MODEL 1038-V13

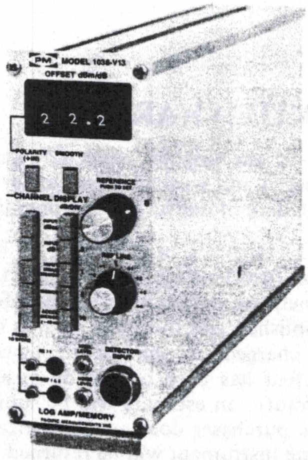
OPERATING AND MAINTENANCE MANUAL

VERTICAL LOG AMPLIFIER PLUG-IN UNIT

MODEL 1038-V13

PM PACIFIC MEASUREMENTS INCORPORATED

INSTRUCTION MANUAL



VERTICAL LOG AMPLIFIER PLUG-IN UNIT

MODEL 1038-V13

SERIAL NUMBER 910

PM

PACIFIC MEASUREMENTS INCORPORATED

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CERTIFICATION

PACIFIC MEASUREMENTS INC. ("PM") certifies that this instrument was thoroughly tested and inspected and found to meet all its published specifications when it was shipped from the factory. PM further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

ONE YEAR LIMITED WARRANTY

PACIFIC MEASUREMENTS INC. ("PM") warrants to the original purchaser, and only the original purchaser, that this instrument will be free from defects in material and workmanship, under normal recommended use and operating conditions, for a period of one year after the date of delivery to the original purchaser.

PM's obligation under this Warranty is limited to (1) repairing or replacing, at PM's option, any part or parts (excluding RF diodes, RF connectors, batteries, and fuses) which are returned to PM in the manner specified below and which, upon inspection by PM's personnel, are determined to be defective as described above; and (2) calibrating the repaired instrument to current published specifications. If it is determined that the instrument is not defective, a nominal inspection charge will be charged and the instrument will be returned with transportation charges collect. If it is determined that the defect has been caused by misuse and/or abnormal operating conditions or that the instrument is not under Warranty, an estimate will be submitted prior to the commencement of necessary repair and calibration work. If the purchaser does not authorize PM to commence such repairs within fifteen days after such estimate is submitted, the instrument will be returned to the purchaser transportation charges collect.

PM'S OBLIGATION TO REPAIR OR REPLACE DEFECTIVE PARTS, AS DESCRIBED ABOVE, SHALL BE THE PURCHASER'S EXCLUSIVE REMEDY AND NO OTHER REMEDY SHALL BE AVAILABLE (INCLUDING, BUT NOT LIMITED TO, INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR LOST PROFITS, LOST SALES, OTHER ECONOMIC LOSS, INJURY TO PERSON OR PROPERTY, OR ANY OTHER INCIDENTAL OR CONSEQUENTIAL LOSS SUSTAINED BY THE ORIGINAL PURCHASER OR ANY OTHER PERSON).

THE WARRANTY DESCRIBED ABOVE IS THE ONLY WARRANTY APPLICABLE TO THIS PM INSTRUMENT AND IS MADE EXPRESSLY IN LIEU OF ANY AND ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR INFRINGEMENT.

WARRANTY PROCEDURE AND SHIPPING INSTRUCTIONS

If any fault develops, the following steps should be taken:

a. Notify PM immediately, giving model number, serial or part number, code number, and a detailed description of the nature and/or conditions of failure. On receipt of this information, service, operating, or shipping instructions will be supplied to you.

b. On receipt of shipping instructions, ship the instrument transportation prepaid to PM. The instrument should be shipped in the original shipping carton or, if damaged or not available, in a suitable rigid container with the instrument wrapped in paper or plastic and surrounded with at least four inches or cushioning material on all sides. If under Warranty, the instrument will be repaired and returned transportation prepaid.

RECEIVING INSTRUCTIONS

The instrument must be thoroughly inspected immediately upon receipt. All material in the shipping container should be checked against the enclosed packing list. PM will not be responsible for shortages against the packing list unless notified immediately. Upon receipt of shipment, if there is any visible evidence of damages, make a notation on the way bill of such damage and immediately contact the nearest office of the carrier in your city. If there is evidence of damage after the goods are unpacked, contact the nearest office of the carrier, request an inspection, and save all packing and materials therein until the inspection has been completed. A full report of the damage should be obtained by the carrier's claim agent, and a copy of this report forwarded to PM. Upon receipt of this report, you will be advised of the disposition of the equipment for repair or replacement. PM shall have no responsibility for damaged instruments if the above inspection requirements are not complied with. Time is of the essence regarding the above instructions.

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SECTION 1

GENERAL INFORMATION

1.1 DESCRIPTION

The Model 1038-V13 is a plug-in unit for the Model 1038 measurement system. It fits into either of the right-hand two slots in the Mainframe and provides signals to drive the vertical deflection system of the CRT. A horizontal drive plug-in is required to form a complete display system. The input to the vertical plug-in unit comes from a microwave diode detector. Several types are available from Pacific Measurements with frequency range and connector types to satisfy most requirements. In addition, a special adapter cable is available to connect to detectors of other manufacture. The adapter cable will also connect to microwave devices which include internally mounted detectors, such as return-loss bridges.

The input to the horizontal plug-in is generally obtained from sweep voltage generated by a swept-frequency RF source. Accordingly, the horizontal (or X) axis of the CRT scales directly in frequency. The vertical (or Y) axis scales in signal amplitude, expressed in decibels.

In general, the vertical plug-ins will display signal levels from -50 dBm to +10 dBm. The display capability depends somewhat upon the characteristics of the specific detector type used; the dynamic range will be found on the specification sheet for the detector. The plug-in has display sensitivities selectable from 10 dB per division down to 0.1 dB per division. Thus small variations with frequency can be viewed on a sensitive scale with good resolution whereas larger variations can be seen on the less sensitive ranges. For absolute power displays, the dBm button provides accurate calibration. For relative power measurements, the dB button works in conjunction with the Reference knob to make any arbitrary power level the reference.

The reference line can be positioned to any of the nine major horizontal lines on the CRT graticule, using the REF. LINE switch. For example, if the dBm button is depressed and the REF. LINE switch is set to the center position, the trace will cross the screen in the center if 1 mW (0 dBm) is applied to the detector. An OFFSET control allows high-resolution level measurements to be made in much the same way that voltage measurements are made using a differential voltmeter. The sensitivity is made low to begin with and the trace moved to the reference line using the OFFSET control. The sensitivity is successively increased and a better adjustment made with the OFFSET control until the best setting is found. The level (either absolute or relative, as desired) is read off the digit switch.

A more complete understanding of the instrument's capabilities can be had by reading the Operation Section of this manual.

This instrument is equipped with a version of the Automemory ® allowing it to record the average of two calibration curves and correct measurements by subtracting this average curve from the measured data. Since the calibration and measured data are in logarithmic (dB) form, subtracting is equivalent to forming the linear ratio. The normal function of the memory is to eliminate the effects of the variation in response with frequency of the measurement system. The 1038-V13 allows the operator to average two response curves during calibration, so that directional couplers and return-loss bridges can be calibrated using both an open circuit and a short circuit. This procedure substantially eliminates the effect of the test-port mismatch upon the calibration curve. It will not eliminate the interaction of the test-port mismatch with the device under test, but this is normally a much smaller problem.

This unit stores data in a 1024 byte memory. Since each byte has eight bits, the vertical resolution is 1/256 of the screen size, or 1/32 of a major division. In order to provide horizontal address information to the vertical plug-in a horizontal plug-in with memory must be used when the memory feature is desired.

1.2 PERFORMANCE SPECIFICATIONS

Detailed specifications are given in Table 1-1.

TABLE 1-1

OFFSET CONTROL	
Resolution	3 Digits
Range	±99.9 dB
	±.02 dB/10 dB ±.05 dB
DISPLAY SENSITIVITY	
Ranges	0.1, 0.5, 1.0, 5.0, and 10 dB/DIV
Accuracy	±3%
REFERENCE CONTROL	
Range	>±59 dB centered on approximately -20 dBm.
MEASUREMENT RANGE	< -50 to >+10 dBm for a detector with between 0.5 and 1.0 mV dc output for -30 dBm input. Its output resistance must be less than 20 k ohms at -30 dBm.
DRIFT, using Pacific Measurements temperature compensated detectors	
At 0 dBm	< .01 dB/°C (+15 to +45°C)
At -40 dBm	< 0.5 dB/24 Hrs. at constant temperature
SYSTEM LINEARITY, using Pacific Measurements detectors	0.1 dB/10 dB. At -50 dBm, an additional 0.5 dB linearity error makes the total 1.1 dB if +10 dBm is the reference.
TEMPERATURE	
Operating	0 to 50°C
Non-operating	-50 to +65°C
DIMENSIONS (H x W x D)	16.8 cm x 6.60 cm x 29.7 cm (6.6" x 2.6" x 11.7")
WEIGHT	2.3 kg. (5 lbs.)

1.3 INPUT/OUTPUT CONNECTOR

The following signals appear on the Input/Output Connector of the Mainframe when the Model 1038-V13 is installed. Refer to the Mainframe manual for additional pin assignments and information.

I/O CONNECTOR PIN NO.	SIGNAL
11	Do not use
12	Do not use
13	External Ratio to A Channel, 100mV/dB*
29	External Ratio to B Channel, 100mV/dB*

*These inputs are available to add marker pips to the display. Input impedance 10KΩ, maximum input 10V.

SECTION 2

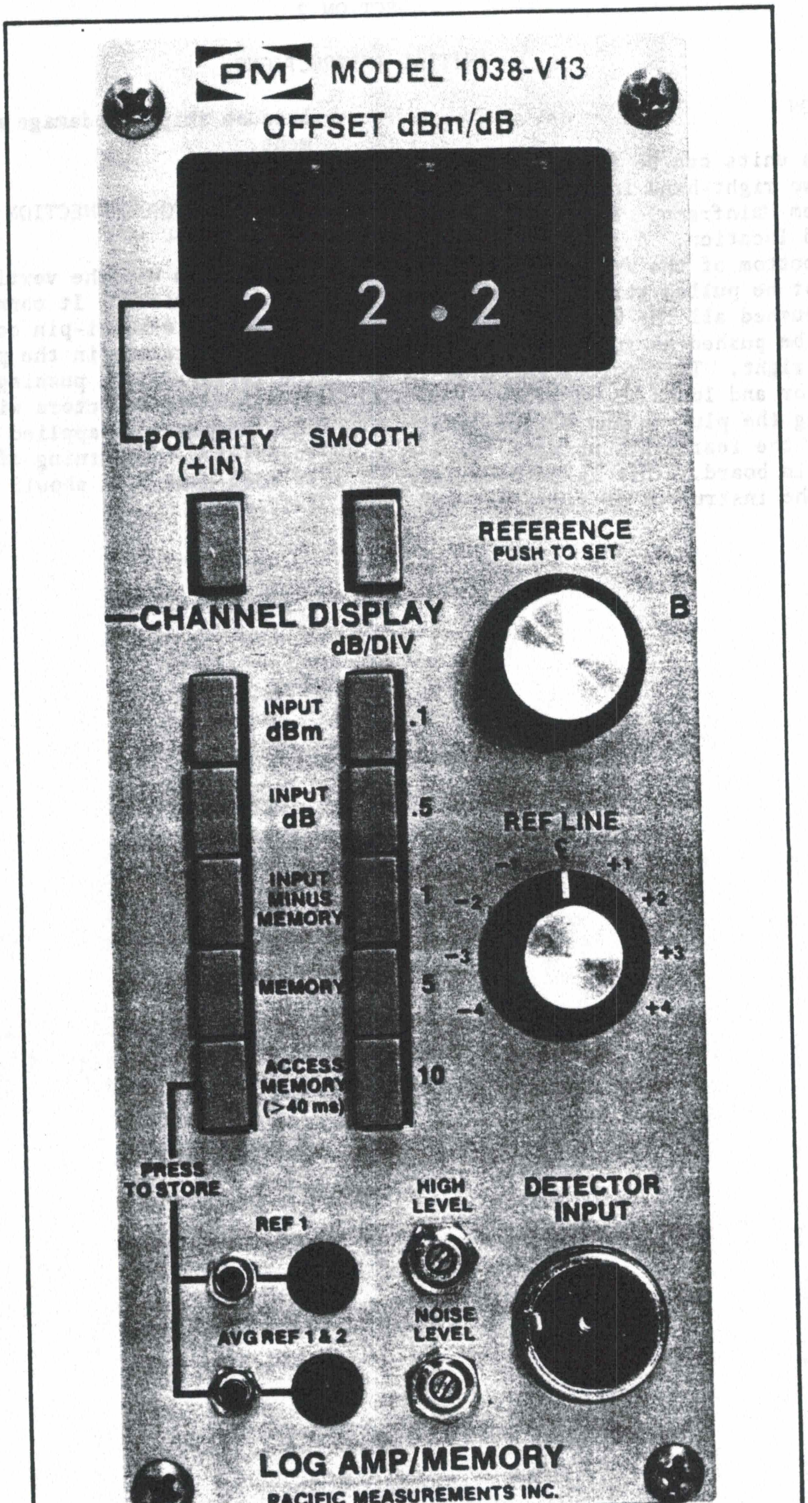
INITIAL INSTRUCTIONS

2.1 INSTALLATION

Vertical plug-in units can be installed in either of the two right-hand locations of the Model 1038 System Mainframe. They will not fit in the left-hand location. A latching lever is located at the bottom of the front panel of the plug-in. It must be pulled straight out before the plug-in is pushed all the way in. After the plug-in can be pushed no further, the lever is moved to the right. This forces the plug-in into the connector and locks it in place. Use care in inserting the plug-in and be sure that the connector at the rear lines up with the end of the plug-in board. This is particularly important when the instrument is first set-up, because shipping damage might cause misalignment.

2.2 DETECTOR CONNECTION

In order to use the vertical plug-in, a detector is required. It connects to the front panel female multi-pin connector. The connector has a keyway in the plastic to mate with the keyway before pushing the connector together. All detectors will be damaged if too much RF power is applied to them, so be sure to observe the warning affixed to the detector. In most cases you should not exceed 50 mW (+17 dBm).



FRONT PANEL
FIGURE 2-1

SECTION 3

OPERATION

3.1 FRONT PANEL CONTROLS

The following controls are listed in order, from the top to the bottom of the panel. A photograph of the Model 1038-V13 front panel appears in Figure 2-1.

a. OFFSET dBm/dB and POLARITY SWITCHES. These controls permit the input signal to be offset to a null on the reference line. The amount and polarity of the offset required can be read from the digits on the OFFSET switch and the position of the polarity switch. The reading obtained is an indication of the difference (in dB) between the signal and the reference. For example, if the INPUT dBm button is used (0 dBm reference) and an offset of -12 dB nulls the signal, the level is just -12 dBm.

b. SMOOTH SWITCH. This switch reduces the bandwidth of the log amplifier on all dB/DIV sensitivity settings. Smoothing is effective when the switch is depressed. At low signal levels (below -40 dBm) there are random variations in signal amplitude due to noise and some signal feed through from the input chopper circuit. Reducing the bandwidth of the log amplifier reduces the noise displayed at low signal levels. It also causes the response to be slower at low signal levels, so that the displayed amplitude will be incorrect if rapid variations are displayed at excessive sweep speeds. This may be checked by slowing the sweep and observing whether the shape of the display changes. The sweep used must be slow enough that this does not occur.

c. REFERENCE KNOB. This knob must be pushed firmly to engage the control. This feature is to avoid accidental mis-setting of the control after a reference has been established. The purpose of the control is to permit the setting of an arbitrary reference level when the INPUT dB button is depressed. For example, when making reflection measurements, it is desired to calibrate the system for total reflection. To do this, a signal corresponding to total reflection is displayed. The OFFSET control is set to 00.0 dB and the trace centered on the reference line using the REFERENCE control. Subsequent reflection measurements can be made using the OFFSET switches and the return loss read directly from them.

When using the memory, the OFFSET switches are set to 00.0 and the REFERENCE knob used to bring the trace on screen when the ACCESS MEMORY button is depressed. The trace can then be recorded by pressing the PRESS TO STORE buttons.

d. DISPLAY SELECTOR SWITCHES. There are two columns of display selector buttons. The switches on the left select what is to be displayed; those on the right select the sensitivity, or resolution, of the display (except when MEMORY is displayed). Individual switch functions are as follows:

i. INPUT dBm. Displays the input signal, with 0 dBm as the reference level.

ii. INPUT dB. Displays the input signal, with the reference level set by the REFERENCE knob.

iii. INPUT MINUS MEMORY. Displays the input signal with the contents of the memory subtracted (in dB). The dB reference is the signal recorded in the memory.

iv. MEMORY. Displays the contents of the memory. Since the memory records the sensitivity of the display (dB/DIV) at the time data is stored, the display of the memory contents will be at the sensitivity recorded. Therefore, the display will be unaffected by the dB/DIV button selected.

v. ACCESS MEMORY and PRESS TO STORE. These buttons are electrically interlocked so that the PRESS TO STORE buttons are inoperative unless ACCESS MEMORY is depressed. When ACCESS MEMORY is pressed, the plug-in is set-up so that any part of the trace that is on the CRT screen can be recorded. Normally, the OFFSET switches should be returned to 00.0 and the trace moved on screen using the REFERENCE knob. The display sensitivity should be increased by selecting an appropriate dB/DIV setting so that the trace covers as much of the available vertical dimension as possible without having part of the trace off screen.

If you are making transmission measurements or you only intend to record one calibration curve, press the PRESS TO STORE REF 1 button to record the display. If you are making return-loss measurements and intend to store the short and open circuit average calibration curves, be sure that they will both be on screen *with the same REFERENCE and dB/DIV setting*. In this case, you must not touch either of these controls between the time REF 1 is recorded and AVG REF 1 & 2 has been recorded. After recording is finished, you may select any dB/DIV setting, but the REFERENCE knob may not be adjusted without upsetting the calibration curve.

vi. dB/DIV. These switches select the sensitivity, or resolution, of the display. The number adjacent to the switch indicates the scale for each major vertical division on the CRT.

e. REF LINE. This switch selects the major horizontal line on the CRT graticule that serves as the reference. That is, if a signal equal in magnitude to reference is applied to the input, it will lie on the line indicated by the pointer on the REF LINE switch. It is also the line about which the display expands as successively greater display sensitivities are selected.

f. HIGH LEVEL SCREWDRIVER ADJUSTMENT. This adjustment is used to calibrate the instrument at +10 dBm using the calibrator on the horizontal plug-in.

g. NOISE LEVEL SCREWDRIVER ADJUSTMENT. This adjustment is used to calibrate the instrument for zero signal input. With no RF applied, at 10 dB/DIV, +4 REF LINE, dBm, 00.0 OFFSET, and no smoothing, adjust so that noise is visible as the trace almost, but not quite, touches the noise-free bottom limit.

3.2 FRONT PANEL DETECTOR CONNECTOR

This multi-pin connector is keyed to prevent misalignment. Be sure that the key on the plug mates with the keyway on the panel connector before inserting. Various types of Pacific Measurements power detectors can be used and an adapter cable is available for use with detectors of other manufacture.

3.3 OPERATING PROCEDURE

The vertical plug-in must be installed in either of the right-hand locations in the Model 1038 Mainframe, as described in Section 2.2. In order to generate a complete display, a horizontal plug-in is also needed. Horizontal plug-ins are all compatible; however, in order for the memory to work, a horizontal plug-in with memory drive must be used in the horizontal location. Connection of a suitable detector to the DETECTOR INPUT of the vertical plug-in completes the system.

3.3.1 DETECTORS

RF Detectors supplied for use with the vertical plug-ins are equipped with RF connectors for connection to sources of RF power. Depending upon the connector type and the characteristics of the detector, the maximum frequency for the detector will be different, so be sure to check the specifications for the detector before using it at the highest RF frequencies. Each detector has slightly different detection characteristics from another. If a detector and an instrument are ordered together, the instrument will be calibrated with the detector it is shipped with and a label will be affixed to the instrument to identify the detector. If the instrument is used with other detectors you should expect slight tracking errors as RF power is varied over the range. These errors will be slight, in most cases limited to less than one half dB over the entire dynamic range. If you want to calibrate an instrument to a different detector, refer to the detector calibration procedure of Section 6.

An adapter cable is available for connecting detectors or devices with built-in detectors having BNC output connectors to the DETECTOR INPUT of the plug-in. The use of the special cable is recommended because it has a low-pass filter to isolate the cable from the RF signal and a temperature compensation sensor. While the temperature sensor is close to the BNC connector in the brass block to which the connector is mounted, you should nonetheless be careful to avoid subjecting it to sources of heat not affecting the detector to which it is connected. For example, sunlight coming in a window where the detector is in a shadow and the adapter is directly illuminated.

