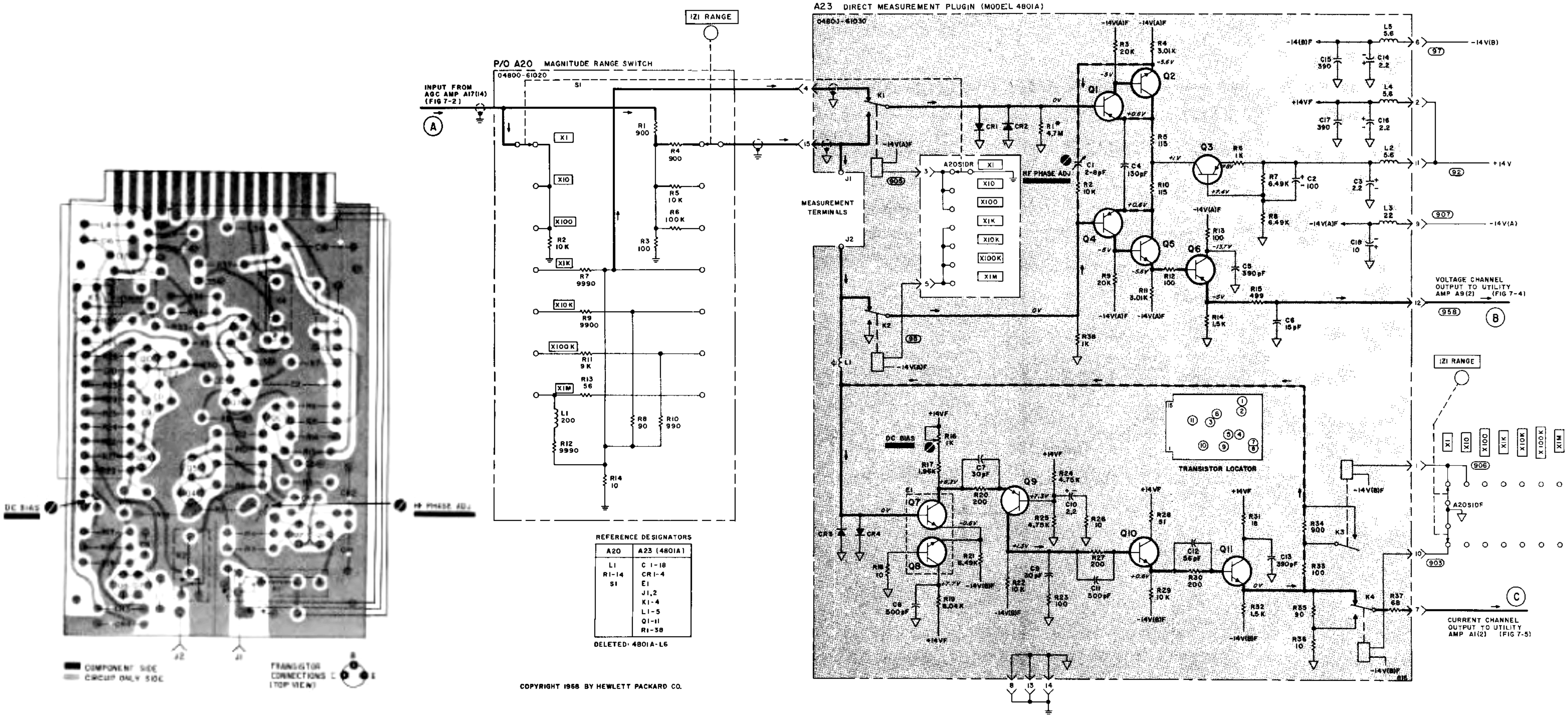


Figure 7-3. Z RANGE SWITCHING & 4801A DIRECT MEASUREMENT PLUG-IN

The Utility Amplifier is a feedback stabilized amplifier. The feedback path is only partially on the circuit board - an external connection is required. If the external connection is a short between pins 11 and 12, the amplifier gain is 10. If a resistor is connected between pins 11 and 12, the gain will be less than 10 and depend on the resistor value.

Some dc feedback (through R11) stabilizes stage biasing with temperature and complementary emitter followers Q3 and Q4 develop low output impedance. The output is dc coupled through pin 13.

The gain of A9 is reduced by the setting of R2, during calibration.

Bandpass filter A10 reduces the effect of signal pickup on leads used to connect networks to the 4801A measurement terminals.

Low and high pass filtering is switched with a relay and a series of diode switches controlled by the FREQUENCY RANGE switch setting.

Low pass filtering is accomplished in a variety of ways:

On the X1 and X10K range K1 contacts are closed: This directly couples the input to Q1, an emitter follower, and no filtering is done.

On the X100 range, K1 contacts are open and filtering is through C1 and C2 in series, and R8 to common.

On the X1K range two filtering sections are used, consisting of C1 - R1 and C2 - R8. (On this range CR1 is made to conduct heavily through CR2.)

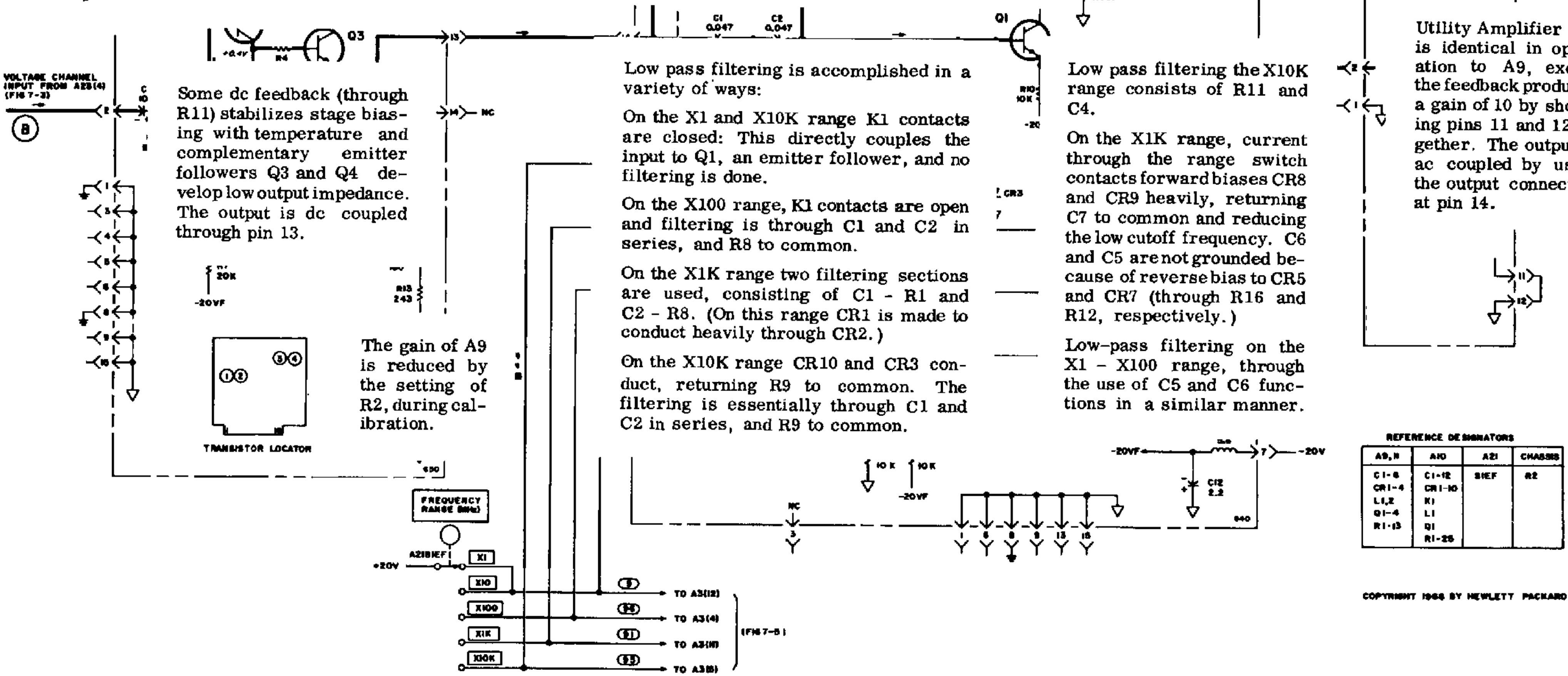
On the X10K range CR10 and CR3 conduct, returning R9 to common. The filtering is essentially through C1 and C2 in series, and R9 to common.

