INSTRUCTION MANUAL

AUDIO GENERATOR

Model AG-51

POTOMAC INSTRUMENTS, INC.

PI

932 PHILADELPHIA AVE.
SILVER SPRING, MD. 20910

WARNING

This instrument must be used with a 3-prong U-grounded receptacle outlet. Failure to use a grounded outlet may result in improper operation or safety hazard.

AUDIO GENERATOR
MODEL AG-51
INSTRUCTION MANUAL

POTOMAC INSTRUMENTS INC.
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Silver Spring, Maryland 20910
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WARRANTY FOR EQUIPMENT AND ACCESSORIES

Potomac Instruments Inc. warrants each new equipment to be free of defects in material and workmanship, for a period of one (1) year after date of original shipment, except for fuses, transistors, diodes, and integrated circuits, which are warranted for a period of ninety (90) days. Any instrument which is found within one year not to meet the foregoing standards after examination by our factory, will be repaired or at the option of Potomac Instruments replaced without charge. This warranty does not apply to equipment which has been altered, improperly handled, or damaged in any way.

CHANGES IN SPECIFICATIONS

The right is reserved to change the published specifications of equipment at any time, and to furnish merchandise in accordance with current specifications, without incurring any liability to modify equipment previously sold.

RETURNING EQUIPMENT TO THE FACTORY

Factory service is available for repair and adjustment of this instrument; however, a description of the trouble, plus the model and serial number(s) of the unit should be forwarded first, whereupon instructions for correcting the trouble or authorization for returning the equipment will be given. This applies to all units, whether under warranty or not. Shipment in an improper container may result in damaged equipment thereby voiding warranty.

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SECTION 1
GENERAL DESCRIPTION

1.1 FUNCTION

The Model AG-51 Audio Generator furnishes audio signals from +20 dBm to –79.9 dBm* over the frequency range of 20 Hz to 200 kHz to a 600-ohm load. At a 150-ohm load, the audio signal levels are 0 dBm to –99.9 dBm. The maximum output level is monitored and can be verified by a built-in test.

1.2 ELECTRICAL CHARACTERISTICS

The Model AG-51 generates low distortion sine wave signals from 20 Hz to 200 kHz in four decade ranges. Frequency of the output signal is indicated by a calibrated dial and a range multiplier. Calibration accuracy is better than ±3%. It also generates an intermodulation distortion test signal of 60 Hz and 7 kHz mixed in a 4:1 ratio. Additionally, it generates a fixed sine wave frequency of 3.15 kHz for use in wow and flutter measurement. The output attenuator is calibrated in 10, 1 and 0.1 decibel steps. When the AG-51 is connected to a 600-ohm resistive load, the maximum power output is +20 dBm* which may be verified by the built-in test feature.

Separate left and right channel outputs are provided, with switch-selected in-phase, inverse-phase, left-only and right-only output signals to facilitate a variety of stereo broadcast system performance measurements.

1.3 SPECIFICATIONS

Frequency Range:	20 Hz to 200 kHz in four decade ranges.
Outputs:	LEFT only, RIGHT only, LEFT and RIGHT in phase (L&R), or LEFT and RIGHT 180^{o} out of phase (L-R); switch selected IM composite 60 Hz and 7 kHz @ 4:1 ratio (SMPTE standard) 3.15 kHz fixed wow & flutter signal (IEEE Standard 193-1971)
Output Impedance:	
Unbalanced:	150 ohms or 600 ohms; switch selected
Fully balanced:	150 ohms or 600 ohms; switch selected
Output Level:	(No Attenuation)
Sine Wave Signals:	+20 dBm* (7.75V) across 600 ohm load, 15.5V open circuit 0 dBm (.387V) across 150 ohm load, 0.774V open circuit
IM Signal:	Peak-to-peak voltage of composite waveform is equal to peak-to-peak voltage of +20 dBm sine wave across 600 ohm load, 0 dB sine wave across 150 ohm load.
Output Level Accuracy:	20 Hz - 100 kHz, ±0.2 dB 100 kHz - 200 kHz, ±0.5 dB

*Units with serial numbers 133 and below have a maximum output level of +18 dBm (6.15V RMS) and and minimum output level of –81.9 dBm.

1.3 **SPECIFICATIONS (Cont.)**

Attenuator Range:	0 to 99.9 dB in 0.1 dB steps		
Attenuator Accuracy:			
0 to 10 dB:	±1.5% of attenuation in dB		
> 10 dB:	±0.2 dB (max.)		
Intrinsic Distortion*:			
Harmonic	Low Distortion		Fast Response
50 Hz to 7.5 kHz	< .05%		< 1%
20 Hz to 20 kHz	< .08%		< 2%
Intermodulation		< .03%	
Incidental FM (3.15 kHz)		< 0.01%	
Hum and Noise:	> 80 dB below rated output		
Dial Accuracy:	±3%		
External Power:	117 VAC, (230 VAC option) 50 or 60 Hz, 9 Watts		
Dimensions with cover, cm (in):	38.74 (15-1/4) wide, 13.34 (5-1/4) high, 25.75 (10-1/8) deep		
Rack mount space with rack mount option	5¼ inches		
Weight with cover, kg (lbs):	5.44 (12)		

*Slightly higher at R output in L-R, UNBAL mode.

SECTION 2
OPERATING INSTRUCTIONS

2.1 INSTALLATION

The Model AG-51 is ready for operation as delivered, and need only be connected to an AC power source.

WARNING

The AG-51 must be used with a 3-prong U-grounded receptacle outlet. Failure to use a grounded outlet may result in improper operation or safety hazard.

2.2 CONTROLS AND INDICATORS

The following controls and indicators are identified on Figure 2-1.

2.2.1 POWER Switch (S1)

Applies AC power to the unit when in the ON position.

2.2.2 POWER Indicator (DS1)

Illuminates to indicate the presence of main DC (+30V) power.

2.2.3 FREQ Range Switch (S2)

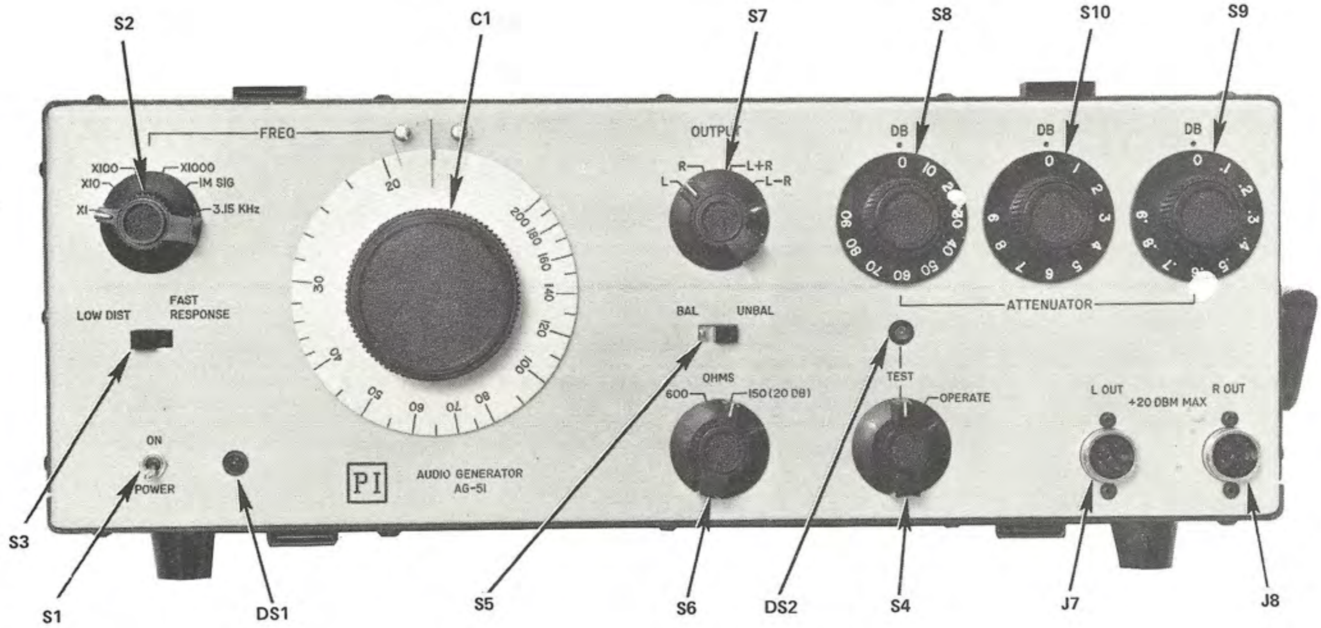
In the X1, X10, X100 and X1000 positions, S2 selects the variable frequency output. The setting of this switch indicates the multiplier for the calibrated FREQ dial (C1).

In the IM SIG position, S2 selects the special IM distortion test signal (60 Hz + 7 kHz) output. The FREQ dial (C1) has no effect when S2 is in this position.

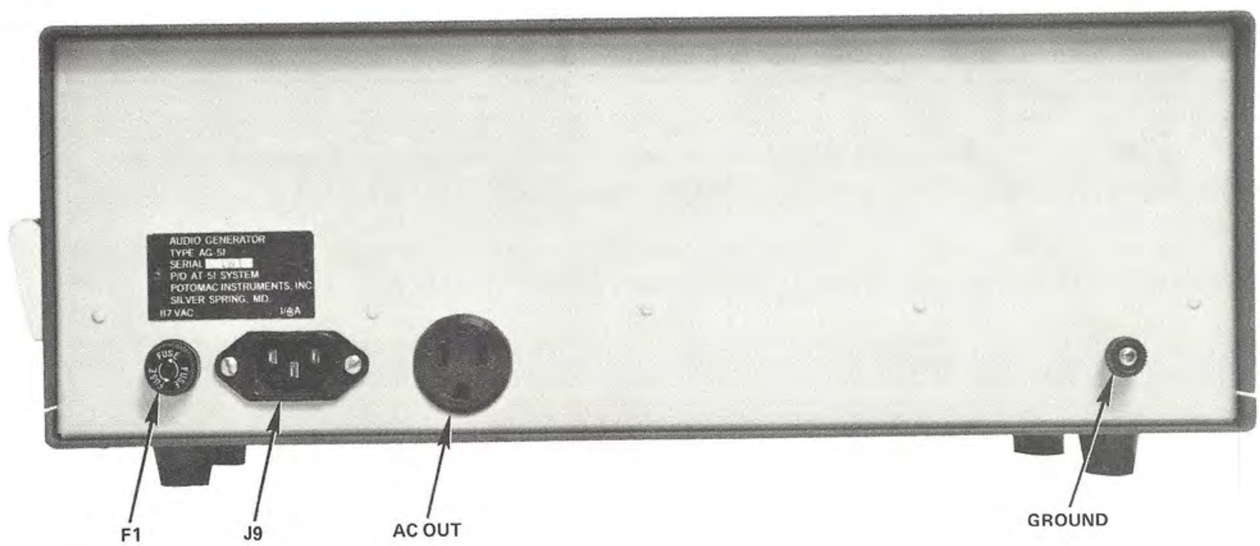
In the 3.15 kHz position, S2 selects the 3.15 kHz wow and flutter test signal. This signal is a fixed frequency; thus, the FREQ dial will have no effect when this position is selected.

2.2.4 FREQ Dial (C1)

This calibrated dial may be used to set the desired output frequency with an accuracy of ±3%, when the FREQ Range Switch is in the X1, X10, X100 or X1000 position. The output frequency in Hertz equals the dial setting multiplied by the switch setting.



FRONT PANEL



REAR PANEL

Figure 2.1. AG-51 Controls and Indicators

2.2.5 LOW DIST/FAST RESPONSE Switch (S3)

In the FAST RESPONSE position, this switch selects a shorter time constant for the automatic gain control circuits associated with the variable frequency oscillator. This position provides fast correction of amplitude as the frequency is varied, but causes higher distortion.

The LOW DIST setting of S3 will insure the lowest distortion throughout the frequency range of the AG-51, but will allow some momentary change in output amplitude if the frequency is changed rapidly.

2.2.6 TEST/OPERATE Switch (S4)

The TEST/OPERATE Switch may be placed in the TEST position to activate a test of the basic output signal level. Indicator DS2 will illuminate if the signal level is correct within ±0.5 dB. This test may be used with any setting of the FREQ Range Switch or FREQ dial.

When S4 is in the TEST position, the output levels go to zero while the correct impedance is maintained. Thus, S4 can be used to remove and reapply a test signal.

2.2.7 TEST Indicator (DS2)

This indicator is used in conjunction with the TEST/OPERATE Switch and illuminates to indicate correct generator output signal level (±0.5 dB).

2.2.8 BAL/UNBAL Switch (S5)

The BAL/UNBAL Switch is used to select either balanced or unbalanced configurations of the generator outputs at the L OUT and R OUT connectors. With S5 in the BAL position, an output signal will be supplied across pins 1 and 3 of each jack, balanced with respect to ground. The connector shell is grounded to the chassis. When S5 is in the UNBAL position, the output signal is supplied on pin 3 of each jack, with pin 1 at chassis ground. In both positions the same voltage exists between pins 1 and 3.

2.2.9 OHMS Switch (S6)

S6 is used to select either 600 Ohm or 150 Ohm output impedance. When the 600 Ohm impedance is selected, the generator output into a 600 ohm load (zero attenuation) will be +20 dBm* for all frequencies. Generator output with S6 in the 150 Ohm position is 0 dBm into a 150 ohm load (zero attenuation).

2.2.10 OUTPUT Select Switch (S7)

This switch selects the following output configurations at J7 (L OUT) and J8 (R OUT):

a. L position – provides generator output at J7 or left channel only; (R OUT) output is zero at the correct impedance.

b. R position – provides generator output at J8 or right channel only; (L OUT) output is zero at the correct impedance.

*+18 dBm for serial numbers 133 and below.

c. L+R position – provides in-phase output signals on both channels.

d. L-R position – provides signals of opposite phase (180^{o} out) on right and left channels; the L signal is unchanged, while the R signal is reversed in phase.

2.2.11 ATTENUATOR Switches: –10 dB Steps (S8), 1 dB Steps (S10); 0.1 dB Steps (S9):

When the 150 Ohm output impedance is selected (S6), generator output level may be set directly in –dBm by using S8 for the tens digit, S10 for the ones digit, and S9 for tenths. If the 600 Ohm output impedance is being used, the ATTENUATOR settings show the amount of attenuation, in dB, being applied to the basic output level of +20 dBm. Thus, for an output of +2 dBm at 600 Ohms impedance, the ATTENUATOR Switches would be set for 18.0 (10 on S8, 8 on S10 and Ø on S9). For units with serial numbers 133 and below, the unattenuated output level is +18 dBm; thus an attenuator setting of 18 would result in an output level of 0 dBm. Note that turning the switches clockwise increases the output level; turning them counterclockwise decreases the output level.

2.3 CONNECTORS

Front and rear panel connectors are identified in Figure 2-1.

Two audio output connectors, J7 (L OUT) and J8 (R OUT), are provided on the front panel. The mating connector for J7 and J8 is Switchcraft part no. 05CL3M, available from Switchcraft distributors or Potomac Instruments.

AC input (J9) and AC output connectors are provided on the rear panel, as well as a binding post for chassis ground.

2.4 FUSE LOCATION

A 1/8 amp, 250V fuse is accessible in a screw-type holder on the generator rear panel.

2.5 OPERATING PROCEDURES

2.5.1 Turn-On Procedure

To place the Audio Generator into operation, proceed as follows:

a. Check that the power switch is in the OFF position.

b. Check that the nameplate AC supply voltage rating agrees with the supply voltage source to be used; if so, connect the power cord.

c. Turn power switch to ON. The power indicator should light, indicating that power is applied to all circuits of the Audio Generator.

d. Set the TEST - OPERATE switch to TEST. Indicator DS2 should light to verify calibrated output level for frequencies below 20 kHz. Return switch to OPERATE. Audio Generator is now ready to use.

e. Set OUTPUT, OHMS, BAL/UNBAL as desired.

f. Set ATTENUATOR switches for desired output level.

g. Set the FREQ switch to the desired output signal or sine wave frequency range.

h. Connect signals.

2.5.2 Output Mode Selection

The setting of the OUTPUT selector switch, S7, will depend on the particular application and test set-up in which the generator is used. In general, differential gain and phase measurements can be made on stereo systems using the L+R output configuration and an analyzer such as the Potomac Instruments AA-51. The L-R output configuration provides opposite-phase signals which can be passed through the equipment under test and summed in a simple resistor network to provide a phase-sensitive output voltage; this technique is useful for stereo record head azimuth alignment. Any measurement involving the application of a signal alternately to left and right channels may be accomplished using the L and R switch positions.

