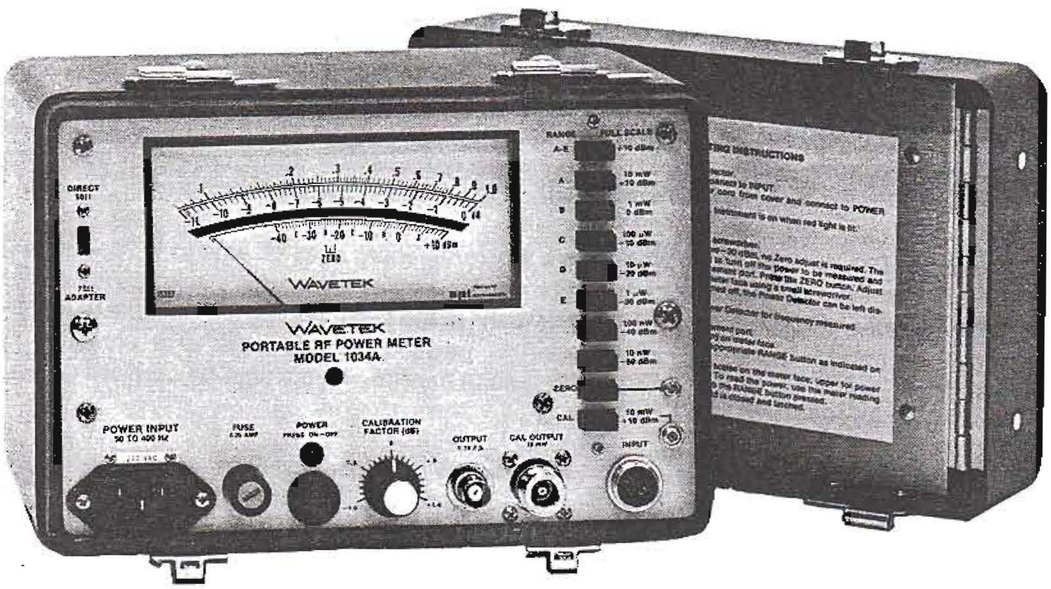
OPERATING AND MAINTENANCE MANUAL



PORTABLE RF POWER METER

MODEL 1034A

SERIAL NUMBER ____________________

WAVETEK MICROWAVE, INC.

488 TASMAN DRIVE, SUNNYVALE, CALIFORNIA 94089

TEL: (408) 734-5780 TWX: (910) 339-9273 TELEX: 371-6460

1499-14166
Code 13 (2-88)

WARRANTY

Wavetek warrants that all products manufactured by Wavetek conform to published Wavetek specifications and are free from defects in materials and workmanship for a period of one (1) year from the date of delivery when used under normal operating conditions and within the service conditions for which they were furnished.

The obligation of Wavetek arising from a Warranty claim shall be limited to repairing, or at its option, replacing without charge, any product which in Wavetek's sole opinion proves to be defective within the scope of the Warranty. In the event Wavetek is not able to modify, repair or replace non-conforming defective parts or components to a condition as warrantied within a reasonable time after receipt thereof, Buyers shall be credited for their value at the original purchase price.

Wavetek must be notified in writing of the defect or nonconformity within the Warranty period and the affected product returned to Wavetek's factory or to an authorized service center within (30) days after discovery of such defect or nonconformity.

For product warranties requiring return to Wavetek, products must be returned to a service facility designated by Wavetek. Buyer shall prepay shipping charges, taxes, duties and insurance for products returned to Wavetek for warranty service. Except for products returned to Buyer from another country, Wavetek shall pay for return of products to Buyer.

Wavetek shall have no responsibility hereunder for any defect or damage caused by improper storage, improper installation, unauthorized modification, misuse, neglect, inadequate maintenance, accident or for any product which has been repaired or altered by anyone other than Wavetek or its authorized representative and not in accordance with instructions furnished by Wavetek.

Exclusion of Other Warranties

The Warranty described above is Buyer's sole and exclusive remedy and no other warranty, whether written or oral, is expressed or implied. Wavetek specifically disclaims the implied warranties of merchantability and fitness for a particular purpose. No statement, representation, agreement, or understanding, oral or written, made by an agent, distributor, representative, or employee of Wavetek, which is not contained in the foregoing Warranty will be binding upon Wavetek, unless made in writing and executed by an authorized Wavetek employee. Under no circumstances shall Wavetek be liable for any direct, indirect, special, incidental, or consequential damages, expenses, losses or delays (including loss of profits) based on contract, tort, or any other legal theory.

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TECHNICAL INFORMATION

DETECTORS FOR USE WITH WAVETEK MICROWAVE, INC. (WMI) SCALAR ANALYZERS AND MODEL 1045 AND 1034A POWER METERS

The purpose of this Technical Information sheet is to define parameters and specifications pertinent to all of the detachable detector options available for the various WMI scalar analyzer systems and the Model 1045 and 1034A power meters. Parameters common to each of the detector configurations are defined first, and then individual detector specifications are given.

WMI offers three different types of detectors for the above scalar systems and power meters. These include the single diode and balanced (dual diode) coaxial detectors, and the balanced element waveguide detector. The single diode and balanced coaxial detectors have a maximum power rating of 200mW (+23dBm), and cover the frequency range of 1MHz to 18.5GHz or 1MHz to 26.5GHz. One version of the single diode detector (used with the Model 1045 Power Meter) has a built-in attenuator to allow it to measure maximum power levels up to 10W (+40dBm) CW or up to 200W (+53dBm) peak. The balanced element waveguide detector has a maximum power rating of 100mW (+dBm), and is designed for the frequency range from 26.5GHz to 40.0GHz.

Coaxial detectors are available with type N, APC7, and APC3.5 (compatible with SMA) connectors, and the waveguide detector comes with a WR28 waveguide (UG-599/U Flange).

Frequencies down to 100kHz are available on special order, and various types of 50 to 75 ohm adapters are available for the coaxial detectors.