Low pass filtering the X10K range consists of R11 and C4.

On the X1K range, current through the range switch contacts forward biases CR8 and CR9 heavily, returning C7 to common and reducing the low cutoff frequency. C6 and C5 are not grounded because of reverse bias to CR5 and CR7 (through R16 and R12, respectively.)

Low-pass filtering on the X1 - X100 range, through the use of C5 and C6 functions in a similar manner.

Utility Amplifier A11 is identical in operation to A9, except the feedback produces a gain of 10 by shorting pins 11 and 12 together. The output is ac coupled by using the output connection at pin 14.



REFERENCE DESIGNATORS

A9, 11	A10	A21	CHASSIS
C1-6	C1-12	S1EF	R2
CR1-4	CR1-10		
L1,2	K1		
Q1-4	L1		
R1-13	Q1		
	R1-26		

Figure 7-3. Z RANGE SWITCHING & 4801A DIRECT MEASUREMENT PLUG IN

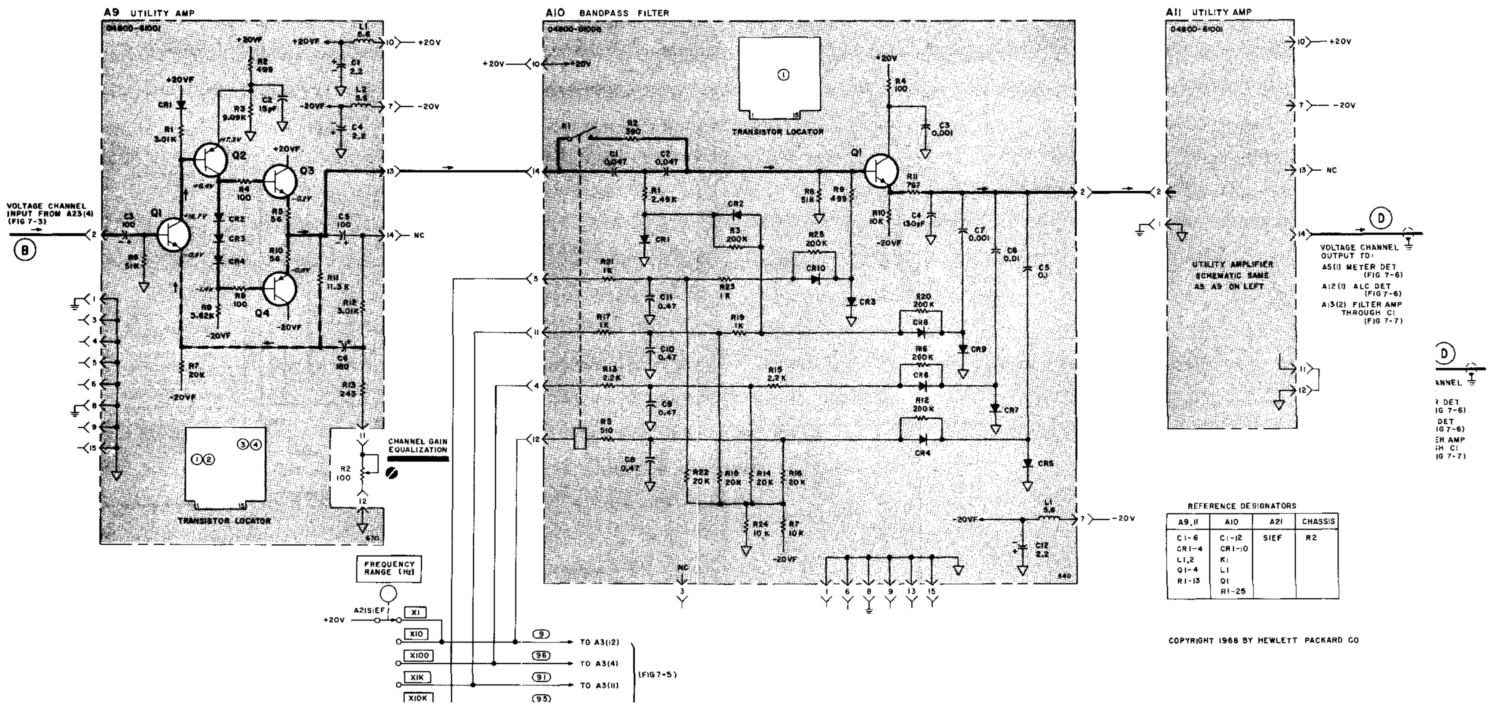
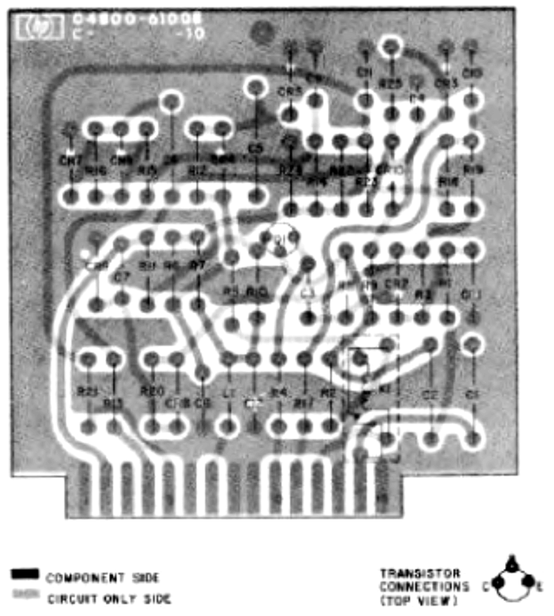


Figure 7-4. VOLTAGE CHANNEL AMPLIFIERS



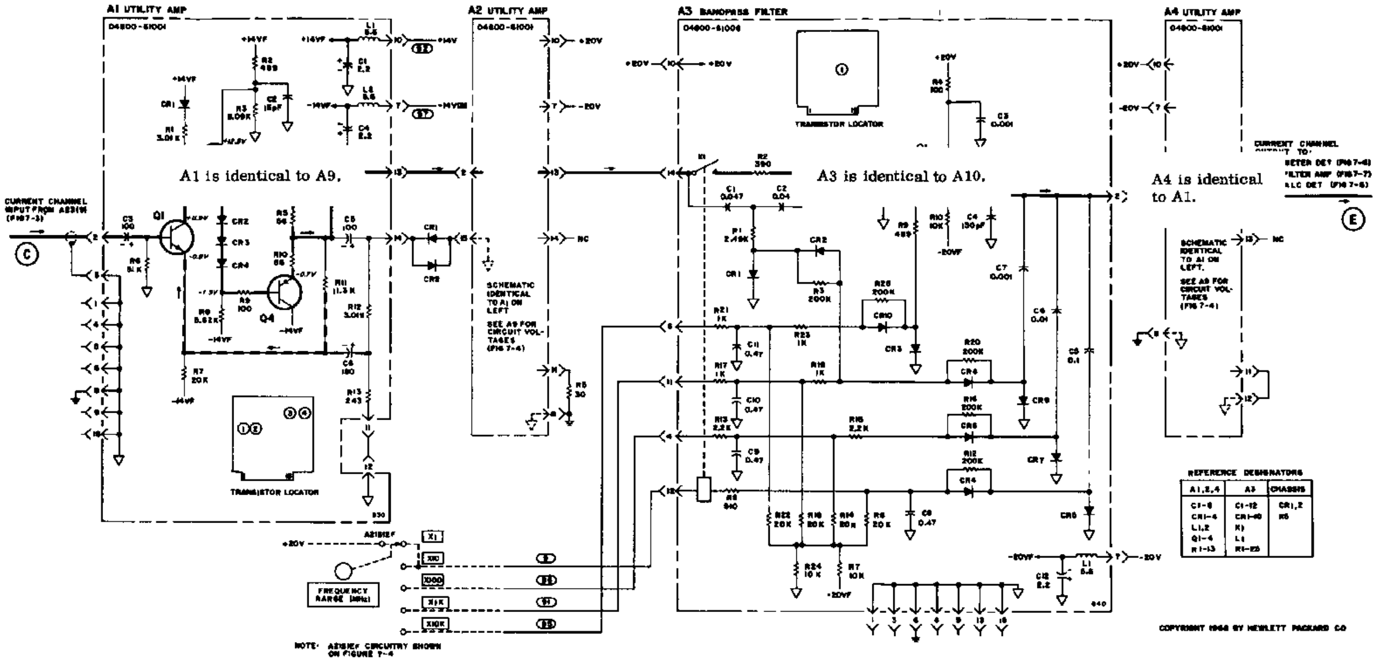
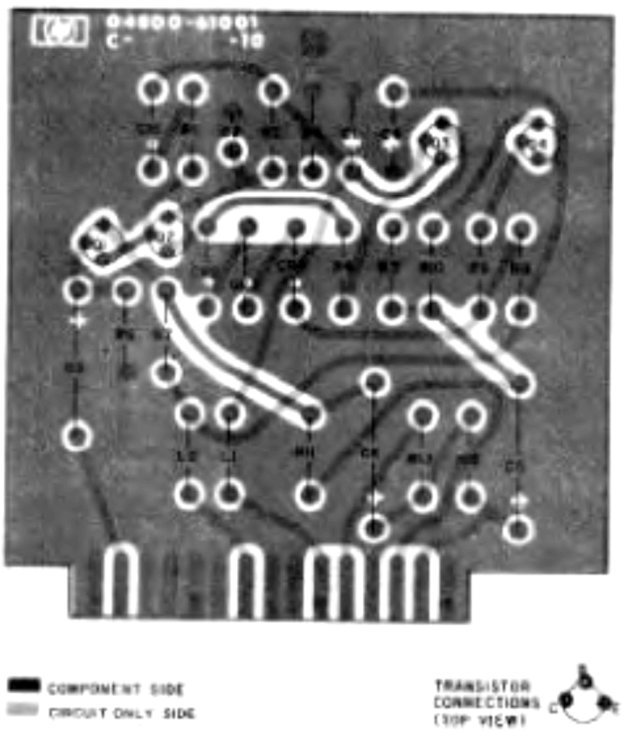