2.6 APPLICATION NOTES

2.6.1 Distortion Measurements

Harmonic and intermodulation distortion measurements in which the right channel output is used are best made with the OUTPUT switch in the L+R position since the residual distortion due to the AG-51 is lowest in this mode. The residual distortion may also be slightly reduced by maintaining a minimum of 1-2 dB attenuation in the 1 dB-per-step attenuator.

2.6.2 Output Circuit and Termination

The AG-51 output circuit does not contain a transformer. To understand its operation, however, the output terminals (connector pins 1 and 3) may be thought of as being driven by a center-tapped transformer winding. In the UNBAL mode, pin 1, or one side of this imaginary transformer winding, is grounded to the chassis; in the BAL mode, the center-tap is grounded to the chassis. In both cases, the open-circuit voltage between pins 1 and 3 is the same, and the source impedance between pins 1 and 3 is 600 ohms or 150 ohms, as selected by the OHMS switch. Any load may be driven without affecting the AG-51's distortion, but the output level obtained by subtracting the attenuator dial settings from +20 dBm or 0 dBm is correct only for the terminations of 600 ohms or 150 ohms, respectively.

On the test cable supplied with the AG-51, connections are indicated by the color of the alligator clip insulators; red is pin 1, blue is pin 3 and black is the cable shield, which is grounded to the chassis.

The output voltage across any load resistor R_L can be calculated from the formulas:

$$e_o = .7746 \frac{2R_L}{600+R_L} \text{ antilog } \frac{P}{20} \qquad \text{(600 ohms)}$$

$$e_o = .387 \frac{2R_L}{150+R_L} \text{ antilog } \frac{P}{20} \qquad \text{(150 ohms)}$$

where P is the power in dBm obtained by subtracting the attenuator switch settings from 20 (600 ohms) or zero (150 ohms).

For unbalanced loads, use the UNBAL AG-51 mode. If the load has an input transformer with a floating primary winding, either UNBAL or BAL mode may be used. If the input transformer primary winding has a grounded center tap, however, the BAL mode must be used.

For 600 ohm operation the test cable capacitance reduces the AG-51 output at 200 kHz by 0.6 dB with no load, or 0.15 dB with a 600 ohm load. At 150 ohms this effect is negligible.

2.6.3 Stereo Tests

With the L OUT and R OUT terminals connected to the inputs of a stereo generator or exciter, various tests can be performed using the modes of operation selected by the OUTPUT switch. The L+R mode yields main carrier modulation without subcarrier modulation (L-R = zero), while the L-R mode yields subcarrier modulation without main carrier modulation (L+R = zero). These modes are useful for modulator adjustments and for main/sub and sub/main crosstalk measurements. The L (R = zero) and R (L = zero) modes are useful for crosstalk and separation measurements.

2.6.4 Equipment Performance Measurements

Equipment Performance Measurements (EPM) to determine a broadcast facility's audio performance are required by the FCC and described in various sections of the FCC Rules, Part 73. These tests are commonly referred to as an "Audio Proof" although the FCC prefers to use the term "Proof" only for measurements to verify the performance of AM directional antenna systems. Useful guides to these EPMs for AM and FM stations have been prepared by Broadcast Engineering Magazine and are available from Broadcast Engineering, P.O. Box 12901, Overland Park, Kansas 66212.

2.6.5 Grounding

When the AG-51 power cord is plugged in, the chassis is connected directly to the AC power neutral line through the third wire of the power cord. This may or may not provide minimum power-frequency (hum) pickup in the signal circuit. Often the AG-51 chassis must be grounded solidly to the chassis of the equipment it is driving to obtain minimum hum pickup. This connection may be made using the shield of the test cable, which is connected to the AG-51 chassis, or by using a separate wire on the ground binding post on the rear of the AG-51. It may also be done by using a three-prong-to-two-prong adapter for the AG-51 power cord, and connecting the ground pigtail of the adapter to the chassis of the equipment being driven. If one of the first two methods are used the adapter may still be required to break the power cord ground connection to obtain minimum hum. In any case, observe the following warning:

> **WARNING**
>
> Be certain that the chassis of the AG-51 is solidly grounded to an earth-grounded point before using an adapter or other means to break the power cord ground connection; otherwise, a safety hazard may exist.

SECTION 3
THEORY OF OPERATION

3.1 OVERALL DESCRIPTION

The electrical circuits of the Model AG-51 are divided into the sections shown in the block diagram of Fig. 3.1. Briefly, the operation is as follows:

a. A Wien bridge oscillator (A6) capacitively tuned over a 10:1 range plus decade switching provides the variable sine wave source from 20 Hz to 200 kHz.

b. The IM signal consists of 60 Hz and 7 kHz mixed in a 4:1 ratio. These two frequencies are generated by fixed tuned Wien bridge oscillators (A4).

c. A fixed tuned Wien bridge oscillator generates the 3.15 kHz frequency (A4).

d. These sources provide the optional inputs to the POWER AMPLIFIER (A2) and INVERTER (A3) through step attenuators S8, S9 and S10.

e. In TEST mode, the attenuators are bypassed by S4; the maximum voltage output of the INVERTER is monitored by a window comparator (A5) and, if correct, lights the LED indicator.

f. Output signal conditions are controlled by three switches (S5, S6, S7) which establish L and R, BAL or UNBAL, 600 or 150 ohm impedance at the two output connectors.

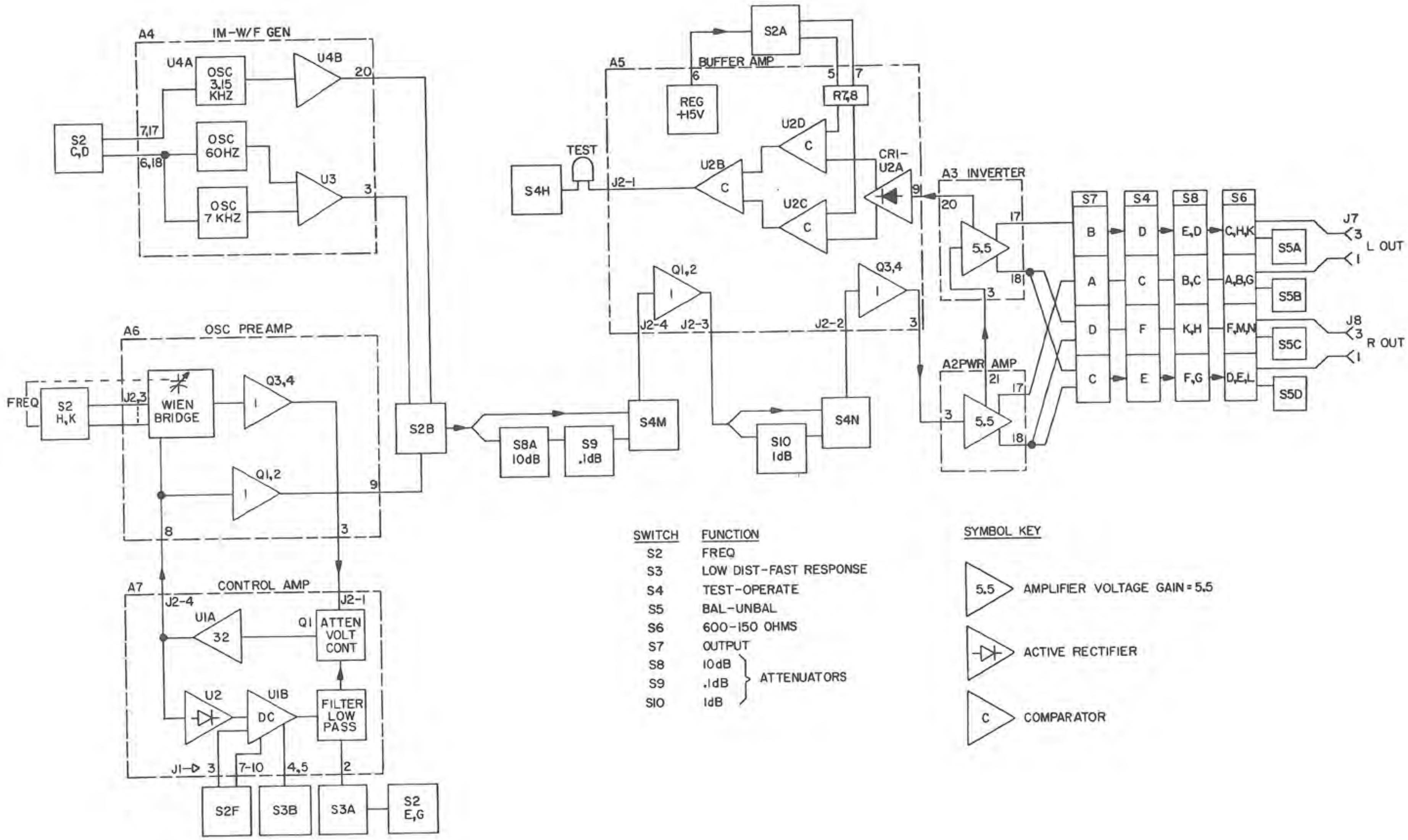
g. An additional stage of attenuation, part of S8, is placed in the right and left channel output lines. The four switchable attenuator stages allow adjustment of the output level in 0.1 dB, 1 dB and 10 dB steps from a maximum of +18 dBm to a minimum of –99.9 dBm (150 ohm position).

3.2 DETAILED THEORY OF OPERATION

3.2.1 Variable Frequency Wien Bridge Oscillator (Ref. Figure 4.14, A6; Figure 4.16, A7)

The Wien bridge oscillator circuit is located on A6. Oscillator frequency is determined by C1, a dual variable capacitor, in conjunction with decade resistors switched by S2. C1 is used to vary frequency over a 10:1 range, while the resistors are switched in four decades to cover the tuning range of 20 Hz to 200 kHz.

Q1, a JFET, in combination with Q2, a PNP transistor, provides impedance conversion to isolate the high impedance of the Wien bridge from the following circuits. One side of the bridge is grounded and the other side must be provided with an in-phase signal with sufficient gain to overcome the bridge losses in order to oscillate. This gain is provided by voltage amplifier U1A on A7. The output of U1A is full wave rectified by CR1, CR2 and U2. In addition, U1A drives the bridge with the necessary in-phase signal. U1B compares the rectified signal to a dc reference voltage, integrates the difference, and controls Q1, a voltage dependent resistor. Q1, in conjunction with R4, is an attenuator which adjusts the effective gain of U1A to just offset the bridge losses resulting in sine wave oscillation. The integration constant is switched to optimize loop stability, distortion, or response time. The output of U1A is low pass filtered by active filter Q3 and Q4 (A6) and provided at a low impedance as the oscillator signal to the power amplifier.



SWITCH	FUNCTION
S2	FREQ
S3	LOW DIST-FAST RESPONSE
S4	TEST-OPERATE
S5	BAL-UNBAL
S6	600-150 OHMS
S7	OUTPUT
S8	10dB (ATTENUATORS)
S9	.1dB (ATTENUATORS)
S10	1dB (ATTENUATORS)

Figure 3.1 AG-51 Block Diagram

3.2.2 Fixed Frequency Wien Bridge Oscillators (Ref. Figure 4.10, A4)

U1, U2 and U4A are operational amplifiers configured as Wien bridge oscillators. Negative feedback is controlled by means of an incandescent lamp (LR1, LR2, LR3) and a potentiometer (R3, R9, R18). The potentiometers are adjusted for a specific output signal and the lamp compensates for circuit variations to maintain the preset amplitude. RC values in the non-inverting amplifier input set the operating frequency in accordance with the formula: $f = 1 / 2 \pi RC$. The IM signal is generated by adding 60 Hz (U2) and 7 kHz (U1) in a 4:1 ratio by summing amplifier U3. TP3 allows overall test set calibration of intermodulation distortion. U4B buffers the 3.15 kHz signal used for wow and flutter reference.

3.2.3 Power Amplifier (Ref. Figure 4.8, A2, A3)

The input signal is applied to the base of Q1, part of differential amplifier Q1 and Q2. Q3, a PNP transistor, provides additional voltage gain. Q4 is utilized as a constant current source and provides very high impedance collector load for Q3. Q5 and Q6 are complementary power transistors required to drive the output load. Forward bias provided by CR1 eliminates cross-over distortion. Negative feedback via R2 to the base of Q1 sets the closed loop gain to 5.5. Power supply voltages of ±30V are necessary to provide the required output power of +20 dBm* into a 600-ohm resistive load. Q5 and Q6 employ heat sinks to prevent excessive junction temperatures. An identical amplifier driven by voltage divider R14 and R15 permits balanced operation.

3.2.4 Output Monitor (Ref. Figure 4.12, A5)

Since the two output amplifiers operate in series, it is possible to monitor the overall operation by rectifying the inverter output by CR1. U2A filters the ripple frequency and furnishes a low impedance source for the window comparator U2D and U2C. The window comparator is furnished an independent and stable dc reference signal by voltage regulator U1. The window bracket is ±0.5 dB and is adjusted for sine wave or IM signals by potentiometers R7 and R8. U2B provides sufficient current to light the LED indicator on the front panel. The monitor check is made at maximum voltage output of the amplifiers and is enabled by the TEST/OPERATE switch, S4, which also removes the attenuators from the amplifier input circuit. This is necessary as the amplifier output voltage is normally a function of the ATTENUATOR setting. A5 contains Q1, Q2, Q3 and Q4, which serve as unity gain buffer amplifiers to isolate circuit loading from the attenuators (Ref. Figure 3.1).

3.2.5 Output Attenuation Switching (Ref. Figure 4.17)

Output attenuation is provided by two groups of switchable resistor networks; one which acts on the oscillator output signal before it is applied to the power amps, and another acting on the output of the power amps. On the input side of the power amps, the finest degree of attenuation (.1 dB increments) is controlled by S9. S9 is a switchable resistor network through which the selected oscillator output signal must pass before it is applied to amplifier stage Q1/Q2 in the A5 module. The 1 dB step attenuator network, S10, acts on the output of Q1/Q2 and provides the input to amplifier stage Q3/Q4, which in turn drives the power amp A2. The 10 dB step attenuator network, S8, acts at two points in the circuit. The 60 through 90 dB steps act on the input to S9 and Q1/Q2, while the 0 through 50 dB steps act on the output of the power amps A2 and A3.

3.2.6 Output Mode Switching

Output mode is selected by OUTPUT switch S7. In the L or R position, S7 connects the output of power amp A2 to either the L or R output jack (pin 3) while grounding the unused output. In the L+R

*+18 dBm for units with serial numbers 133 and below.

position, S7 connects the output of A2 to pin 3 of both L and R output jacks. In the L-R position, the A2 output is applied to the L output jack, and the A3, or inverse output, is applied to the R output jack on pin 3.

When the BAL - UNBAL switch, S5, is in the UNBAL position, a ground will be applied to pin 1 of the L and R output jacks. When S5 is in the BAL position, this ground is removed from pin 1 and a signal determined by the position of S7 is applied. The signal applied to pin 1 will always be the inverse of the signal applied to pin 3, e.g., if the output of A2 is applied to pin 3, the output of A3 will be applied to pin 1. This provides an output across pins 1 and 3 which is balanced with respect to ground.

Output impedance is determined by S6, which selects an output circuit path either directly from S8, giving 600 Ohm impedance, or through a resistor network which provides a 150 Ohm impedance.

3.2.7 Test/Operate Switching

The TEST/OPERATE switch, S4, disconnects the generator output and supplies a ground to the output impedance network, S6, when placed in the TEST position. It also provides a signal path bypassing the attenuator networks (S8, S9, S10) on the input side of the power amps when in the TEST position, so that the maximum output signal level is available to the output level monitor circuits in the A5 module.

3.2.8 Regulated Power Supply (Ref. Figure 4.6, A1)

A center tapped transformer (Ref. Figure 4.17) converts the 115 V ac line voltage to 48 Vrms. This secondary voltage is applied to CR1 and CR2 which provide full wave rectification. Capacitor C1 filters the positive 30-volt output. R1 is a bleeder resistor, while R12 provides current to the LED power-on indicator. The decoupling network of R2 and C3 provides input dc to integrated regulator circuit U1. A positive regulated voltage of 15 volts is provided for all analyzer circuits. CR7 prevents negative latch-up. The variable voltage divider circuit composed of R3, R4 and R5 provides an adjustable reference voltage for U1, allowing adjustment of the supply output voltage. C7 filters the reference voltage to ensure stability. The regulated negative 15 volts is derived by an identical circuit except for polarity of components.

SECTION 4
MAINTENANCE

4.1 GENERAL

The troubleshooting procedures given in this section should enable a qualified technician to determine the specific component or adjustment responsible for a malfunction. Replacement of components in a module or performance of alignment procedures should not be attempted unless the equipment specified for performance of the module alignment is available. If there is any doubt as to the advisability of a maintenance operation, factory consultation or service should be sought (REF. page ii).