NOTE: *If it is desired to check the detector/instrument system performance, refer to the Performance Verification Test in the Operating and Maintenance Manual for the particular instrument.*

SINGLE DIODE DETECTOR FEATURES AND SPECIFICATIONS

Further features and specifications for the WMI single diode detector include the following:

- o 70dB Dynamic Range
- o Temperature Compensated
- o Linearity Compensated
- o Frequency Response Curve Data Accuracy: The uncertainty of calibration for the single diode detector at 1mW (0dBm) is 3% to 18GHz and 5% to 26.5GHz
- o Flatness: The maximum total variation of flatness for the single diode detector will be between 1dB and 4dB from 1MHz to 26.5GHz, depending on the detector model and instrument with which it is used. (See the reverse side of this sheet.)
- o Return Loss: Return loss of the single diode detector is 25dB from 1MHz to 2GHz and 20dB from 2GHz to 12.4GHz with any connector. With type N or APC7 connectors, return loss is 18dB from 12.4 to 18GHz and 14dB between 18 and 18.5GHz. When detectors with APC3.5 connectors are used, return loss is 16dB from 12.4 to 18GHz and 14dB to 26.5GHz.
- o Measurement Accuracy: Figures 6 and 7 show the measurement accuracy for the single diode detectors used with the power meters. Single diode detectors specified for the 1038-H/V system have a measurement accuracy of 0.1dB/10dB plus 0.5dB at -50dBm

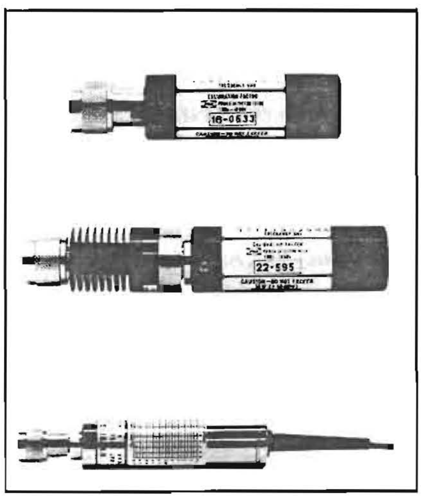

Figure 1. Typical Configurations of Wavetek Microwave's Single Diode Detectors

BALANCED (DUAL DIODE) DETECTOR FEATURES AND SPECIFICATIONS

Further features and specifications for the WMI balanced detector include the following:

- o 76dB Dynamic Range
- o Effects of even harmonics are reduced, thereby increasing measurement accuracy
- o Absorbs low level dc offset voltages
- o Very low thermal drift
- o Temperature Compensated
- o Linearity Compensated
- o Input Impedance: 50 ohms, nominal
- o Frequency Response Curve Data Accuracy: The uncertainty of calibration for the balanced detector is 3% to 18GHz and 5% to 26.5GHz
- o Flatness: The maximum total variation of flatness for the balanced detector is 1.5dB from 1MHz to 18GHz and 2dB from 18 to 26.5GHz
- o Return Loss: Return loss of the balanced detector is 20dB from 1MHz to 2GHz, 18dB to 12.4GHz, 16dB to 18GHz, and 10dB up to 26.5GHz.
- o Measurement Accuracy: See Figure 4

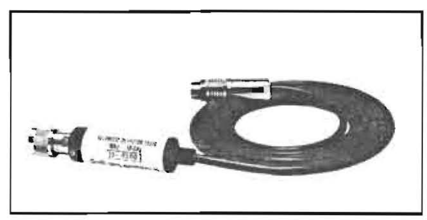

Figure 2. Wavetek Microwave's Patented Balanced (Dual Diode) Detector

DETECTOR HANDLING PRECAUTIONS

Any RF detector is, of necessity, a very delicate instrument and must always be handled with care. Care must be taken to avoid exceeding the detector's electrical rating through static electricity, power input greater than specified, or use of measuring equipment. Also avoid mechanical stress that could be caused by dropping or over-torquing the detector. See the Operating and Maintenance Manual for the appropriate instrument with which the detector is to be used for further details.

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WAVEGUIDE DETECTOR FEATURES AND SPECIFICATIONS

Further features and specifications for the WMI waveguide detector include the following:

- 70dB Dynamic Range
- Has a plastic housing to reduce thermal shock when handling
- Frequency Response Curve Data Accuracy: The relative uncertainty of calibration for the waveguide detector is 5% from 26.5 to 40.0GHz
- Flatness: The maximum total variation of flatness for the waveguide detector is 4dB from 26.5 to 40.0 GHz
- Return Loss: Return loss of the waveguide detector is > 10dB from 26.5 to 40.0GHz
- Measurement Accuracy: See Figure 5

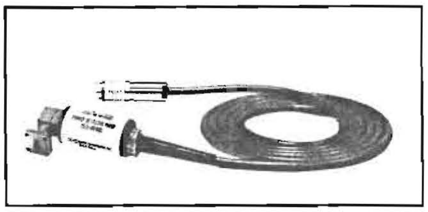

Figure 3. Wavetek Microwave's Balanced Element Waveguide Detector

INDIVIDUAL INSTRUMENT SPECIFICATIONS

The detector parameters given on the reverse side of this Technical Information sheet cover the specifications that are generally to be expected of WMI detectors. Some specifications can be slightly different due to characteristics of the instrument with which the detector is used. These deviations are given below, with all other specifications as given on the reverse side of this sheet.