Figure 7-4. VOLTAGE CHANNEL AMPLIFIERS



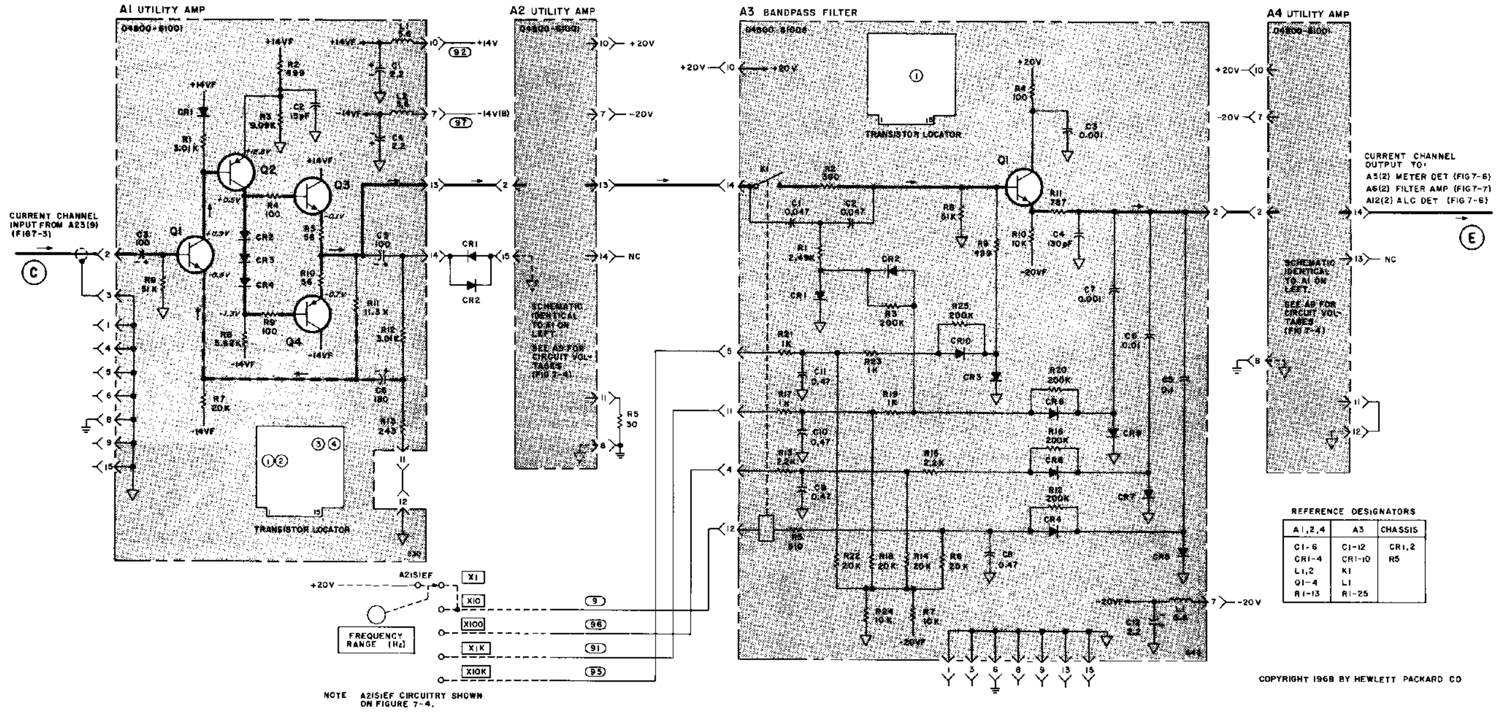
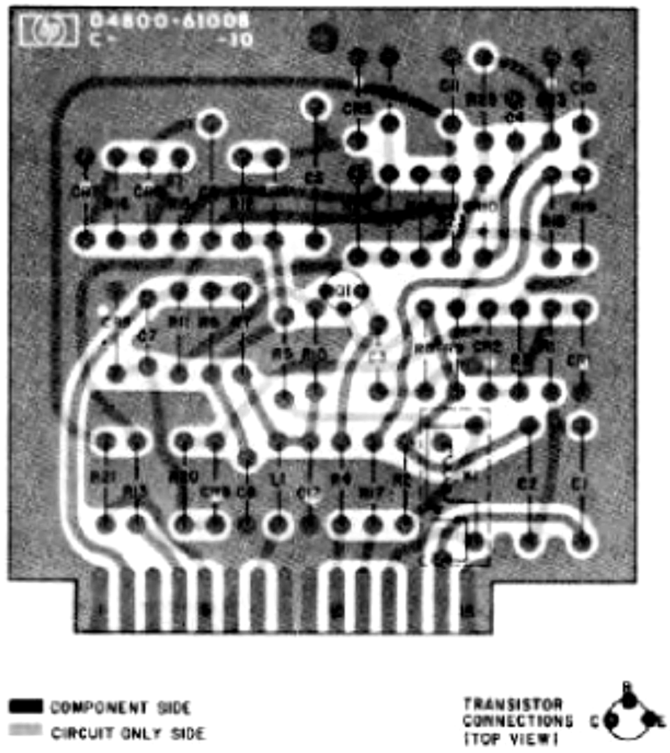
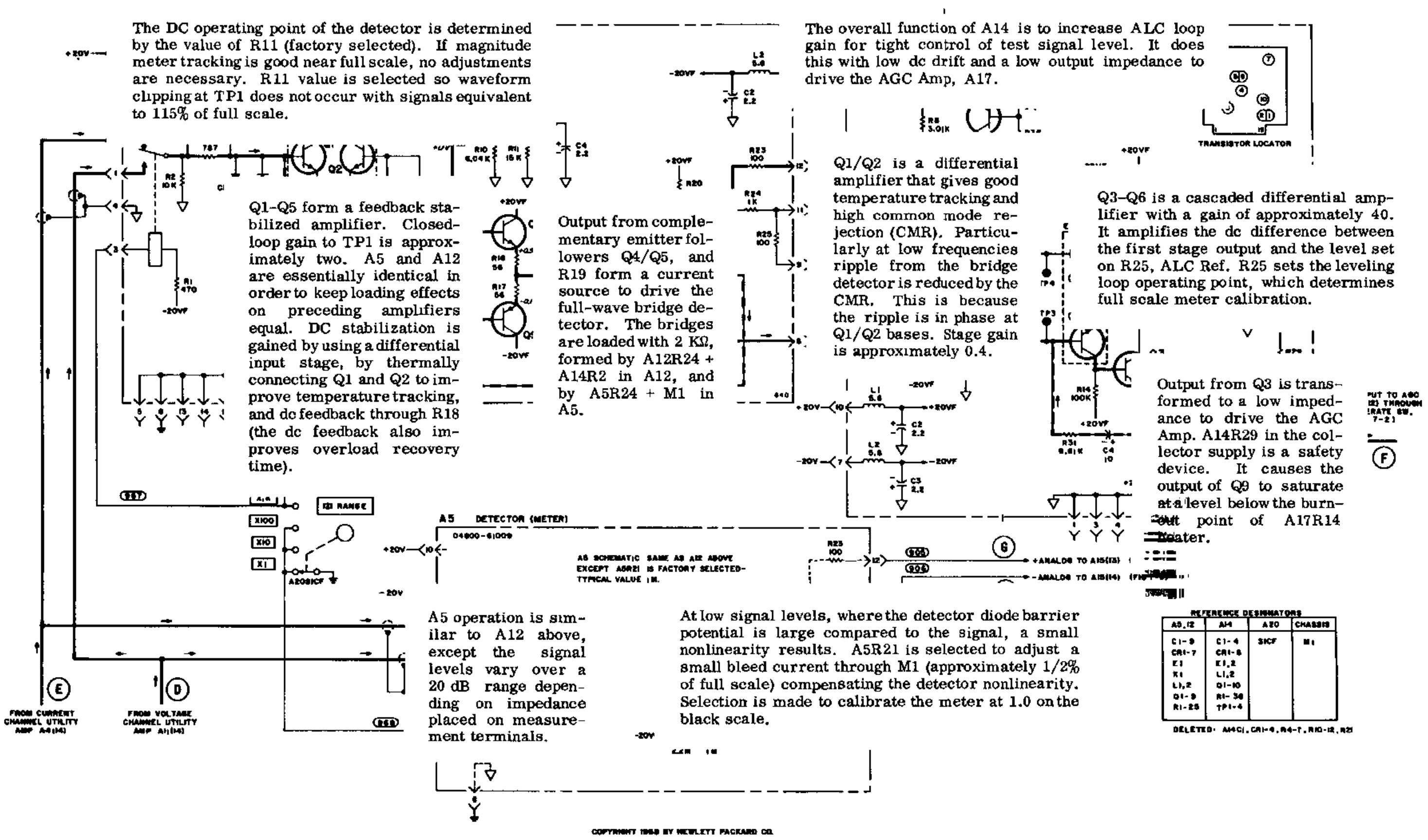