4.2 PERIODIC MAINTENANCE

The AG-51 has no periodic maintenance requirements.

4.3 ALIGNMENT PROCEDURE/PERFORMANCE TEST

The following procedure may be used to perform alignment of the AG-51 and to verify generator performance. Alignment should be attempted only if accurate test equipment of the type specified, and qualified personnel, are available.

Test and adjustment points may be located by referring to Figure 4.3 or to the appropriate component location diagram.

4.3.1 Power Supply

a. Adjust R5 for +15 VDC ±20 mV at Pin 6.

b. Adjust R6 for –15 VDC ±20 mV at Pin 18.

c. Check for approximately +30 VDC ±1 VDC at Pin 8.

d. Check for approximately –30 VDC ±1 VDC at Pin 16.

4.3.2 Oscillator Pre-Amplifier, A6

The following procedures require the use of a calibrated frequency counter or other means for accurate frequency measurement (±3%, min.).

FRONT PANEL CONTROL SETTINGS	
POWER	ON
FREQ	X100 (20 kHz)
LOW DIST/FAST RESPONSE	LOW DIST
OUTPUT	L + R
BAL/UNBAL	UNBAL
OHMS	600
TEST/OPERATE	OPERATE
ATTEN	

ADJUST	CHECK	VALUE
C3	Gen. output	20 kHz

a. Monitor the generator output using the frequency counter. Set the generator FREQ dial exactly at 200. Adjust C3 on A6 for a reading of 20,000 Hz on the frequency counter.

b. Turn the generator FREQ dial to various intermediate settings and check that generator output frequency is within 3% of the dial setting.

In rare instances, it may be necessary to adjust the mechanical alignment of the FREQ dial in order to achieve accurate frequency tracking. This procedure should not be attempted unless all other possible sources of error have been eliminated and personnel are available with experience in this type of adjustment. The procedure is as follows:

a. Set the generator FREQ switch to X100 and set the output frequency carefully at 2 kHz.

b. Loosen the two set screws holding the frequency dial coupler to the shaft of the variable capacitor C1 and set the dial at 20; see that frequency remains 2000 Hz. Adjust the variable capacitor position for a reading of 2000.0 Hz on the frequency counter.

c. Tighten screws on the FREQ dial coupler and proceed with the regular frequency alignment procedure described above. Steps (b) and (c) may have to be repeated on other ranges and a best compromise reached in conjunction with Step (a).

4.3.3 Control Amplifier Board, A7

The following procedures require the use of an accurate RMS voltmeter (±3% min.), a 600 ohm load (1%) and an accurate frequency counter.

FRONT PANEL CONTROL SETTINGS	
POWER	ON
FREQ	As required
LOW DIST/FAST RESPONSE	LOW DIST
OUTPUT	L + R
BAL/UNBAL	UNBAL
OHMS	600
TEST/OPERATE	TEST
ATTEN	Ø

ADJUST	CHECK	VALUE
R20	Gen. output	20 dBm
R2	J1-2 (R22)	–2 VDC
C11	Gen. output	20 dBm

a. Monitor the generator output using an RMS voltmeter and 600 ohm load. Set generator frequency to 1 kHz. Adjust R20 on the A7 module for an output level of +20 dBm*.

b. Set generator frequency to 200 kHz. Using a DC voltmeter, monitor the voltage at pin J1-2 of A7 or at either end of R22 and adjust R2 for a reading of –1 VDC. This voltage should vary approximately –1V to –3V over the whole frequency range. R2 may be adjusted in some cases for minimum distortion.

c. Set FREQ to X1000 and dial to 200 and adjust C11 on the A7 module for a generator frequency of 200 kHz.

*+18 dBm for units with serial numbers 133 and below.

4.3.4 Output Monitor, Buffer Amplifier, A5

FRONT PANEL CONTROL SETTINGS	
POWER	ON
FREQ	3.15 kHz
LOW DIST/FAST RESPONSE	LOW DIST
OUTPUT	L + R
BAL/UNBAL	UNBAL
OHMS	600
TEST/OPERATE	TEST
ATTEN	∅

ADJUST	CHECK	VALUE
R7	TEST indicator	ON
R8	TEST indicator	ON

a. Insure that generator output level is correct, as in 4.3.5. Adjust R7 for illumination of the TEST indicator. After determining the range of R7 adjustment over which the indicator will illuminate, set R7 to the center of this range. Check to see that the TEST indicator illuminates in all modes except IM.

b. Turn the frequency selector switch to the IM SIG position and adjust R8 to the center of the range over which illumination of the TEST indicator occurs, as was done for R7.

c. Select various generator frequencies and check proper operation of the TEST indicator.

4.3.5 IM/WF Signal Generator, A4

The following procedures require the use of a calibrated frequency counter or other means for accurate frequency measurement (±3% min.) as well as an accurate RMS voltmeter (±3% min.) and 600 ohm load (1% resistor).

FRONT PANEL CONTROL SETTINGS	
POWER	ON
FREQ	3.15 kHz or IM SIG
LOW DIST/FAST RESPONSE	
OUTPUT	L + R
BAL/UNBAL	UNBAL
OHMS	600
TEST/OPERATE	TEST
ATTEN	∅

ADJUST	CHECK	VALUE
R21	TP-4 (red)	3.15 kHz
R18	Gen. output	7.75 VRMS
R9	Gen. output	6.20 VRMS
R12	Gen. output	60 Hz
R3	Gen. output	1.55 VRMS
R6	Gen. output	7 kHz

a. Adjust R21 for a reading of 3.15 kHz on the frequency counter, measured at TP-4.

b. Monitor the generator output as in paragraph 4.3.3. Adjust R18 for an output level of +20 dBm*.

c. Repeat steps a and b until no further improvement can be obtained.

d. Short the 7 kHz output to ground at TP1; adjust R9 for a generator output level (60 Hz) of 6.20 VRMS across 600 Ohm load. Adjust R12 for a generator output frequency of 60 Hz. Recheck the adjustment of R9 and R12.

e. Short the 60 Hz output to ground at TP2; adjust R3 for a generator output level (7 kHz) of 1.55 VRMS across 600 Ohm load. Adjust R6 for a generator output frequency of 7 kHz. Recheck the adjustment of R9 and R12.

*+18 dBm for units with serial numbers 133 and below.

4.3.6 AG-51 Overall Performance Test

Table 4-1 may be followed to perform a final test of AG-51 performance following repair or alignment, or to verify normal operation. Measurement of generator output parameters should be made at the L OUT connector across a 600 ohm load, unless otherwise specified. BAL output mode should be used for all measurements except where otherwise specified.

TABLE 4.1. AG-51 PERFORMANCE TEST

CHECK	VALUE
1. Output frequency	
X1 position	
20 Hz	20 Hz ±3%
100 Hz	100 Hz ±3%
200 Hz	200 Hz ±3%
X10 position	
200 Hz	200 Hz ±3%
1000 Hz	1000 Hz ±3%
2000 Hz	2000 Hz ±3%
X100 position	
2 kHz	2 kHz ±3%
10 kHz	10 kHz ±3%
20 kHz	20 kHz ±3%
X1000 position	
20 kHz	20 kHz ±3%
100 kHz	100 kHz ±3%
200 kHz	200 kHz ±3%
2. IM signal amplitude ratio (IM SIG position)	4 to 1 ratio
3. Output frequency in 3.15 kHz position	3.15 kHz ±3%
4. Max. output level (600 ohm)	
20 Hz to 50 kHz	+20 dBm ±.2 dBm*
200 kHz	+20 dBm, ±.5 dBm
3.15 kHz position	+20 dBm*
5. Max. output level (150 ohm)	
20 Hz to 50 kHz	0 dBm ±.2 dBm
200 kHz	0 dBm, ±.5 dBm
3.15 kHz position	0 dBm ±.1 dBm
6. Attenuator accuracy	±.2 dB max.
7. L, R, L+R, L-R outputs in both BAL and UNBAL modes; check for signal presence, proper phase.	

*+18 dBm for units with serial numbers 133 and below.

TABLE 4.1. AG-51 PERFORMANCE TEST (Cont.)

CHECK	VALUE	
	LOW DIST	FAST RESPONSE
9. Distortion		
X1 position		
20 Hz	.08% max.	2% max.
50 Hz	.05% max.	1% max.
100 Hz	.05% max.	1% max.
200 Hz	.05% max.	1% max.
X10 position		
200 Hz	.05% max.	1% max.
1000 Hz	.05% max.	1% max.
2000 Hz	.05% max.	1% max.
X100 position		
2 kHz	.05% max.	1% max.
7.5 kHz	.05% max.	1% max.
10 kHz	.08% max.	2% max.
20 kHz	.08% max.	2% max.
X1000 position		
20 kHz	.08% max.	2% max.
50 kHz	.2% max.	2% max.
10. Output level in TEST mode. FREQ = 200 kHz (hum, noise, residual output)	30 - 50 μv typical	

4.4 TROUBLESHOOTING, GENERAL

The troubleshooting charts provided in Figures 4.1 and 4.2 may be used to isolate AG-51 malfunctions to a circuit card or switch network. Figure 4.1 should be used for malfunctions involving improper self-test indication, distortion or improper level at the generator output, while Figure 4.2 should be used for frequency malfunctions.

Once a malfunction has been isolated to a specific board or switch, reference should then be made to the detailed troubleshooting information for that circuit in Section 4.5.

The following notes and suggestions will be helpful in troubleshooting the AG-51:

- For checking plug-in boards in operation, an extender card is available from Potomac Instruments for $20.00.

- Always check power supply voltages before checking other circuits.

- To check signal voltages, an oscilloscope with accurate voltage calibration is recommended, as the scope will show oscillations, distortion, hum and other effects not shown by meter readings.

- In case of circuit failure, feel board for hot components. Most run cool except on A1, A2 and A3.

- Use the AG-51 Block Diagram, Figure 3.1, to follow signal paths through modules and switches to the outputs; it will serve as a guide when tracing the actual circuits on the various schematic diagrams.
- If the correct signal appears at a module output but not at the input of the next module, switch contact failure is a likely cause. The switch circuits to check can be identified on the block diagram and then traced out using the schematic diagram.

4.5 CIRCUIT MODULE TROUBLESHOOTING

4.5.1 General

All circuit boards and test points may be accessed after removal of the top and bottom covers. The covers are attached by screws and the removal procedure is self-evident. For the location of circuit modules and test points, refer to Figure 4.3. Test points may be accessed without removing circuit boards from the chassis; however, component voltage measurements require the use of a module extender board for those modules on the top of the chassis. IC and transistor pin voltages are listed in Tables 4-2 through 4-6; these readings are taken in L+R, BAL mode with no load. Voltage readings are DC voltages read with a voltmeter of 10 Megohm input impedance, with a 22K series resistor at the probe to isolate the probe capacitance from the circuit.

4.5.2 Power Supply A1

If the +15V regulated output cannot be adjusted to exactly +15V, U1 or associated components may be faulty or the unregulated voltage at pin 8 may be low or have excessive ripple. If the unregulated voltage is faulty, check the filter components C1, R2, C3, CR2 and the transformer secondary voltage.

If the −15V regulated output cannot be adjusted to exactly −15V, U2 or associated components may be faulty or the unregulated voltage at pin 8 may be low or have excessive ripple. If the unregulated voltage is faulty, check the filter components C2, R10, C4, CR3, CR4 and the transformer secondary voltage.

4.5.3 Power Amplifier/Inverter A2, A3

Compare the output at board pin 21 with the input at pin 31 using an oscilloscope. The two waveforms should be identical, of approximately equal voltage. If they are not, check DC voltages on all transistor pins to locate the problem. If the oscilloscope check is normal, check the signal at pins 17, 18 and 20. In L+R, BAL, 150 ohm mode, pins 17 and 18 should show 21.9V pp, pin 20 should show 43.8V pp.

4.5.4 IM/WF Generator A4

4.5.4.1 IM Generator

Check for IM signal (7 kHz sine wave riding on 60 Hz sine wave) at board pin 3. If either or both output frequencies are missing, check U3, U2, U1, DS1 and DS2. Lamps DS1 and DS2 glow yellow in normal operation. The lamp's resistance should measure 20-40 ohms with power off.

4.5.4.2 WF Generator

If the 3.15 kHz signal is missing at pin 20, check U4 and DS3. DS3 does NOT glow visibly in normal operation; it should measure 20-40 ohms when cold.