Model 1038-H/V System

Flatness: Flatness of the coaxial detectors (maximum total variation) is 1.0dB from 1MHz to 18GHz and 2.0dB to 26.5GHz when APC3.5 connectors are used. With type N or APC7 connectors, flatness is 2.0dB to 18GHz

Return Loss: Coaxial detector return loss is 18.0dB from 2 to 12.4GHz, and 14.0dB up to 26.5GHz

Temperature: On Figure 5, H/V System temperature range is 35° to 45°C instead of 35° to 50°C

INDIVIDUAL SYSTEM OR POWER METER DETECTOR SPECIFICATIONS

Part Number	Frequency Range	Absolute Maximum Power Input Without Damage (Peak or CW)	Connector	Type	Diode Replacement Kit No's.
		N10/NS20 System Detectors			
15176	1MHz to 18.5GHz	200mW	Type N	Balanced	15360
15177	1MHz to 18.5GHz	200mW	APC7	Balanced	15360
15285	1MHz to 26.5GHz	200mW	APC3.5*	Balanced	15361
15850	26.5 to 40.0GHz	100mW	UG-599U (WR28)	Balanced	Not Field Replaceable
		H/V System Detectors			
15272	1MHz to 26.5GHz	200mW	APC3.5*	Single	15416
13782	1MHz to 18GHz	200mW	Type N	Single	14016
13783	1MHz to 18GHz	200mW	APC7	Single	14016
15882	26.5 to 40.0GHz	100mW	UG-599/U (WR28)	Single	Not Field Replaceable
		Model 1045 Power Meter Detectors			
13786	1MHz to 18GHz	200mW	Type N	Single	14018
13787	1MHz to 18GHz	200mW	APC7	Single	14018
14139	1MHz to 18GHz	10W CW - 200W Pk	Type N	Single	14018
15271	1MHz to 26.5GHz	200mW	APC3.5*	Single	15417
		Model 1034A Power Meter Detector			
13780	1MHz to 18GHz	200mW	Type N	Single	14015

*Compatible with SMA connector

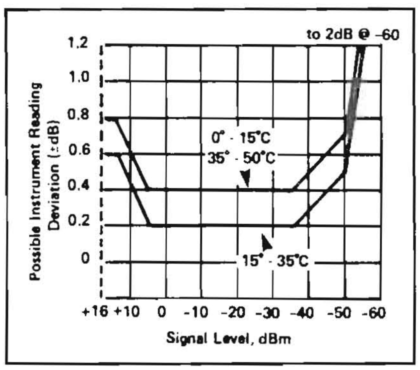

Figure 4 Model 1038-N10 and NS20 System Coaxial Detector Accuracy from 30MHz to 26.5GHz. (An additional 0.2dB is added to the deviation reading for operation from 1 to 30MHz)

Model 1045 Power Meter

Flatness: With type N or APC7 connectors, flatness (maximum total variation) is 2.0dB to 18GHz. With APC3.5 connectors, flatness is 1.0dB to 18GHz and 2.0dB to 26.5GHz

Return Loss: Same as H/V system

Measurement Accuracy: See Figure 6

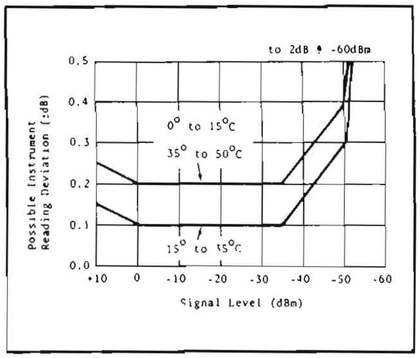

Figure 6 Model 1045 Detector Measurement Accuracy from 1MHz to 26.5GHz

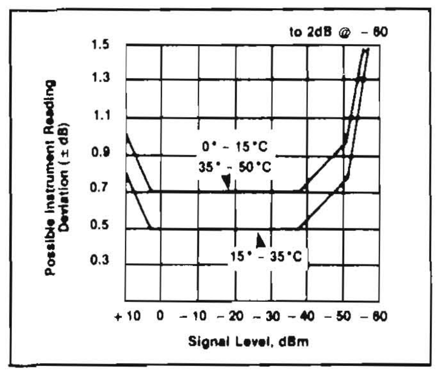

Figure 5 Model 1038-N10, NS20, and H/V Systems Waveguide Detector Accuracy from 26.5GHz to 40GHz

Model 1034A Power Meter

Frequency Response Curve Data Accuracy: The uncertainty of calibration at 1mW (0dBm) is 2% to 12.4GHz and 3% to 26.5GHz

Flatness: 2.0dB to 18GHz

Return Loss: Same as H/V System

Measurement Accuracy: See Figure 7

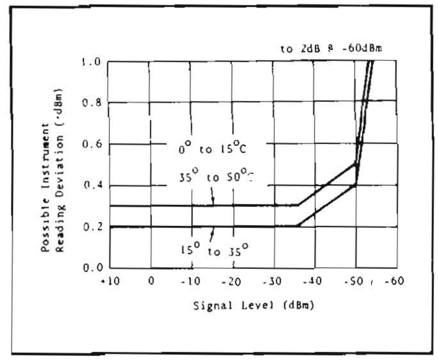

Figure 7 Model 1034A Detector Measurement Accuracy from 1MHz to 10GHz. (Add 0.2dB to the above for frequencies from 10GHz to 18GHz)

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DETECTOR ELEMENT AND TRACKING RESISTOR REPLACEMENT PROCEDURES FOR DETECTORS USED WITH THE 1038-H/V SYSTEM (P/N'S 13782, 13783, 13784, 15272); THE MODEL 1045 POWER METER (P/N'S 13785, 13786, 13787, 13838, 13840, 14139, 15271); AND THE MODEL 1034A POWER METER (P/N'S 13779, 13780, 13781)

All of the detector part numbers listed in this Technical Information Sheet represent single diode detectors. In the single diode detector, the detector element is replaced at the detector end of the cable and the tracking resistor is replaced at the instrument input end of the detector cable.

WARNING: Dimensional tolerances of the detectors are critical. Care must be taken to keep the work area very clean when performing a diode and resistor changeout so that dirt and dust cannot get into the detector.

Before starting any of these replacement procedures, be sure to read all of the Handling Precautions shown inside the box at the bottom of this page.