Figure 7-5. CURRENT CHANNEL AMPLIFIERS





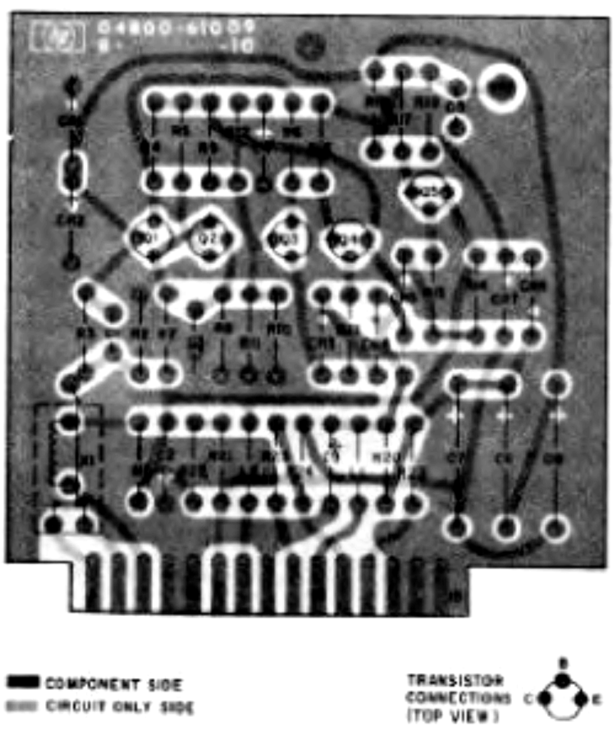
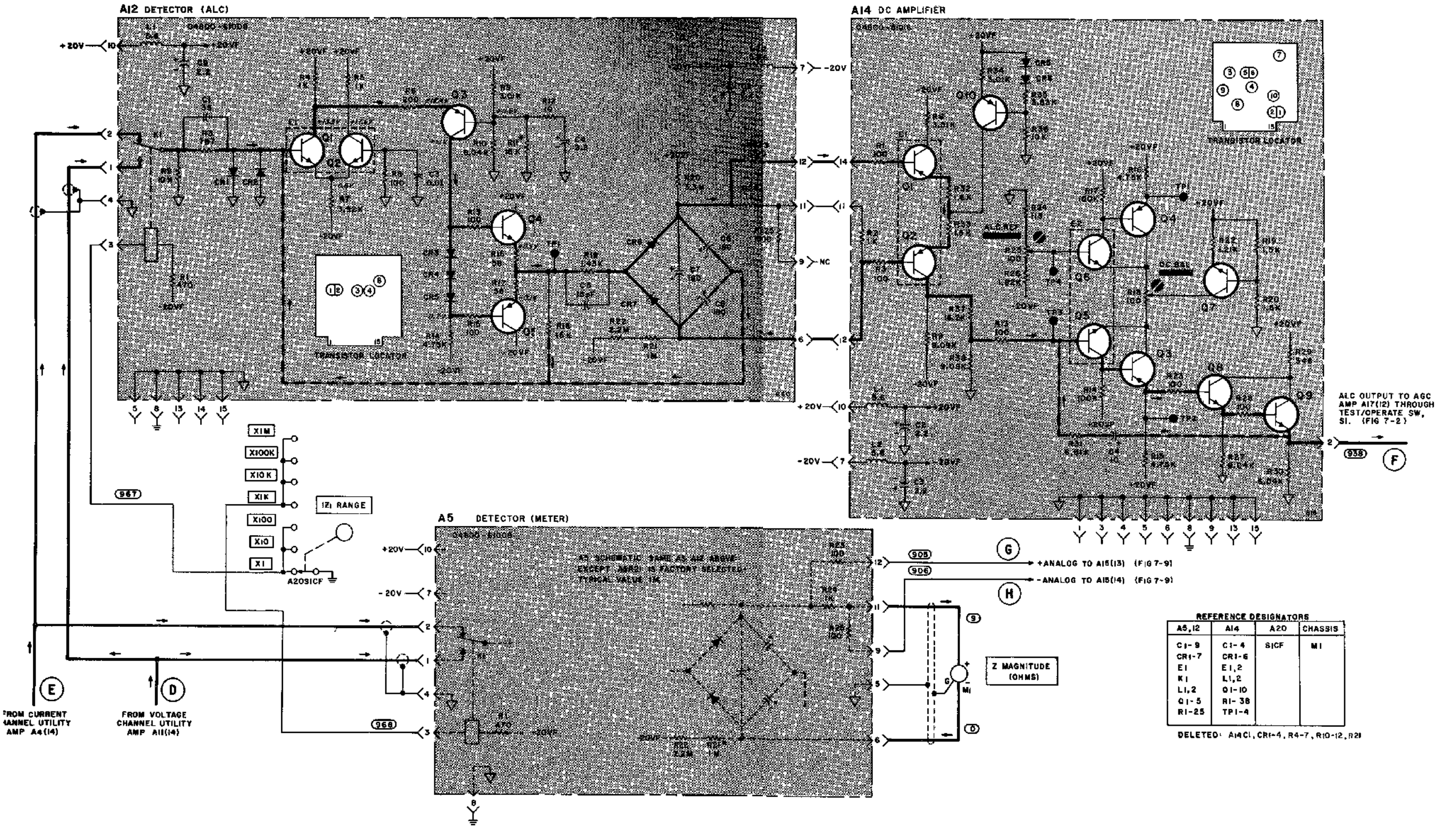