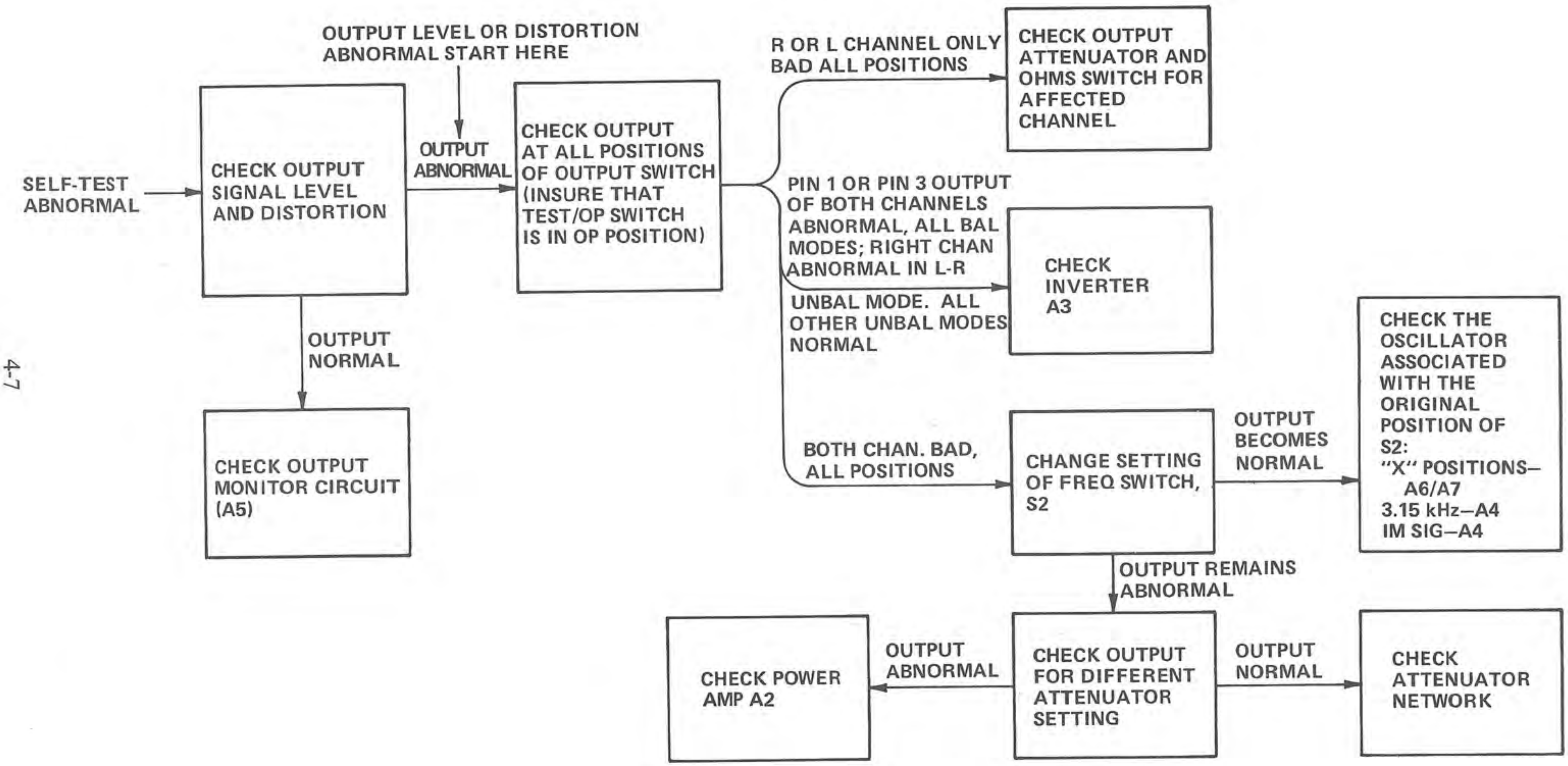


Figure 4.1. Troubleshooting Chart, Output Level/Distortion

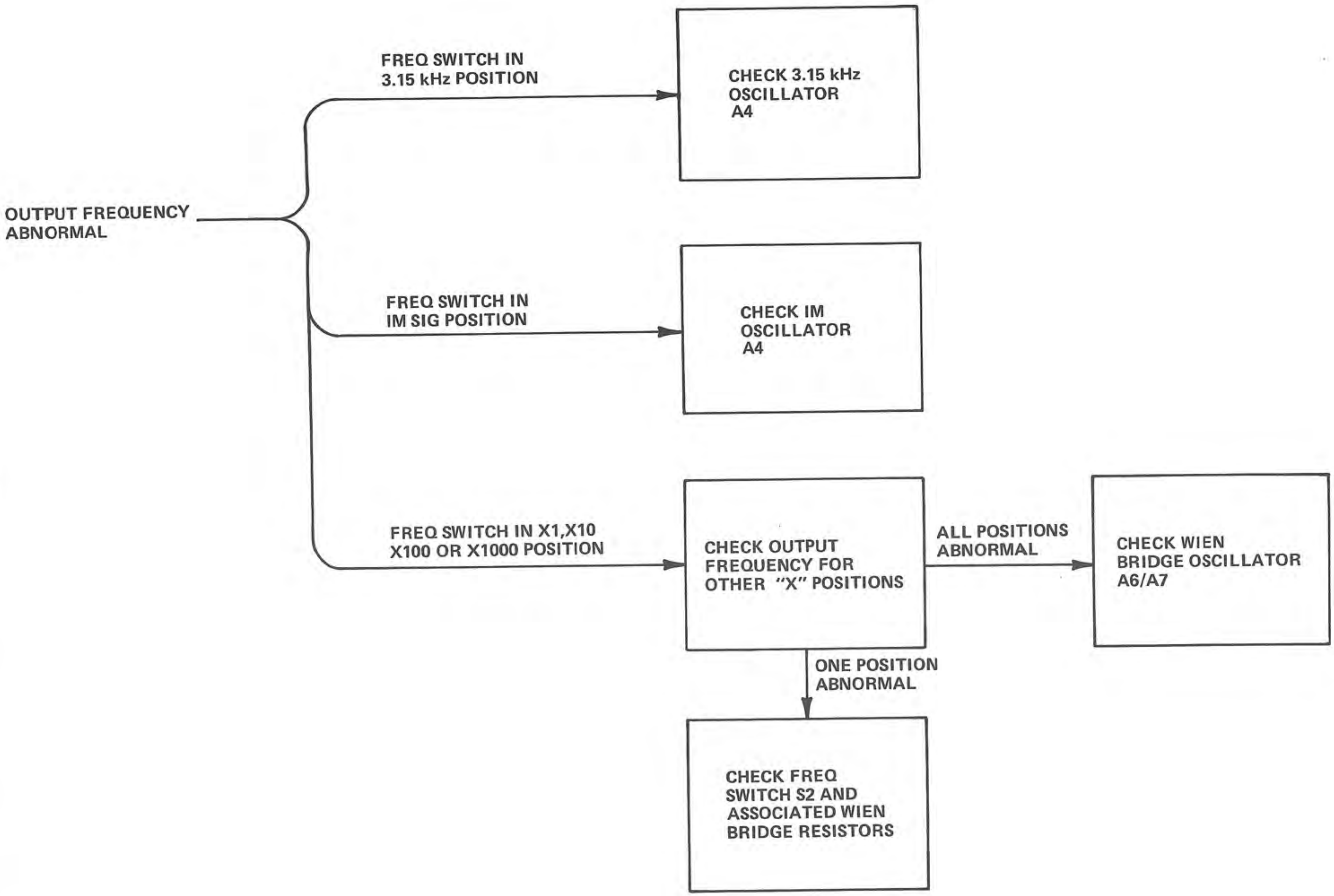


Figure 4.2. Generator Frequency Troubleshooting Chart.

4.5.5 Buffer Monitor A5

4.5.5.1 Buffers

Check for an output signal at J2-3 equal to the input signal at J2-4. If the output is faulty, check the voltages at all pins of Q1 and Q2; check associated components. Check for an output signal at J1-3 equal to the input signal at J2-2. If the output is faulty, check the voltages at all pins of Q3 and Q4; check associated components.

4.5.5.2 Output Monitor

Check for +30V at J1-8 and U1-1, and +15 ±.6 VDC at J1-6 and U1-2. If the +15V output of U1 is faulty, replace U1. In TEST mode, measure the DC voltage at J2-1. If this voltage is –15V, check lamp DS2 and switch assembly S4-K. If the voltage at J2-1 in TEST mode is +15V, check U2 pin voltages. If the voltage at J2-1 is incorrect, check for 44V pp input signal at J1-9.

4.5.6 Oscillator Preamp, A6 and Control Amp, A7

The A6 and A7 modules work together and must both be checked if the sine wave source fails.

If there is no output signal at pin J1-9 of A6, check for a signal at J1-8 and J1-3. If these are normal, check the pin voltages of Q3 and Q4. If the voltages measured at J1-9, J1-8 and J1-3 are normal, check Q1 and Q2 pin voltages and, on A7, check U1 and U2 pin voltages.

If oscillator output amplitude is normal but frequency is not correct, check the frequency determining resistors R1 through R8, R17 and R18.

TABLE 4.2. VOLTAGE READINGS, POWER AMP/INVERTER A2 AND A3

TRANSISTOR PIN VOLTAGES						
	Q1	Q2	Q3	Q4	Q5	Q6
PIN	2N3904	2N3904	92PU56/57	92PU06/07	2N5320	2N5322
E	–.6	–.6	+29.8	–29.1	+.4	–.4
B	0	0	+29.2	–28.4	+1.2	–1.1
C	+29.8	+29.2	+1.2	–1.1	+29.8	–30.2

TABLE 4.3. VOLTAGE READINGS, IM/WF GENERATOR A4

INTEGRATED CIRCUIT PIN VOLTAGES				
PIN NO.	U1	U2	U3	U4
1	NC	NC	NC	0
2	0	0	0	0
3	0	0	0	0
4	−13.9	−15	−15	−15
5	NC	NC	NC	0
6	0	0	0	0
7	+13.9	+15	+15	0
8	NC	NC	NC	+15
	FREQ AT IM SIG (U1–U3)			FREQ AT 3.15 kHz (U4)

TABLE 4.4. VOLTAGE READINGS, OUTPUT MONITOR/ ATTENUATOR BUFFER A5

INTEGRATED CIRCUIT PIN VOLTAGES		
PIN NO.	U1	U2
1	+31	+6.9
2	+15	0
3	0	0
4		+15
5		+.9
6		+.9
7		−15
8		−15
9		+6.9
10		+6.6
11		NC
12		+6.9
13		+7.2
14		−15

TRANSISTOR PIN VOLTAGES		
	Q1, Q3	Q2, Q4
PIN	MPS8097	2N3906
E	−.52	+14.9
B	0	+14.3
C	+14.3	−.52

All attenuators at 0 or OPERATE-TEST at TEST

TABLE 4.5. VOLTAGE READINGS, WEIN BRIDGE OSCILLATOR PRE AMP A6

TRANSISTOR PIN VOLTAGES				
	Q1	Q2	Q3	Q4
PIN	2N4416A	2N3906	2N4416	2N3906
E(1) (S)	+1.5– +3.5	+14.9	+1.5– +3.5	+14.9
B(2) (D)	+14.3	+14.3	+14.3	+14.3
C(3) (G)	0	+1.5– +3.5	–	+1.5– +3.5
(4)	0		0	

FREQ at X1
X10
X100
X1000

TABLE 4.6. VOLTAGE READINGS, CONTROL AMP A7

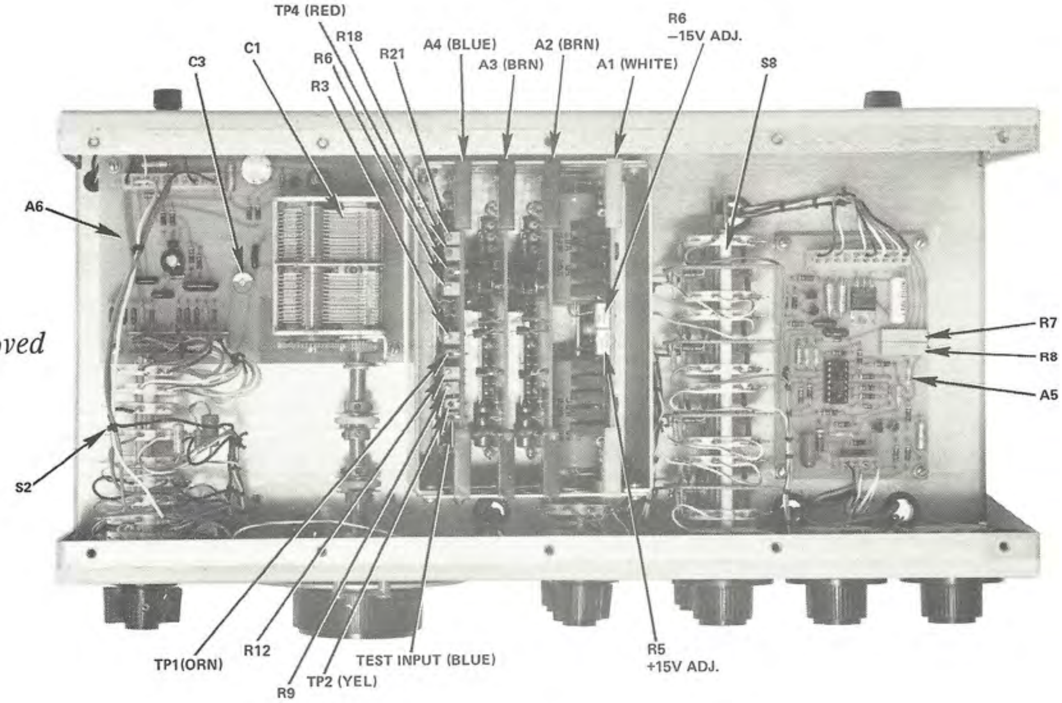
INTEGRATED CIRCUIT PIN VOLTAGES		
PIN NO.	U1	U2
1	0	NC
2	+13.8	−1.1
3	+11.5	−1.1
4	+11.5	−15
5	0	NC
6	0	−2.2
7	−15	+15
8	0	NC
9	0	
10	+11.5	
11	+11.5	
12	+13.8	
13	−2.0	
14	+15	