3.3.2 CALIBRATION CHECK

When the instrument is first set-up, its detector exchanged, the temperature of the room substantially changed, or you have any reason to question the calibration, use the following procedure.

a. High Level Calibration Check. Allow the instrument to warm-up for at least 10 minutes--longer if it has been stored in a cold place. Connect the detector to the CALIBRATOR OUTPUT on the horizontal plug-in, turn the CALIBRATOR switch to ON, and set the HORIZONTAL INPUT switch to INT. Set the OFFSET switch to +10.0, the REF LINE to center, and press the INPUT dBm and .1 dB/DIV buttons. The trace should be in the center of the screen; if necessary, adjust the HIGH LEVEL control with a small, narrow screwdriver to center the trace.

b. Noise Level Calibration Check. Connect the detector to the measurement system where it will be used. Allow the temperature to stabilize for 5 minutes. Turn the RF power off (be sure that it is *completely* off--not just attenuated 20 or 30 dB). Set the OFFSET switch to -40, the REF LINE to center, the SMOOTH button out, and press the dBm and 10 dB/DIV buttons. On the horizontal unit turn the CALIBRATOR to OFF and the input to INT. Adjust the NOISE LEVEL control so that the trace 'bottoms out' and the noise disappears into a straight line--then return the control until the noise is a maximum and the trace is just clear of the limiting line.

3.3.3 ABSOLUTE POWER DISPLAY

If power is to be displayed against another variable, typically frequency, connect the X-axis drive to the INPUT of the horizontal plug-in and adjust for a full-screen sweep. To obtain the display, connect the detector to the signal to be measured, set the OFFSET switches to -20 dB, SMOOTH button out, REF LINE to center, and press the INPUT dBm and 10 dB/DIV buttons. Having obtained a display set the REF LINE to the desired position. If smoothing is desired, check to see that pushing SMOOTH does not change the shape of the picture. If it does, slow down the sweep until the effect is no longer noticed.

In order to see small variations in signal level across a band of frequencies, you will need to use greater display sensitivity (smaller number of dB/DIV). To do this you must move the portion of the display of interest to the reference line, using the OFFSET switches. The display is expanded using a more sensitive dB/DIV setting. The reading on the OFFSET switch is the power (in dBm) at the point where the trace crosses the reference line. Variations from that level can be read directly off the CRT graticule.

3.3.4 RELATIVE POWER DISPLAY

Set up a display according to the first paragraph of Section 3.3.3. Press the INPUT dB button and move the REFERENCE control until the trace is in the desired position. In general the REFERENCE control is set when the unit is displaying a calibration curve. For example, when making a transmission measurement the detector is first connected to the RF source and the trace centered on the reference line, with the OFFSET set to 00.0 dB. Then the device to be tested is inserted between the source and the detector. The resulting trace is the loss vs. frequency. By increasing the sensitivity to a small number of dB/DIV and moving the OFFSET control to center any desired portion of the trace on the reference line, the loss at that point can be read precisely from the OFFSET switch.

3.3.5 USE OF THE MEMORY

a. Single Reference. The memory can be thought of as an extension of the relative power mode. The display is set up in the same way, except that the ACCESS MEMORY button is pressed prior to adjusting the REFERENCE control. The action of the memory is to reduce the calibration curve to a straight line lying on the reference line. The OFFSET switch is set to 00.0 and the trace centered on the screen using the REFERENCE control. The sensitivity is increased so that the calibration trace fills the screen but does not go beyond the screen. Now, when the PRESS TO STORE REF 1 button is pressed the trace will momentarily appear to be made up of dots, then return to its previous form. This indicates that the trace has been recorded in the memory. To check the contents of the memory, press the MEMORY button; you should see the same or nearly the same curve as the calibration trace. When INPUT MINUS MEMORY is pressed a straight line should result, as the calibration curve recorded is subtracted from the calibration curve from the input. When subsequent measurements are made on an RF device, the data displayed will be just the characteristics of the device, since the apparent calibration curve is just a straight line corresponding to the reference line. If the OFFSET switch is used, its dial will read the loss or gain of the device under test directly. It is important not to move the REFERENCE control after memorization as this will move the reference an unknown amount. The control knob disengages from the shaft unless it is pushed in, to avoid accidental movement.

b. Average of Two Reference Curves. When making return loss measurements, there is the possibility of storing an error during calibration. The error is due to the interaction of the directional device's source mismatch with the total reflection of the short or open circuit used during calibration. The magnitude of the error depends upon the match of the output port of the directional device used. As a practical matter, errors of the order of from one half to one dB are frequently observed. This error will be additive (in dB) to any measured value subsequent to calibration.

To substantially avoid this error, two reference curves can be averaged; the first made using an open circuit and the second using a short. Since the phase of the reflected signals are opposite in the two cases, the resultant curves will have equal and opposite errors. By averaging them the final calibration curve will be the correct one.

The Model 1038-V13 accomplishes this by recording the first curve, as described in a. above. As the second curve is being determined, the value of the first curve from the memory is added to it at each point. The result is divided by two and the dividend placed in memory, replacing the data from the first curve. For this process to work the two curves must be made in the same way; thus the dB/DIV switches and the REFERENCE knob cannot be changed from the first curve to the second.

To make a recording, the REFERENCE knob and dB/DIV selection buttons are set as in a. If the trace is within a division of the edge of the screen at any point in the display, it should be checked with the opposite kind of reflecting termination to be sure that both curves will be on-screen without changing these controls. If it won't fit, select a lesser sensitivity. Typically, 0.5 dB/DIV will accommodate both curves, but little is lost if you must memorize on 1 dB/DIV. After the display has been set up, record the first curve by pressing REF 1 momentary contact button. Now change the reflecting termination to the other kind and press the AVG REF 1 & 2 to record the average. Note that the indicator light indicates which button has been used last. Also, after the AVG REF 1 & 2 has been pressed, you cannot use it again unless REF 1 has been pressed. The average is now stored and you can change the dB/DIV setting to any convenient value during measurement. Don't touch the REFERENCE knob unless you want to recalibrate the unit.

SECTION 4

PERFORMANCE CHECKS

4.1 GENERAL

The purpose of this section is to provide a series of tests that will insure that the instrument is operating properly. It is useful for incoming inspection and for periodic performance evaluations. Major specifications are checked and other tests performed which would point out a malfunction within the unit.

4.2 EQUIPMENT REQUIRED

The following equipment is needed to check the performance of the Model 1038-V13.

a. A properly calibrated Model 1038 Mainframe and Display Unit.

b. A properly calibrated horizontal plug-in with memory drive is required.

c. A precision, calibrated step attenuator or separate individual attenuators. Steps of 10 dB from 0 through 60 dB are required. Attenuators should be within 0.4 dB of the nominal value and their exact attenuator should be known to within 0.02 dB at 30 MHz.

d. A sweep signal source with a frequency band compatible with the detector, together with a low-pass filter with a cutoff frequency in the low end of the band. The purpose is to generate a display with considerable amplitude variation across the band.

4.3 INITIAL TURN-ON

Install the plug-in in the Model 1038 Mainframe, connect the Model 1038 to a line of suitable voltage and frequency. Allow the instrument to warm up for at least one-half hour in a room with a temperature of 25°C ± 5°C. The detector with which the instrument was calibrated (as indicated by the label on the front panel) should be connected to the DETECTOR INPUT during this period.

4.4 POWER LEVEL TRACKING

a. Adjust the HIGH LEVEL and NOISE LEVEL controls according to the procedure of Section 3.3.2. The detector should be screwed on to the attenuator when adjusting the NOISE LEVEL control.

b. Connect the detector to the attenuator if a step attenuator is used and set the attenuator for 0 dB. Connect the input to the attenuator to the CALIBRATOR OUTPUT of the horizontal plug-in. If fixed attenuators are used, connect the detector directly to the CALIBRATOR OUTPUT. Set the OFFSET switch to read the insertion loss of the attenuator at the 0 dB setting for 30 MHz. Set to -00.0 if a fixed attenuator is used. Press the INPUT dB button and adjust the REFERENCE control so that the trace is on the center of the screen with the REF LINE switch set to center. It will be easiest to see the trace if the INT horizontal setting is used. Start at 10 dB/DIV and increase the sensitivity from there so that the final adjustment is at .1 dB/DIV.

c. Press the 10 dB/DIV button and check to see that the trace is within one-half of a minor graticule mark of the center. Using the REF LINE switch, set the trace on each of the major graticule divisions. It should lie within 1 minor division of the graticule line. Return the REF LINE switch to center.

d. Set the attenuation to 60 dB and set the OFFSET switch to 60 dB. Adjust the NOISE LEVEL control so that the trace crosses the screen an amount above or below the center corresponding to the correction factor for the attenuator. For example, if the correction factor indicates that the attenuation is less than nominal by 0.2 dB, the trace should be 1 minor division above the center on the 1 dB/DIV range. Make the final adjustment on the 0.5 dB/DIV range. There will be some noise on the trace and it will be necessary to average this out when making the final adjustment.

e. Return the attenuation to 0 and check that the trace is centered except for the insertion loss with the OFFSET set to 00.0.

f. Step the attenuation from 0 to 60 dB in 10 dB steps. Set the OFFSET switch to the same setting as the attenuator and check to see that the trace goes across the screen an amount above or below the center corresponding to the correction factor for the attenuation used, within 0.1 dB. This will be within one division on the .1 dB/DIV range.

4.5 MEMORY OPERATION

a. Connect the low-pass filter to the output of the sweep signal source. Connect the detector to the output of the low-pass filter. Set up a display showing the curve of the filter on 10 dB/DIV. Refer to Section 3.3.3 and following for information about how this is done. When the set-up is complete you should have a trace starting near the upper left corner of the screen and ending near the lower right corner. The actual details of the appearance of the trace are not important if it covers most of the horizontal and vertical dimensions of the screen.

b. Press ACCESS MEMORY and be sure that the trace is all on-screen. Record the trace by pressing PRESS TO STORE REF 1. Press the MEMORY button and examine the display. The trace should be very similar to the display when ACCESS MEMORY was depressed. Now press INPUT MINUS MEMORY; the display should be very nearly a straight line.

c. Since the display was recorded on 10 dB/DIV, pressing the 1 dB/DIV button should expand the size of the vertical steps by ten. In the region of the filter response where there is considerable vertical movement, the display will appear as a series of diagonal lines. These lines should be about one-third of a division long, with some appearing to be twice that long. If this is the case, the memory can be considered to be working properly.

d. Once again press ACCESS MEMORY and 10 dB/DIV. This time memorize using PRESS TO STORE AVG REF 1 & 2. Return to INPUT MINUS MEMORY; the display should once again be a straight line.

SECTION 5

CIRCUIT DESCRIPTION

5.1 INTRODUCTION

Figure 5-1 shows a block diagram of the basic amplifiers, logging and detector compensation circuits. Figure 5-2 shows a block diagram of the memory circuits. The block diagrams will be described first then the details within the blocks. For detailed descriptions of the blocks, reference will be made to the circuit diagrams. They will be found in Section 7.

5.2 DESCRIPTION OF THE BASIC CIRCUIT BLOCK DIAGRAM

Because of the extremely small signals measured by the detector and the resulting sensitivity of the circuits amplifying them it is necessary that no extraneous currents flow in the signal ground leads. For this reason the input amplifier circuits are isolated from the chassis ground. An oscillator-type power supply provides an isolated source of dc to power these circuits. A differential amplifier transmits the signal from the isolated portion of the circuit to the output circuits which are at chassis ground. The differential amplifier has a high input impedance for good isolation and high common-mode voltage rejection so that parasitic signals appearing on the bench ground to which the detector is attached will be ignored. We shall first consider the isolated portion if the circuit.

The RF Detector converts the RF power incident upon it to a dc voltage. This voltage is proportional to power at very low input levels and gradually becomes proportional to RF voltage at high input levels. The sensitivity at low levels and the point at which it starts to deviate from a power-law device are functions of the detector temperature. Accordingly, the detector temperature is monitored and appropriate corrections applied to the circuits following the detector. Three leads come from the detector: a common lead tied to the detector shell, a power sensing lead and a lead from a thermistor. The thermistor is an intimate thermal contact with the brass detector shell.

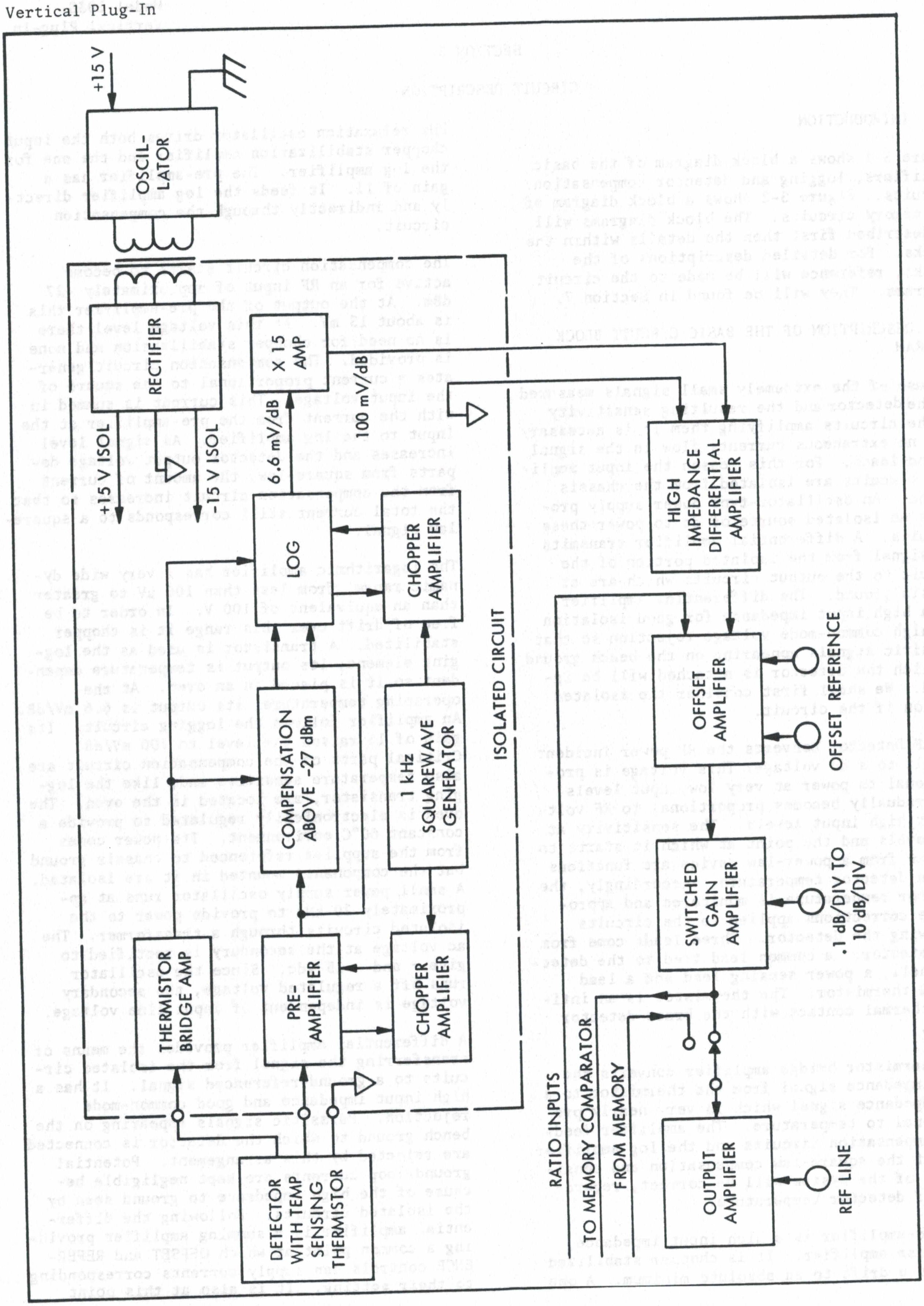
The thermistor bridge amplifier converts the high impedance signal from the thermistor to a low impedance signal which is very nearly proportional to temperature. The amplifier feeds the compensation circuits and the log amplifier so that the square-law compensation and sensitivity of the system will be correct, regardless of detector temperature.

The pre-amplifier is a high input impedance, low noise amplifier. It is chopper stabilized to reduce drift to an absolute minimum. A one kHz relaxation oscillator drives both the input chopper stabilization amplifier and the one for the log amplifier. The pre-amplifier has a gain of 11. It feeds the log amplifier directly and indirectly through the compensation circuit.

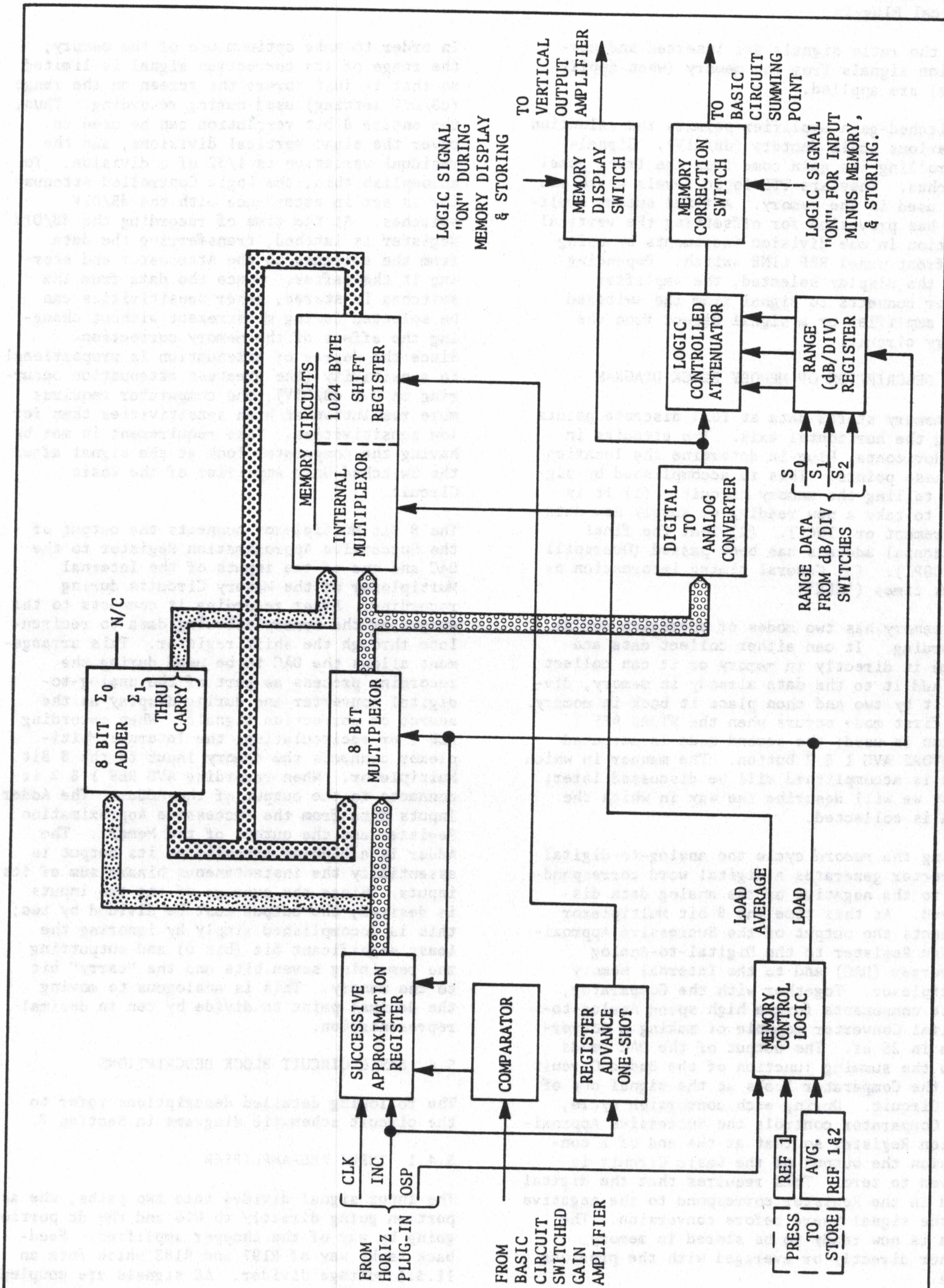
The compensation circuit starts to become active for an RF input of approximately -27 dBm. At the output of the pre-amplifier this is about 15 mV. At this voltage level there is no need for chopper stabilization and none is provided. The compensation circuit generates a current proportional to the square of the input voltage. This current is summed in with the current from the pre-amplifier at the input to the log amplifier. As signal level increases and the detector output voltage departs from square-law, the amount of current from the compensation circuit increases so that the total current still corresponds to a square-law signal.