Figure 7-5. CURRENT CHANNEL AMPLIFIERS



REFERENCE DESIGNATORS

A5, 12	A14	A20	CHASSIS
C1-9	C1-4	S1CF	M1
CR1-7	CR1-6		
E1	E1,2		
K1	L1,2		
L1,2	Q1-10		
Q1-5	R1-38		
R1-25	TP1-4		

DELETED: A14C1, CR1-4, R4-7, R10-12, R21

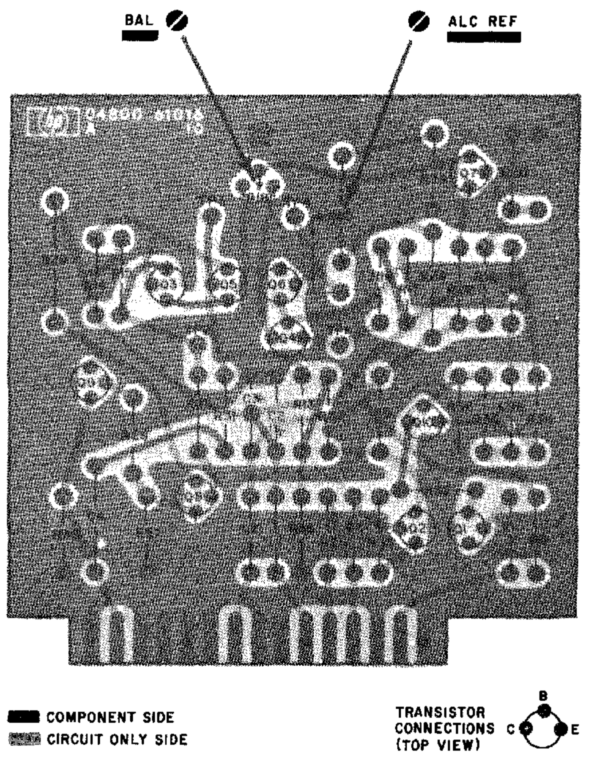
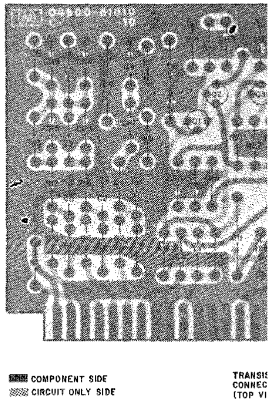
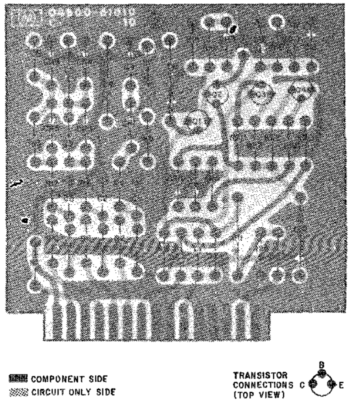
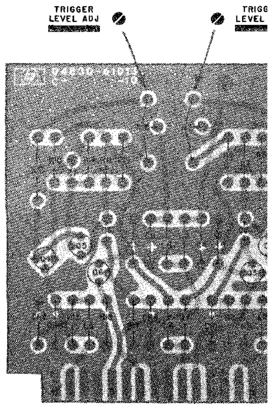
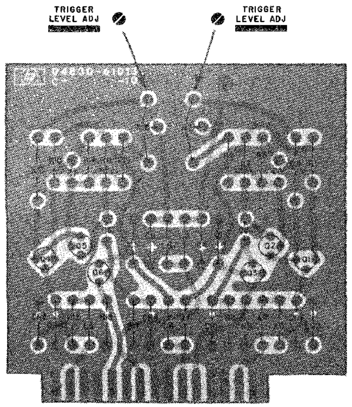


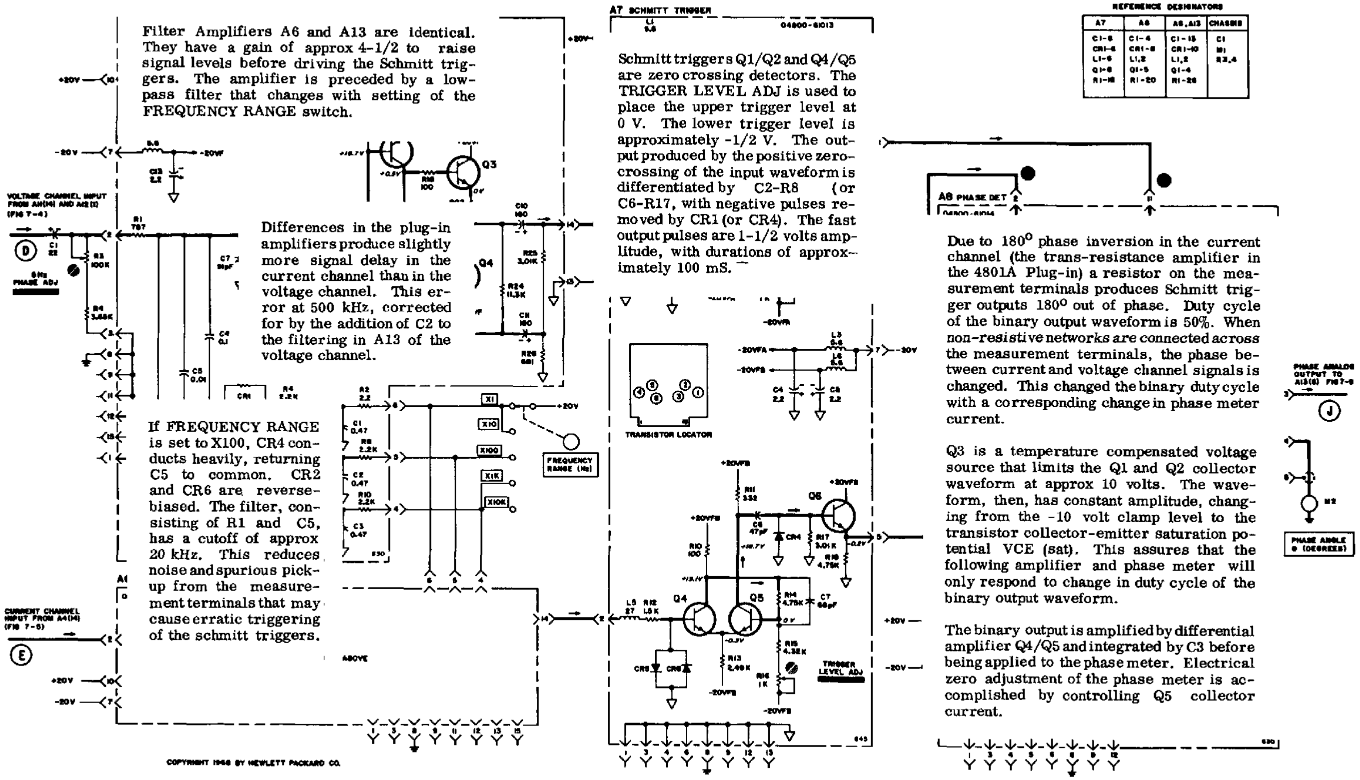
Figure 7-6. DETECTORS AND DC AMPLIFIER











Filter Amplifiers A6 and A13 are identical. They have a gain of approx 4-1/2 to raise signal levels before driving the Schmitt triggers. The amplifier is preceded by a low-pass filter that changes with setting of the FREQUENCY RANGE switch.

Differences in the plug-in amplifiers produce slightly more signal delay in the current channel than in the voltage channel. This error at 500 kHz, corrected for by the addition of C2 to the filtering in A13 of the voltage channel.

If FREQUENCY RANGE is set to X100, CR4 conducts heavily, returning C5 to common. CR2 and CR6 are reverse-biased. The filter, consisting of R1 and C5, has a cutoff of approx 20 kHz. This reduces noise and spurious pickup from the measurement terminals that may cause erratic triggering of the schmitt triggers.

Schmitt triggers Q1/Q2 and Q4/Q5 are zero crossing detectors. The TRIGGER LEVEL ADJ is used to place the upper trigger level at 0 V. The lower trigger level is approximately -1/2 V. The output produced by the positive zero-crossing of the input waveform is differentiated by C2-R8 (or C6-R17, with negative pulses removed by CR1 (or CR4). The fast output pulses are 1-1/2 volts amplitude, with durations of approximately 100 mS.