TRANSISTOR PIN VOLTAGES	
PIN	Q1 VCR4N
1	0
2	0
3	−1.0 to −3.0

TABLE 4.7. VOLTAGE READINGS, POWER SUPPLY A1

PIN	U1 LM317T	U2 7912
V_{IN}	+30	−30
ADJ	+13.75	−2.5 to −3.5
V_{OUT}	+15	−15

Top View
Cover Removed



Botton View
Cover Removed

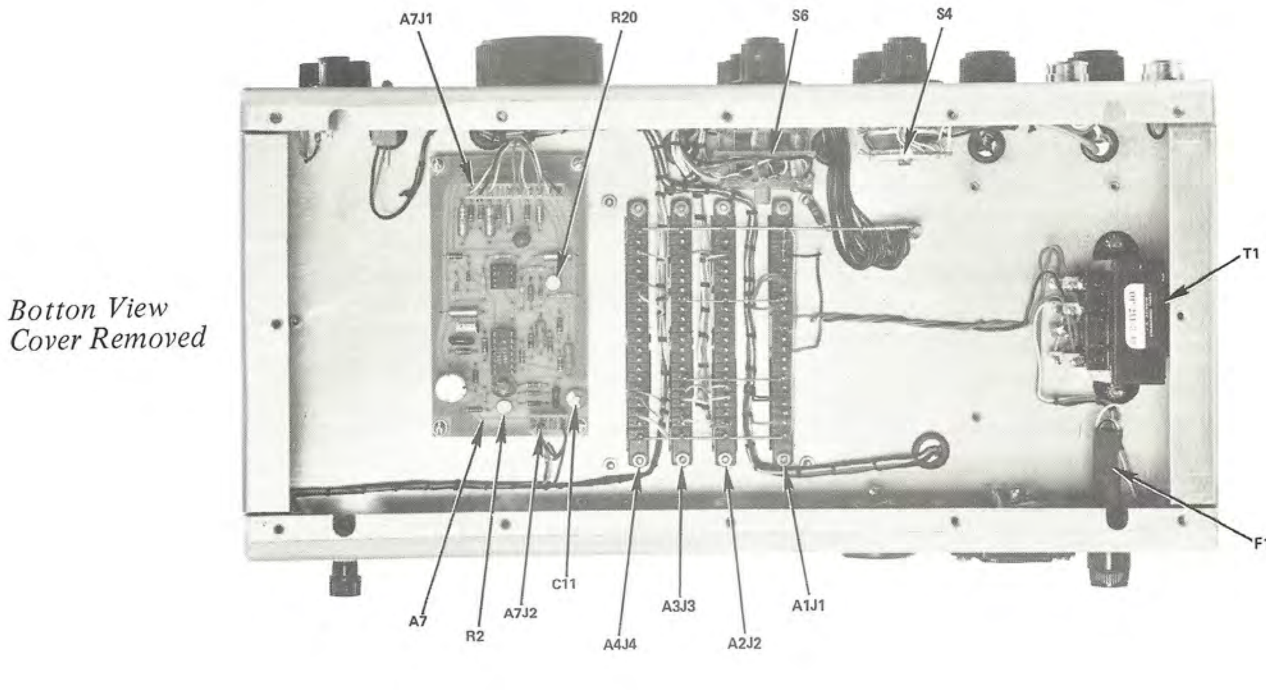


Figure 4.3. Circuit Module and Test Point Location, AG-51

Viewed From Rear

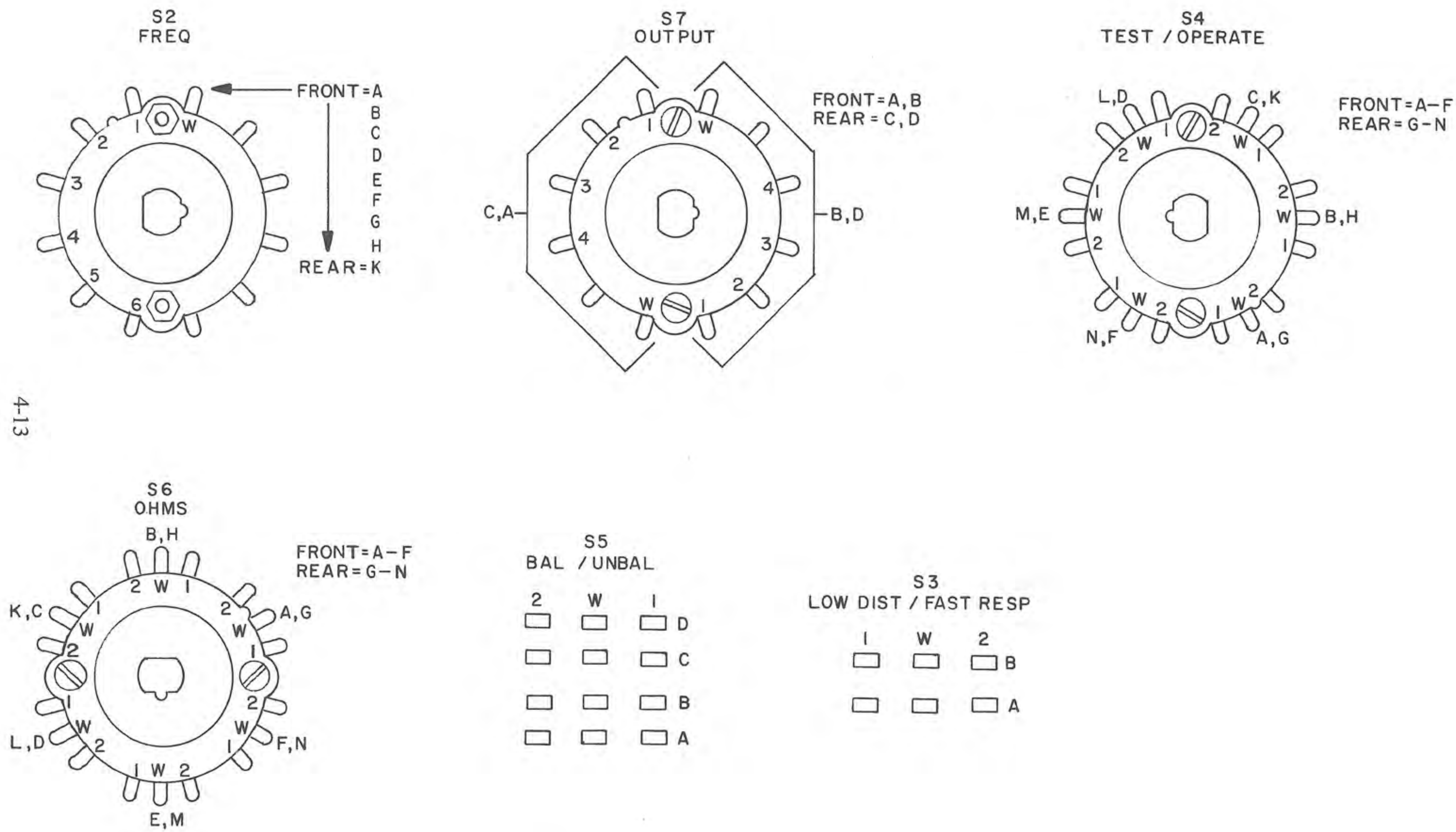


Figure 4.4. Switch Configuration

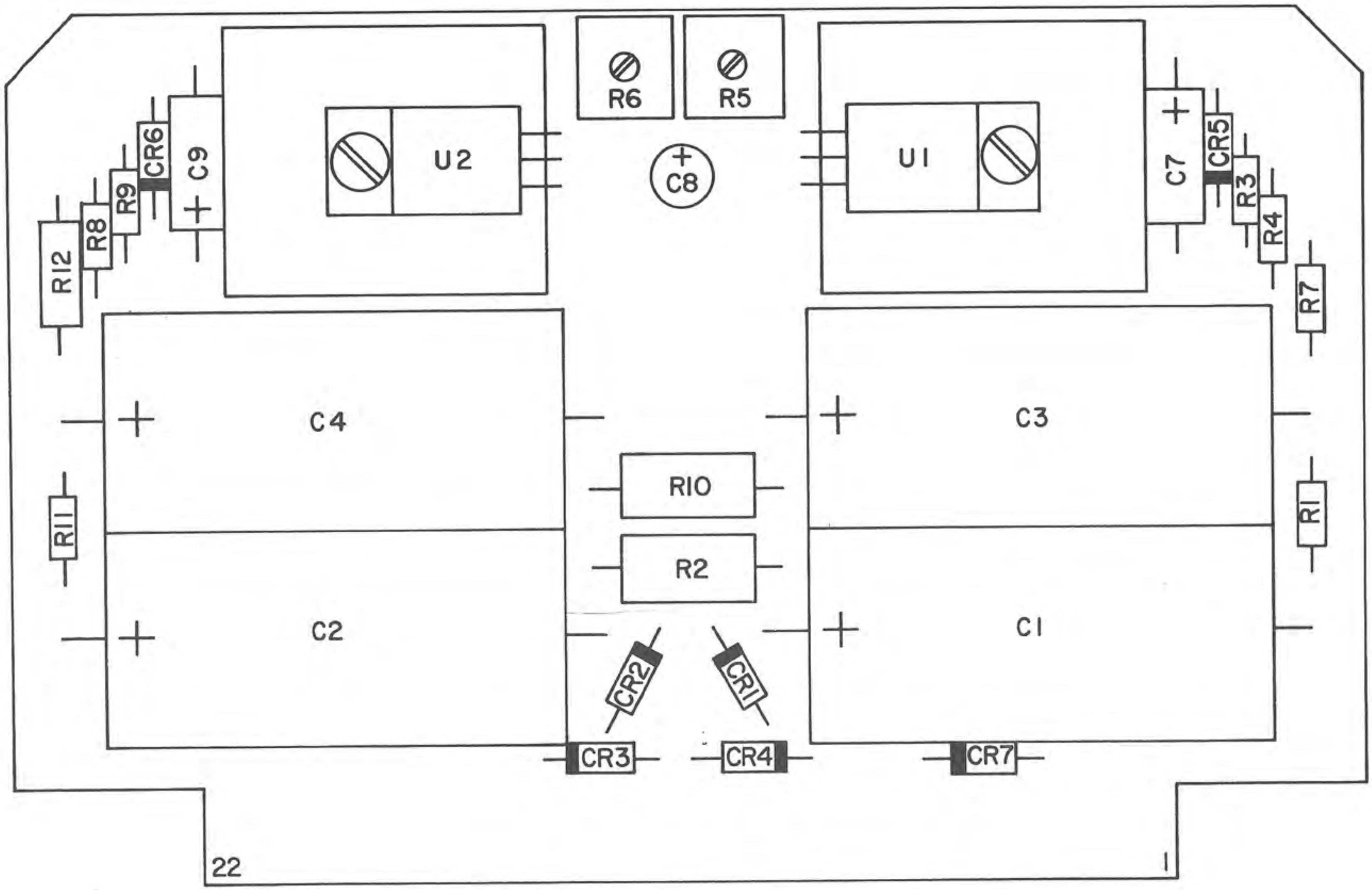
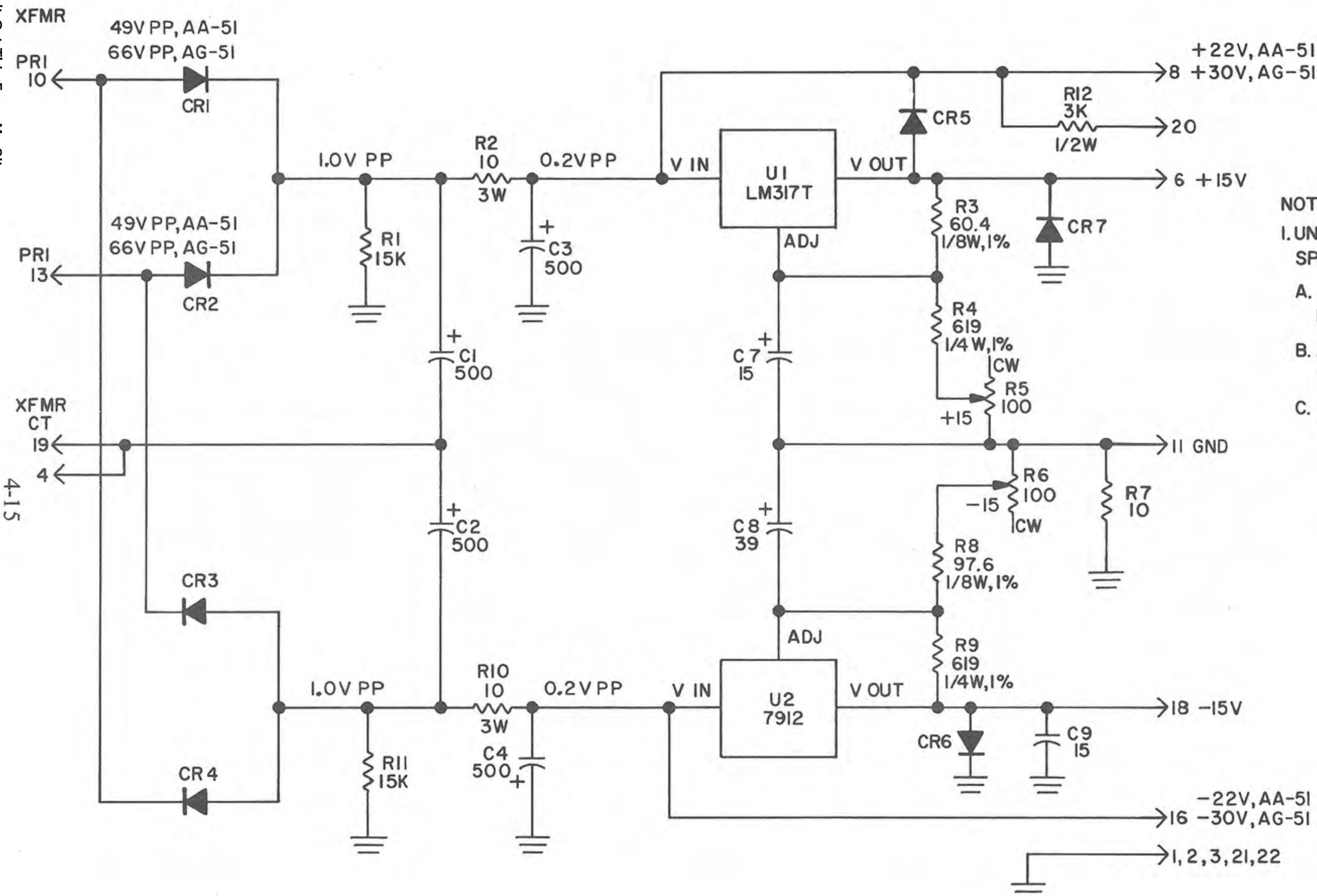


Figure 4.5. Component Location, Power Supply, A1



NOTES

1. UNLESS OTHERWISE SPECIFIED
   - A. ALL CAPACITORS IN MICROFARADS
   - B. ALL RESISTORS IN OHMS, 1/4 W, 5%
   - C. ALL DIODES 1N5059