The logarithmic amplifier has a very wide dynamic range, from less than 100 µV to greater than an equivalent of 100 V. In order to be free of drift over this range it is chopper stabilized. A transistor is used as the logging element; its output is temperature dependent so it is placed in an oven. At the operating temperature, its output is 6.6 mV/dB. An amplifier follows the logging circuit. Its gain of 15 raises the level to 100 mV/dB. Critical parts of the compensation circuit are also temperature sensitive and, like the logging transistor, are located in the oven. The oven is electronically regulated to provide a constant 60°C environment. Its power comes from the supplies referenced to chassis ground but the components mounted in it are isolated. A small power supply oscillator runs at approximately 20 kHz to provide power to the isolated circuits through a transformer. The ac voltage at the secondary is rectified to give + and - 15 Vdc. Since the oscillator runs off a regulated voltage, the secondary voltage is independent of input line voltage.

A differential amplifier provides the means of transferring the signal from the isolated circuits to a ground-referenced signal. It has a high input impedance and good common-mode rejection. Parasitic signals appearing on the bench ground to which the detector is connected are rejected by this arrangement. Potential ground-loop currents are kept negligible because of the high impedance to ground seen by the isolated circuits. Following the differential amplifier is a summing amplifier providing a common point at which OFFSET and REFERENCE controls can supply currents corresponding to their setting. It is also at this point



BASIC BLOCK DIAGRAM
FIGURE 5-1



MEMORY BLOCK DIAGRAM
FIGURE 5-2

that the ratio signals are inserted and correction signals from the memory (when applicable) are applied.

A switched-gain amplifier permits the selection of various scale factors (dB/DIV). Signals controlling its gain come from the front panel switches. They are TTL logic levels which are also used in the memory. A final output amplifier has provision for offsetting the vertical position in one division increments by using the front panel REF LINE switch. Depending upon the display selected, the amplifier either connects to signal from the switched gain amplifier or a signal direct from the memory circuit.

5.3 DESCRIPTION OF MEMORY BLOCK DIAGRAM

The memory stores data at 1024 discrete points along the horizontal axis. The circuits in the Horizontal Plug-in determine the location of these points. This is accomplished by signals telling the memory circuit: (1) It is time to take a new reading or supply new data (Increment or 'INC'). (2) That the final horizontal address has been passed (Overspill or 'OSP'). (3) General timing information or clock times ('CLK').

The memory has two modes of operation during recording. It can either collect data and place it directly in memory or it can collect it, add it to the data already in memory, divide it by two and then place it back in memory. The first mode occurs when the STORE REF 1 button is used; the second mode is actuated by STORE AVG 1 & 2 button. The manner in which this is accomplished will be discussed later; first we will describe the way in which the data is collected.

During the *record* cycle the analog-to-digital converter generates a digital word corresponding to the negative of the analog data displayed. At this time the 8 bit Multiplexor connects the output of the Successive Approximation Register to the Digital-to-Analog Converter (DAC) and to the Internal Memory Multiplexor. Together with the Comparator, these components form a high speed Analog-to-Digital Converter capable of making a conversion in 25 μs. The output of the DAC feeds into the summing junction of the Basic Circuit and the Comparator looks at the signal out of the Circuit. During each conversion cycle, the Comparator controls the Successive Approximation Register so that at the end of a conversion the output of the Basic Circuit is driven to zero. This requires that the digital word in the Register correspond to the negative of the signal there before conversion. The data is now ready to be stored in memory, either directly or averaged with the previous data.

In order to make optimum use of the memory, the range of its correction signal is limited so that it just covers the screen on the range (dB/DIV setting) used during recording. Thus, the entire 8 bit resolution can be used to cover the eight vertical divisions, and the residual variation is 1/32 of a division. To accomplish this, the Logic Controlled Attenuator is set in accordance with the dB/DIV switches. At the time of recording the dB/DIV Register is latched, transferring the data from the switches to the Attenuator and storing it thereafter. Since the data from the switches is stored, other sensitivities can be selected during measurement without changing the effect of the memory correction. Since the degree of attenuation is proportional to sensitivity (the greatest attenuation occurring on 0.1 dB/DIV), the comparator requires more resolution at high sensitivities than for low sensitivities. This requirement is met by having the comparator look at the signal after the Switched-Gain Amplifier of the Basic Circuit.

The 8 Bit Multiplexor connects the output of the Successive Approximation Register to the DAC and one of the inputs of the Internal Multiplexor of the Memory Circuits during recording. After recording it connects to the output of the memory allowing data to recirculate through the shift register. This arrangement allows the DAC to be used during the recording process as part of the analog-to-digital converter and during display as the source of correction signals. When recording REF 1 or recirculating, the Internal Multiplexor connects the memory input to the 8 Bit Multiplexor. When recording AVG REF 1 & 2 it connects to the output of the Adder. The Adder inputs data from the Successive Approximation Register and the output of the Memory. The Adder is a bipolar circuit, so its output is essentially the instantaneous binary sum of its inputs. Since the average of the two inputs is desired, the output must be divided by two; this is accomplished simply by ignoring the least significant bit (bit 0) and outputting the remaining seven bits and the "carry" bit to the memory. This is analogous to moving the decimal point to divide by ten in decimal representation.

5.4 BASIC CIRCUIT BLOCK DESCRIPTIONS

The following detailed descriptions refer to the circuit schematic diagrams in Section 7.

5.4.1 INPUT PRE-AMPLIFIER

The input signal divides into two paths, the ac portion going directly to U15 and the dc portion going by way of the chopper amplifier. Feedback is by way of R197 and R183 which form an 11.3:1 voltage divider. AC signals are coupled to U15 by C79 with the feedback signal coupling through C78. The chopper, Q29 and Q30 converts any difference voltage between the feedback divider and the input to an ac signal at the drive frequency of 1 kHz. A transformer, T2 transmits this ac signal to U13. U13 is connected together with a Twin-Tee network to form a narrow-band active filter with a center-frequency gain of about 3,500. The full-wave balanced demodulator, U14 detects the signal and its output at R161 supplies correction signals to U15 so that the voltage at the feedback divider will be exactly equal to the input voltage at dc and very low ac frequencies. At higher frequencies, the action of U15 itself assures equality.

Both the chopper and the demodulator require two separate out-of-phase signals. They are generated by a Schmitt Trigger consisting of Q32 and Q33 with Q34 supplying a constant current. Since a constant current is supplied to the common emitters, whichever transistor is on will have the same collector current as the other when it is on. This results in identical, but out-of phase, square waves appearing across the equal collector load resistors. Q35 supplies a constant current required by the demodulator IC. To make the circuit oscillate, Q31 supplies current to the capacitor C77 when Q33 is on. When the voltage on the capacitor exceeds the common-emitter potential by a few hundred millivolts Q32 turns on and positive feedback to the base of Q33 turns it off. This also turns Q31 off and the voltage on the capacitor decays until it is a few hundred millivolts above the new (and lower) potential of the common emitters. At this point Q33 begins to conduct and positive feedback turns it all the way on so that Q32 is off. This once again turns Q31 on and the process repeats. The output voltages also drive the choppers and demodulator for the log amplifier.

5.4.2 LOG CONVERSION CIRCUIT

The log conversion circuit is a high gain operational amplifier with feedback from the collector of a transistor. The emitter-base voltage is proportional to the log of the collector current over many decades of current values. The logging transistor is located in an oven operating at 60°C; at this temperature the emitter-base voltage changes by 66.5 mV for each factor of ten that the collector current changes. Since a factor of 10 represents 10 dB, this is 6.65 mV per dB. An amplifier follows the log transistor with a gain of 15, raising the levels to 100 mV/dB.

The operational amplifier part of the log conversion circuit is chopper stabilized in much the same way as the pre-amplifier. Since the sensitivity is not so great the circuit is simpler. The integrated amplifier, U10, receives ac input directly through C45, dc signals are routed through the chopper amplifier and go to pin 3 of U10. The current summing junction is common to the chopper input and C45 with a voltage monitoring test point, J7 connected through an isolating resistor R74. If at any time the summing junction is not at zero dc potential, the chopper switching transistors, Q16 and Q17, will convert this potential to an ac signal. The ac amplifier, U9, amplifies the signal and supplies it to the synchronous demodulator, Q22 where it is converted to dc. A low pass filter, R107 and C44, removes the ac component and the dc correction signal goes to pin 3 of U10, causing its output to change the current through the logging transistor bringing the summing junction back to zero. The 1 kHz drive for the chopper comes from the circuit driving the input chopper.

It is required to reduce the noise present on the display for low signal levels and when viewing the signal at high sensitivity (e.g., 0.1 dB/DIV). To accomplish this, Q25 connects a capacitor, C50, in the feedback path. The optical coupler, Q26, permits ground-referenced signals to control whether Q25 is on or off.

Integrated amplifier U11 provides the gain of 15 required to raise the signal level to 100 mV/dB. It also offsets the signal so that zero volts output represents approximately -20 dBm.

5.4.3 SQUARE-LAW COMPENSATION CIRCUIT

Above -27 dBm the square-law compensation circuit generates a current proportional to the square of the input signal to compensate for the detector's becoming linear rather than square-law at high input power. Q18 and U7 form a high input impedance operational amplifier. Feedback through Q19 results in the emitter-base potential of Q19 being proportional to the log of the input signal in the same way as for the log conversion circuit. Operational amplifier U8 has a gain of very nearly 2 and its output drives the emitter of another transistor, Q21, to generate an exponential current. The mathematical effect of the arrangement is to take the log, multiply by 2 then take the anti-log--simply resulting in squaring the input signal. Since the characteristics of the transistors are temperature dependent, they are located in the oven.

The output current from Q21 is summed at the input to the log conversion circuit along with the direct signal from the pre-amplifier. The direct signal is dominant at low levels with the compensation signal becoming most important at high levels.

To provide temperature compensation for the detector U12 acts as a bridge amplifier for the thermistor located in the detector mount. R130 is a resistor whose value was selected to linearize the thermistor output over the range 0 to 50°C. The output at pin 6 changes approximately 2.5 mV/°C. Correction signals from U12 go to U8 to compensate the shape of the square-law compensation and to U11 to correct the absolute calibration.

5.4.4 OFFSET CIRCUIT

The offset circuit is referenced to chassis ground. Differential amplifier U1 has its inputs connected to the output of the log conversion circuit and the isolated signal common. Since it has good common mode rejection, only the signal between the log conversion circuit's output and isolated common will be amplified. The differential amplifier has a gain of unity. Its output feeds the offset summing junction through R7 and R6. R6 is adjusted to match the current steps from the OFFSET switch which is 10 μA/dB.

Several other signals are applied to the summing junction. Each input independently moves the trace an amount corresponding to the current applied. The inputs are: (1) HIGH LEVEL cal, (2) The four ratio inputs, (3) The OFFSET switch current, (4) The dBm calibration adjustment, (5) A resistive divider R13 and R14 to cause 0 dBm to be the reference when dBm is depressed, and (6) The output of the REFERENCE control through R13 when dBm is not depressed. Integrated amplifier U2 amplifies the currents at the junction and converts the sum to voltage.

5.4.5 SENSITIVITY CONTROL CIRCUIT

The integrated amplifier U3 has its input and feedback circuits controlled by logic signals derived from the front panel dB/DIV switches. Its output swing is limited by the action of Q6 and Q7 so that its recovery time following an overload will be short. The four gates of U5 are connected to generate a three big logic code convenient for the control of the FET switches which determine the gain of the circuit. The basic gain of the circuit is one-half and gives 1 dB/DIV. Q4 increases the gain by a factor of 2 when active (on the .5, .1, and 5 dB/DIV ranges). Q3 increases the gain by an additional factor of 5 on the 0.1 dB/DIV range. Q5 reduces the feedback resistor by a factor of ten resulting in an equivalent gain reduction on the 5 and 10 dB/DIV ranges. The signal from U3 goes to U4 for output to the display, except when MEMORY is selected for display, in which case Q8 is opened and the input to U4 is on pin 2 from the memory. The REF LINE position current feeds pin 2 of U4 also, except that the front panel switches disconnect it for MEMORY or ACCESS MEMORY.

5.4.6 ISOLATED POWER SUPPLY

Power to run the isolated circuits comes from an oscillator-type power supply. Q14 and Q15 obtain positive feedback base drive from T1. The action of T1 is to supply base current to whichever transistor is turned on until the transformer saturates. At the saturation point the base-drive winding is effectively uncoupled from the primary. Without base drive, the previously conducting transistor stops conducting so the primary current drops, allowing the magnetic field to start to collapse. The collapsing magnetic field induces a voltage of the opposite polarity in the base-drive winding causing the previously nonconducting transistor to switch on. This new state continues until the transformer is saturated in the new direction, then the process repeats. The frequency of operation is about 20 kHz.

A bridge rectifier supplies dc from the secondary to the isolated circuits. Voltage breakdown diodes CR7 and CR8 provide precisely regulated sources of + and -6.2 V to critical points. RC filter networks remove ac ripple and spikes on the secondary side and an LC filter keeps ac currents from disturbing the +15 V primary supply.

5.4.7 OVEN CONTROLLER

The oven controller maintains the temperature of the oven at 60°C. At that temperature the thermistor in the oven resistance has changed from its 25°C value of 100 kΩ to a value equal to R56, or 23.7 kΩ. At this value the two inputs to the amplifier, U6, are equal. If the oven cools slightly, the value of the thermistor increases causing the output of the amplifier to move positive increasing the current through Q12 and Q13. This causes Q13 to generate more heat, returning the oven to the proper temperature so that the thermistor circuit is once more in balance. At equilibrium, the circuit is just slightly off balance and the transistor supplies just enough heat to account for the heat loss to the surroundings.

5.5 MEMORY CIRCUIT BLOCK DESCRIPTIONS

The following material relates to those units equipped with memory. The memory block diagram is shown in Figure 5-2 and the schematic diagrams are found in Section 7.

5.5.1 MEMORY CONTROL LOGIC

The purpose of the Memory Control Logic is to provide signals which cause the memory to load new data for one horizontal sweep and to control the flow of data through the two multiplexors.

The inputs from the buttons STORE REF 1 and STORE AVG REF 1 & 2 are latched so that the button need only be depressed for an instant to cause storage to take place. U16A and U16B perform this function for STORE REF 1; U2A does it for STORE AVG REF 1 & 2. If either of the store buttons are pressed during a sweep, nothing happens until the end of that sweep but then storage starts. If either of the latched requests to store are high, U4A or U4B will respond to the OSP signal at its 'T' input, transferring the request to its output. This occurs at the end of a sweep, generating either the *Load 1* or the *Load 2* signal. These signals immediately clear their respective store button latch so that when OSP again occurs at the end of the next sweep the *Load* signal will be terminated. Thus, the *Load* signal will be true for just one sweep following a request to store. In the case of STORE REF 1, holding the button down has the effect of repeating the request, so loading is repeated. However, as soon as the button is released, loading will stop at the end of the current sweep.

In the case of AVG REF 1 & 2, it is important that data only be taken once after the button is pressed. Otherwise, data will continue to be averaged with itself instead of the data stored as REF 1. To insure that there will be no bounce from the button, U20A generates a 1.2μs pulse to buffer the storage circuits from the button. In addition, it is disabled through its 'Not Clear' input after recording so that it cannot be triggered until STORE REF 1 has been pressed. This signal comes by way of gate U3B from the Memory Status Register, U15A and U15B.

The Memory Status Register has three states; nothing stored, REF 1 stored and AVG REG 1 & 2 stored. Each latch is cleared by either 'power on' or the alternate memory state. U5A and U5B generate these signals. The appropriate latch is clocked by *Load 1* or *Load 2* to indicate the status. The latches cannot be set unless ACCESS MEMORY has been depressed. As soon as the *Load* signal goes away at the end of the sweep, gates U3A and U3B transmit the status to the indicator lamps. Therefore, the indicator lamps will indicate nothing stored after power is applied until STORE REF 1 is pressed; then the REF 1 indicator will light. When STORE AVG REF 1 & 2 is pressed, the first indicator will go out during the sweep during which storing is taking place, then the AVG REF 1 & 2 indicator will light.

5.5.2 dB/DIV REGISTER AND LOGIC-CONTROLLED ATTENUATOR

Latches U1A, U1B and U2B store the dB/DIV functions S_0, S_1, and S_2 which come from U5 of A2 (see Section 5.4.5). The data at the D inputs of the latches are transferred when the output of U5C goes up at the beginning of the recording process and it remains at the outputs of the latches until another recording is made. The latches drive the Logic-Controlled Attenuator.

In the logic controlled attenuator, transistors Q4 through Q7 operate FET switches which change the attenuation. Minimum attenuation occurs when Q11 and Q12 are on and all other switches are off; this happens on the 10 dB/DIV setting. Attenuation increases by a factor of 2 when Q13 goes on and Q12 is off; this happens on the 5 dB/DIV, .5 dB/DIV and .1 dB/DIV settings. Attenuation increases by a factor of 10 when Q14 turns on; this happens on ranges more sensitive than 5 or 10 dB/DIV. Attenuation increases by an additional factor of 5 when Q11 opens on the .1 dB/DIV range. Each attenuation factor is independent of the others and more than one part of the attenuator may be in use at any one time.

A similar drive circuit controls Q10. When Q10 is on, the signal from the attenuator is connected to the offset summing point on A2, and corrections from the memory are effective. Q10 is on when in the MEMORY, INPUT MINUS MEMORY modes, or when recording. In INPUT-MEMORY mode or while loading the memory, Q10 is turned on by Q8. In the MEMORY display mode, Q15 is turned on by Q9 to send a signal directly to A2U4. In addition the function "control A" is generated by Q16 to disconnect the other signals to A2U4.

5.5.3 SUCCESSIVE APPROXIMATION LOGIC AND MEMORY ADVANCE TIMING

The Successive Approximation Register is reset to start a conversion. This sets all outputs high except for the most significant one. If the comparator is high during the first clock pulse following reset, the most significant bit will be set high and the next most significant bit reset and then on the following clock pulse that bit will be set low or high depending upon the comparator's state. This proceeds through all eight bits. For a complete description of this process see *Linear Data Book*, National Semiconductor Corporation, 1976, pages 8-14. At the end of the process, the Register has data corresponding to the negative of the signal displayed.

The Successive Approximation Register is told to start a conversion and the memory location is advanced by a signal from the Horizontal Plug-in, INC. It is required to advance the shift register to move the previously converted data before the next conversion is started. Use is made of the fact that the register will not reset until the leading edge of the clock pulse following a start command. As it happens, INC occurs at the trailing edge of the clock and the leading edge of the next clock will not occur for about 2.5 μs. By using the leading of INC to trigger the Register Advance One-Shot, U20B, a 1 μs pulse is generated to advance the shift register. Thus, the shift register is advanced about 1.5 μs ahead of the resetting of the data.

SECTION 6

MAINTENANCE

6.1 PERIODIC MAINTENANCE

The following maintenance should be performed once a year unless the instrument is operated in an extremely dirty or chemically contaminated environment or is subjected to severe abuse. In such cases, more frequent maintenance is indicated.

a. Blow out all accumulated dust with forced air under moderate pressure.

b. Inspect the instrument for loose wires and damaged components. Check to see that all wire lead connectors are properly seated on their PC board pins.

c. Make a performance check in accordance with the procedure of Section 4. If the performance is within specifications no further service is required.

6.2 INTERNAL ADJUSTMENTS AND TEST POINTS

The following is a list of adjustments and test points supplied for ready reference. *Do not attempt to make any adjustment until you have carefully read the material in Section 6.3.*

6.2.1 DESCRIPTION OF ADJUSTMENTS

The function of each adjustment is described below.

a. A2C88, CHOPPER COMPENSATION. Used to balance the capacity of the two FETs used in the pre-amplifier chopper. Adjust for correct phase at TP211.

b. A2R6, OFFSET CAL. Used to adjust the signal from the log amplifier so that it matches the current from the OFFSET switch.

c. A2R21, 0 dBm CAL. Used to set the absolute calibration of the instrument with the front panel HIGH LEVEL adjustment centered.

d. A2R28, OUTPUT ZERO. Used to center the trace for 10 dB/DIV.

e. A2R79, SECOND STAGE INPUT NULL. Used to set the voltage measured at TP207 to 0 V within 10 µV.

f. A2R85, -27 dBm CALIBRATION ADJUSTMENT. Used to adjust the compensation amplifier so that it just becomes active at -27 dBm RF input.

g. A2R89, MEDIUM LEVEL CALIBRATION ADJUSTMENT. Used to adjust the compensation circuit for correct amplitude tracking at RF input levels near 0 dBm.

h. A2R94, MAXIMUM LEVEL CALIBRATION ADJUSTMENT. Used to adjust the compensation circuit for correct amplitude tracking at RF input levels near +10 dBm.

i. A2R163, PRE-AMPLIFIER CHOPPER BALANCE. Used to adjust the pre-amplifier for minimum chopper frequency noise signal.

j. A2R181, PRE-AMPLIFIER COARSE ZERO. Used to adjust the pre-amplifier for zero output voltage with no RF power applied to the detector and the NOISE LEVEL control centered in its range.

k. A2R186, FREQUENCY RESPONSE. Used to set the pre-amplifier for minimum settling time when the input RF signal is changed abruptly from +10 dBm to -50 dBm.

l. A327, MEMORY ZERO. (Units with memory only.) Used to set the memory so that the recorded reference line is displayed on the line set by the REF LINE switch.

m. A4R1 (or A2R72 on units with code 04 or higher) +10 dBm COMPENSATION. Used to correct amplitude tracking at +10 dBm.