FOR DETECTOR P/N'S 13779, 13780, 13781, 13782, 13783, 13784, AND 15272 (1038-H/V SYSTEM AND MODEL 1034A) USE THE FOLLOWING PROCEDURES:

1. Using Figure 1 on page 3 of this sheet as a guide, remove the knurled nut that secures the insulator to the detector. Slide the insulator back along the cable to expose the metal detector body.

2. Unscrew the cap assembly from the detector housing assembly.

3. Remove the detector element and, if included, the ring from the detector housing assembly. (Older detectors may have a capsule spacer and capacitive washer. Remove these. They will be replaced by the ring included in the kit. If your detector has just the ring, replace it with the ring from the kit.)

4. Late model detectors have only the detector element; no spacer, washer, or ring. If your detector has no spacer, washer, or ring, then discard the ring from the kit and replace just the element as shown in Figure 1. Make sure that components are correctly seated and pressed firmly into the detector.

WARNING: Use care when pressing the detector element into the housing to avoid damaging the female socket contacts.

5. Replace the cap assembly onto the detector housing assembly, and tighten to 30 inch-pounds (4.4 N-M). Reassemble the insulator and knurled nut onto the detector.

Steps 6 through 11 apply only to P/N'S 13779, 13780, 13781

6. Using Figure 2 as a guide, unscrew the strain relief from the connector body.

7. Remove the shrink sleeving from the existing resistor in the detector and check its value against the value of the resistor included in the kit. If they are the same value, leave the existing resistor re-cover it with shrink sleeving).

8. If the resistor values are different, unsolder the existing resistor and replace it with the new resistor from the kit at the same point (pins 3 and 4). Be sure to place shrink sleeving over the new resistor before reassembling.

9. Reassemble by reversing the above steps.

HANDLING PRECAUTIONS

1. GENERAL

Avoid unnecessary handling of the detector element used in the RF detector.

A. Static electricity builds up on a person, especially on dry days, and must never be allowed to discharge through the RF detector. Avoid any exposed leads on the detector input or output.

B. Before installing the detector element in the detector housing, touch the exposed metal housing with your hand to discharge static electricity. Then install the element into the housing.

C. Before handing a detector element to another person, touch hands first to remove the static electricity potential between you.

D. Do not use an ohmmeter to measure the detector element's diode resistance. The ohmmeter's open circuit voltage or short circuit current could easily damage the diode.

2. MECHANICAL PRECAUTIONS

The RF detector is a very delicate instrument that can be easily damaged during handling. Possible excessive return loss or mechanical breakage can occur. To avoid problems while installing the detector element, review the procedures detailed in the diode replacement section of this Technical Information sheet. The following precautions are provided as supplemental information and are general in nature.

A. During disassembly of the detector assembly, note the position and alignment of all components. If small components are damaged, replace them before reassembly.

B. Ensure that all parts are clean, but use extreme care in cleaning them to avoid causing other problems. If a cleaning solution must be used, use only ISOPROPYL ALCOHOL, as other solvents can affect the materials used in the detector assembly.

C. Reassemble the assembly using minimum force. Normally, the assembly can be HAND-TIGHTENED to the point that no space is left between the housing and the cap. If you can no longer tighten it and any space remains, something may be misaligned internally.

D. Seat the assembly firmly using a torque wrench and the specified torque of 30 inch-pounds (4.4 N-M), ensuring that the wrenches are properly seated on the flat surfaces provided.

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10. Remove the old calibration label since its data will no longer apply. Leave the old part number label on the detector.

11. Check the detector in accordance with the Detector Performance Evaluation Procedure shown at the bottom of the next column.

12. If facilities are available for evaluating frequency response characteristics, the new calibration data can be marked on the new label, if supplied, or recorded for reference. If a new label is marked, it should be affixed to the detector insulator to replace the old label. If no facilities are available to check frequency response, the detector can be returned to the factory for calibration.

FOR DETECTOR P/N'S 13785, 13786, 13787, 13838, 13840, 14139, AND 15271 (MODEL 1045) USE THE FOLLOWING PROCEDURES:

1. Using Figure 3 on page 3 of this sheet as a guide, remove the two #2-56 screws from the sides of the insulator. Slide the insulator back.

2. Unscrew the cap assembly from the detector housing assembly.

3. Remove the detector element and, if included, the ring from the detector housing assembly. (Older detectors may have a capsule spacer and capacitive washer. Remove these. They will be replaced by the ring included in the kit. If your detector has just the ring, replace it with the ring from the kit.)

4. Late model detectors have only the detector element; no spacer, washer, or ring. If your detector has no spacer, washer, or ring, then discard the ring from the kit and replace just the element as shown in Figure 3. Make sure that the components are correctly seated and pressed firmly into the detector.

WARNING: Use care when pressing the detector element into the housing to avoid damaging the female socket contacts.

5. Using Figure 4 on page 4 of this sheet as a guide, unscrew the coupling nut from the cap. Remove the #2 screw from the thermistor mount so that it is free to revolve in the cap.

6. Holding the cap securely, use the spanner wrench (P/N 14238) provided in the kit to unscrew the audio connector. Make sure that the thermistor mount also revolves in the cap in the same direction as the audio connector.

7. Check the value of the existing resistor against the value of the resistor included in the kit. If they are the same value, leave in the existing resistor.

8. If the resistor values are different, unsolder the existing resistor and replace it with the new resistor from the kit. Solder the resistor across pins 1 and 5. The red wire must be re-soldered back into connector pin 1.

9. Screw the audio connector back into the cap, allowing the thermistor mount to revolve in the same direction as the connector.

10. Using the #2 screw, secure the thermistor mount to the cap. Then screw the coupling nut back onto the cap.

11. Replace the coupling nut/cap assembly onto the detector housing and tighten it to 30 inch-pounds (4.4 N-M).

12. Replace the insulator and secure it with the two #2-56 screws.

13. Remove the old calibration label since its data will no longer apply. Leave the old part number label on the detector.