Figure 4.6. Schematic Diagram, Power Supply, A1

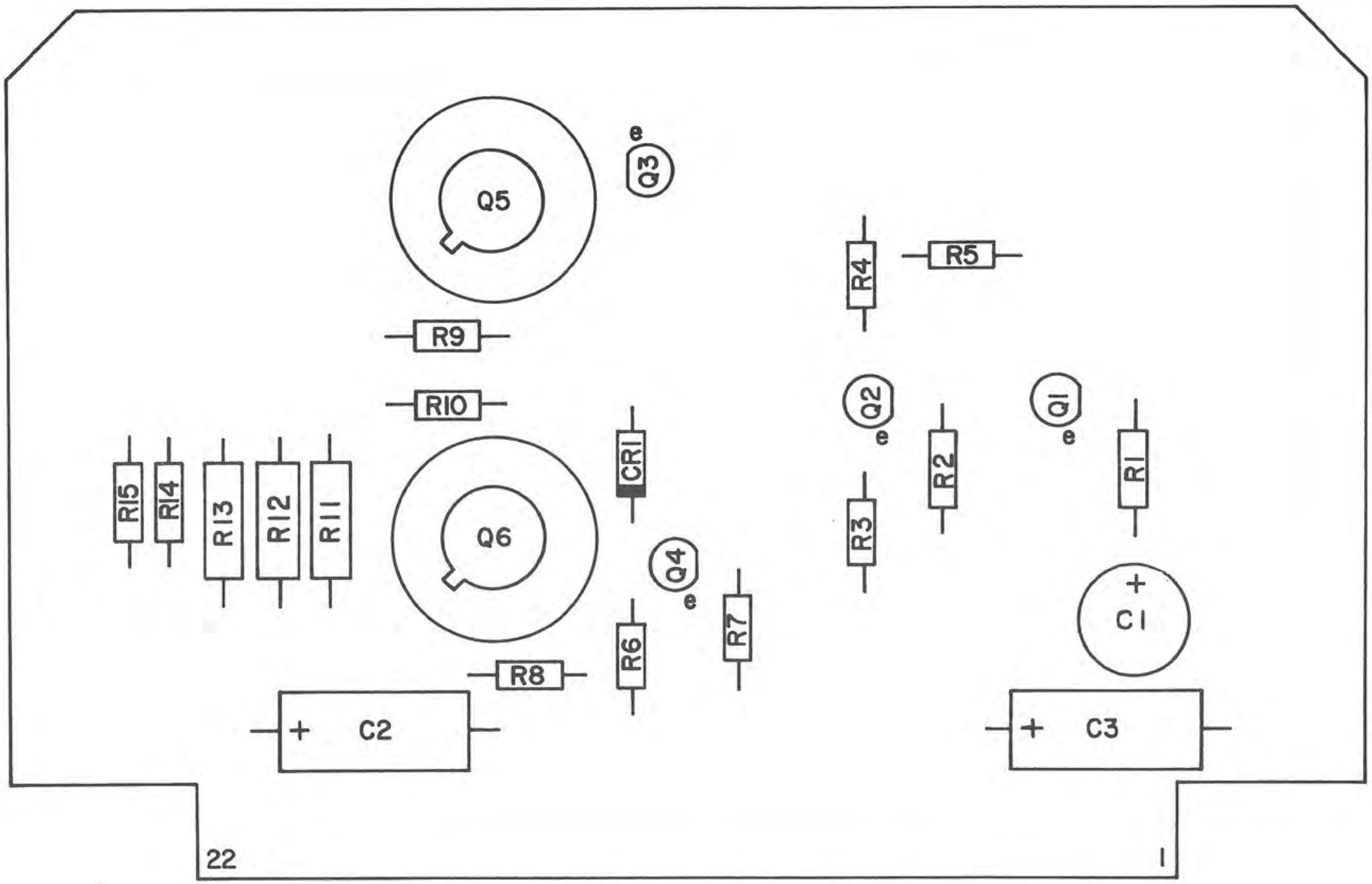


Figure 4.7. Component Location, Power Amp/Inverter, A2, A3

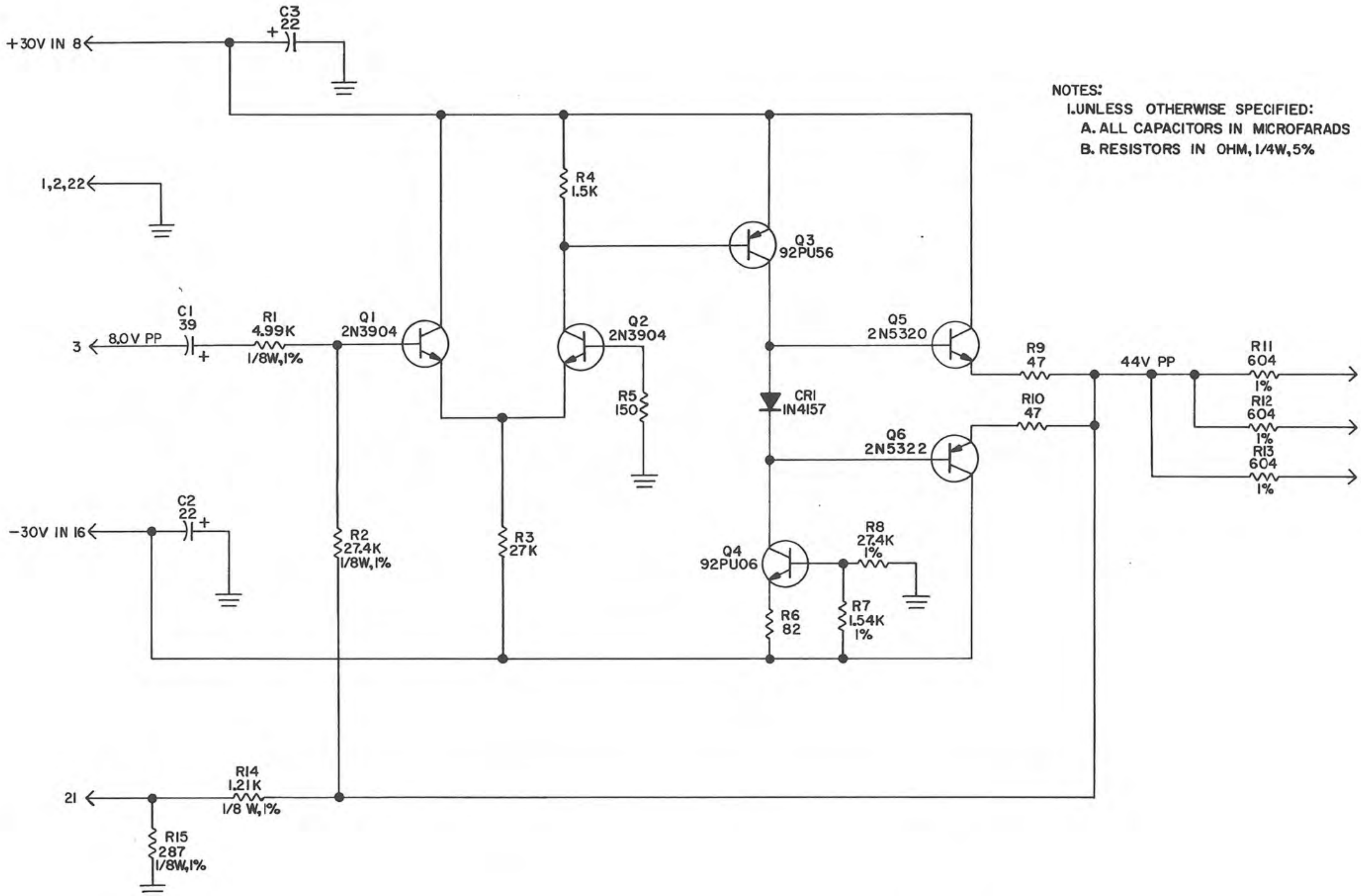


Figure 4.8. Schematic Diagram, Power Amp/Inverter, A2, A3

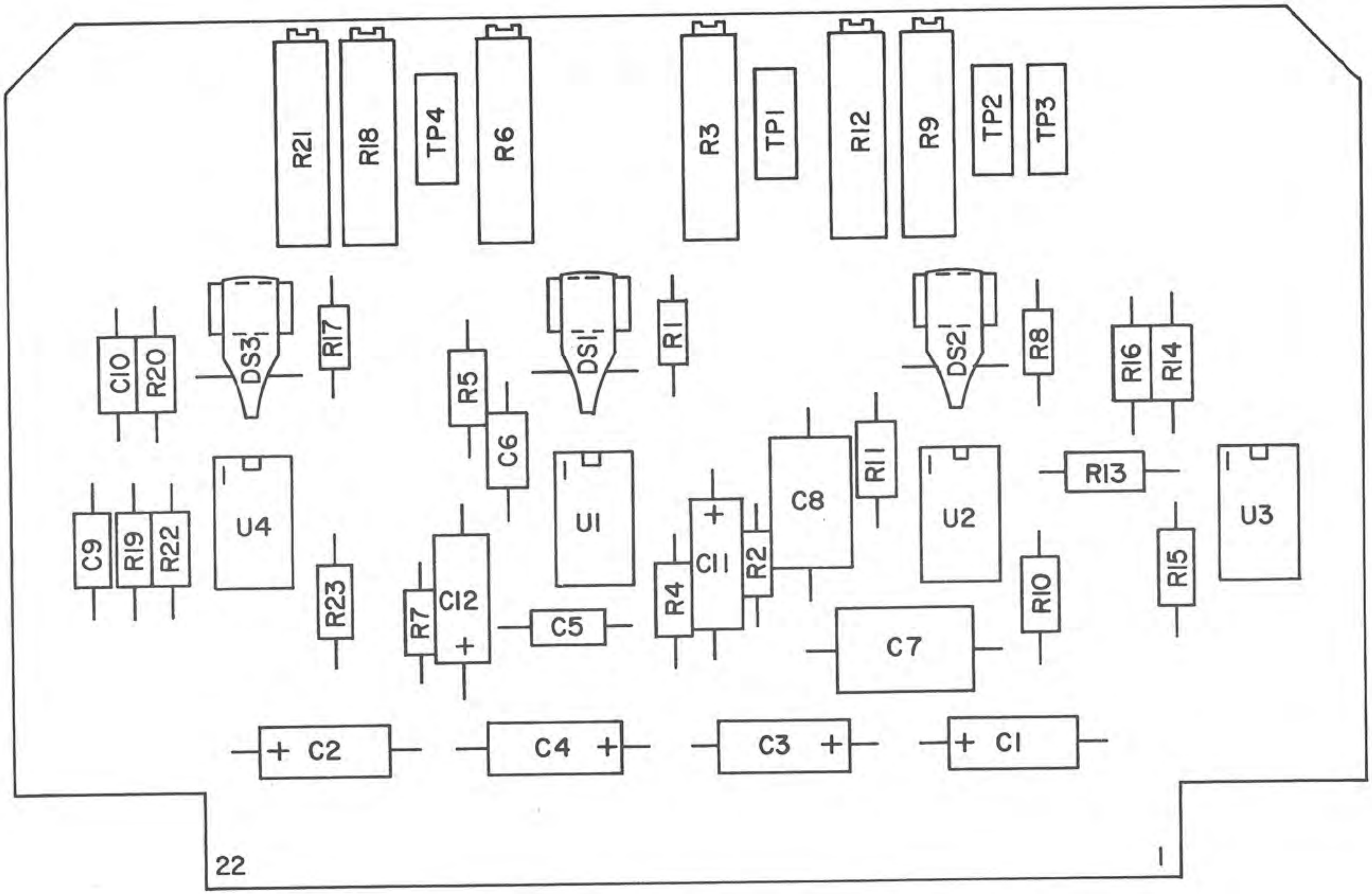


Figure 4.9. Component Location, IM/WF Signal Generator, A4

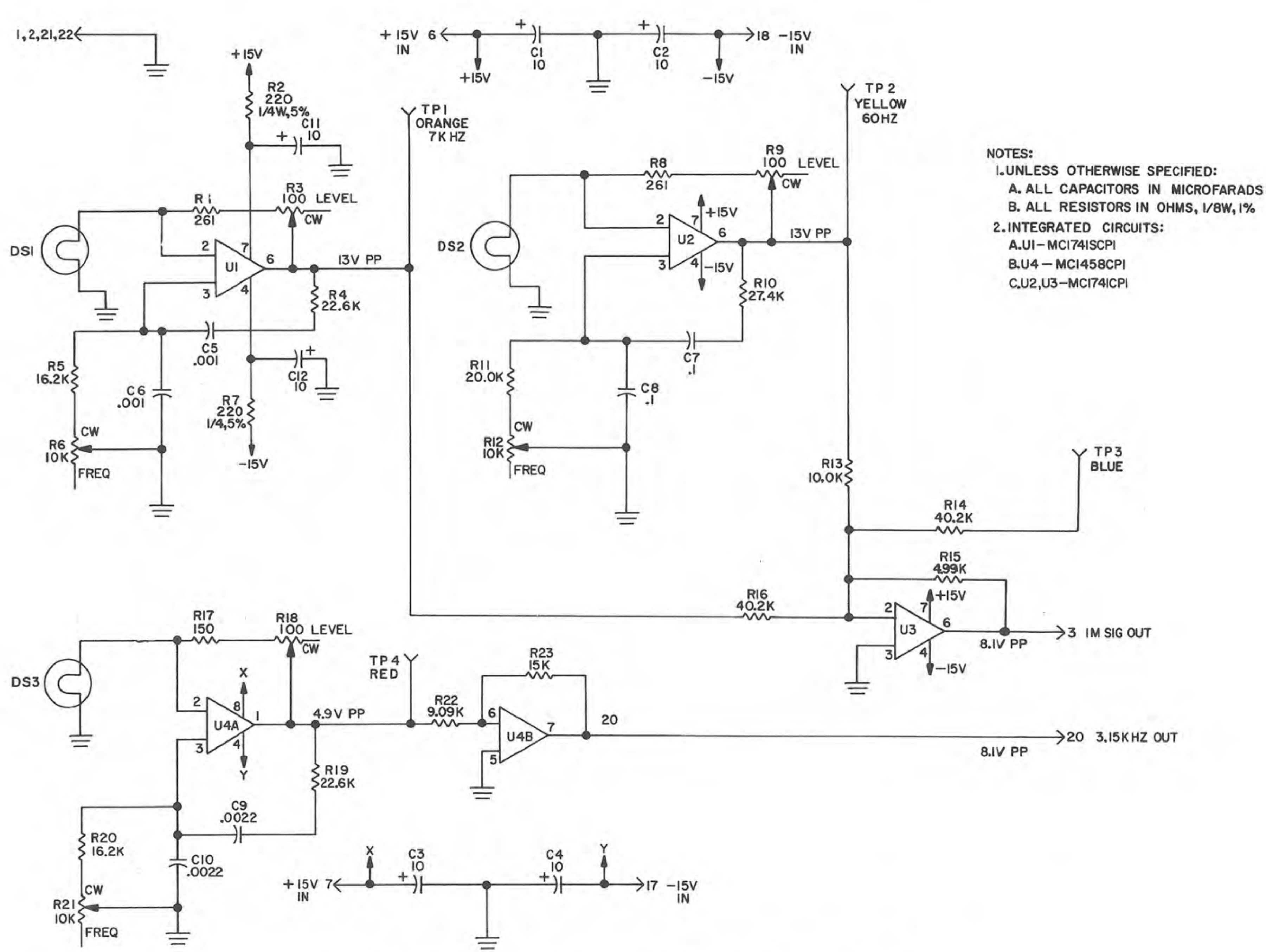


Figure 4.10. Schematic Diagram, IM/WF Signal Generator, A4

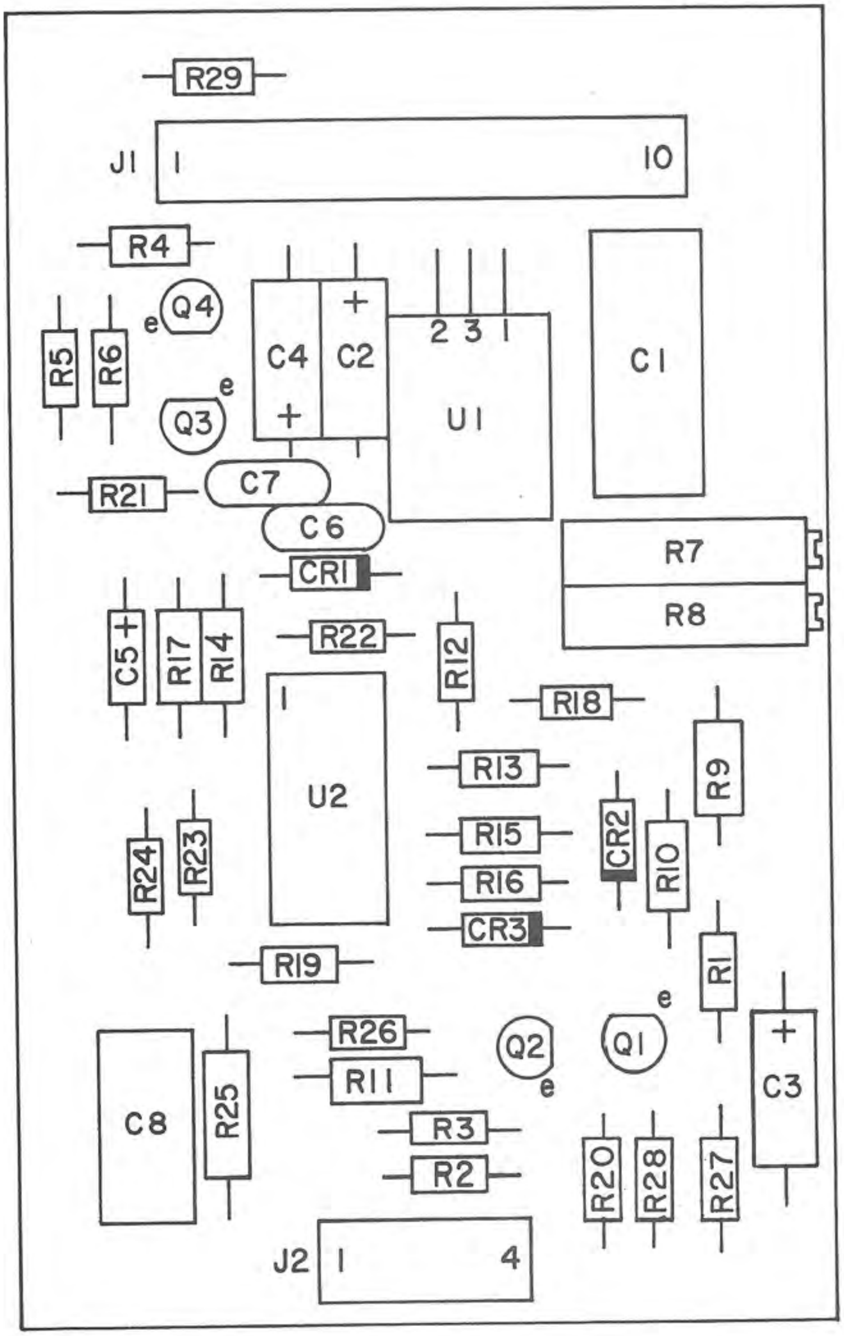
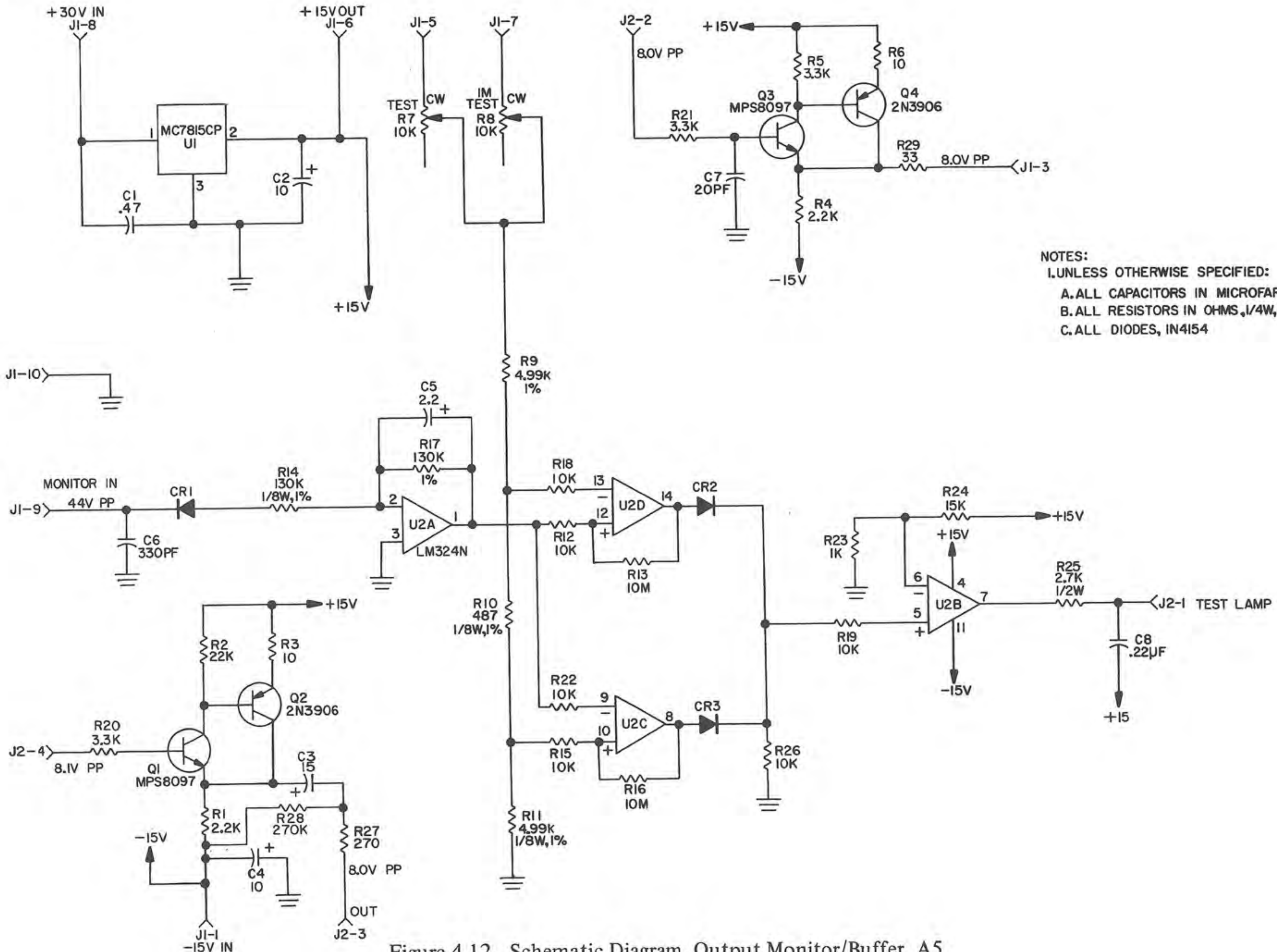


Figure 4.11. Component Location, Output Monitor/Buffer, A5



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
A. ALL CAPACITORS IN MICROFARADS
B. ALL RESISTORS IN OHMS, 1/4W, 5%
C. ALL DIODES, 1N4154