6.2.2 DESCRIPTION OF TEST POINTS

The signal available at each test point or its function is described below.

a. A2J1 (TP201), +5 Vdc LOGIC SUPPLY. Measure between TP201 and Ground, TP203. Voltage should be +5 V ±0.2 V. Can also be used to power a logic probe.

b. A2J2 (TP202), OFFSET AMPLIFIER OUTPUT. Used to monitor the operation of the circuits ahead of the offset amplifier. Voltage coefficient should be 100 mV/dB within about one percent.

c. A2J3 (TP203), GROUND. Used as a reference point for measurements on the grounded portions of the circuit.

d. A2J4 (TP204), OVEN CURRENT MONITOR POINT. The oven current can be measured here by subtracting the test point voltage from 15 V and dividing by 11 ohms.

NOTE: THE FOLLOWING TEST POINTS ARE MEASURED WITH RESPECT TO THE FLOATING COMMON, TP209.

e. A2J5 (TP205), +15 Vdc ISOLATED SUPPLY.

Nominal 15 V supply, actual voltage will be between 14.4 to 14.8 Vdc.

f. A2J6 (TP206), -15 Vdc ISOLATED SUPPLY. Nominal -15 V supply, actual voltage will be between -14.4 and -14.8 Vdc.

g. A2J7 (TP207), SECOND STAGE SUMMING JUNCTION. Measure with a sensitive voltmeter. Set A2R79 so that the voltage is within 10 µV of zero.

h. A2J8 (TP208), COMPENSATION AMPLIFIER FIRST STAGE OUTPUT. Used to monitor the operation of the compensation amplifier, particularly when adjusting A2R85. Adjust so that the polarity of the voltage measured changes as the RF input signal goes through -27 dBm.

i. A2J9 (TP209), INPUT CURCUIT FLOATING COMMON.

j. A2J10 (TP210), CHOPPER FREQUENCY. Use a frequency counter with a high input impedance. The frequency should be 1 kHz within 30 Hz.

k. A2J11 (TP211), CHOPPER DEMODULATOR INPUT. Used to monitor the action of the preamplifier chopper circuit when setting A2C88. Monitor with an oscilloscope and set for minimum signal and spikes lying at the zero-crossing points on the sinewave.

l. A2J13 (TP213), PRE-AMPLIFIER OUTPUT. Measure with a sensitive voltmeter. With no RF signal applied to the detector, adjust A2R181 for 0 Vdc within 10 µV. The NOISE LEVEL control should be centered when this is done.

m. A3J1 (TP31), +5 Vdc LOGIC SUPPLY. Measure between TP31 and logic ground TP34. Voltage should be +5 V ±0.2 V. Can also be used to power a logic probe.

n. A3J2 (TP32), DIGITAL TO ANALOG CONVERTER OUTPUT. Used to monitor the action of the digital to analog converter. Depending upon the digital word at the input to the D to A converter, the voltage will be between the limits of -4 and +4 V.

o. A3J3 (TP33), COMPARATOR OUTPUT. Used to monitor the action of the voltage comparator in the analog to digital converter.

p. A3J4 (TP34), INCREMENT PULSE (INC). A pulse appears here each time the memory address is incremented. Useful to trigger a monitor scope.

q. A3J5 (TP35), -12 Vdc SUPPLY. The voltage will be -12 Vdc within 0.2 V.

r. A3J6 (TP 36), LOGIC GROUND.

6.3 CALIBRATION

6.3.1 EQUIPMENT REQUIRED FOR CALIBRATION

The following equipment is required in order to perform the calibration procedure.

a. Pacific Measurements Model 1038 Mainframe and Display. The display section can be of any type supplied with the Mainframe. It is important that the Unit be correctly calibrated, as its calibration affects that of the plug-in to be tested.

b. Pacific Measurements Power Detector Cable, Part No. 12868.

c. Pacific Measurements Model 1038, Horizontal Plug-In. For calibrating units with memory, the Horizontal Plug-In must have memory drive capability. The calibrator should put out 10 mW, if you are calibrating with a detector, step o. It is important that the Horizontal Plug-In be properly calibrated before using it as part of the calibration set-up for the Vertical Plug-In.

d. An oscilloscope with 5 mV/Division sensitivity and at least 100 kHz bandwidth.

e. A Digital Voltmeter with 5-1/2 digit resolution and 1 µV per digit resolution. For example, Data Precision Model 2540A1.

f. A Precision Power Supply with 10 µV resolution in the range from 1 mV to 1 V. For example, John Fluke Model 382A Voltage/Current Calibrator.

g. An attenuator made up of resistors as shown in Figure 6-1. The circuit can be conveniently constructed in a small phenolic box such as Pomona Electronics Model 2098. The box is equipped with banana plugs and jacks; since the output will connect to a BNC plug, a Double Banana to BNC adapter will be needed.

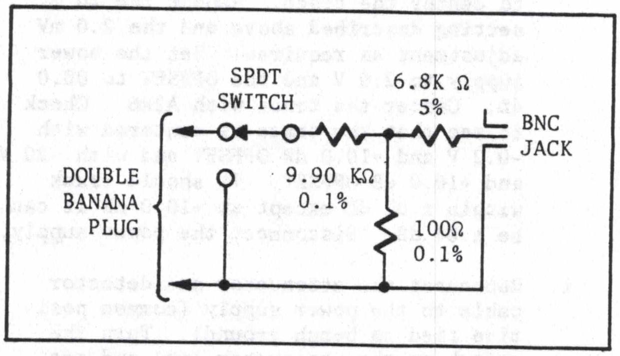
h. This item is required for calibration of units with memory. A Low Frequency Function Generator capable of generating a ramp going from 0 to 10 V into 50 kilohms. The time to go from 0 to 10 V should be capable of being set to 40 ms.

i. An electronic counter capable of measuring 1 kHz. Input impedance 1 MΩ shunted by less than 100 pF.

The following items will be needed if the calibration is to be checked with an RF detector. This calibration will normally be performed if the specific RF detector with which it will normally be used is available.

j. The RF detector with which the instrument will be used. Normally this will be the Pacific Measurements detector supplied with the instrument.

k. A precision attenuator calibrated at 30 MHz. If a step attenuator is used it should have steps of 10 dB from 0 to 60 dB. Individual attenuators can be used with some sacrifice in convenience. The actual attenuation should be known to better than 0.02 dB at 30 MHz.



ATTENUATOR USED FOR CALIBRATION

FIGURE 6-1

6.3.2 CALIBRATION PROCEDURE

The components used in this instrument are extremely reliable and generate little heat. Consequently there is little drift due to component aging, and adjustments are rarely required. We therefore strongly recommend that if measurements indicate that an adjustment is set within the stated range, that you do not attempt to put it "right on". It is often the case that variations in the equipment used to test the instrument account for small differences in measured values. Other adjustments dependent upon a given adjustment will be affected if it is reset. In short, BE ABSOLUTELY SURE THAT AN ADJUSTMENT IS REALLY REQUIRED BEFORE MAKING IT.

If a component is replaced, depending upon where in the circuit it is located, only certain of the calibration steps need be performed. In general, only those steps shown in the section pertaining to the specific circuit repaired need be carried out.

It will be most convenient to gain access to the adjustments by placing the plug-in on an extender cable. Such a cable can be ordered from Pacific Measurements, Part No. 12715, Extender Cable Kit. Alternatively, place the plug-in in the middle plug-in location of the Mainframe and remove the side cover from the Mainframe/Display unit. It will be necessary to move the plug-in to the right-hand location to perform step l.

Set the horizontal plug-in to display the channel into which the vertical unit to be calibrated is connected. This will be A or B; do not use the A/B, B/A, A/REF, or B/REF. Be sure the unused channel is OFF to avoid a confusing display. Select INT operation and turn the CALIBRATOR OFF.

The steps listed below must be carried out in the order listed. It will be helpful for you to read the entire procedure once through before starting. Allow at least one-half hour warm-up before starting. If the code number of your unit is code 02 or 03, start the procedure by setting A4R1 full CCW. If your unit is code 04 or higher, set A2R72 full CCW.

a. Check the + and - 15 V isolated supplies. Measure between TP205 and TP209 then between TP206 and TP209. The magnitude of the voltage should be between 14.4 and 14.8 V. If the voltage does not fall between these limits, trouble is indicated.

b. Check the operation of the oven regulator. Measure between TP204 and TP203. The voltage should be approximately -13.7 V immediately after turn-on, dropping to about -14.7 V after 1 to 5 minutes (depending upon the ambient temperature and how long the oven has been turned off). Operation markedly different from the above is an indication of trouble with the oven circuit.

c. Using the electronic counter, measure the frequency at TP210 with the common lead of the counter connected to TP209. The frequency should be 1 kHz within 30 Hz. If not, A2R166 can be changed to correct it.

d. Connect the Power Detector Cable to the DETECTOR INPUT and connect the BNC end of the cable to the attenuator described in Section 6.3.1g. Turn the switch on the attenuator to the 'off' position. Set the attenuator and detector cable assembly on an insulated surface not connected to ground. Connect the input of the oscilloscope to TP211 and the ground lead of the oscilloscope to TP209. Be sure that the oscilloscope and the Model 1038 both have their chassis grounded through the 3 prong power cords.

Connect a trigger input lead from the external trigger connection of the oscilloscope to TP210, set the sweep to 0.5 ms/DIV and adjust the trigger level control on the scope to obtain a stable display. Set the input sensitivity to 5 or 10 mV/DIV as desired.

Adjust A2C88 (use an insulated tool) to

obtain the minimum signal viewed by the scope. When the correct adjustment is obtained the sharp spikes on the waveform should be centered on the zero-crossing points of the sinewave. See Figure 6-2, which shows the waveform at that point. Since the capacitance of the tool will slightly affect the waveform, be sure that you look at it with the tool removed to check the final adjustment. Disconnect the oscilloscope.

e. Connect the attenuator input to the power supply. The positive terminal of the supply should be connected to the common side of the attenuator and tied to bench ground. Leave the switch on the attenuator set to 'off'. Set the power supply to 0 V. Connect the voltmeter input to TP213 and the low side of the voltmeter to TP209. The voltmeter should be floating free of ground. Adjust A2R181 to obtain 0 V within 10 µV.

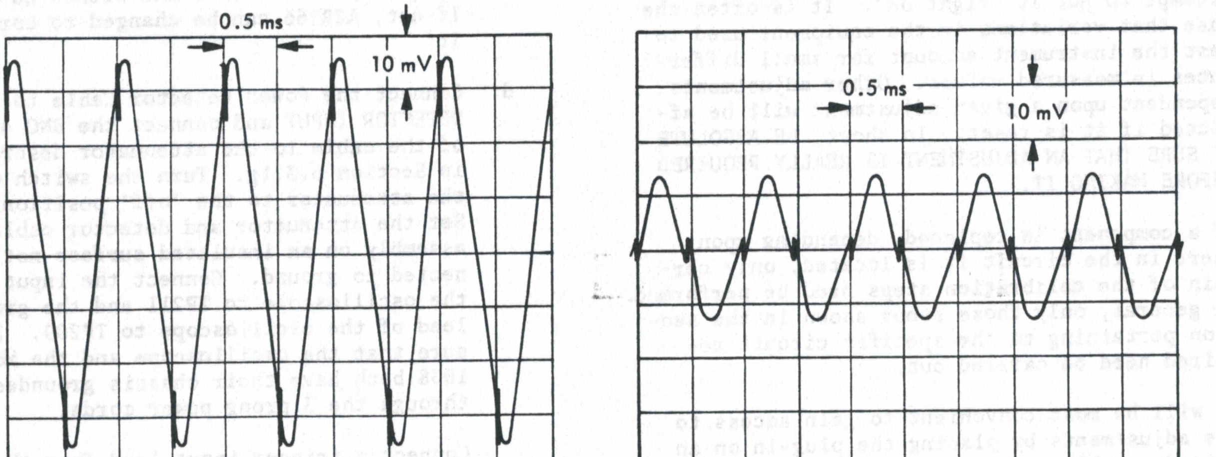
f. Move the voltmeter input to TP207 and adjust A2R79 to obtain 0 V within 10 µV.

g. Move the voltmeter input to TP208 and reduce the sensitivity to 1 V full scale. Set the power supply to 0.140 V and turn the switch on the attenuator to 'on'. Adjust A2R85 for -.45 to -.49 V at TP208. Remove the voltmeter and return the attenuator switch to 'off'. Remove the attenuator from the supply and set it on an insulated place.

h. Connect the negative side of the power supply to TP207 and the positive side (which should also be connected to earth ground) to TP209. Set the supply to 20 mV. Press the INPUT dB button, set the OFFSET to -20.0 dB. Use the REFERENCE control to center the trace. When the final centering adjustment is made, the REF LINE switch should be in the center and the 0.1 dB/DIV switch depressed. Set the supply to -2.0 mV and the OFFSET to -30 and adjust the NOISE LEVEL control to center the trace. Repeat the 20 mV setting described above and the 2.0 mV adjustment as required. Set the power supply to 2.0 V and the OFFSET to 00.0 dB. Center the trace with A2R6. Check to see that the trace is centered with -0.2 V and -10.0 dB OFFSET and with -20 V and +10.0 dB OFFSET. It should track within ±.02 dB except at +10.0 dB it can be ±.04 dB. Disconnect the power supply.

i. Reconnect the attenuator and detector cable to the power supply (common positive tied to bench ground). Turn the switch on the attenuator 'on' and set the power supply to 0.070 V.

Set the OFFSET switches to -30. Press the dB button and center the trace using the REFERENCE control. Make the final adjustment on 0.1 dB/DIV. Be sure that the REF LINE switch is centered. Set the power supply to -7 mV and the OFFSET switches to -40.0 dB. Center the trace



TP211 WITH A2C88 INCORRECTLY ADJUSTED

FIGURE 6-2a

TP211 WITH A2C88 CORRECTLY ADJUSTED

FIGURE 6-2b

WAVEFORMS AT TP211

FIGURE 6-2

with the NOISE LEVEL control. Remove the attenuator and connect the detector cable directly to the power supply, observing the same polarity as with the attenuator. Set the OFFSET to -00.0 dB and the power supply to 0.228 V.

In making the following adjustments it will be easiest to start using 1 dB/DIV then, as the adjustment improves, increasing the sensitivity to 0.1 dB/DIV. The final adjustment must be made at 0.1 dB/DIV.

Adjust A2R89 to center the trace. Increase the voltage to 0.844 V and set the OFFSET +10.0 dB. Note where the trace is with respect to the center line. Adjust A2R94 so that the trace moves to a point *five times* as far on the opposite of the center line as it had been. For example, if the trace is found to be 0.1 dB above the center line, it should be adjusted to be 0.5 dB below the line. Now return to 0.228 V and recenter the line using A2R89. Repeat this procedure until the line is centered for both 0.229 V and 0.844 V at 0.1 dB/DIV with the respective OFFSET settings. When finished, leave the voltage at 0.228 V.

j. Adjust the front panel HIGH LEVEL control to the center of its range. Press the INPUT dBm button, set the OFFSET to 00.0 and adjust A2R21 to center the trace. The final adjustment should be made using the 0.1 dB/DIV sensitivity.

k. When finished with step j, the trace should be centered on the 0.1 dB/DIV range. Press the 10 dB/DIV button and adjust A2R28 to recenter the trace. The adjustment has relatively limited range and when it is adjusted correctly the trace should go right across the center graticule mark.

l. Connect the function generator to the input to the horizontal plug-in. Set the generator and the controls on the horizontal plug-in to give a linear (ramp) sweep that just covers the screen at 40 ms per sweep. That is, 4 ms per screen division. Since the retrace time is substantial for most function generators, this will be a sweep repetition frequency somewhat less than 16 per second. Press the 10 dB/DIV and ACCESS MEMORY buttons. Adjust the REFERENCE control to put the trace on the screen. Momentarily press the PRESS TO STORE REF 1 button. Press INPUT MINUS MEMORY and 1 dB/DIV buttons. If the trace is not centered, slightly reset A3R27 and repeat this step. It is normal to see small deviations due to the resolution of the memory.

m. Connect the detector cable to the attenuator and the attenuator to the power supply (positive ground). Set the power supply to 0 V and the attenuator switch to 'off'. Adjust the front panel NOISE LEVEL control (see Section 3.3.2b--the attenuator replaces the detector). Turn the attenuator switch to 'on' and set the power supply to 7 mV. Press the 5 dB/DIV button and bring the trace on screen with the OFFSET switch. Adjust A2R163 for minimum 1 kHz noise.

n. Set the power supply to 22.9 V and press the 10 dB/DIV button. Turn the switch off and observe the action. The trace should move rapidly for 40 dB then settle slowly downward. It may be necessary to reposition the trace to see the entire movement. Adjust A2R186 so that when the switch is turned off you see the best response without excessive overshoot.

If you have the detector with which the plug-in will be used you can improve the tracking with that detector. The following procedure will adjust the instrument for optimum tracking with a specific detector. NOTE: The adjustments called for can be made through holes in the right hand cover of the plug-in.

o. Connect the detector to the DETECTOR INPUT. Screw the detector to the precision attenuator of Section 6.3.1j. Connect the input of the attenuator to the CALIBRATOR OUTPUT of the horizontal plug-in. Set the attenuator for 40 dB. With the calibrator turned off, adjust the NOISE LEVEL control per Section 3.3.2b.

Turn the calibrator on, press dBm, set the OFFSET switch to -30 and adjust the HIGH LEVEL control so that the trace is as much above or below the reference line as is called for by the calibration data for the attenuator. The final adjustment should be done on the 0.1 dB/DIV setting. Set the attenuator to 10 dB and the OFFSET to 00.0. If necessary, slightly readjust A2R89 to bring the trace as much above or below the reference line as called for by the attenuator calibration data. Repeat at 0 attenuation and +10.0 OFFSET, adjusting A4R1 (or A2R72 on units with code 04 or higher) if necessary. Remove the attenuator. This step completes the calibration procedure.

6.4 TROUBLESHOOTING

In order to localize the source of trouble in an instrument such as this, it is necessary to have a rather detailed working knowledge of the instrument. You are urged to read Section 5, Circuit Description and to make use of the circuit diagrams of Section 7. Relevant dc voltages are shown on the schematic diagrams and are typical of values to be found during normal operation. The data were taken with a digital voltmeter with 10 M ohm input impedance. The detector was connected to the calibrator of a horizontal plug-in and the calibrator turned on. The display switches of the horizontal plug-in were set so the channel under test was on and the other channel off. The controls of the vertical plug-in under test were set as follows:

OFFSET	00.0
SMOOTH	OFF
DISPLAY	dBm
DISPLAY	10 dB/DIV
REF LINE	CENTER LINE

In general, dc voltages will not be shown at points where they will vary substantially depending upon the mode of operation. In many cases, such points will have a waveform shown. Figures 6-3 and 6-4 show various waveforms.

Since the vertical plug-ins are only part of the total system, trouble in other parts of the system can lead the technician to suspect the vertical units when, in fact, the trouble is elsewhere. Be sure that the power supplies are at their correct voltage and that the deflection circuits of the mainframe are working. Also, the memory depends upon signals from the horizontal unit; be sure that these are normal.

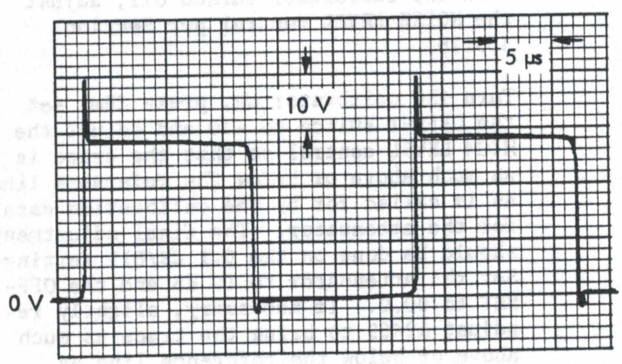
6.5 SEMICONDUCTOR DEVICES

A variety of semiconductor devices are used in this instrument. The type numbers shown are either EIA registered numbers or manufacturer's numbers. Devices meeting the corresponding specifications can be used for replacement purposes and can probably be obtained locally. Individual instruments may have equivalent devices of other manufacturers installed and the type number may not agree with those shown on the schematic diagram or parts list.