14. Check the detector in accordance with the Detector Performance Evaluation Procedure given below.

15. If facilities are available for evaluating frequency response characteristics, the new calibration data can be marked on the new label, if supplied, or recorded for reference. If a new label is marked, it should be affixed to the detector insulator to replace the old label. If no facilities are available to check frequency response, the detector can be returned to the factory for calibration.

DETECTOR PERFORMANCE EVALUATION PROCEDURE

This test will check the detector for proper linearity and VSWR characteristics.

Standard procedures can be used to check return loss. The measurement of return loss up to a frequency of 34GHz requires considerable care if measurement errors are to be avoided. It is highly recommended that a slotted line be used, or to use couplers or bridges with open/short calibration and an air line during the measurement procedure.

To check linearity, the power meter or analyzer compatible with the detectors must be within proper calibration. To supply power to the detector, a source with a power output between 0 and 16dBm must be used. This is usually a 30 to 50MHz source of 40mW. The source must have harmonics down at least 50dB, and a well matched step attenuator (10dB steps, return loss greater than 20dB, and a 70dB range). Due to the tightness of the linearity specification for the detectors, the coaxial attenuator must have a correction chart with it allowing the attenuation to be known within 0.03dB down to -40dBm, and within 0.1dB below -40dBm.

Connect the attenuator between the detector and the source. Starting with 0 attenuation, step the attenuator in 10dB steps. If detectors for the 1038-H/V System are being checked, measurement accuracy should be 0.1dB/10dB plus 0.5dB at -50dBm. If detectors for the Model 1045 or Model 1034A are being checked, use the linearity curves of either Figure 5 or Figure 6 on page 4 of this sheet for comparison.

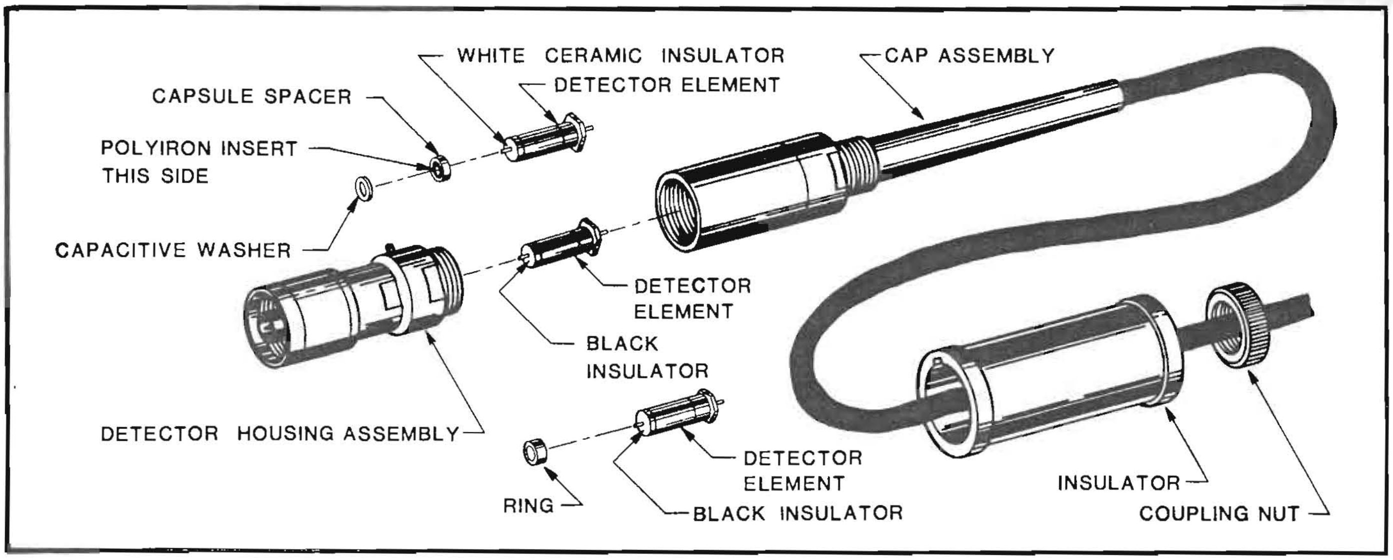

Figure 1. Element Replacement for Detectors Used With the 1038-H/V and 1034A Units