REFERENCE DESIGNATORS

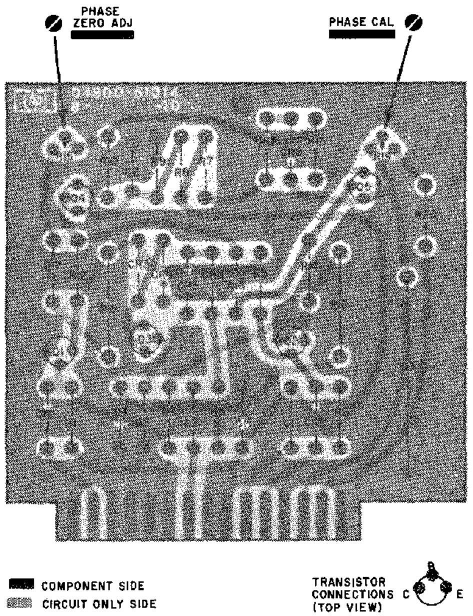
A7	A8	A6,A13	CHASSIS
C1-8	C1-4	C1-15	C1
CR1-6	CR1-8	CR1-10	M1
L1-6	L1,2	L1,2	R2,4
Q1-6	Q1-5	Q1-4	
R1-18	R1-20	R1-26	

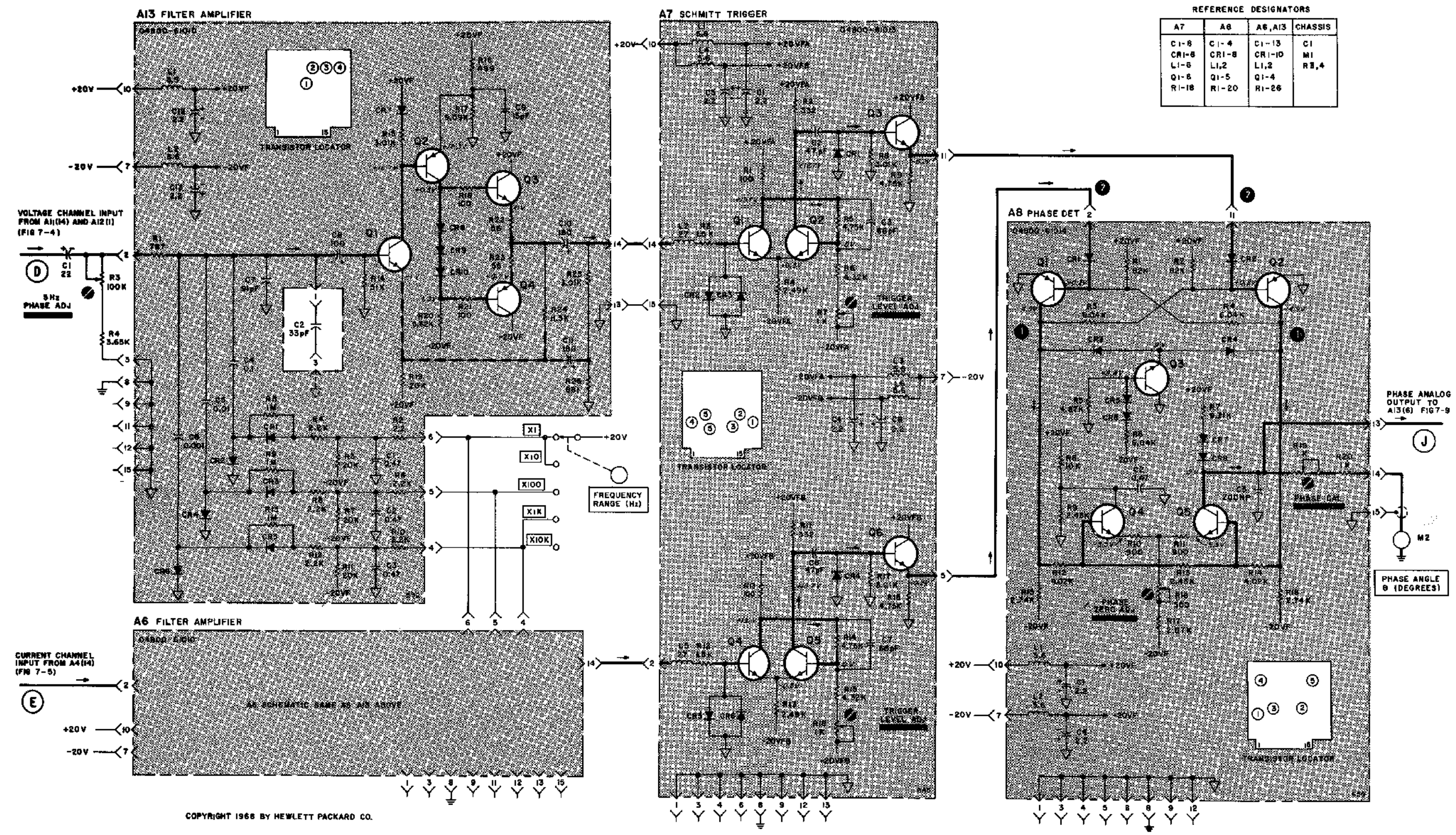
Due to 180° phase inversion in the current channel (the trans-resistance amplifier in the 4801A Plug-in) a resistor on the measurement terminals produces Schmitt trigger outputs 180° out of phase. Duty cycle of the binary output waveform is 50%. When non-resistive networks are connected across the measurement terminals, the phase between current and voltage channel signals is changed. This changed the binary duty cycle with a corresponding change in phase meter current.

Q3 is a temperature compensated voltage source that limits the Q1 and Q2 collector waveform at approx 10 volts. The waveform, then, has constant amplitude, changing from the -10 volt clamp level to the transistor collector-emitter saturation potential VCE (sat). This assures that the following amplifier and phase meter will only respond to change in duty cycle of the binary output waveform.

The binary output is amplified by differential amplifier Q4/Q5 and integrated by C3 before being applied to the phase meter. Electrical zero adjustment of the phase meter is accomplished by controlling Q5 collector current.

Figure 7-8. DETECTORS AND DC AMPLIFIER

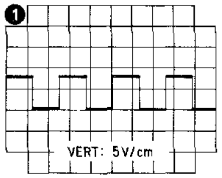


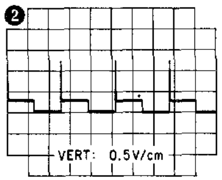


WAVEFORMS

NOTE

Refer to Troubleshooting Tree #4 for information on waveforms.