6.6 ACCESS TO INTERNAL COMPONENTS

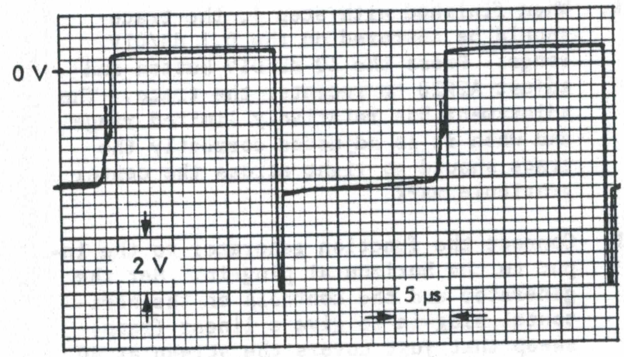
Access to the internal components is obtained by removing the side covers. The covers are retained in slots and held in place by two screws at the rear of the unit.

Access to the back side of the PC boards in units with memory is obtained by removing the screws that secure the memory board and swinging the board out on its flat flexible cable. Remove the shield between the boards if access to the rear of the amplifier board is required.



Q3 OR Q4 COLLECTOR

FIGURE 6-7a

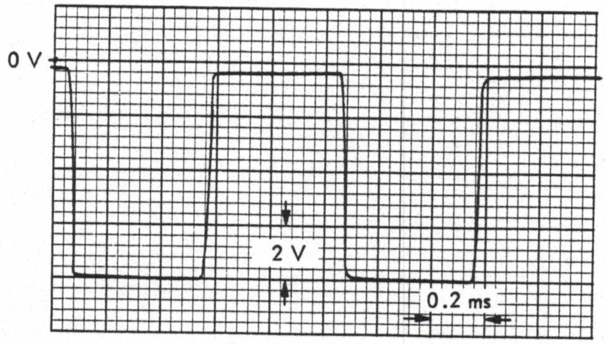


Q3 OR Q4 BASE

FIGURE 6-7b

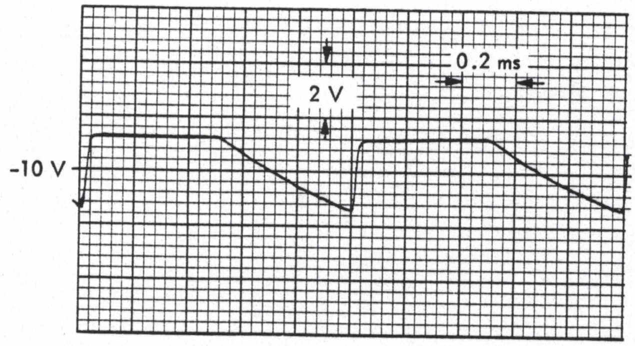
NOTE: INTERNAL TRIGGERING WAS USED.

WAVEFORMS OF THE ISOLATED POWER SUPPLY
FIGURE 6-3



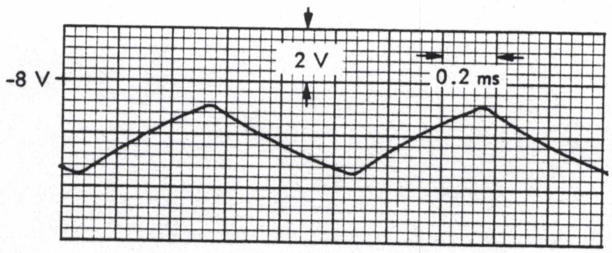
Q33 COLLECTOR
Q32 IS SIMILAR BUT OUT OF PHASE

FIGURE 6-3a



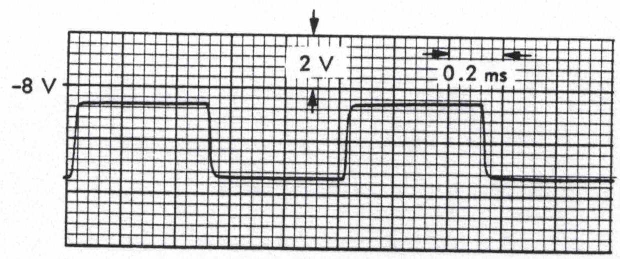
Q32 AND Q33 COMMON EMITTER

FIGURE 6-3b



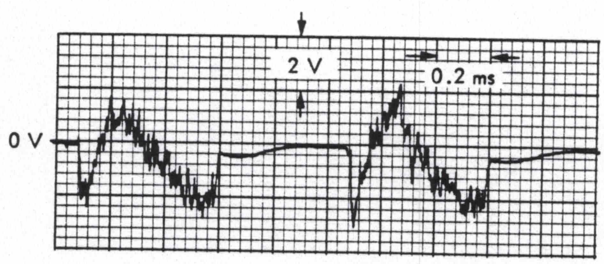
Q32 BASE

FIGURE 6-3c



Q33 BASE

FIGURE 6-3d



Q22 DRAIN

FIGURE 6-3e

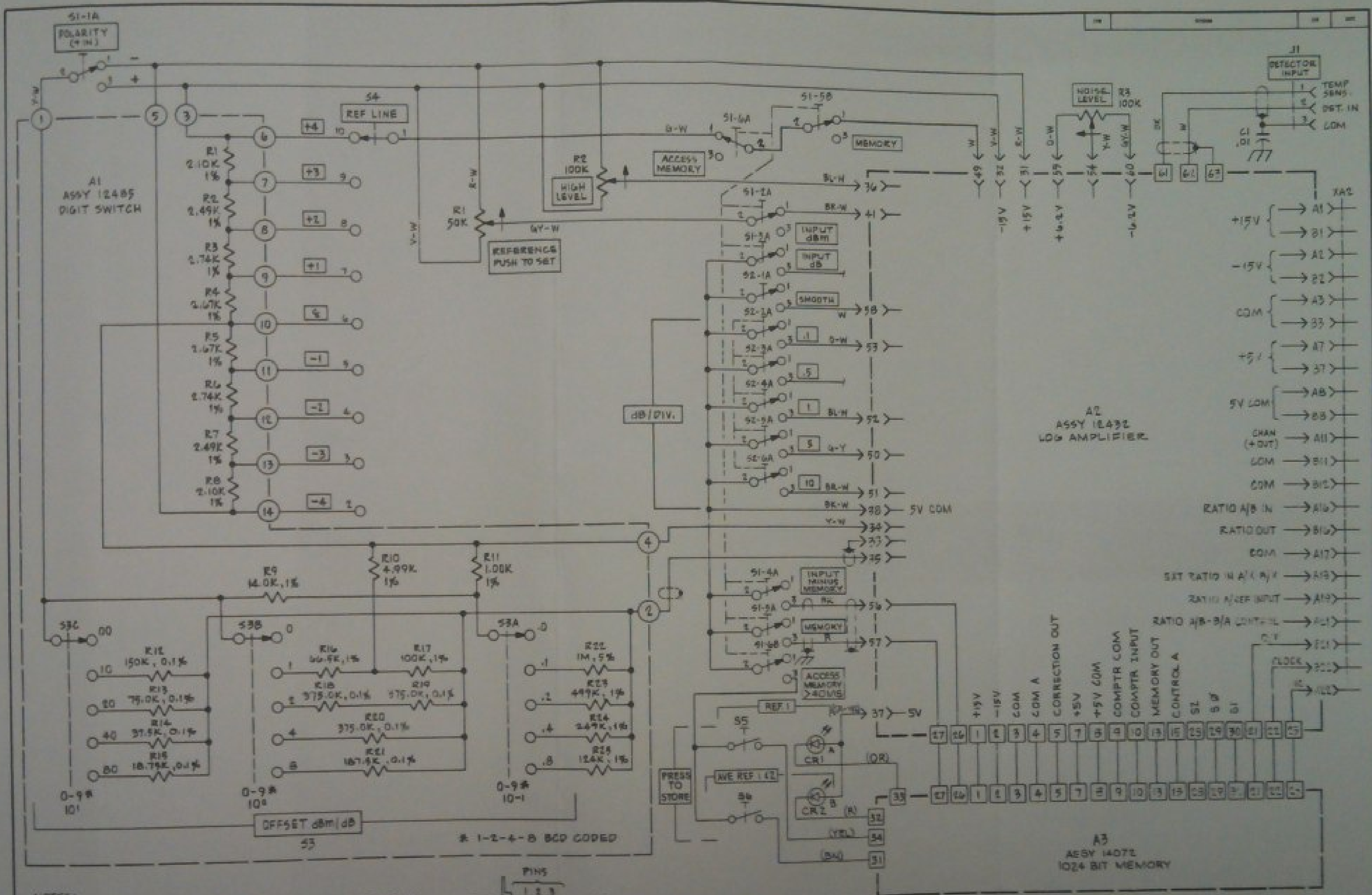
NOTE: A HIGH IMPEDANCE SCOPE PROBE WAS USED. FOR WAVEFORMS AT U14, SEE FIGURE 6-2, THE TRIGGER SOURCE WAS TP210.

WAVEFORMS OF THE CHOPPING CIRCUIT
FIGURE 6-4

SECTION 7
SCHEMATIC DIAGRAMS

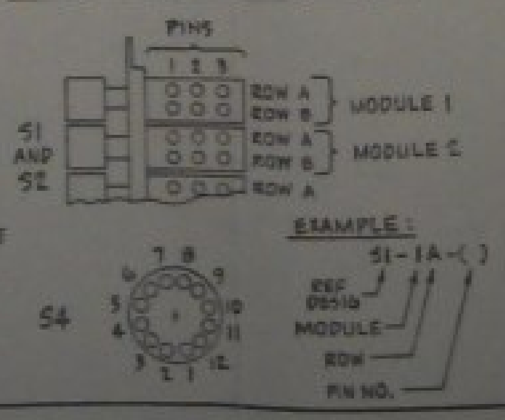
Schematic diagrams in this section are filed in the order of their reference designators.

Reference Designator	Title	Drawing Number
--	Log Amplifier/Memory	14212
A1	Digit Switch	14212
A2	Log Amplifier (4 Sheets)	12433
A3	Memory Circuit (2 Sheets)	14073



NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5%, 1/4W. CAPACITOR VALUES ARE IN MICROFARADS.
2. TERMINAL NUMBERING FOR SWITCHES S1 AND S2 ARE FOR REFERENCE ONLY. RELATIVE LOCATION OF TERMINALS IS SHOWN IN DIAGRAM AT RIGHT. SWITCHES ARE VIEWED WITH ALL BUTTONS AT OUT POSITION.
3. TERMINAL NUMBERING FOR SWITCH S4 IS FOR REFERENCE ONLY. RELATIVE LOCATION OF TERMINALS IS SHOWN IN DIAGRAM AT RIGHT. SWITCH IS SHOWN VIEWED FROM FRONT WITH KNOB IN EXTREME CW POSITION.
4. POTENTIOMETER ARROW INDICATES CW ROTATION.
5. CR1 AND CR2 ARE MV5025 LED'S.

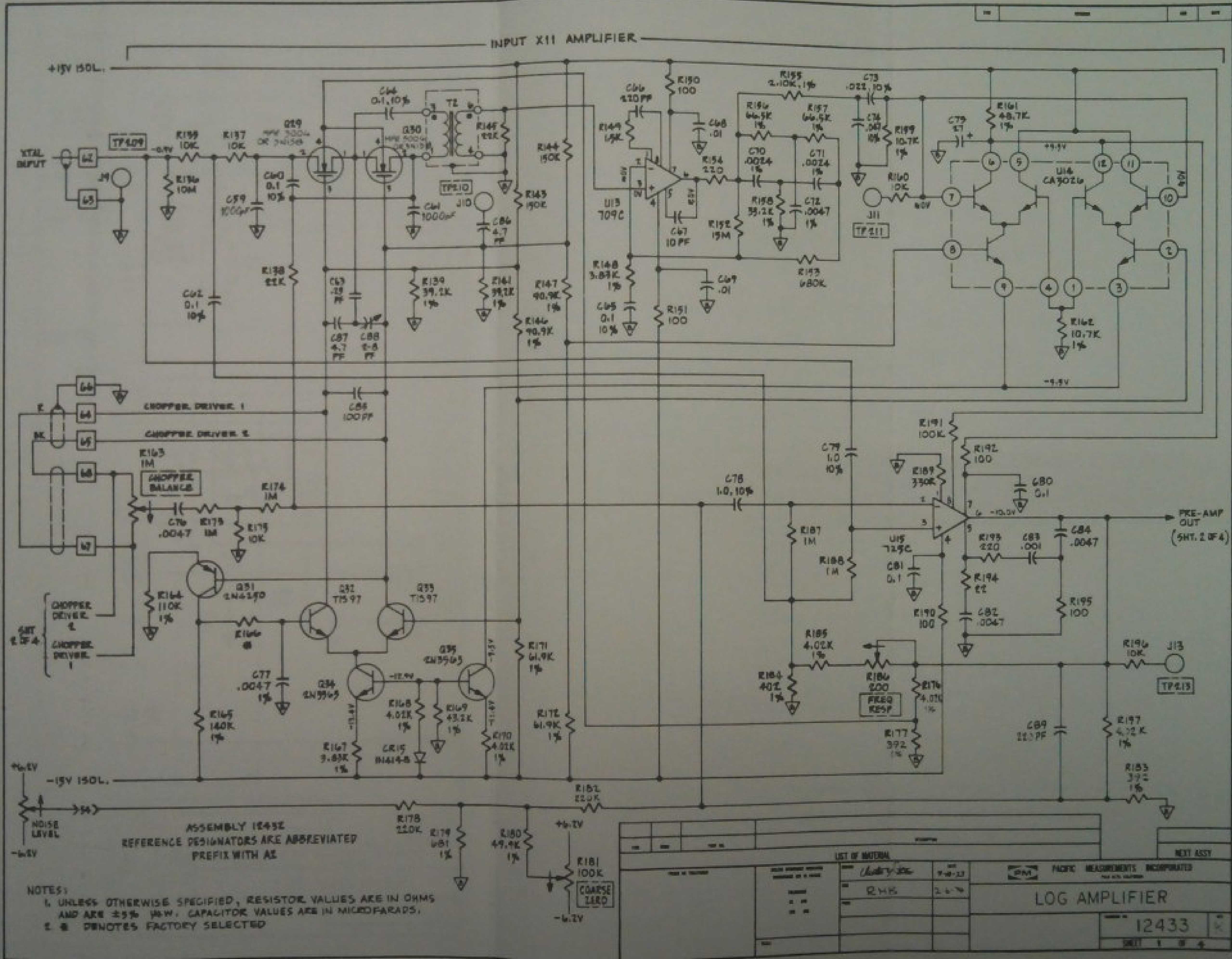


LIST OF MATERIAL

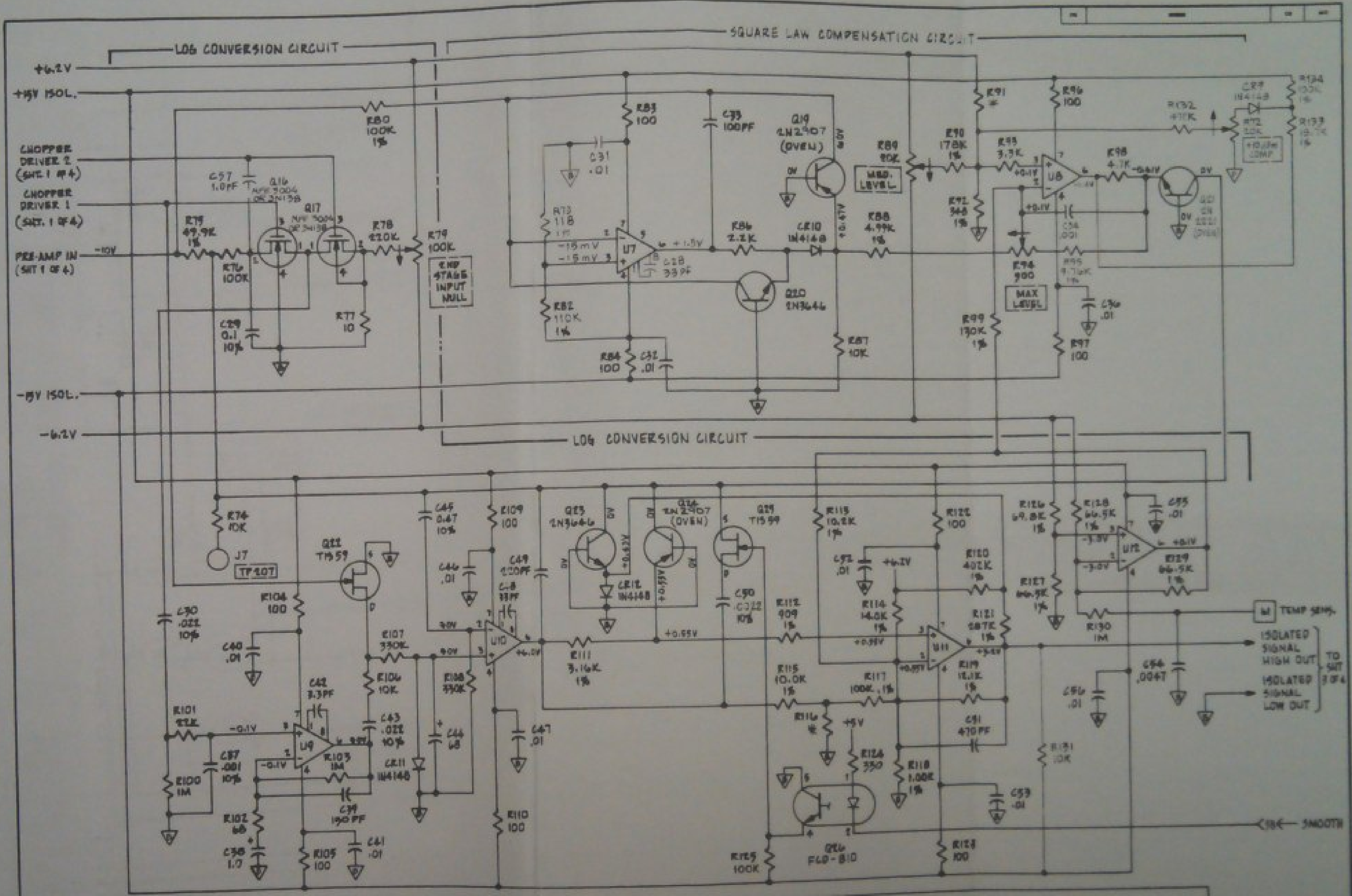
PACIFIC MEASUREMENTS INCORPORATED

LOG AMPLIFIER/MEMORY
MODEL 1038-V13

14212



INPUT X11 AMPLIFIER
+15V ISOL.
-15V ISOL.
XTAL INPUT
TP209
TP210
TP211
TP213
R133 10K
R136 10M
R137 10K
C59 100pF
C60 0.1 10%
C62 0.1 10%
Q29
Q30
C64 0.1, 10%
T2
R145 22K
C61 1000pF
J9
J10
J11
J13
C86 4.7 PF
R144 150K
R143 150K
R138 22K
C63 .25 PF
R139 39.2K 1%
R141 39.2K 1%
C87 4.7 PF
C88 2-8 PF
R147 90.9K 1%
R146 90.9K 1%
C66 220PF
R149 1.5K
R150 100
C68 .01
U13 709C
C67 10PF
R154 220
R148 3.83K 1%
C65 0.1 10%
C69 .01
R151 100
R152 15M
R155 2.10K, 1%
R156 66.5K 1%
R157 66.5K 1%
C70 .0024 1%
C71 .0024 1%
R158 33.2K 1%
C72 .0047 1%
R153 680K
C73 .022, 10%
C74 .047 10%
R159 10.7K 1%
R160 10K
R161 48.7K 1%
C75 27
U14 CA3026
R162 10.7K 1%
CHOPPER DRIVER 1
CHOPPER DRIVER 2
C85 100 PF
R163 1M
CHOPPER BALANCE
C76 .0047
R173 1M
R174 1M
R175 10K
Q31 2N4250
Q32 TIS97
Q33 TIS97
R164 110K 1%
R166 ⊕
C77 .0047 1%
Q34 2N3563
Q35 2N3563
R168 4.02K 1%
R169 43.2K 1%
R165 140K 1%
R167 3.83K 1%
CR15 IN4148
R170 4.02K 1%
R171 61.9K 1%
R172 61.9K 1%
SHT 2 OF 4
C79 1.0 10%
C78 1.0, 10%
R187 1M
R188 1M
U15 725C
C81 0.1
R191 100K
R192 100
R189 330K
C80 0.1
R193 220
C83 .001
C84 .0047
R194 22
R190 100
C82 .0047
R195 100
PRE-AMP OUT (SHT. 2 OF 4)
R185 4.02K 1%
R186 200
FREQ RESP
R184 402Ω 1%
R176 4.02K 1%
R177 392 1%
C89 220 PF
R196 10K
R197 4.02K 1%
R183 392 1%
R182 220K
R178 220K
R179 681 1%
R180 49.9K 1%
R181 100K
COARSE ZERO
+6.2V
-6.2V
NOISE LEVEL
ASSEMBLY 12432
REFERENCE DESIGNATORS ARE ABBREVIATED
PREFIX WITH A2
NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5% 1/4W. CAPACITOR VALUES ARE IN MICROFARADS.
2. ⊕ DENOTES FACTORY SELECTED
LIST OF MATERIAL
NEXT ASSY
RHB
PACIFIC MEASUREMENTS INCORPORATED
LOG AMPLIFIER
12433
SHEET 1 OF 4