Figure 4.12. Schematic Diagram, Output Monitor/Buffer, A5

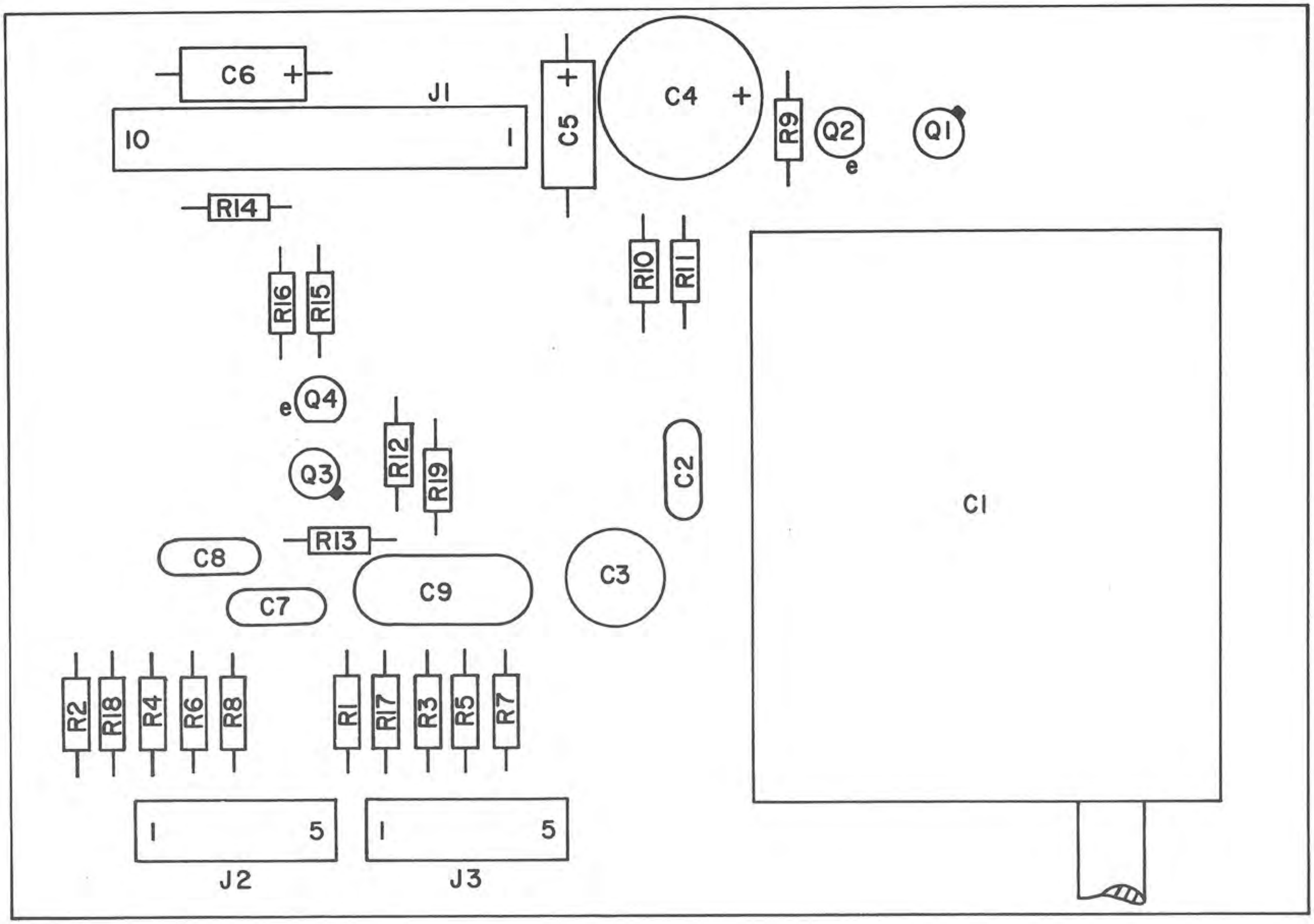


Figure 4.13. Component Location, Oscillator PreAmp, A6

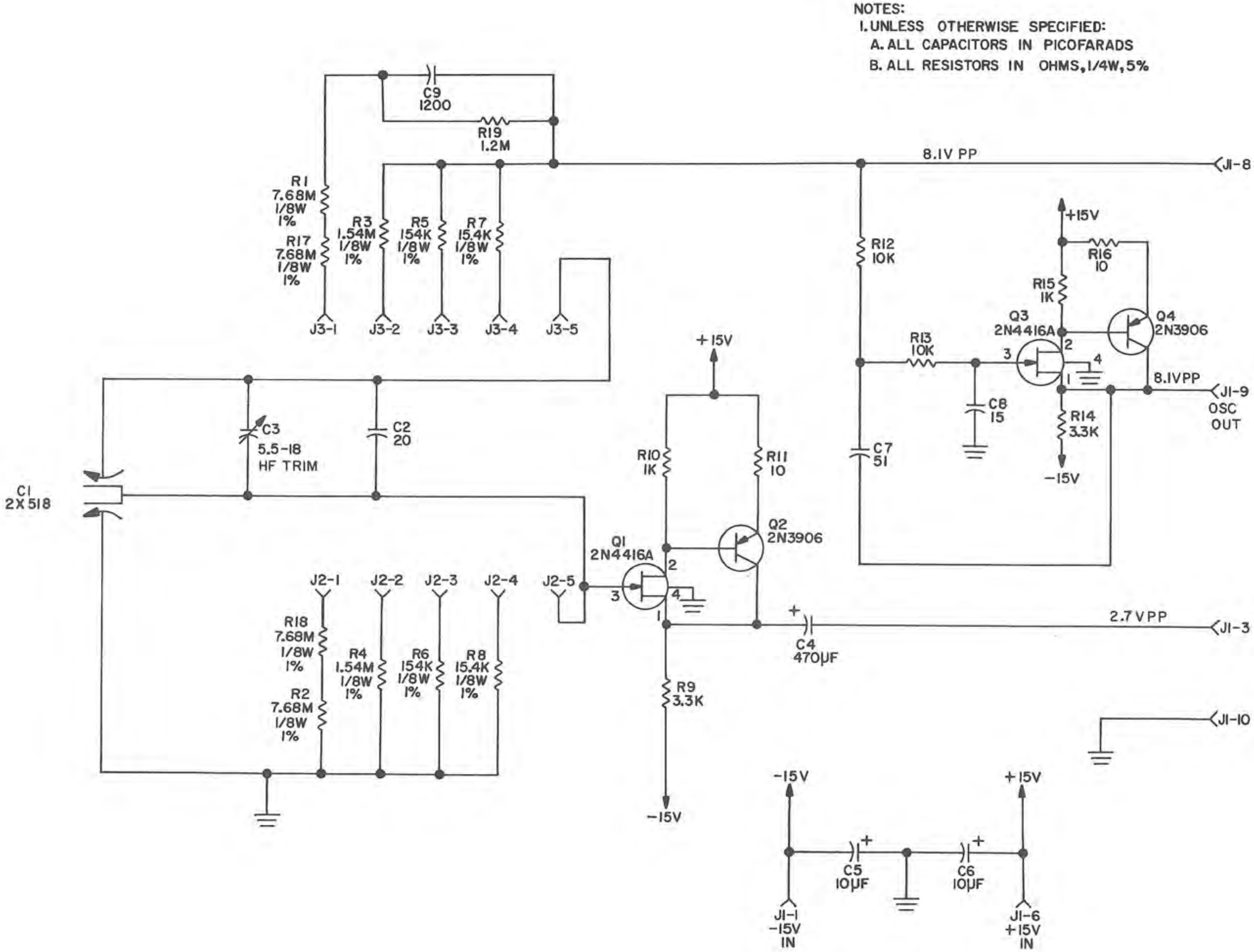


Figure 4.14. Schematic Diagram, Oscillator Preamp, A6

NOTE:
1. — INDICATES JUMPER WIRE

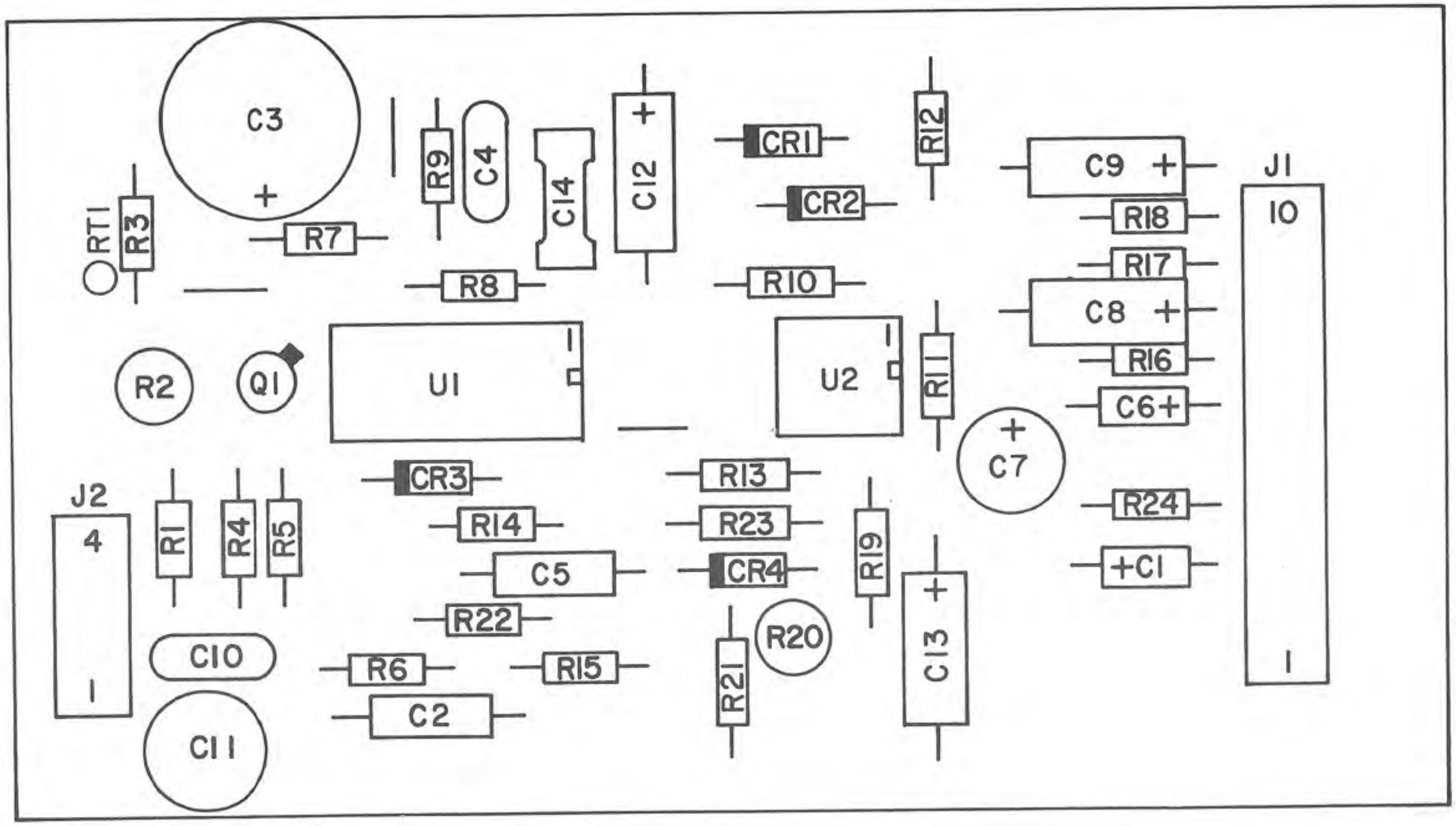


Figure 4.15. Component Location, Control Amp, A7

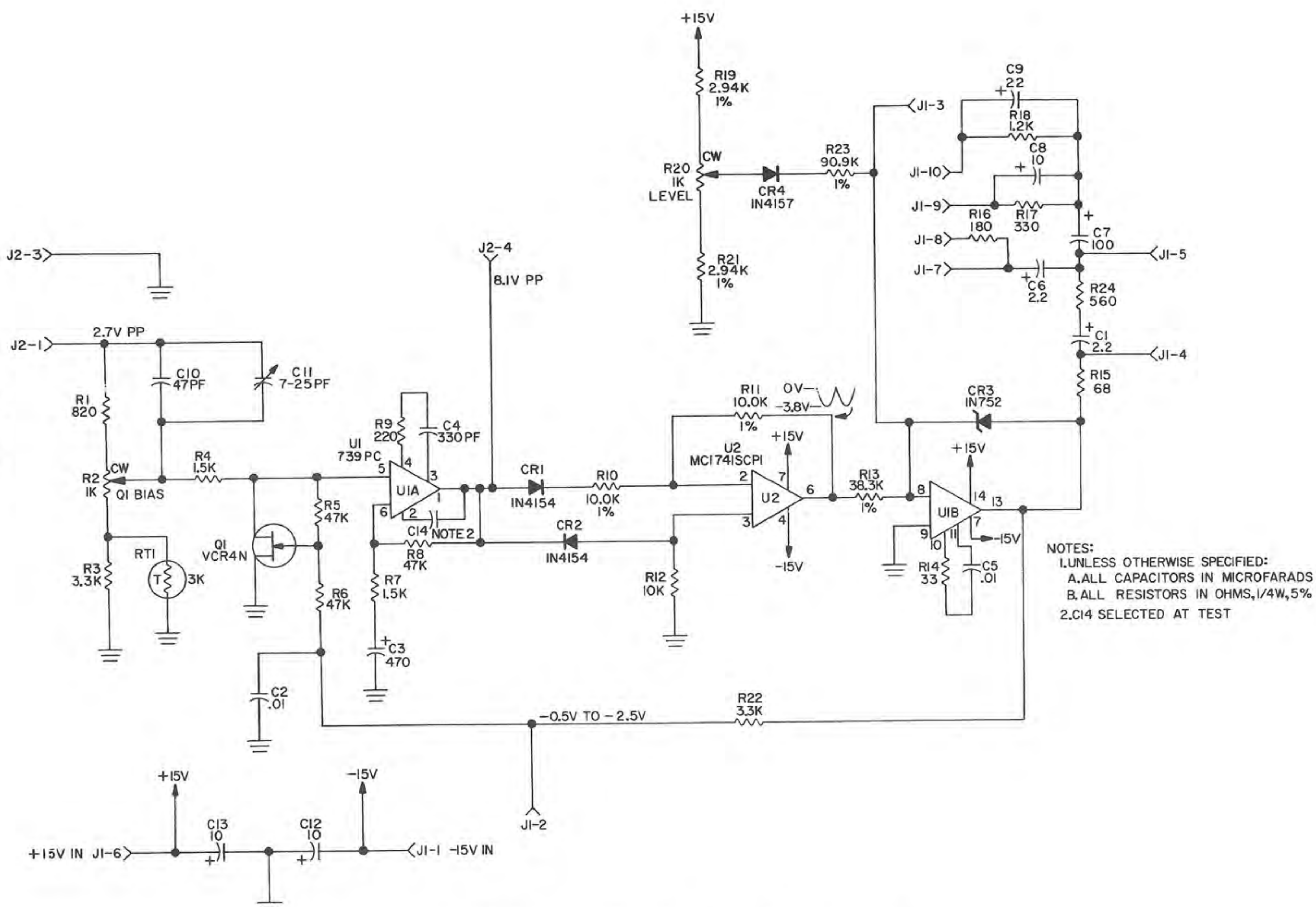
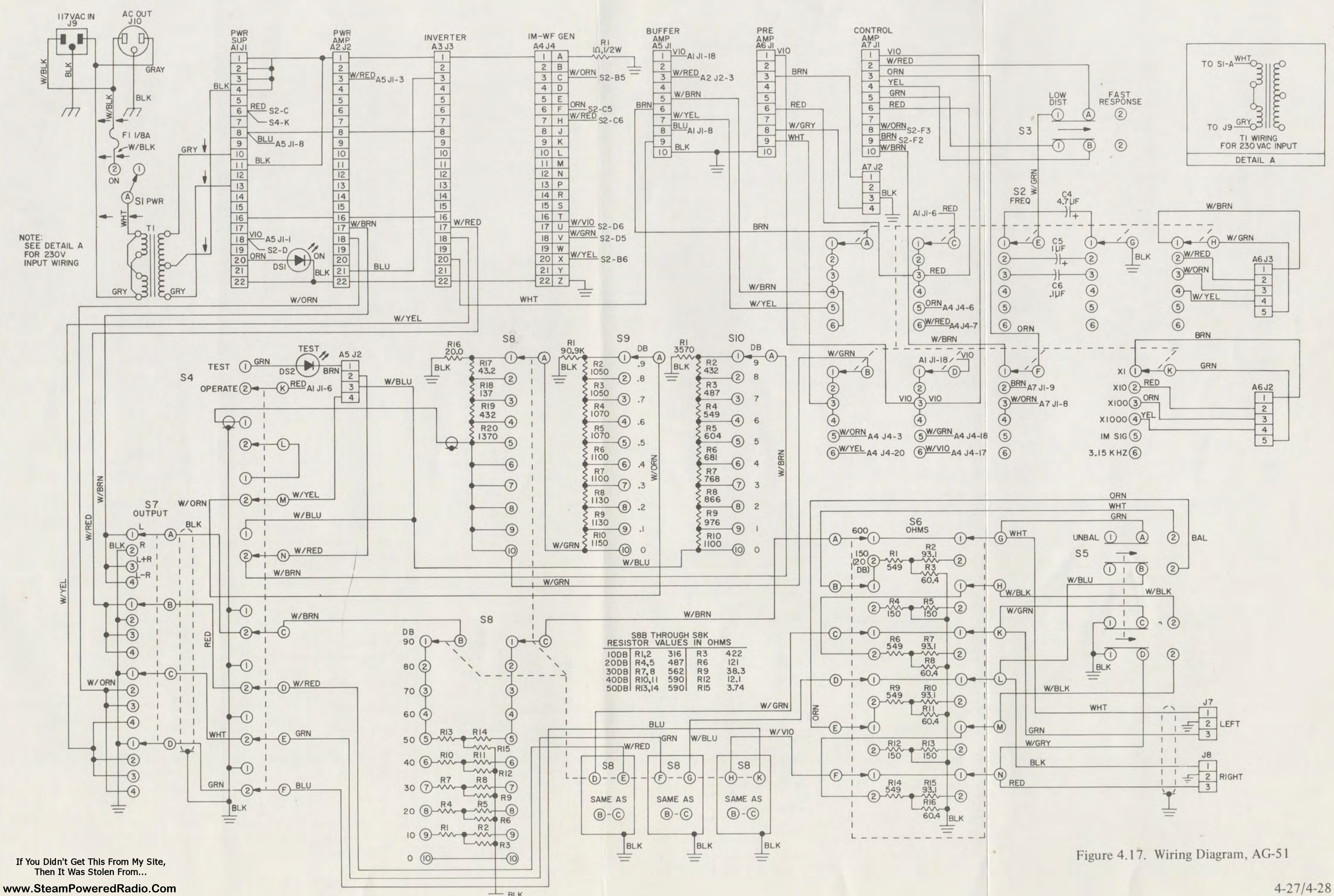