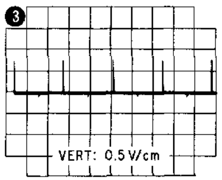
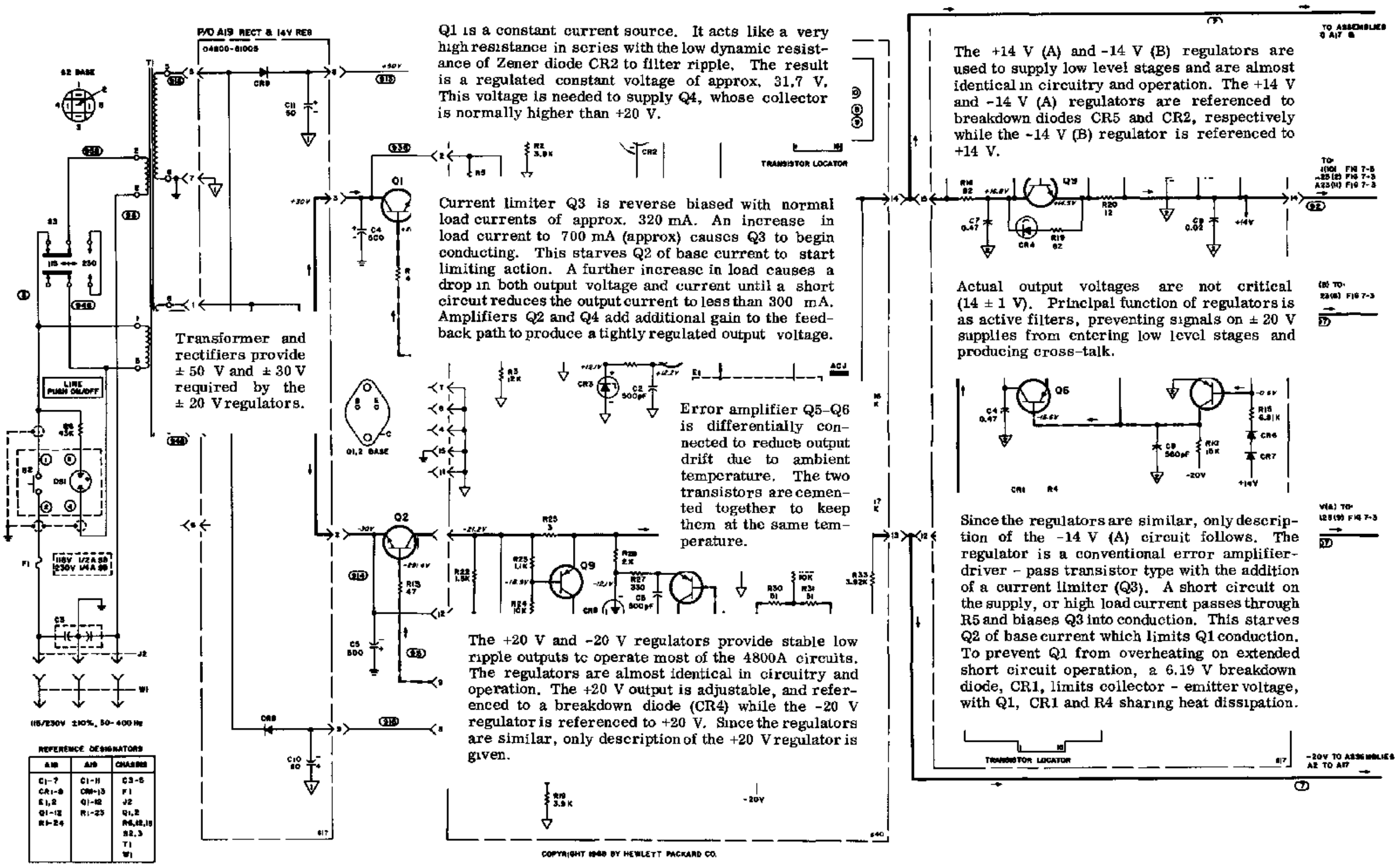


Figure 7-7. PHASE MEASUREMENT CIRCUITS



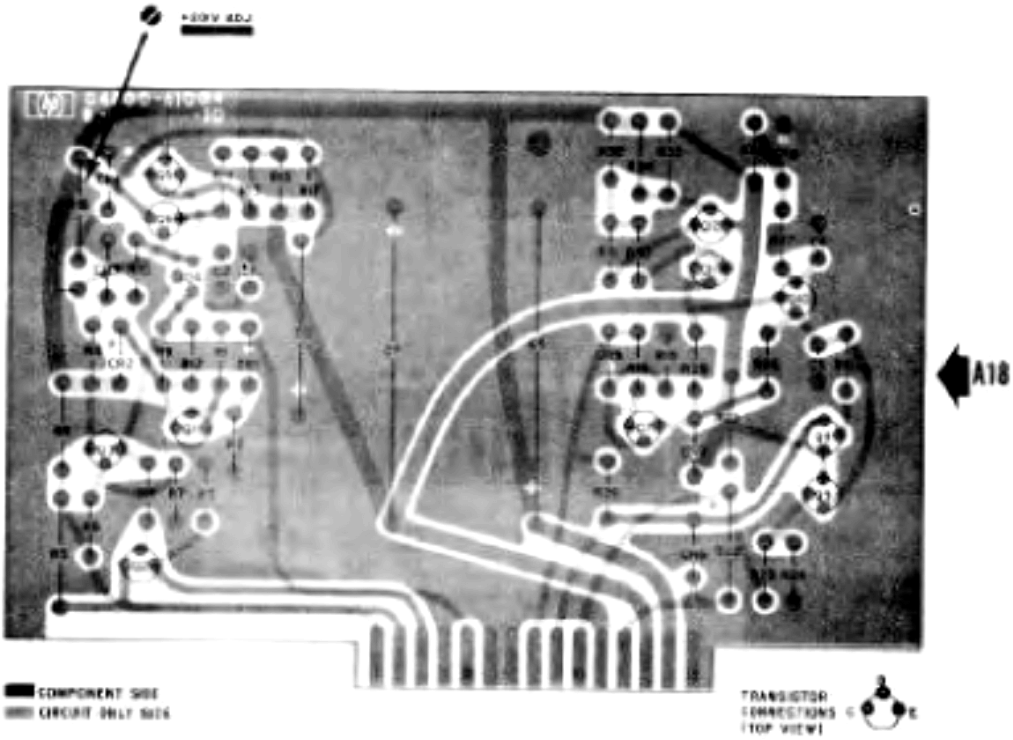
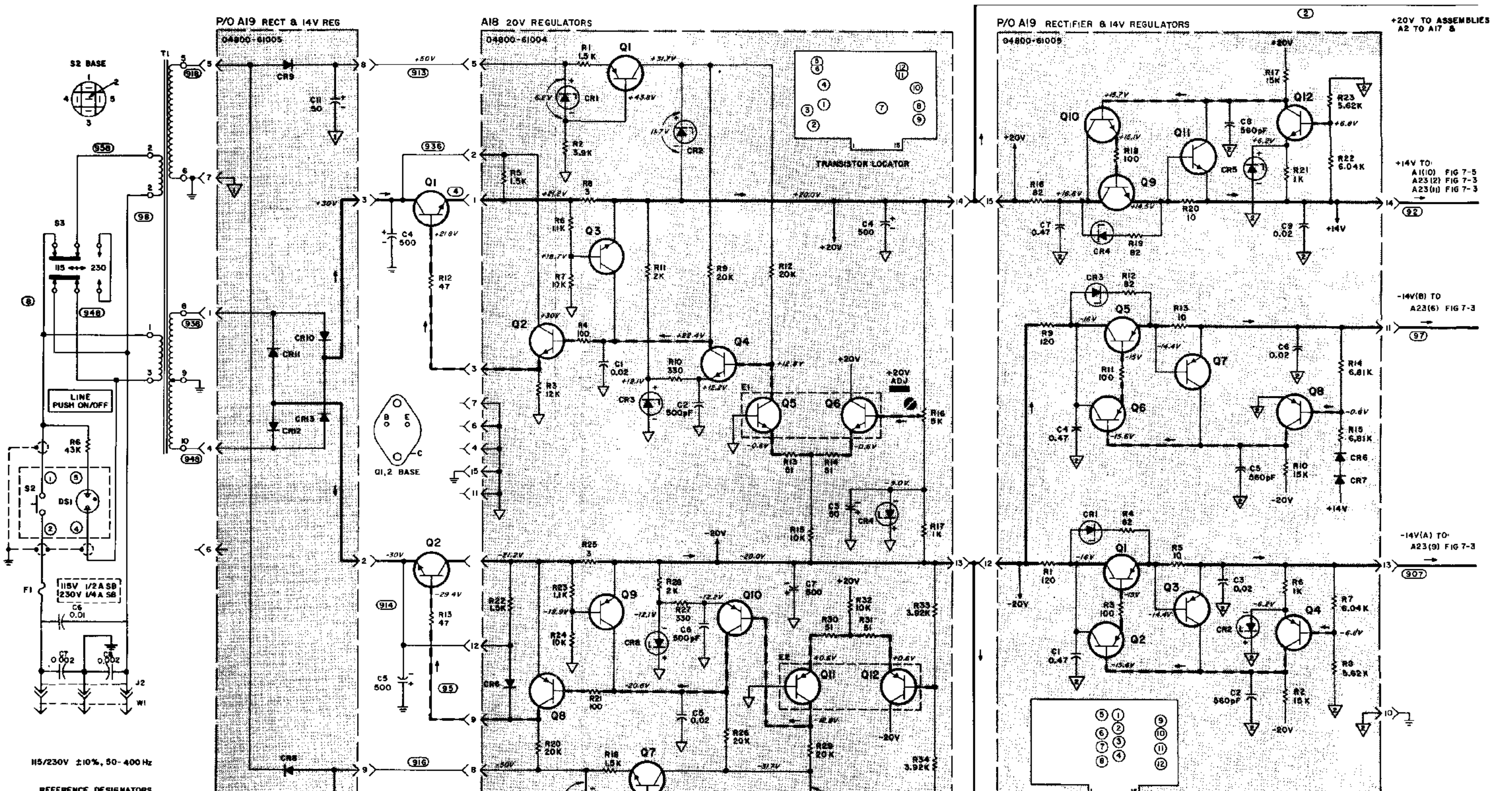