ASSEMBLY 12432

REFERENCE DESIGNATORS ARE ABBREVIATED PREFIX WITH A2

NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5% 1/4W. CAPACITOR VALUES ARE IN MICROFARADS.
2. * DENOTES FACTORY SELECTED

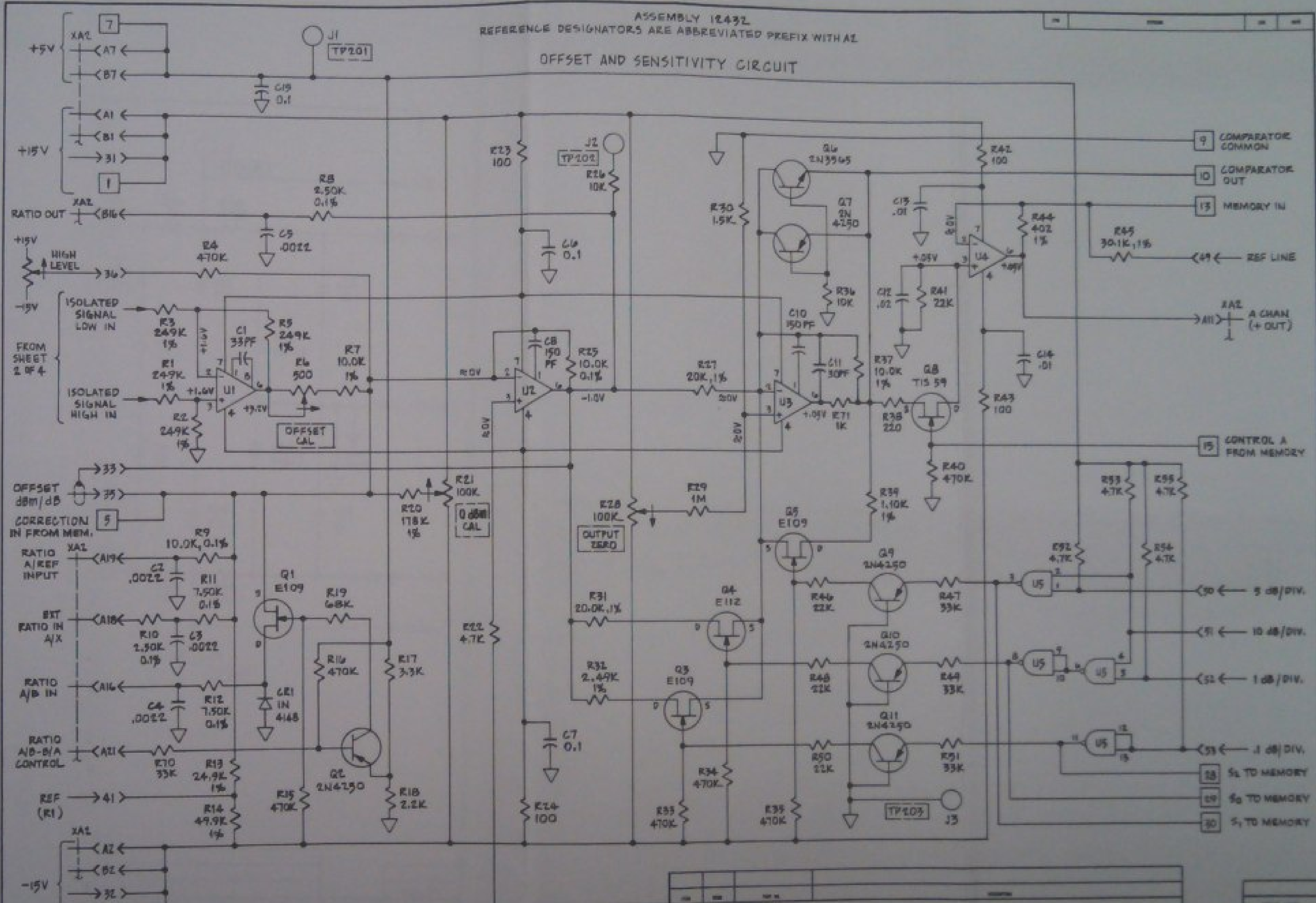
REF DESIG.	TYPE
U7	LM308AH
U9, U10	LM301A
U8 U11, U12	741C

LIST OF MATERIAL

PACIFIC MEASUREMENTS INCORPORATED

LOG AMPLIFIER

12433



LIST OF MATERIAL

REF DESIG	TYPE
U5	SN7400N
U4	741C
U3	LM301A
U2	LM301A
U1	LM301A

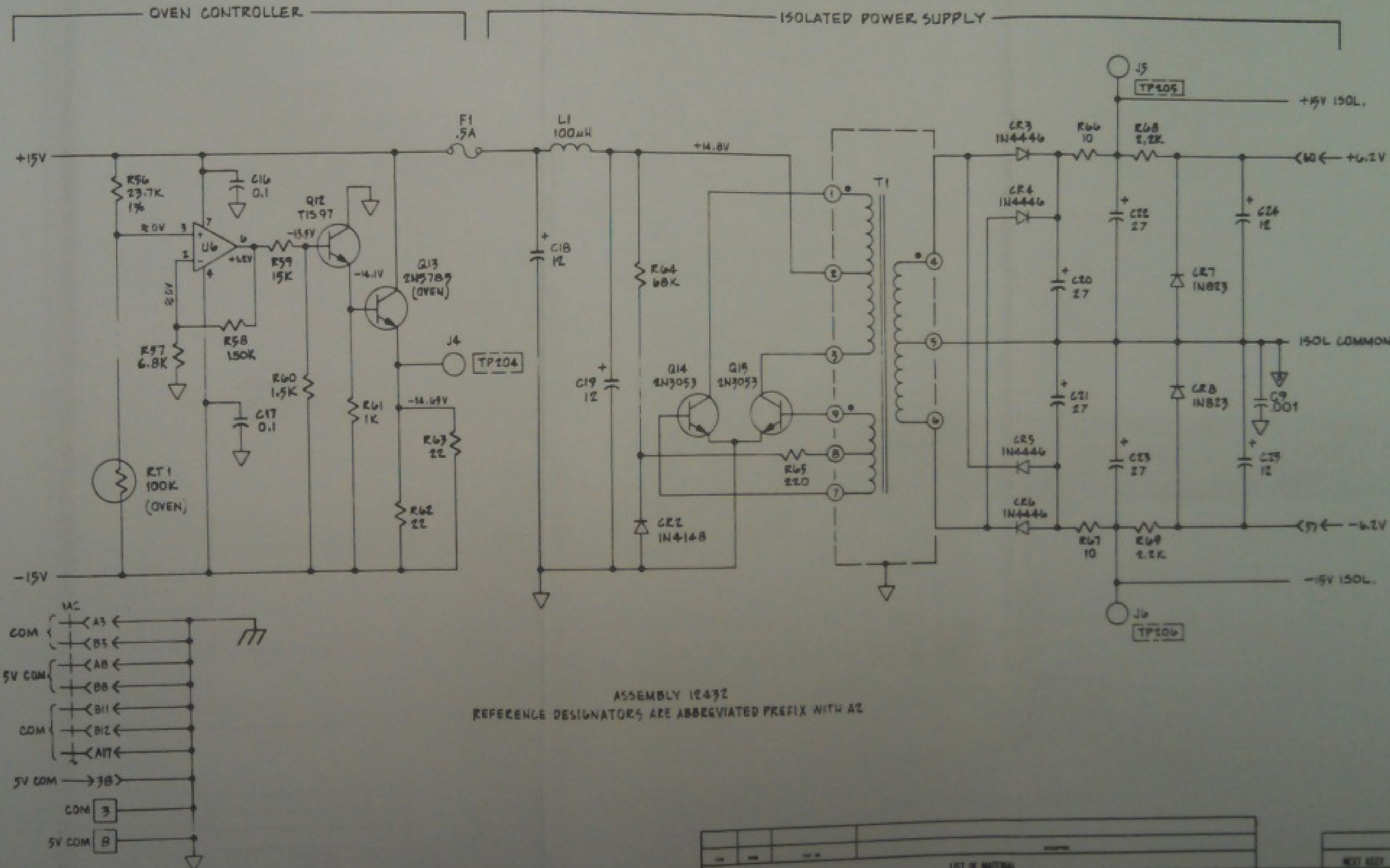
NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5% 1/4W. CAPACITOR VALUES ARE IN MICROFARADS.
2. * DENOTES FACTORY SELECTED.

PACIFIC MEASUREMENTS INCORPORATED

LOG AMPLIFIER

12433 B

SHEET 3 OF 4



ASSEMBLY 12432

REFERENCE DESIGNATORS ARE ABBREVIATED PREFIX WITH A2

NOTE

1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5% 1/4W. CAPACITOR VALUES ARE IN MICROFARADS.

U6	741C
REF DESIG	TYPE

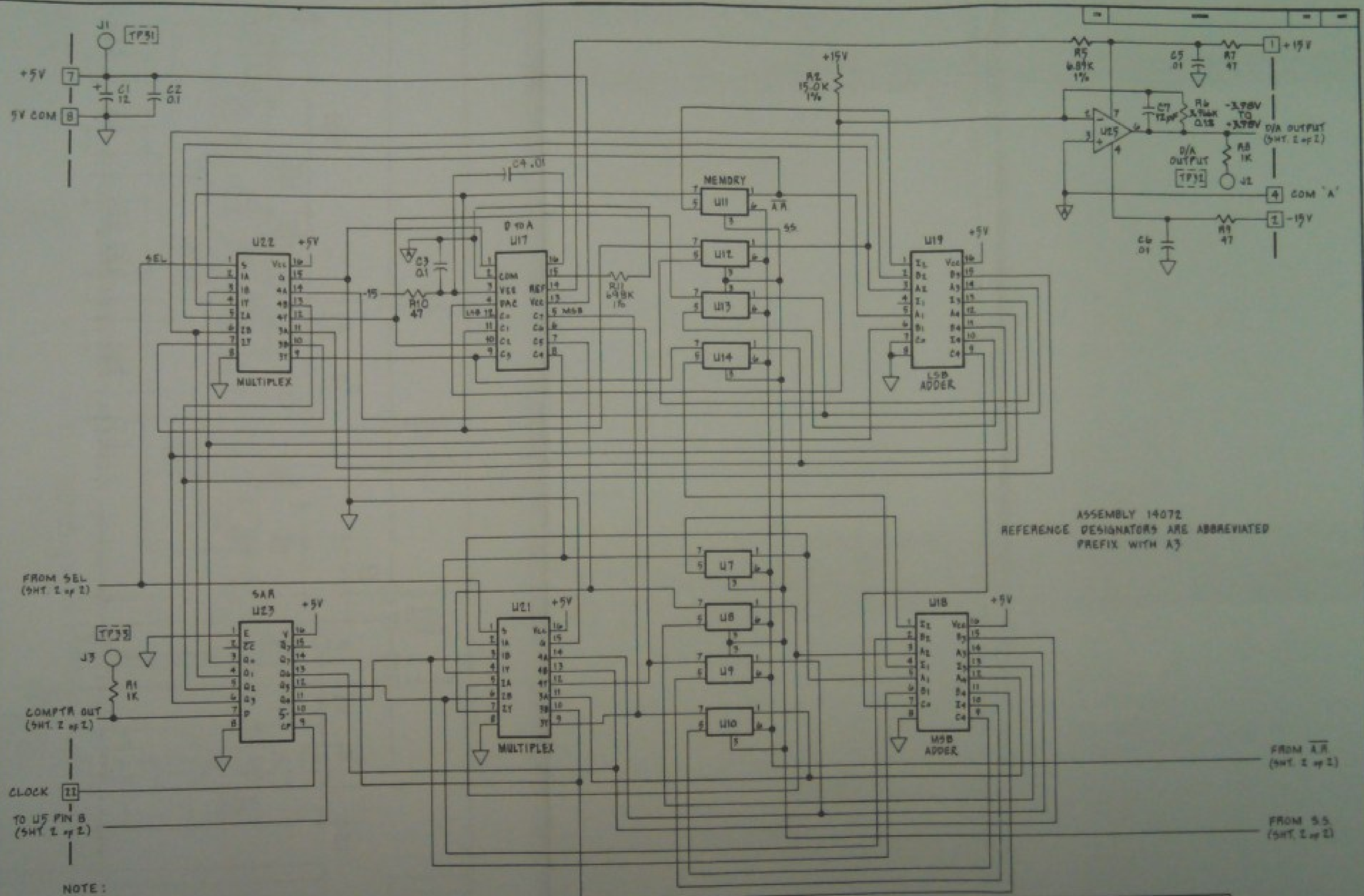
LIST OF MATERIAL

NEXT ASSY

PACIFIC MEASUREMENTS INCORPORATED

LOG AMPLIFIER

12433 E



NOTE:

UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE ±5% 1/4 WATT AND ARE IN OHMS. CAPACITOR VALUES ARE IN MICROFARADS.

REF DESIG	TYPE
U25	AD518J
U23	AM2503
U21, U22	SN74LS157N
U18, U19	SN74LS283N
U17	DAC 08EQ
U7 THRU U14	2533
U6	SN74LS04N

LIST OF MATERIAL

C4, 10 not used
R10, R11 not used

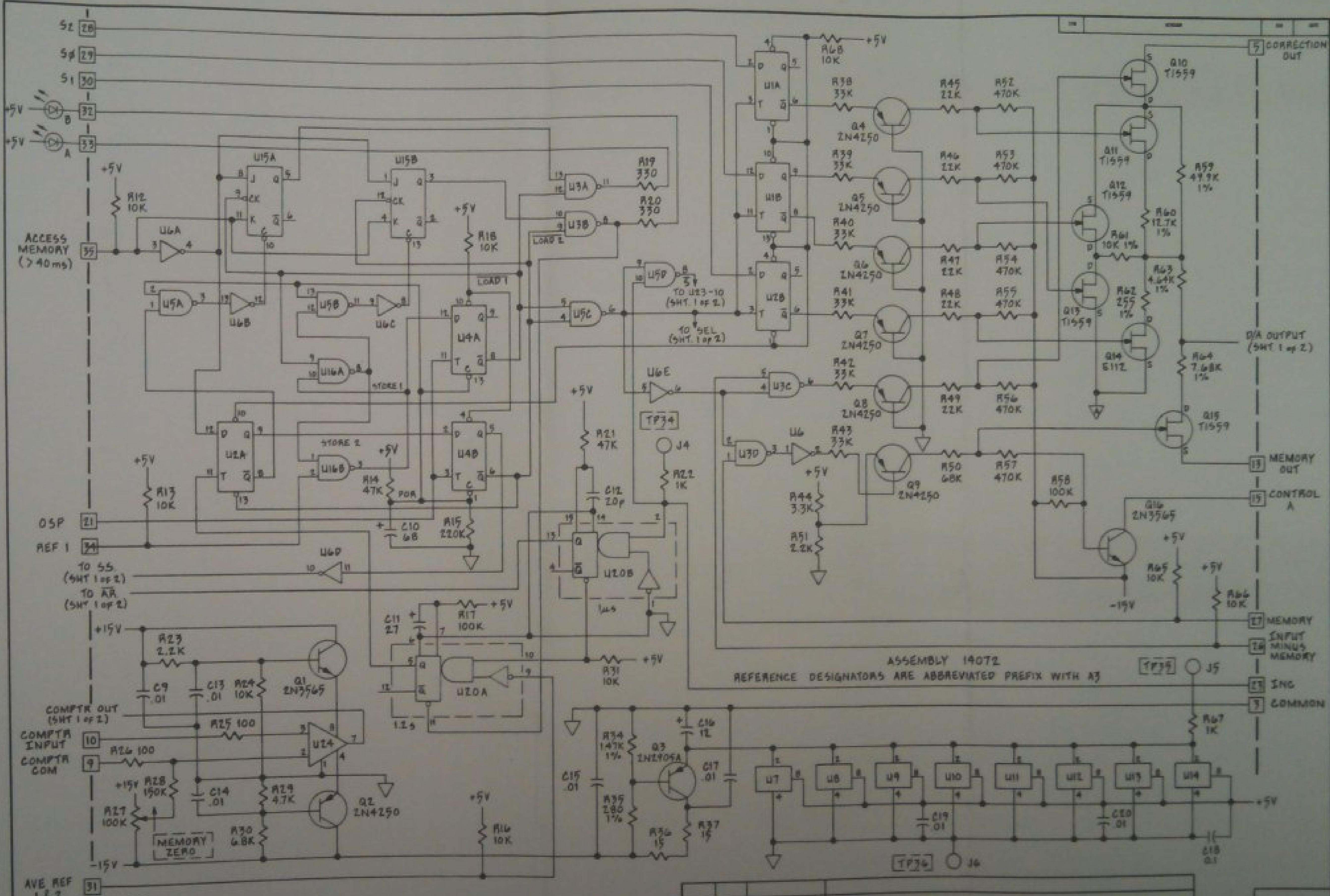
1-11-78
3-31-78

PACIFIC MEASUREMENTS INCORPORATED

MEMORY CIRCUIT-1024 BIT

14073

SHEET 1 OF 2



NOTE:

UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE ±5% 1/4 WATT AND ARE IN OHMS. CAPACITOR VALUES ARE IN MICROFARADS.

REF DESIGN	TYPE
U24	710C
U20	SN74LS123N
U15	SN74LS107N
U7 THRU U14	2533
U6	SN74LS04N
U5, U16	SN74LS00N
U3	SN7400N
U1, U2, U4	SN74LS74N