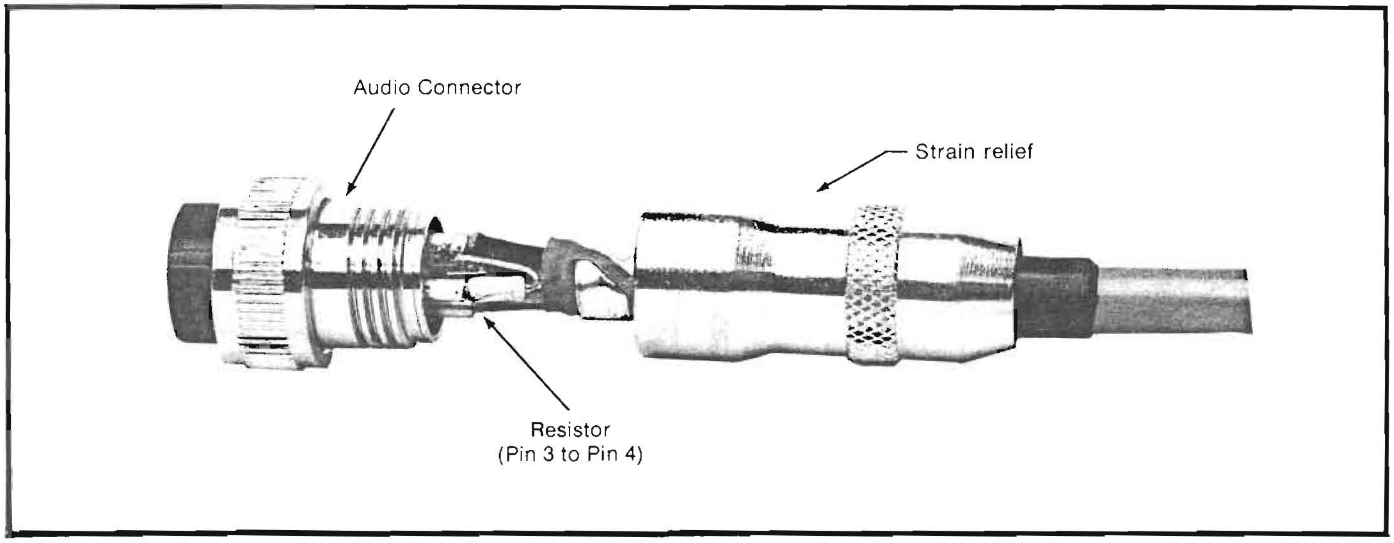

Figure 2. Resistor Replacement for Detectors Used With the 1034A Units

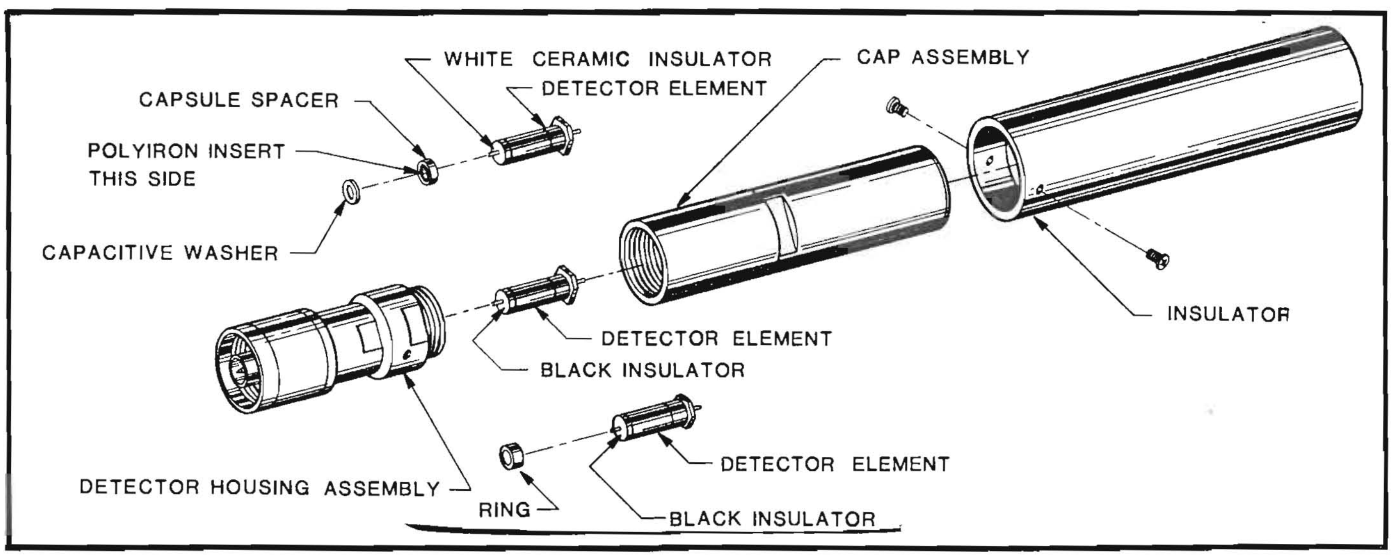

Figure 3. Element Replacement for Detectors Used With the Model 1045 Unit

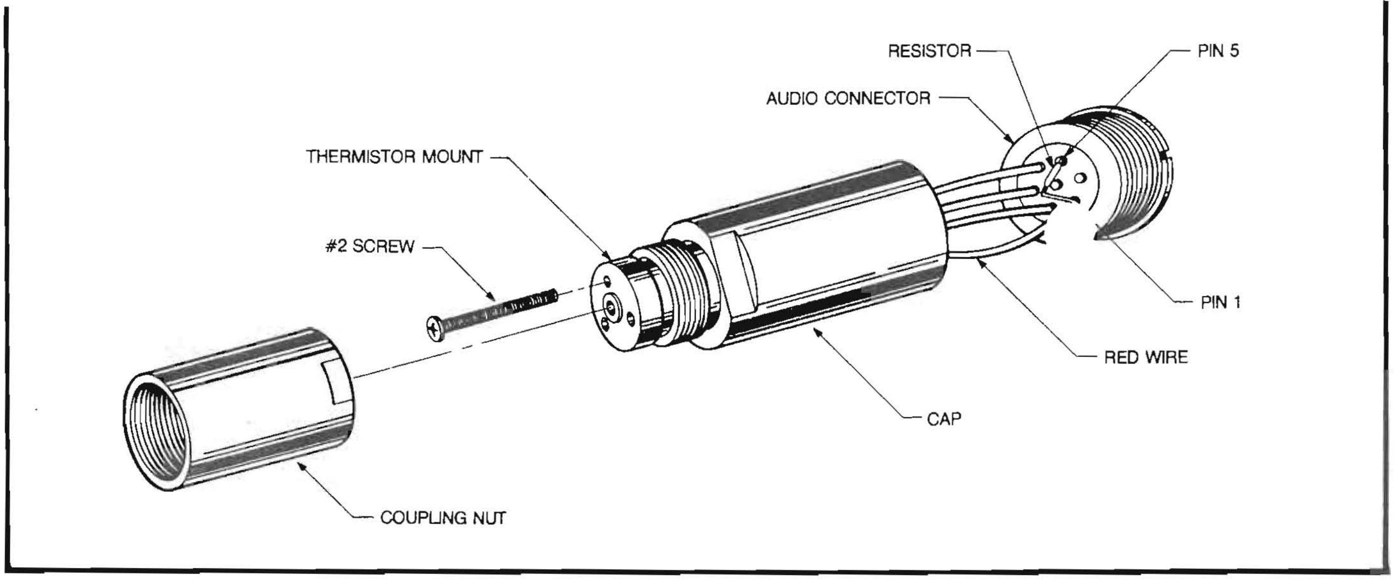

Figure 4. Resistor Replacement for Detectors Used With the Model 1045 Unit

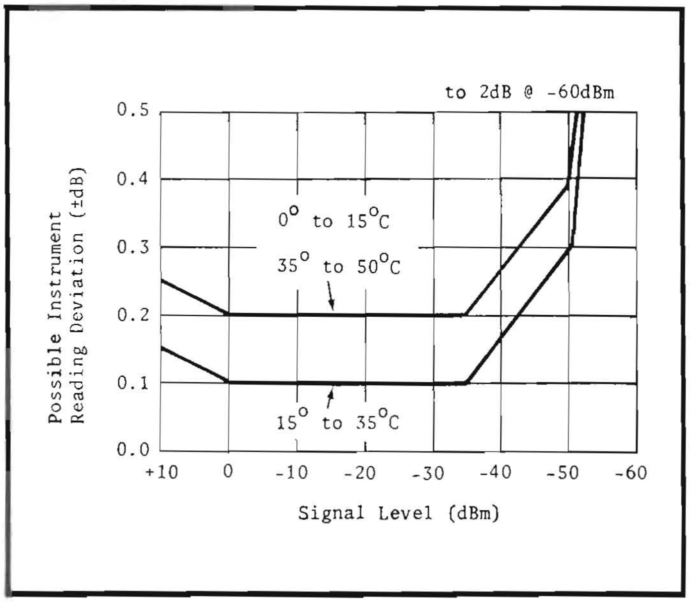

Figure 5. Model 1045 Detector Measurement Accuracy from 1MHz to 26.5GHz.

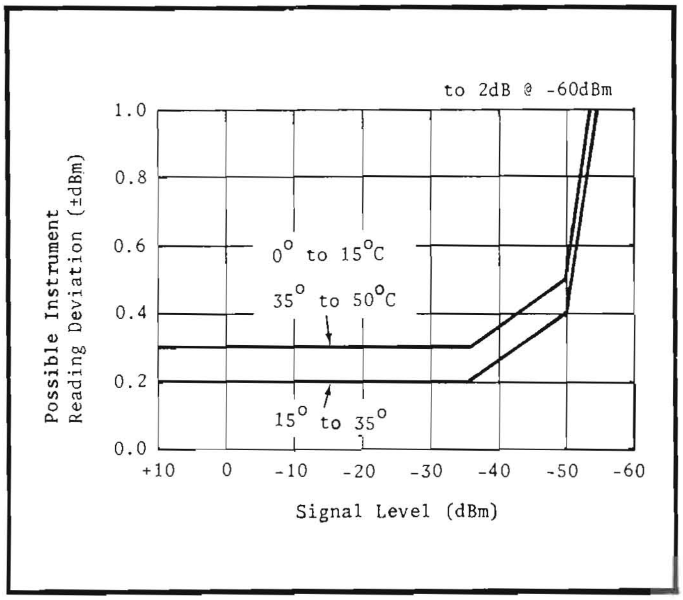

Figure 6. Model 1034A Detector Measurement Accuracy from 1MHz to 10GHz. (Add 0.2dB to the curve for frequencies from 10GHz to 18GHz.)

1. GENERAL INFORMATION

1.1 WAVETEK MICROWAVE, INC. (WMI) MODEL 1034A PORTABLE RF POWER METER

The WMI Model 1034A Portable Power Meter is used with an RF power detector to indicate the power level incident upon the detector. A panel meter with a scale length of 4 1/2 inches indicates the power on three scales. The two top scales cover a decade range of power with a one decibel overlap. The top scale indicates power in linear terms, and the scale below it indicates in decibels. The third (bottom) scale covers a 50dB range from -40 to +10dBm and indicates in dBm. One of seven ranges can be selected by push buttons arranged in a column on the right side of the meter's front panel. These will cause the meter to read on-scale for the decade ranges as long as the input power is within the measurement range of the instrument. An additional button at the top of the column selects the -40 to +10dBm range.

A calibration factor control allows the sensitivity of the instrument to be set to compensate for variations in detector calibration factors. The calibration factor for the detector is supplied in the form of a chart showing the calibration factor at several different frequencies throughout the operating frequency range of the detector. By setting the control to correspond to that given for the detector at or near the specific frequency of the test signal, the instrument will compensate for this factor and read it as if the calibration factor were unity. 