Figure 7-7. PHASE MEASUREMENT CIRCUITS



A18	A19	CHASSIS
C1-7	C1-11	C3-5
CR1-8	CR1-13	F1
E1,2	Q1-12	J2
Q1-12	R1-23	Q1,2
R1-24		R6,12,13
		S2,3
		T1
		W1

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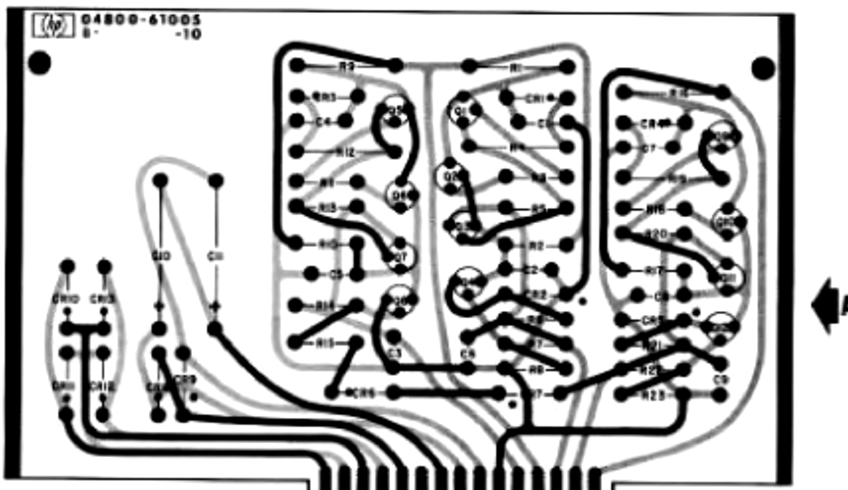
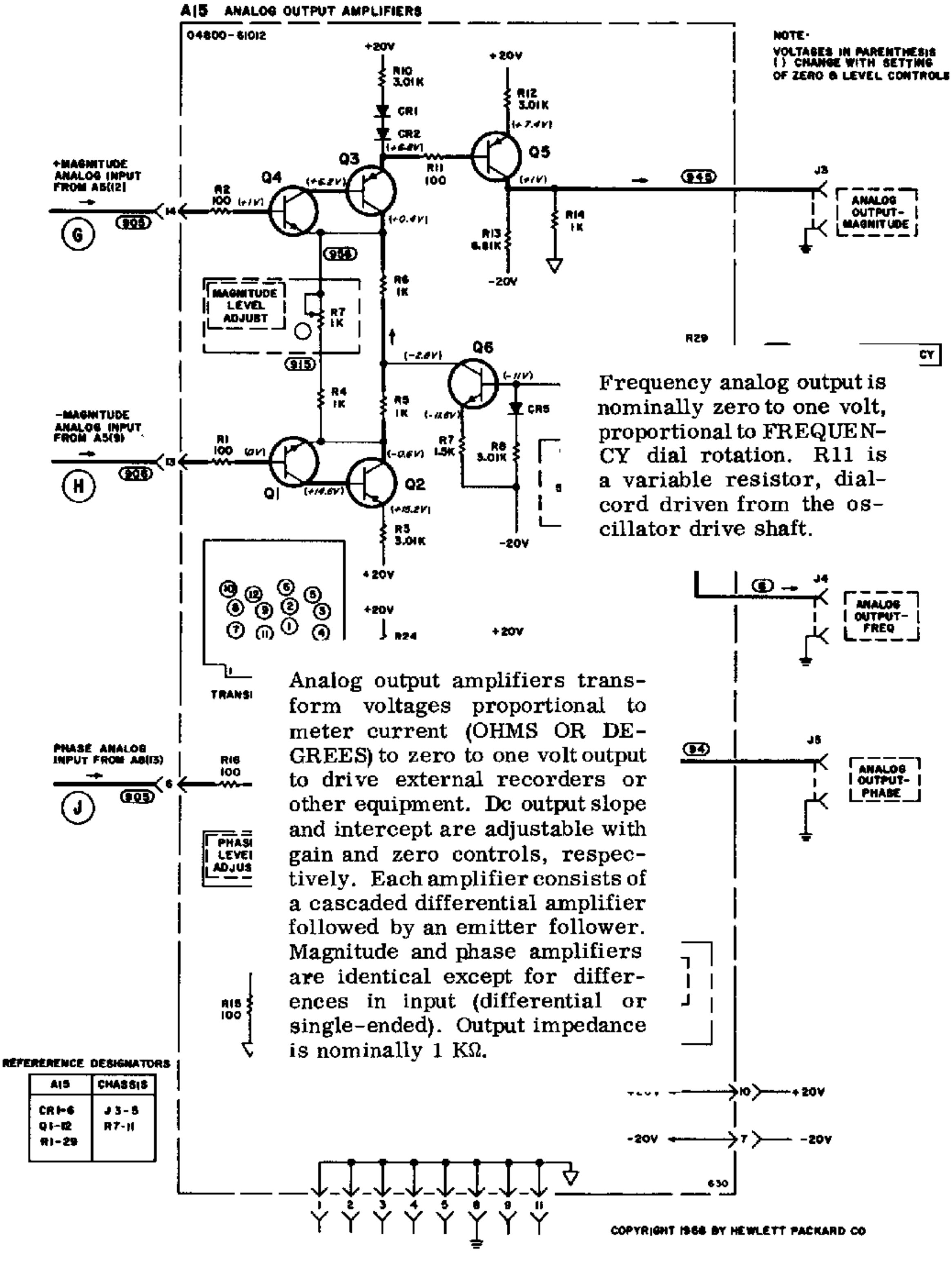


COMPONENT SIDE
CIRCUIT ONLY SIDE

TRANSISTOR CONNECTIONS (TOP VIEW)

Figure 7-8. POWER SUPPLIES



Frequency analog output is nominally zero to one volt, proportional to FREQUENCY dial rotation. R11 is a variable resistor, dial-cord driven from the oscillator drive shaft.

Analog output amplifiers transform voltages proportional to meter current (OHMS OR DEGREES) to zero to one volt output to drive external recorders or other equipment. Dc output slope and intercept are adjustable with gain and zero controls, respectively. Each amplifier consists of a cascaded differential amplifier followed by an emitter follower. Magnitude and phase amplifiers are identical except for differences in input (differential or single-ended). Output impedance is nominally 1 KΩ.

Figure 7-8. POWER SUPPLIES

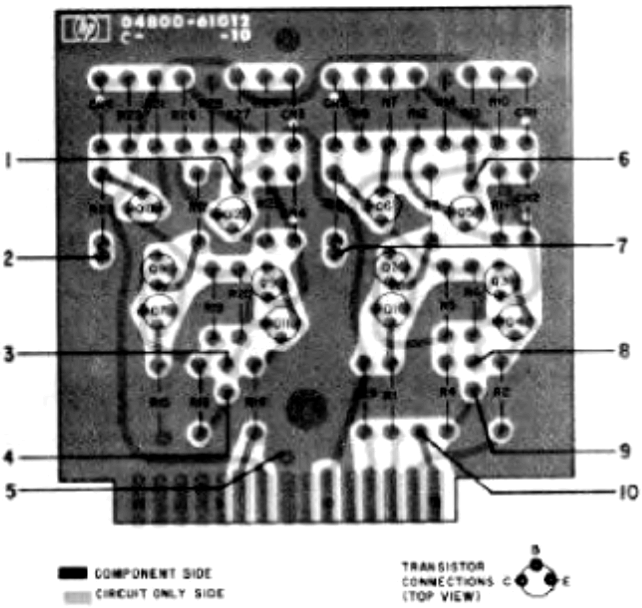


Figure 7-9. ANALOG OUTPUTS