LIST OF MATERIAL

NEXT ASSY

PACIFIC MEASUREMENTS INCORPORATED

MEMORY CIRCUIT - 1024 BIT

14073

SECTION 8

REPLACEABLE PARTS LIST

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
		CHASSIS ASSEMBLY 14158
C1	10000-11	Ceramic .01 µF ±20% 100 V
CR1	12389	MV5025
CR2	12389	MV5025
J1	12564	Connector, 3 conductor audio
R1	13076	Variable 50 KΩ 10 turns
R2	11676-1	Variable 100 KΩ ±20% 1/2 W
R3	11676-1	Variable 100 KΩ ±20% 1/2 W
S1	12479	Switch, Pushbutton, 7 station
S2	12479	Switch, Pushbutton, 7 station
S3	12475	Thumbwheel, 3 station
S4	12690	Switch, Rotary SP9T
S5	12483	Switch, Momentary SPST
S6	12483	Switch, Momentary SPST
		DIGIT SWITCH PC BOARD ASSEMBLY - 12485
A1R1	10015-84	Metal Film 2.10 KΩ ±1% 1/4 W
A1R2	10015-47	Metal Film 2.49 KΩ ±1% 1/4 W
A1R3	10015-211	Metal Film 2.74 KΩ ±1% 1/4 W
A1R4	10015-79	Metal Film 2.67 KΩ ±1% 1/4 W
A1R5	10015-79	Metal Film 2.67 KΩ ±1% 1/4 W
A1R6	10015-211	Metal Film 2.74 KΩ ±1% 1/4 W
A1R7	10015-47	Metal Film 2.49 KΩ ±1% 1/4 W
A1R8	10015-84	Metal Film 2.10 KΩ ±1% 1/4 W
A1R9	10015-99	Metal Film 14.0 KΩ ±1% 1/4 W
A1R10	10015-65	Metal Film 4.99 KΩ ±1% 1/4 W
A1R11	10015-19	Metal Film 1.00 KΩ ±1% 1/4 W
A1R12	12449-16	Metal Film 150 KΩ ±0.1% 1/8 W
A1R13	12449-15	Metal Film 75.0 KΩ ±0.1% 1/8 W
A1R14	12449-14	Metal Film 37.5 KΩ ±0.1% 1/8 W
A1R15	12449-13	Metal Film 18.75 KΩ ±0.1% 1/8 W
A1R16	10015-191	Metal Film 66.5 KΩ ±1% 1/4 W
A1R17	10015-13	Metal Film 100 KΩ ±1% 1/4 W
A1R18	12449-23	Metal Film 375.0 KΩ ±0.1% 1/4 W
A1R19	12449-23	Metal Film 375.0 KΩ ±0.1% 1/4 W
A1R20	12449-23	Metal Film 375.0 KΩ ±0.1% 1/4 W
A1R21	12499-17	Metal Film 187.5 KΩ ±0.1% 1/8 W
A1R22	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A1R23	10015-45	Metal Film 499 KΩ ±1% 1/4 W
A1R24	10015-102	Metal Film 249 KΩ ±1% 1/4 W
A1R25	10015-208	Metal Film 124 KΩ ±1% 1/4 W
		LOG AMPLIFIER PC BOARD ASSEMBLY - 12432
A2C1	10001-5	Ceramic 33 pF ±5% 1000 V
A2C2	10000-5	Ceramic .0022 µF ±20% 500 V
A2C3	10000-5	Ceramic .0022 µF ±20% 500 V
A2C4	10000-5	Ceramic .0022 µF ±20% 500 V
A2C5	10000-5	Ceramic .0022 µF ±20% 500 V
A2C6	11501-2	Ceramic 0.1 µF ±20% 50 V
A2C7	11501-2	Ceramic 0.1 µF ±20% 50 V
A2C8	10000-12	Ceramic 150 pF ±20% 1000 V
A2C9	10000-4	Ceramic .001 µF ±20% 1000V
A2C10	10000-12	Ceramic 150 pF ±20% 1000 V
A2C11	10001-8	Ceramic 15 pF ±5% 1000 V
A2C12	10000-8	Ceramic .02 µF ±20% 1000 V
A2C13	10000-11	Ceramic .01 µF ±20% 100 V
A2C14	10000-11	Ceramic .01 µF ±20% 100 V
A2C15	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A2C16	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A2C17	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A2C18	10787-2	Tantalum 12 µF ±20% 15 V
A2C19	10787-2	Tantalum 12 µF ±20% 15 V
A2C20	10787-3	Tantalum 27 µF ±20% 25 V
A2C21	10787-3	Tantalum 27 µF ±20% 25 V
A2C22	10787-3	Tantalum 27 µF ±20% 25 V
A2C23	10787-3	Tantalum 27 µF ±20% 25 V
A2C24	10787-2	Tantalum 12 µF ±20% 15 V
A2C25	10787-2	Tantalum 12 µF ±20% 15 V
A2C26	---	Not Used
A2C27	---	Not Used
A2C28	10001-5	Ceramic 33 pF ±5% 1000V
A2C29	10007-7	Mylar 0.1 µF ±10% 200 V
A2C30	10007-5	Mylar .022 µF ±10% 200 V
A2C31	10000-11	Ceramic .01 µF ±20% 100 V
A2C32	10000-11	Ceramic .01 µF ±20% 100 V
A2C33	10000-1	Ceramic 100 pF ±20% 1000 V
A2C34	10000-4	Ceramic .001 µF ±20% 1000 V
A2C35	10000-11	Ceramic .01 µF ±20% 1000 V
A2C36	10000-11	Ceramic .01 µF ±20% 1000 V
A2C37	10007-1	Mylar .001 µF ±10% 200 V
A2C38	10787-5	Tantalum 1.0 µF ±20% 15 V
A2C39	10000-12	Ceramic 150 pF ±20% 1000 V
A2C40	10000-11	Ceramic .01 µF ±20% 100 V
A2C41	10000-11	Ceramic .01 µF ±20% 100 V
A2C42	10001-12	Ceramic 3.3 pF ±5% 1000 V
A2C43	10007-5	Mylar .022 µF ±10% 200 V
A2C44	10787-4	Tantalum 68 µF ±20% 15 V
A2C45	10007-9	Mylar .47 µF ±10% 200 V
A2C46	10000-11	Ceramic .01 µF ±20% 100 V
A2C47	10000-11	Ceramic .01 µF ±20% 100 V
A2C48	10001-5	Ceramic 33 pF ±5% 1000 V
A2C49	10000-2	Ceramic 220 pF ±20% 1000 V
A2C50	10007-2	Mylar .0022 µF ±10% 200 V
A2C51	10000-3	Ceramic 470 pF ±20% 1000 V
A2C52	10000-11	Ceramic .01 µF ±20% 100 V
A2C53	10000-11	Ceramic .01 µF ±20% 100 V
A2C54	10000-6	Ceramic .0047 µF ±20% 500 V
A2C55	10000-11	Ceramic .01 µF ±20% 100 V
A2C56	10000-11	Ceramic .01 µF ±20% 100 V
A2C57	11501-4	Ceramic 1.0 pF ±10% 100 V
A2C58	---	Not Used
A2C59	10000-4	Ceramic .001µF ±5% 100V
A2C60	10007-7	Mylar 0.1 µF ±10% 200 V
A2C61	10677-18	Ceramic 1000pF ±5% 100V
A2C62	10007-7	Mylar 0.1 µF ±10% 200 V
A2C63	---	Factory Select
A2C64	10007-7	Mylar 0.1 µF ±10% 200 V
A2C65	10007-7	Mylar 0.1 µF ±10% 200 V
A2C66	10000-2	Ceramic 220 pF ±20% 1000 V
A2C67	10001-3	Ceramic 10 pF ±5% 1000 V
A2C68	10000-11	Ceramic .01 µF ±20% 100 V
A2C69	10000-11	Ceramic .01 µF ±20% 100 V
A2C70	10909-4	Mica .0024 µF ±1% 500 V
A2C71	10909-4	Mica .0024 µF ±1% 500 V
A2C72	10909-5	Mica .0047 µF ±1% 500 V
A2C73	10007-5	Mylar .022 µF ±10% 200 V
A2C74	10007-6	Mylar .047 µF ±10% 200 V
A2C75	10787-3	Tantalum 27 µF ±20% 15 V
A2C76	10000-6	Ceramic .0047 µF ±20% 500 V
A2C77	10909-5	Mica .0047 µF ±1% 500 V
A2C78	10011-2	Mylar 1.0 µF ±10% 100 V
A2C79	10011-2	Mylar 1.0 µF ±10% 100 V
A2C80	11501-2	Ceramic 0.1 µF ±20% 50 V
A2C81	11501-2	Ceramic 0.1 µF ±20% 50 V
A2C82	10000-6	Ceramic .0047 µF ±20% 500 V
A2C83	10000-4	Ceramic .001 µF ±20% 1000 V
A2C84	10000-6	Ceramic .0047 µF ±20% 500 V
A2C85	10000-1	Ceramic 100 pF ±20% 1000 V
A2C86	10001-2	Ceramic 4.7 pF ±5% 1000 V

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A2C87	10001-2	Ceramic 4.7 pF ±5% 1000 V
A2C88	10630-1	Variable Ceramic NPO 2-8 pF
A2C89	10000-2	Ceramic 220 pF ±20% 1000 V
A2CR1	10043	1N4148
A2CR2	10043	1N4148
A2CR3	11715	1N4446
A2CR4	11715	1N4446
A2CR5	11715	1N4446
A2CR6	11715	1N4446
A2CR7	10045	1N823
A2CR8	10045	1N823
A2CR9	---	Not Used
A2CR10	10043	1N4148
A2CR11	10043	1N4148
A2CR12	10043	1N4148
A2CR13	---	Not Used
A2CR14	---	Not Used
A2CR15	10043	1N4148
A2F1	13503-1	Fuse .5A 125 V
A2J1	10140-1	Test Jack, Red
A2J2	10140-2	Test Jack, Yellow
A2J3	10140-3	Test Jack, Black
A2J4	10140-2	Test Jack, Yellow
A2J5	10140-1	Test Jack, Red
A2J6	10140-4	Test Jack, Blue
A2J7	10140-2	Test Jack, Yellow
A2J8	---	Not Used
A2J9	10140-3	Test Jack, Black
A2J10	10140-2	Test Jack, Yellow
A2J11	10140-2	Test Jack, Yellow
A2J12	---	Not Used
A2J13	10140-2	Test Jack, Yellow
A2L1	10920-1	Coil, RF 100 μH ±10%
A2Q1	12799	E109 (Siliconix)
A2Q2	11119	2N4250
A2Q3	12799	E109 (Siliconix)
A2Q4	12591	E112 (Siliconix)
A2Q5	12799	E109 (Siliconix)
A2Q6	10019	2N3565
A2Q7	11119	2N4250
A2Q8	11585	TIS59
A2Q9	11119	2N4250
A2Q10	11119	2N4250
A2Q11	11119	2N4250
A2Q12	11507	TIS97
A2Q13	12439	2N5785
A2Q14	10206	2N3053
A2Q15	10206	2N3053
A2Q16	10896	MFE 3004 or 3N138*
A2Q17	10896	MFE 3004 or 3N138*
A2Q18	---	Not Used
A2Q19	13533	2N2907 or 2N2907A
A2Q20	10018	2N3646
A2Q21	13534	2N2221 or 2N2221A
A2Q22	11585	TIS59
A2Q23	10018	2N3646
A2Q24	13533	2N2907 or 2N2907A
A2Q25	11585	TIS59
A2Q26	12474	FCD-810 (Fairchild)
A2Q27	---	Not Used
A2Q28	---	Not Used
A2Q29	10896	MFE 3004 or 3N138*
A2Q30	10896	MFE 3004 or 3N138*
A2Q31	11119	2N4250
A2Q32	11507	TIS97
A2Q33	11507	TIS97
A2Q34	10019	2N3565
A2Q35	10019	2N3565
A2R1	10015-102	Metal Film 249 KΩ ±1% 1/4 W
A2R2	10015-102	Metal Film 249 KΩ ±1% 1/4 W
A2R3	10015-102	Metal Film 249 KΩ ±1% 1/4 W
A2R4	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R5	10015-102	Metal Film 249 KΩ ±1% 1/4 W
A2R6	10046-1	Variable Comp 500 Ω ±20% 1/4 W
A2R7	10015-7	Metal Film 10.0 KΩ ±1% 1/4 W
A2R8	12449-22	Metal Film 2.50 KΩ ±0.1% 1/8 W
A2R9	12449-21	Metal Film 10.0 KΩ ±0.1% 1/8 W
A2R10	12449-22	Metal Film 2.50 KΩ ±0.1% 1/8 W
A2R11	12449-18	Metal Film 7.50 KΩ ±0.1% 1/8 W
A2R12	12449-18	Metal Film 7.50 KΩ ±0.1% 1/8 W
A2R13	10015-90	Metal Film 24.9 KΩ ±1% 1/4 W
A2R14	10015-133	Metal Film 49.9 KΩ ±1% 1/4 W
A2R15	10013-57	Carbon Film 470 K ±5% 1/4 W
A2R16	10013-57	Carbon Film 470 K ±5% 1/4 W
A2R17	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A2R18	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A2R19	10013-47	Carbon Film 68 KΩ ±5% 1/4 W
A2R20	10015-213	Metal Film 178 KΩ ±1% 1/4 W
A2R21	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A2R22	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R23	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R24	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R25	12449-21	Metal Film 10.0 KΩ ±0.1% 1/8 W
A2R26	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R27	10015-207	Metal Film 20.0 KΩ ±1% 1/4 W
A2R28	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A2R29	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R30	10013-27	Carbon Film 1.5 KΩ ±5% 1/4 W
A2R31	10015-207	Metal Film 20.0 KΩ ±1% 1/4 W
A2R32	10015-47	Metal Film 2.49 KΩ ±1% 1/4 W
A2R33	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R34	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R35	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R36	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R37	10015-7	Metal Film 10.0 KΩ ±1% 1/4 W
A2R38	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R39	10015-20	Metal Film 1.10 KΩ ±1% 1/4 W
A2R40	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R41	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R42	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R43	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R44	10015-159	Metal Film 402 Ω ±1% 1/4 W
A2R45	10015-116	Metal Film 30.1 KΩ ±1% 1/4 W
A2R46	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R47	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A2R48	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R49	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A2R50	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R51	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A2R52	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R53	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R54	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R55	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R56	10015-28	Metal Film 23.7 KΩ ±1% 1/4 W
A2R57	10013-35	Carbon Film 6.8 KΩ ±5% 1/4 W
A2R58	10013-51	Carbon Film 150 KΩ ±5% 1/4 W
A2R59	10013-39	Carbon Film 15 KΩ ±5% 1/4 W
A2R60	10013-27	Carbon Film 1.5 KΩ ±5% 1/4 W
A2R61	10013-25	Carbon Film 1 KΩ ±5% 1/4 W

* Must all come from same mfr.

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A2R62	10013-5	Carbon Film 22 Ω ±5% 1/4 W
A2R63	10013-5	Carbon Film 22 Ω ±5% 1/4 W
A2R64	10013-47	Carbon Film 68 KΩ ±5% 1/4 W
A2R65	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R66	10013-1	Carbon Film 10 Ω ±5% 1/4 W
A2R67	10013-1	Carbon Film 10 Ω ±5% 1/4 W
A2R68	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A2R69	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A2R70	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A2R71	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R72	---	Not Used
A2R73	10015-182	Metal Film 118 Ω ±1% 1/4 W
A2R74	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R75	10015-133	Metal Film 49.9 KΩ ±1% 1/4 W
A2R76	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R77	10013-1	Carbon Film 10 Ω ±5% 1/4 W
A2R78	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A2R79	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A2R80	10015-13	Metal Film 100 KΩ ±1% 1/4 W
A2R81	---	Not Used
A2R82	10015-54	Metal Film 110 KΩ ±1% 1/4 W
A2R83	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R84	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R85	---	Not Used
A2R86	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A2R87	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R88	10015-65	Metal Film 4.99 KΩ ±1% 1/4 W
A2R89	11711-3	Variable Comp 20 KΩ ±20% 1/4 W
A2R90	10015-213	Metal Film 178 KΩ ±1% 1/4 W
A2R91	10015-9	Metal Film 17.8 KΩ ±1% 1/4W
A2R92	10015-170	Metal Film 348 Ω ±1% 1/4 W
A2R93	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A2R94	10046-1	Variable Comp 500 Ω ±20% 1/4 W
A2R95	10015-58	Metal Film 9.76 KΩ ±1% 1/4 W
A2R96	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R97	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R98	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R99	10015-209	Metal Film 130 KΩ ±1% 1/4 W
A2R100	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R101	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R102	10013-11	Carbon Film 68 Ω ±5% 1/4 W
A2R103	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R104	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R105	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R106	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R107	10013-55	Carbon Film 330 KΩ ±5% 1/4 W
A2R108	10013-55	Carbon Film 330 KΩ ±5% 1/4 W
A2R109	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R110	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R111	10015-31	Metal Film 3.16 KΩ ±1% 1/4 W
A2R112	10015-71	Metal Film 909 Ω ±1% 1/4 W
A2R113	10015-73	Metal Film 10.2 KΩ ±1% 1/4 W
A2R114	10015-99	Metal Film 14.0 KΩ ±1% 1/4 W
A2R115	10015-7	Metal Film 10.0 KΩ ±1% 1/4 W
A2R116	---	Factory Selected
A2R117	10015-13	Metal Film 100 KΩ ±1% 1/4 W
A2R118	10015-19	Metal Film 1.00 KΩ ±1% 1/4 W
A2R119	10015-96	Metal Film 12.1 KΩ ±1% 1/4 W
A2R120	10015-63	Metal Film 402 KΩ ±1% 1/4 W
A2R121	10015-85	Metal Film 287 KΩ ±1% 1/4 W
A2R122	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R123	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R124	10013-19	Carbon Film 330 Ω ±5% 1/4 W
A2R125	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R126	10015-120	Metal Film 69.8 KΩ ±1% 1/4 W
A2R127	10015-191	Metal Film 66.5 KΩ ±1% 1/4 W
A2R128	10015-191	Metal Film 66.5 KΩ ±1% 1/4 W
A2R129	10015-191	Metal Film 66.5 KΩ ±1% 1/4 W
A2R130	10013-61	Carbon Film 1 MΩ ±1% 1/4 W
A2R131	10013-37	Carbon Film 10 KΩ ±1% 1/4 W
A2R132	---	Not Used

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A2R133	---	Not Used
A2R134	---	Not Used
A2R135	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R136	10013-73	Carbon Film 10 MΩ ±5% 1/4 W
A2R137	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R138	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R139	10015-61	Metal Film 39.2 KΩ ±1% 1/4 W
A2R140	---	Not Used
A2R141	10015-61	Metal Film 39.2 KΩ ±1% 1/4 W
A2R142	---	Not Used
A2R143	10013-51	Carbon Film 150 KΩ ±5% 1/4 W
A2R144	10013-51	Carbon Film 150 KΩ ±5% 1/4 W
A2R145	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R146	10015-91	Metal Film 90.9 KΩ ±1% 1/4 W
A2R147	10015-91	Metal Film 90.9 KΩ ±1% 1/4 W
A2R148	10015-32	Metal Film 3.83 KΩ ±1% 1/4 W
A2R149	10013-27	Carbon Film 1.5 KΩ ±5% 1/4 W
A2R150	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R151	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R152	10142-2	Carbon Film 15 MΩ ±5% 1/4 W
A2R153	10013-59	Carbon Film 680 KΩ ±5% 1/4 W
A2R154	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R155	10015-84	Metal Film 2.10 KΩ ±1% 1/4 W
A2R156	10015-191	Metal Film 66.5 KΩ ±1% 1/4 W
A2R157	10015-191	Metal Film 66.5 KΩ ±1% 1/4 W
A2R158	10015-188	Metal Film 33.2 KΩ ±1% 1/4 W
A2R159	10015-22	Metal Film 10.7 KΩ ±1% 1/4 W
A2R160	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R161	10015-41	Metal Film 48.7 KΩ ±1% 1/4 W
A2R162	10015-22	Metal Film 10.7 KΩ ±1% 1/4 W
A2R163	10046-13	Variable Comp 1 MΩ ±20% 1/4 W
A2R164	10015-54	Metal Film 110 KΩ ±1% 1/4 W
A2R165	10015-179	Metal Film 140 KΩ ±1% 1/4 W
A2R166	10015-90	Metal Film 24.9 KΩ ±1% 1/4 W
A2R167	10015-32	Metal Film 3.83 KΩ ±1% 1/4 W
A2R168	10015-80	Metal Film 4.02 KΩ ±1% 1/4 W
A2R169	10015-40	Metal Film 43.2 KΩ ±1% 1/4 W
A2R170	10015-80	Metal Film 4.02 KΩ ±1% 1/4 W
A2R171	10015-25	Metal Film 61.9 KΩ ±1% 1/4 W
A2R172	10015-25	Metal Film 61.9 KΩ ±1% 1/4 W
A2R173	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R174	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R175	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R176	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R177	10013-21	Carbon Film 470 Ω ±5% 1/4 W
A2R178	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A2R179	10015-70	Metal Film 681 Ω ±1% 1/4 W
A2R180	10015-133	Metal Film 49.9 KΩ ±1% 1/4 W
A2R181	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A2R182	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A2R183	10015-158	Metal Film 392 Ω ±1% 1/4 W
A2R184	10015-159	Metal Film 402 Ω ±1% 1/4 W
A2R185	10015-80	Metal Film 4.02 KΩ ±1% 1/4 W
A2R186	10046-6	Variable Comp 200 Ω ±20% 1/4 W
A2R187	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R188	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R189	10013-55	Carbon Film 330 KΩ ±5% 1/4 W
A2R190	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R191	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R192	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R193	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R194	10013-5	Carbon Film 22 Ω ±5% 1/4 W
A2R195	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R196	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R197	10015-80	Metal Film 4.02 KΩ ±1% 1/4 W
A2RT1	10209	Thermistor

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A2T1	12468	Transformer
A2T2	12260	Transformer, Transistor
A2T3	12261	Case, Magnetic Shield
A2U1	11627	LM301A (National Semiconductor)
A2U2	11627	LM301A (National Semiconductor)
A2U3	11627	LM301A (National Semiconductor)
A2U4	11539	741C
A2U5	11270-1	SN7400N
A2U6	11539	741C
A2U7	15250	LM308AH
A2U8	11539	741C
A2U9	15505	LM301AH
A2U10	15505	LM301AH
A2U11	11539	741C
A2U12	11539	741C
A2U13	10769	709C
A2U14	11117	CA3026 (RCA)
A2U15	15504	725C
		MEMORY CIRCUIT PC BOARD ASSEMBLY (1024 Bit) 14072
A3C1	10787-2	Tantalum 12 µF ±20% 20 VDC
A3C2	10000-10	Ceramic 0.1 µF +80% -20% 100 VDC
A3C3	10000-10	Ceramic 0.1 µF +80% -20% 100 VDC
A3C4	10000-11	Ceramic .01 uF ±20% 100 VDC
A3C5	10000-11	Ceramic .01 µF ±20% 100 VDC
A3C6	10000-11	Ceramic .01 µF ±20% 100 VDC
A3C7	10001-13	Ceramic 12pF ±5% 1000 V
A3C8	---	Not Used
A3C9	10000-11	Ceramic .01 µF ±20% 100 VDC
A3C10	10787-4	Tantalum 68 µF ±20% 15 VDC
A3C11	10787-3	Tantalum 27 µF ±20% 25 VDC
A3C12	10001-10	Ceramic 20 pF ±5% 1000 VDC
A3C13	10000-11	Ceramic .01 µF ±20% 100 VDC
A3C14	10000-11	Ceramic .01 µF ±20% 100 VDC
A3C15	10000-11	Ceramic .01 µF ±20% 100 VDC
A3C16	10787-2	Tantalum 12 µF ±20% 20 VDC
A3C17	10000-11	Ceramic .01 µF ±20% 100 VDC
A3C18	10000-10	Ceramic 0.1 µF +80% -20% 100 VDC
A3C19	10000-11	Ceramic .01 µF ±20% 100 VDC
A3C20	10000-11	Ceramic .01 µF ±20% 100 VDC
A3J1	10140-1	Test Jack, Red
A3J2	10140-2	Test Jack, Yellow
A3J3	10140-2	Test Jack, Yellow
A3J4	10140-2	Test Jack, Yellow
A3J5	10140-2	Test Jack, Yellow
A3J6	10140-3	Test Jack, Black
A3Q1	10019	2N3565
A3Q2	11119	2N4250
A3Q3	12942	2N2905A
A3Q4	11119	2N4250
A3Q5	11119	2N4250
A3Q6	11119	2N4250
A3Q7	11119	2N4250
A3Q8	11119	2N4250
A3Q9	11119	2N4250
A3Q10	11585	TIS59
A3Q11	11585	TIS59
A3Q12	11585	TIS59