50 to 75 ohm adapters are available as accessories. These will reduce the effective sensitivity by 1.76dB. To compensate for this, the sensitivity of the instrument can be increased an equivalent amount by switching the slide switch on the left of the meter to the 75 ohm position. It is important to be sure that the switch has been returned to the 50 ohm position when the adapter is not in use.

There will be a small change in the sensitivity of the detector with a change in the temperature. The detector is equipped with a temperature sensor to allow compensation for this effect, but there can be some small residual variation. To allow the operator to adjust for this and to provide a convenient self-test feature, there is a calibration signal available from the front panel connector. This signal is very stable with respect to changes in temperature, has very low harmonic output, and is precisely matched to 50 ohms. The bottom push button on the right-hand column turns on the calibrator and selects the range for the instrument to read full-scale when connected to the calibrator output. A screwdriver adjustment adjacent to this button sets the instrument for a correct reading. To measure low level signals, it is necessary to check to see that there has been no appreciable zero drift in the instrument. Like all power meters, the Model 1034A will drift somewhat if the detector temperature is changing. Ideally, the detector should be connected to the measurement system with the power turned off, and the instrument set for an indication in the center scale "Zero" range. This is done by pressing the ZERO button and adjusting the screwdriver control next to the button.

To allow plotting of the power indication on an X-Y plotter, there is an analog output on the front panel. The output is 1.1V for a full-scale deflection of the meter. Since there is an 11dB range on the meter scale, this represents 0.1V for each dB on the single-range scale. For the -40 to +10dBm scale, the corresponding factor is 0.0167V/dB, or 60dB per volt. The recorder input must be isolated from ground.