Figure 4.16. Schematic Diagram, Control Amp, A7



S8B THROUGH S8K
RESISTOR VALUES IN OHMS

10DB	R1,2	316	R3	422
20DB	R4,5	487	R6	121
30DB	R7,8	562	R9	38.3
40DB	R10,11	590	R12	12.1
50DB	R13,14	590	R15	3.74

Figure 4.17. Wiring Diagram, AG-51

TABLE 4.8 PARTS LIST, AG-51 CHASSIS

REFERENCE DESIGNATION	DESCRIPTION	MFR.	PART NO.
A1	PCB Assy., BD 48 Power Supply	Potomac	BLM 20166
A2, A3	PCB Assy., BD 52 Power Amp	Potomac	BLM 20186
A4	PCB Assy., BD 45 IM Signal Generator	Potomac	BLM 20180
A5	PCB Assy., BD 44 Output Monitor/ Buffer Amp	Potomac	BLM 20170
A6	PCB Assy., BD 36 Oscillator Pre-Amp	Potomac	BLM 20181
A7	PCB Assy., BD 37 Control Amp	Potomac	BLM 20184
C1, 2, 3	Not used		
C4	Capacitor, 4.7 uF, 35V, 10%		CS13BF475K
C5	Capacitor, 1 uF, 35V, 10%		CS13BF105K
C6	Capacitor, .1 uF, 80V, 10%	Sprague	192P1049R8
DS1	LED, red	Litronix	RL2000
DS2	LED, green	Litronix	GL4850
F1	Fuse, 1/8 amp		MDL 1/8
J1, 2, 3, 4	Connector, P.C.	Amphenol	143-022-01
J5, 6	Not used		
J7, 8	Connector, receptacle	Switchcraft	57HA3F
J9	AC Receptacle, male	Switchcraft	EAC-301
J10	AC Receptacle, female	Amphenol	160-2N
R1	Resistor, 1 ohm, 1/2W, 5%		RC20GF1R0J
S1	Switch, Toggle	C&K	7101
S2	Switch Assy.	Potomac	20182-2
S3	Slide switch, DPDT	Switchcraft	46206LR
S4	Switch, modified (T219CTS)	Potomac	20187-4
S5	Slide switch, 4PDT	Switchcraft	50212L
S6	Switch Assy., 600/150 Ohm	Potomac	20189
S7	Switch, modified (T212CTS)	Potomac	20187-5
S8	Switch Assy.	Potomac	30083
S9	Switch Assy.	Potomac	10205
S10	Switch Assy.	Potomac	10204
T1	Transformer	Signal	DP241-5-48
XF1	Fuse holder	Bussman	HKP
	Cable Assy. (test)	Potomac	20190
	LED mounting clip & collar	Litronix	004-9002
	Connector plug	Switchcraft	05CL3M
	Binding post, black	H.H. Smith	220-103
	AC power cord	Belden	17250

TABLE 4.9 PARTS LIST, POWER SUPPLY PCB ASSEMBLY, A1

REFERENCE DESIGNATION	DESCRIPTION	MFR.	PART NO.
C1, 2, 3, 4	Capacitor, 500uf, 50V	Cornell Dublier	WBR500-50
C5, 6	Not used		
C7, 9	Capacitor, 15 uf, 20V, 10%		C513BE156K
C8	Capacitor, 39 uf, 10V, 10%	Sprague	196D396X9010KA1
CR1, 2, 3, 4, 5, 6, 7	Diode		1N5059
R1, 11	Resistor, 15K Ohm, ¼W, 5%		RCR07G153JM
R2, 10	Resistor, 10 Ohms, 3W, 5%	Clarostat	VC3D
R3	Resistor, 60.4 Ohms, 1/8W, 1%		RN55D60R4F
R4, 9	Resistor, 619 Ohms, ¼W, 1%	Allen Bradley	CC6190F
R5, 6	Potentiometer, 100 Ohms	Beckman	72PR100
R7	Resistor, 10 Ohms, ¼W, 5%		RCR07G100JM
R8	Resistor, 97.6 Ohms, 1/8W, 1%		RN55D97R6F
R12	Resistor, 3K Ohms, ½W, 5%		RCR20G302JM
U1	I.C., pos. voltage reg.	National	LM317T
U2	I.C., neg. voltage reg.	Fairchild	µA7912UC

TABLE 4.10 PARTS LIST, POWER AMP/INVERTER PCB ASSEMBLY, A2, A3

REFERENCE DESIGNATION	DESCRIPTION	MFR.	PART NO.
C1	Capacitor, 39 uf, 10V, 10%	Sprague	196D396X9010KA1
C2, 3	Capacitor, 22 uf, 35V, 10%		C513BF226K
CR1	Diode	G.E.	1N4157
Q1, 2	Transistor		2N3904
Q3	Transistor	National	92P U56
Q4	Transistor	National	92PU06
Q5	Transistor		2N5320
Q6	Transistor		2N5322
R1	Resistor, 4.99K Ohms, 1/8W, 1%		RN55D4991F
R2	Resistor, 27.4K Ohms, 1/8W, 1%		RN55D2742F
R3	Resistor, 27K Ohms, ¼W, 5%		RCR07G273JM
R4	Resistor, 1.5K Ohms, ¼W, 5%		RCR07G152JM
R5	Resistor, 150 Ohms, ¼W, 5%		RCR07G151JM
R6	Resistor, 82 Ohms, ¼W, 5%		RCR07G820JM
R7	Resistor, 1.54K Ohms, 1/8W, 1%		RN55D1541F
R8	Resistor, 27.4K Ohms, 1/8W, 1%		RN55D2742F
R9, 10	Resistor, 47 Ohms, ¼W, 5%		RCR07G470JM
R11, 12, 13	Resistor, 604 Ohms, ¼W, 1%		RN60D6040E
R14	Resistor, 1.21K Ohms, 1/8W, 1%		RN55D1211F
R15	Resistor, 287 Ohms, 1/8W, 1%		RN55D2870F

TABLE 4.11 PARTS LIST, IM/WF SIGNAL GENERATOR PCB ASSEMBLY, A4

REFERENCE DESIGNATION	DESCRIPTION	MFR.	PART NO.
C1, 2, 3, 4, 11, 12	Capacitor, 10 uf, 20V, 10%		CS13BE106K
C5, 6	Capacitor, .001 uf, 200V, 10%	Sprague	192P10292
C7, 8	Capacitor, .1 uf, 80V, 10%	Sprague	192P1049R8
C9, 10	Capacitor, .0022 uf, 80V, 10%	Sprague	192P2229R8
DS1, 2, 3	Lamp	Chicago Miniature	2158
R1, 8	Resistor, 261 Ohms, 1/8W, 1%		RN55D2610F
R2, 7	Resistor, 220 Ohms, ¼W, 5%		RCR07G221JM
R3, 9, 18	Potentiometer, 100 Ohms	Beckman	89PR100
R4, 19	Resistor, 22.6K Ohms, 1/8W, 1%		RN55D2262F
R5, 20	Resistor, 16.2K Ohms, 1/8W, 1%		RN55D1622F
R6, 12, 21	Potentiometer, 10K Ohms	Beckman	89PR10K
R10	Resistor, 27.4K Ohms, 1/8W, 1%		RN55D2742F
R11	Resistor, 20K Ohms, 1/8W, 1%		RN55D2002F
R13	Resistor, 10K Ohms, 1/8W, 1%		RN55D1002F
R14, 16	Resistor, 40.2K Ohms		RN55D4022F
R15	Resistor, 4.99K Ohms		RN55D4991F
R17	Resistor, 150 Ohm, 1/8W, 1%		RN55D1500F
R22	Resistor, 9.09K Ohms, 1/8W, 1%		RN55D9091F
R23	Resistor, 15K Ohms, 1/8W, 1%		RN55D1502F
TP1	Test jack, orange	E.F. Johnson	105-0756-001
TP2	Test jack, yellow	E.F. Johnson	105-0757-001
TP3	Test jack, blue	E.F. Johnson	105-0760-001
TP4	Test jack, red	E.F. Johnson	105-0752-001
U1	I.C.	Motorola	MC1741SCP1
U 2, 3	I.C.	Motorola	MC1741CP1
U4	I.C.	Motorola	MC1458CP1

TABLE 4.12 PARTS LIST, OUTPUT MONITOR/BUFFER AMP PCB ASSEMBLY, A5

REFERENCE DESIGNATION	DESCRIPTION	MFR.	PART NO.
C1	Capacitor, .47 uf, 200V, 10%	Paktron	474K02MY800L1
C2, 4	Capacitor, 10 uf, 20V, 10%		CS13BE106K
C3	Capacitor, 15 uf, 20V, 10%		CS13BE156K
C5	Capacitor, 2.2 uf, 20V, 10%		CS13BE225K
C6	Capacitor, 330 pf, 500V, 5%		DM15331J
C7	Capacitor, 20 pf, 500V, 5%		DM15200J
C8	Capacitor, .22 uf, 200V, 10%	Paktron	224K0MY600L1
CR1, 2, 3	Diode		1N4154
J1	Connector, 10-pin	Molex	09-64-1101
J2	Connector, 4-pin	Molex	09-64-1041
Q1, 3	Transistor	Motorola	MPS8097
Q2, 4	Transistor		2N3906
R1	Resistor, 2.2K Ohms, ¼W, 5%		RCR07G222JM
R2, 5	Resistor, 22K Ohms, ¼W, 5%		RCR07G223JM
R3, 6	Resistor, 10 Ohms, ¼W, 5%		RCR07G100JM
R4, 20, 21	Resistor, 3.3K Ohms, ¼W, 5%		RCR07G332JM
R7, 8	Potentiometer, 10K Ohms	Beckman	89PR10K
R9, 11	Resistor, 4.99K Ohms, 1/8W, 1%		RN55D4991F
R10	Resistor, 487 Ohms, 1/8W, 1%		RN55D4870F
R12, 15, 18, 19, 22, 26	Resistor, 10K Ohms, ¼W, 5%		RCR07G103JM
R13, 16	Resistor, 10M Ohms, ¼W, 5%		RCR07G106JM
R14, 17	Resistor, 130K Ohms, 1/8W, 1%		RN55D1303F
R23	Resistor, 1K Ohms, ¼W, 5%		RCR07G102JM
R24	Resistor, 15K Ohms, ¼W, 5%		RCR07G153JM
R25	Resistor, 2.7K Ohms, ½W, 5%		RCR20G272JM
R27	Resistor, 270 Ohms, ¼W, 5%		RCR07G271JM
R28	Resistor, 270K Ohms, ¼W, 5%		RCR07G274JM
R29	Resistor, 33 Ohms, ¼W, 5%		RCR07G330JM
U1	I.C., Positive Voltage Reg.	Motorola	MC7815CP
U2	I.C.	National	LM324N

TABLE 4.13 PARTS LIST, OSCILLATOR PRE-AMP PCB ASSEMBLY, A6

REFERENCE DESIGNATION	DESCRIPTION	MFR.	PART NO.
C1	Capacitor, 2X518 pf	Jackson Bros.	5084/2/518/G25
C2	Capacitor, 20 pf, 500V, 5%		DM15200J
C3	Capacitor, variable, 5.5-18 pf	J.F.D.	DV11PS18A
C4	Capacitor, 470 uf, 16V, –10% +75%	Sprague	502D477G016DK1C
C5, 6	Capacitor, 10 uf, 20V, 10%		CS13BE106K
C7	Capacitor, 51 pf, 500V, 5%		DM15510J
C8	Capacitor, 15 pf, 500V, 5%		DM15150J
C9	Capacitor, 1200 pf, 500V, 5%		DM19122J
J1	Connector, wafer, 10-pin	Molex	09-64-1101
J2, 3	Connector, wafer, 5-pin	Molex	09-64-1051
Q1, 3	Transistor	T.I.	2N4416A
Q2, 4	Transistor		2N3906
R1, 2, 17, 18	Resistor, 7.68M Ohms, 1/8W, 1%	Allen Bradley	CC7684F
R3, 4	Resistor, 1.54M Ohms, 1/8W, 1%	Allen Bradley	CC1544F
R5, 6	Resistor, 154K Ohms, 1/8W, 1%		RN55D1543F
R7, 8	Resistor, 15.4K Ohms, 1/8W, 1%		RN55D1542F
R9, 14	Resistor, 3.3K Ohms, ¼W, 5%		RCR07G332JM
R10, 15	Resistor, 1K Ohms, ¼W, 5%		RCR07G102JM
R11, 16	Resistor, 10 Ohms, ¼W, 5%		RCR07G100JM
R12, 13	Resistor, 10K Ohms, ¼W, 5%		RCR07G103JM
R19	Resistor, 1.2M Ohms, ¼W, 5%		RCR07G125JM

TABLE 4.14 PARTS LIST, CONTROL AMP PCB ASSEMBLY, A7

REFERENCE DESIGNATION	DESCRIPTION	MFR.	PART NO.
C1, 6	Capacitor, 2.2 uf, 20V, 10%		CS13BE225K
C2, 5	Capacitor, .01 uf, 80V, 10%	Sprague	192P1039R8
C3	Capacitor, 470 uf, 16V, +75% –10%	Sprague	502D477G016DK1C
C4	Capacitor, 330 pf, 500V, 5%		DM15331J
C7	Capacitor, 100 uf, 10V, 10%	Sprague	196D107X901PE4
C8, 12, 13	Capacitor, 10 uf, 20V, 10%		CS13BE106K
C9	Capacitor, 22 uf, 15V, 10%		CS13BD226K
C10	Capacitor, 47 pf, 500V, 5%		DM15470J
C11	Capacitor, variable, 7.0-25 pf	J.F.D.	DV11PS25B
C14	Capacitor, selected at test (typ. 3.3 pf)		
CR1, 2	Diode		1N4154
CR3	Diode, zener		1N752
CR4	Diode		1N4157
J1	Connector, wafer	Molex	09-64-1101
J2	Connector, wafer	Molex	09-64-1041
Q1	Transistor	Siliconix	VCR4N
R1	Resistor, 820 Ohms, ¼W, 5%		RCR07G827JM
R2, 20	Resistor, Variable, 1K Ohms	Beckman	82PR1K
R3, 22	Resistor, 3.3K Ohms, ¼W, 5%		RCR07G332JM
R4, 7	Resistor, 1.5K Ohms, ¼W, 5%		RCR07G152JM
R5, 6, 8	Resistor, 47K Ohms, ¼W, 5%		RCR07G473JM
R9	Resistor, 220 Ohms, ¼W, 5%		RCR07G221JM
R10, 11	Resistor, 10K Ohms, 1/8W, 1%		RN55D1002F
R12	Resistor, 10K Ohms, ¼W, 5%		RCR07G103JM
R13	Resistor, 38.3K Ohms, 1/8W, 1%		RN55D3832F
R14	Resistor, 33 Ohms, ¼W, 5%		RCR07G330JM
R15	Resistor, 68 Ohms, ¼W, 5%		RCR07G680JM
R16	Resistor, 180 Ohms, ¼W, 5%		RCR07G181JM
R17	Resistor, 330 Ohms, ¼W, 5%		RCR07G331JM
R18	Resistor, 1.2K Ohms, ¼W, 5%		RCR07G122JM
R19, 21	Resistor, 2.94K Ohms, 1/8W, 1%		RN55D2941F
R23	Resistor, 90.9K Ohms, 1/8W, 1%		RN55D9092F
R24	Resistor, 560 Ohms, ¼W, 5%		RCR07G561JM
RT1	Thermistor, 3K Ohms	Fenwal	JA33J1
U1	I.C.	Fairchild	739PC
U2	I.C.	Motorola	MC1741SCP1