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A3Q13	11585	TIS59
A3Q14	12591	E112
A3Q15	11585	TIS59
A3Q16	10019	2N3565
A3R1	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A3R2	10015-87	Metal Film 15.0 KΩ ±1% 1/8 W
A3R3	---	Not Used
A3R4	---	Not Used
A3R5	10015-177	Metal Film 6.98 KΩ ±1% 1/8 W
A3R6	12449-	Metal Film 3.966 KΩ ±1% 1/8 W
A3R7	10013-9	Carbon Film 47 Ω ±5% 1/4 W
A3R8	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A3R9	10013-9	Carbon Film 47 Ω ±5% 1/4 W
A3R10	10013-9	Carbon Film 47 Ω ±5% 1/4 W
A3R11	10015-177	Metal Film 6.98K ±1% 1/8 W
A3R12	---	Not Used
A3R13	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R14	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A3R15	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A3R16	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R17	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A3R18	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R19	10013-19	Carbon Film 330 Ω ±5% 1/4 W
A3R20	10013-19	Carbon Film 330 Ω ±5% 1/4 W
A3R21	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A3R22	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A3R23	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A3R24	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R25	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A3R26	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A3R27	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A3R28	10013-51	Carbon Film 150 KΩ ±5% 1/4 W
A3R29	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R30	10013-35	Carbon Film 6.8 KΩ ±5% 1/4 W
A3R31	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R32	---	Not Used
A3R33	---	Not Used
A3R34	10015-50	Metal Film 1.47 KΩ ±1% 1/8 W
A3R35	10015-203	Metal Film 280.0 Ω ±1% 1/8 W
A3R36	10013-3	Carbon Film 15 Ω ±5% 1/4 W
A3R37	10013-3	Carbon Film 15 Ω ±5% 1/4 W
A3R38	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R39	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R40	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R41	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R42	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R43	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R44	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A3R45	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A3R46	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A3R47	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A3R48	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A3R49	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A3R50	10013-47	Carbon Film 68 KΩ ±5% 1/4 W
A3R51	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A3R52	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R53	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R54	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R55	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R56	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R57	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R58	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A3R59	10015-133	Metal Film 49.9 KΩ ±1% 1/8 W
A3R60	10015-97	Metal Film 12.7 KΩ ±1% 1/8 W
A3R61	10015-7	Metal Film 10.0 KΩ ±1% 1/8 W
A3R62	10015-44	Metal Film 255.0 Ω ±1% 1/8 W
A3R63	10015-21	Metal Film 4.64 KΩ ±1% 1/8 W
A3R64	10015-30	Metal Film 7.68 KΩ ±1% 1/8 W

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A3R65	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R66	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R67	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A3R68	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3U1	13470-13	SN74LS74N
A3U2	13470-13	SN74LS74N
A3U3	11270-1	SN7400N
A3U4	13470-13	SN74LS74N
A3U5	13470-1	SN74LS00N
A3U6	13470-4	SN74LS04N
A3U7	12664	2533
A3U8	12664	2533
A3U9	12664	2533
A3U10	12664	2533
A3U11	12664	2533
A3U12	12664	2533
A3U13	12664	2533
A3U14	12664	2533
A3U15	13470-16	SN74LS107N
A3U16	13470-1	SN74LS00N
A3U17	14644	DAC08EQ
A3U18	13470-37	SN74LS283N
A3U19	13470-37	SN74LS283N
A3U20	13470-17	SN74LS123N
A3U21	13470-25	SN74LS157N
A3U22	13470-25	SN74LS157N
A3U23	14142	AM2503PC
A3U24	11230	710C
A3U25	14140	AD518J
		DET. W/LOW +10 dBm OUTPUT PC BOARD ASSEMBLY - 14196
A4CR1	10043	1N4148
A4R1	13300-3	Variable Cermet 20 KΩ ±20% 1/2 W
A4R2	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A4R3	10015-16	Metal Film 18.7 KΩ ±1% 1/8 W
A4R4	10015-13	Metal Film 100 KΩ ±1% 1/8 W

PART NO. CROSS REFERENCE

PART NO.	MFGR. CODE	MFGR. PART NO.
10000-1	56289	5GA-T10
10000-2	56289	5GA-T22
10000-3	56289	5GA-T47
10000-4	56289	5GA-D10
10000-5	56289	5GA-D22
10000-6	56289	5GAB-D47
10000-8	56289	5GAS-S20
10000-10	91418	Type TA 0.1 µF
10000-11	84171	TCP-R01
10000-12	56289	5GA-T15
10001-2	56289	10TCC-V47
10001-3	56289	10TCC-Q10
10001-5	56289	10TCC-Q33
10001-10	56289	10TCC-Q25
10001-12	56289	10TCC-V33
10001-13	56289	10TCC-Q12
10001-20	56289	10TCC-Q30
10007-1	01002	75F1R2A102
10007-2	01002	75F1R2A 222
10007-5	01002	75F1R2A 223
10007-6	01002	75F1R2A 473
10007-7	01002	75F1R2A 104
10007-9	01002	75F1R2A 474
10011-2	27556	ZA1652K
10013-1	73445	B803104NB 100
10013-3	73445	B803104NB 150
10013-5	73445	B803104NB 220
10013-9	73445	B803104NB 470
10013-11	73445	B803104NB 680
10013-13	73445	B803104NB 101
10013-17	73445	B803104NB 221
10013-19	73445	B803104NB 331
10013-21	73445	B803104NB 471
10013-25	73445	B803104NB 102
10013-27	73445	B803104NB 152
10013-29	73445	B803104NB 222
10013-31	73445	B803104NB 332
10013-33	73445	B803104NB 472
10013-35	73445	B803104NB 682
10013-37	73445	B803104NB 103
10013-39	73445	B803104nB 153
10013-41	73445	B803104NB 223
10013-43	73445	B803104NB 333
10013-45	73445	B803104NB 473
10013-47	73445	B803104NB 683
10013-49	73445	B803104NB 104
10013-51	73445	B803104NB 154
10013-53	73445	B803104NB 224

PART NO. CROSS REFERENCE

PART NO.	MFGR. CODE	MFGR. PART NO.
10013-55	73445	B803104NB 334
10013-57	73445	B803104NB 474
10013-59	73445	B803104NB 684
10013-61	73445	B803104NB 105
10013-73	73445	B803104NB 106
10015-7	91637	RN55D,10.0 KΩ 1%
10015-13	91637	RN55D, 100 KΩ 1%
10015-16	91637	RN55D, 18.7 KΩ 1%
10015-19	91637	RN55D, 1.00 KΩ 1%
10015-20	91637	RN55D, 1.10 KΩ 1%
10015-21	91637	RN55D, 4.64 KΩ 1%
10015-22	91637	RN55D, 10.7 KΩ 1%
10015-25	91637	RN55D, 61.9 KΩ 1%
10015-28	91637	RN55D, 23.7 KΩ 1%
10015-30	91637	RN55d, 7.68 KΩ 1%
10015-31	91637	RN55D, 3.16 KΩ 1%
10015-32	91637	RN55D, 3.83 KΩ 1%
10015-40	91637	RN55D, 43.2 KΩ 1%
10015-41	01637	RN55D, 48.7 KΩ 1%
10015-44	91637	RN55D, 255Ω 1%
10015-45	91637	RN55D, 499 KΩ 1%
10015-47	91637	RN55D, 2.49 KΩ 1%
10015-50	91637	RN55D, 1.47 KΩ 1%
10015-54	91637	RN55D, 110 KΩ 1%
10015-58	91637	RN55D, 9.76 KΩ 1%
10015-61	91637	RN55D, 39.2 KΩ 1%
10015-63	91637	RN55D, 402 KΩ 1%
10015-65	91637	RN55D, 4.99 KΩ 1%
10015-70	91637	RN55D, 681Ω 1%
10015-71	91637	RN55D, 909Ω 1%
10015-73	91637	RN55D, 10.2 KΩ 1%
10015-79	91637	RN55D, 2.67 KΩ 1%
10015-80	91637	RN55D, 4.02 KΩ 1%
10015-84	91637	RN55D, 2.10 KΩ 1%
10015-85	91637	RN55D, 287 KΩ 1%
10015-87	91637	RN55D, 15.0 KΩ 1%
10015-90	91637	RN55D, 24.0 KΩ 1%
10015-91	91637	RN55D 90.9 KΩ 1%
10015-96	91637	RN55D, 12.1 KΩ 1%
10015-97	91637	RN55D, 12.7 KΩ 1%
10015-99	91637	RN55D, 14.0 KΩ 1%
10015-102	91637	RN55D, 249 KΩ 1%
10015-116	91637	RN55D, 30.1 KΩ 1%
10015-120	91637	RN55D, 69.8 KΩ 1%
10015-133	91637	RN55D, 49.9 KΩ 1%
10015-143	91637	RN55D, 71.5 Ω 1%
10015-158	91637	RN55D, 392 Ω 1%
10015-159	91637	RN55D, 402 Ω 1%
10015-170	91637	RN55D, 348 Ω 1%
10015-177	91637	RN55D, 6.98 KΩ 1%
10015-179	91637	RN55D, 140 KΩ 1%
10015-183	91637	RN55D, 80.6 KΩ 1%

PART NO. CROSS REFERENCE

PM PART NO.	MFGR. CODE	MFGR. PART NO.
10015-188	91637	RN55D, 33.2 KΩ 1%
10015-191	91637	RN55D, 66.5 KΩ 1%
10015-196	91637	RN55D, 205 Ω 1%
10015-203	91637	RN55D, 280 Ω 1%
10015-207	91637	RN55D, 20.0 KΩ 1%
10015-208	91637	RN55D, 124 KΩ 1%
10015-209	91637	RN55D, 130 KΩ 1%
10015-211	91637	RN55D, 2.74 KΩ 1%
10015-213	91637	RN55D, 178 KΩ 1%
10018	07263	2N3646
10019	07263	2N3565
10043	09214	1N4148
10045	07910	1N823
10046-1	71450	X201R501B
10046-6	71450	X201R201B
10046-8	71450	X201R103B
10046-10	71450	X201R104B
10046-13	71450	X201R105B
10140-1	74970	105852
10140-2	74970	105857
10140-3	74970	105853
10140-4	74970	105860
10142-2	01121	CB1565
10206	07263	2N3053
10209	90634	51RD21
10630-1	72982	538-011, 2-8pF, A
10769	04713	MC1709CG
10787-2	12954	D12GSB20M
10787-3	12954	D27GSB15M
10787-4	12954	D68GSC15M
10787-5	12954	D1R0GSA15M
10787-6	12954	D2R7GSA15M
10896	02735	3N138
10909-4	84171	DM-19F242F
10909-5	84171	DM-19F472F
10920-1	99800	2890-42
11117	02735	CA3026
11118	02735	CA3039
11119	07263	2N4250
11230	07263	U5B7710393
11270-1	01295	SN7400N
11432	27014	FM3955

PART NO. CROSS REFERENCE

PM PART NO.	MFGR. CODE	MFGR. PART NO.
11501-2	72982	8131-050-651-104M
11501-4	72982	8101-100-C0K0-109B
11507	01295	T1S97
11539	07263	U5B7741393
11585	01295	T1S59
11627	27014	LM301Ah
11676-1	01121	WA1G ϕ12S1 ϕ4MZ
11711-3	73138	66WR2ϕK
11715	01295	1N4446
11260	81095	SP-66
12261	81095	SP310
12389	76541	MV5025
12439	02735	2N5785
12445	07263	U5T7725393
12449-13	14298	EE 1/8C2 18.75 KΩ 0.1%
12449-14	14298	EE 1/8C2 37.50 KΩ 0.1%
12449-15	14298	EE 1/8C2 75.00 KΩ 0.1%
12449-16	14298	EE 1/8C2 150.00 KΩ 0.1%
12449-17	14298	EE 1/8C2 187.50 KΩ 0.1%
12449-18	14298	EE 1/8C2 7.50 KΩ 0.1%
12449-21	14298	EE 1/8C2 10.00 KΩ 0.1%
12449-22	14298	EE 1/8C2 2.50 KΩ 0.1%
12449-23	14298	EE 1/8C2 375.0 KΩ 0.1%
12449-29	14298	EE 1/8C2 25.0 KΩ 0.1%
12468	28821	12468
12474	07263	FCD-810
12479	71590	12479
12483	09353	8632
12564	82389	57HA3F
12591	17856	E112
12664	18324	2533
12690	76854	399633-511
12799	17856	E109
12942	07263	2N2905A
13076	19477	850-10T-50K
13300-3	71450	375T103B
13470-1	01295	SN74LS00N
13470-4	01295	SN74LS04N
13470-13	01295	SN74LS74N
13470-16	01295	SN74LS107N
13470-17	01295	SN74LS123N
13470-25	01295	SN74LS157N
13470-37	01295	SN74LS283N
13503-1	75915	276-500
13533	04713	2N2907/2N2907A
13534	04713	2N2221/2N2221A
14140	24355	AD518J
14141	24355	AD559KD
14142	34335	AM2503DC
14644	28821	DAC08EQ
15250	28821	LM308AH
15504	28821	LM725
15505	28821	LM301AH

FEDERAL SUPPLY CODE FOR MANUFACTURERS

The following five-digit code numbers are listed in numerical sequence along with the manufacturer's name and address to which the code has been assigned.

The Federal Supply Code has been taken from Cataloging Handbook H 4-2, Code to Name.

00303 Shelly Associates Inc.
El Segundo, California

00656 Aerovox Corp.
New Bedford, Massachusetts

00779 AMP Inc.
Harrisburg, Pennsylvania

01002 General Electric Co.
Capacitor Dept.
Hudson Falls, New York

01121 Allen-Bradley Co.
Milwaukee, Wisconsin

01295 Texas Instruments, Inc.
Semiconductor Components Div.
Dallas, Texas

01961 Pulse Engineering Inc.
Santa Clara, California

02114 Ferroxcube Corp. of America
Saugerties, New York

02660 Amphenol-Borg Elect. Corp.
Broadview, Illinois

02735 Radio Corp. of America
Semiconductor and Materials Div.
Somerville, New Jersey

04062 Elmenco Products Co.
New York, New York

04713 Motorola, Inc.
Semiconductor Products Div.
Phoenix, Arizona

05035 Ayer Manufacturing Co.
Chicago Heights, Illinois

05245 Corcom Inc.
Chicago, Illinois

07126 Digitran Co.
Pasadena, California

07263 Fairchild Camera and Inst. Corp.
Semiconductor Div.
Mountain View, California

07910 Continental Device Corp.
Hawthorne, California

09214 General Electric Co.
Semiconductor Products Dept.
Auburn, New York

09353 C and K Components Inc.
Newton, Massachusetts

11332 General Microwave Corp.
Farmingdale, New York

11711 General Instruments Inc.
Semiconductor Div.
Newark, New Jersey

12674 Syncro Corp.
Hicksville, Ohio

12954 Dickson Electronics Corp.
Scottsdale, Arizona

14298 American Components, Inc.
Conshohocken, Pennsylvania

16733 Cablewave Systems
North Haven, Connecticut

17540 Alpha Industries
Woburn, Massachusetts

17856 Siliconix Inc.
Santa Clara, California

18235 KRL Electronics, Inc.
Manchester, New Hampshire

18324 Signetics Corp.
Sunnyvale, California

19447 Electro-Technique Inc.
Oceanside, California

21847 Aertech Industries
Sunnyvale, California

22045 Jordan Electric Co.
Van Nuys, California

22526 Berg Electronics Corp.
York Expressway
New Cumberland, Pennsylvania

24546 Corning Glass Works Electronic
Components Div.
Raleigh, North Carolina

24931 Speciality Connector Co. Inc.
Indianapolis, Indiana

25088 Siemens America Corp.
Iselin, New Jersey

27014 National Semiconductor Corp.
Santa Clara, California

27556 IMB Electronic Products
Santa Fe Springs, California

28480 Hewlett-Packard Co.
Palo Alto, California

28821 Pacific Measurements Inc.
Sunnyvale, California

31918 International Electro Exchange
Eden Prairie, Minnesota

32284 Rotron Manufacturing Co. Inc.
Woodstock, New York

33025 Omni Spectra
Tempe, Arizona

34078 Midwest Microwave Inc.
Ann Arbor, Michigan

44655 Ohmite Mfg. Co.
Skokie, Illinois

50625 Revere Corp. of America
Wallingford, Connecticut

56289 Sprague Electric Co.
North Adams, Massachusetts

70903 Belden Mfg. Co.
Chicago, Illinois

71034 Bliley Electric Co.
Erie, Pennsylvania

71400 Bussman Mfg.
Div. of McGraw-Edison Co.
St. Louis, Missouri

71450 CTS Corp.
Elkhart, Indiana

71590 Centralab Electronics
Milwaukee, Wisconsin

72982 Erie Tech. Products Inc.
Erie, Pennsylvania

73138 Beckman Instruments Inc.
Helipot Division
Fullerton, California

73445 Amperex Electronic Corp.
Hicksville, New York

74970 E.F. Johnson Co.
Waseca, Minnesota

75915 Littlefuse Inc.
Des Plaines, Illinois

76493 J.W. Miller Co.
Compton, California

76541 Monsanto Commercial Products Co.
Cupertino, California

76854 Oak Mfg. Co.
Crystal Lake, Illinois

79727 Continental-Wirt Electronics Corp.
Philadelphia, Pennsylvania

80031 Mepco/Electra Inc.
A North American Phillips Co.
Morristown, New Jersey

80294 Bourns Inc.
Trimpot Div.
Riverside, California

81073 Grayhill Inc.
La Grange, Illinois

81095 Traid Transformer Corp.
Venice, California

81483 International Rectifier Corp.
El Segundo, California

82389 Switchcraft Inc.
Chicago, Illinois

83330 H.H. Smith Inc.
Brooklyn, New York

83594 Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83701 Electronic Devices Inc.
Yonkers, New York

84171 Arco Electronics Inc.
Great Neck, New York

90303 Mallory Battery Co.
Tarrytown, New York

90634 Saft America Inc.
Metuchen, New Jersey

91418 Radio Materials Co.
Chicago, Illinois

91637 Dale Electronics Inc.
Columbus, Nebraska

91929 Honeywell Inc.
Microswitch Div.
Freeport, Illinois

94144 Raytheon Co.
Components Div.
Quincy, Massachusetts

94222 Southco Inc.
Lester, Pennsylvania

95146 Alco Electronics
Lawrence, Massachusetts

99392 STM Corp.
Oakland, California

99800 Delavan Electronics Corp.
East Aurora, New York

15558 Micon Electronics Inc.
Garden City, N.Y.

SECTION 9

MANUAL CORRECTIONS

This section lists the corrections that must be incorporated in this manual to make it correspond to a particular instrument. The serial number of each instrument is prefixed by a code number. This code number is used to identify the applicable manual corrections for a particular instrument. When correcting this manual start with the corrections corresponding to the Code No. on the instrument. If a particular component has been changed more than one time, make only the first change encountered.

CODE NO.	CORRECTIONS	PM PART NO.	SECTION OF MANUAL AFFECTED
ALL	There is a slight possibility that, when using the Model 1038-H/V Swept Measurement System, an occasional oscillation of a preamplifier can occur when detector cables are not attached to all three (A, B, and Ref channel) inputs. This is an intermittent phenomena caused by slightly different circuit parameters within the individual plug-ins, and could result in a noisy display on whatever channel was currently being viewed. To remedy this, be sure that cables are attached to all three inputs (or both inputs if only one vertical plug-in is in use). On page 6-4, delete ALL of Section 6.3.2.g.		6
08	On the page shown below, change the indicated resistors shown opposite the page: From: Carbon Film, 47Ω ±5% 1/4W To: Carbon Comp 47Ω ±5% 1/4W Pg. 8-5 A3R7, A3R9, A3R10	10013-9 10142-8	8