The 1034A will operate steadily from its battery, without line power, for more than 10 hours. To recharge the battery, the instrument is plugged into the line power source with its power switch off (the pilot light will not be lit) for 14 to 20 hours. The unit can be left connected to the line at all times with no danger of damage to the battery. Recharging will take place if the instrument is turned on during the charging cycle, but the recharging time will increase to approximately 40 hours. If the power is supplied during normal use, the battery will remain charged and battery power will be available when needed.

1.2 PERFORMANCE SPECIFICATIONS

POWER RANGE

Seven 11dB ranges with full-scale readings of 10mW, 1mW, 100uW, 10uW, 1uW, 100-nW, 10nW, and an eighth range covering -40 to +10dBm.

ACCURACY (See Figure 1-1, below)

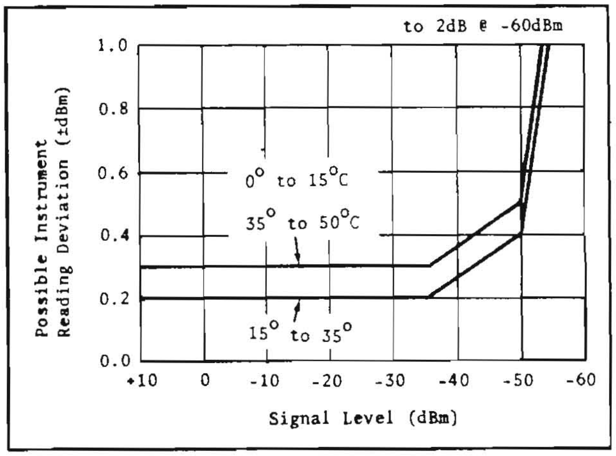

Figure 1-1. Model 1034A Detector Measurement Accuracy from 1MHz to 10GHz. (Add 0.2dB to the above for frequencies from 10GHz to 18GHz. The curve includes uncertainty due to detector non-linearity, but not mismatch or efficiency calibration errors. Not applicable to -40 to +10dBm range.)

ZERO CARRYOVER

Included in the accuracy specifications.

NOISE

Less than 0.05dB p-p for signal levels greater than -40dBm. Less than 0.2dB p-p for signal levels greater than -50dB, as observed on the meter.

ZERO DRIFT

At -50dBm, less than 1dB/hour. Proportionately less as the input signal increases (constant 25°C temperature, after 1/2 hour stabilization).

DRIFT WITH TEMPERATURE CHANGE

At -50dBm, less than 0.5dB/°C. Proportionately less as the input signal increases.

CALIBRATION OUTPUT

Calibrator output is 10mW (+10dBm) with an uncertainty of 1.5%. Nominal frequency is 30MHz. Output impedance is 50 ohms. Source VSWR better than 1.04. Drift is less than 0.04dB over a three month period. Temperature coefficient is better than 0.001dB/°C.

ANALOG OUTPUT

1.1V for full-scale reading with a coefficient of 100mV/dB. Output impedance is approximately 10K ohms. Noise is less than 0.1dB p-p at -20dBm.

METER

Taut band 1mA movement with mirror-backed scale. Milliwatt scale length is 4 1/2 inches.

POWER REQUIREMENT

115/230Vac ±10%, 50 - 400Hz, 10VA

OPERATING TEMPERATURE RANGE

0 to 50°C (+32 to +122°F)

WEIGHT

3.4 kg (7.5 lbs) (without battery)
3.86 kg (8.5 lbs) (with battery)

OVERALL DIMENSIONS (H x W x D)

191 x 152 x 229 mm
(7 1/2 x 6 x 9 in)

BATTERY POWER SUPPLY (Option 01)

Battery provides more than 10 hours of continuous operation. Full charge is obtained after 16 hours of charging time. Input line voltage range is 90 to 130 and 180 to 260Vac, 50 to 400 Hz. (This option obviates Option 04.)

OPTION 03

APC7 connector on the Calibrator output.

OPTION 04

Operation from 100/200Vac ±10% line. No extra charge. (See also Option 01 description, preceding.)

2. INITIAL INSTRUCTIONS

2.1 RECEIVING INSTRUCTIONS

Inspect the instrument for any shipping damage. Be sure that all portions of the shipment are located and removed before discarding the shipping container.

2.2 RETURNING THE INSTRUMENT

If it is felt the instrument should be returned to WMI for any reason, it is recommended that the Wavetek Microwave Customer Service Department be contacted prior to sending back the unit. It is often the case that many problems can be resolved by telephone or Telex without the necessity of returning the instrument. The telephone number is (408) 734-5780, extension 260, or Telex 3716460.

2.3 POWER REQUIREMENTS

Before applying power to the instrument from the line, **be sure that the instrument is set for the correct line voltage.** When the instrument leaves the factory, a plate is installed just above the power input connector showing the correct line voltage. If it is required to change the line voltage, the large screws at the left and right center of the front panel and the screws on the bottom of the case should be removed. Lift the instrument out of its case to allow access to the line voltage switch. Move the switch to expose the correct line voltage indicator on the moveable plastic part of the switch. If the 115V indicator is exposed, standard units will operate from 115V ac ±10%. If the 230V indicator is exposed, the unit is set to operate from 230V ±10%. If equipped with option 04, the unit will operate from 100V ±10% if set to 115V, or 200V if set to 230V. If equipped with option 01 (battery) the 115V setting will cover the range from 180V to 256V. If the switch setting is changed, be sure to remove the plate above the power input connector and reinstall it so that the correct voltage is facing up (the plate is marked on both sides).

2.4 CHASSIS GROUNDING

WARNING: Failure to properly ground the instrument can allow dangerous voltage levels to build up on the chassis which could be dangerous to operating personnel.

The 1034A is supplied with a three conductor power cord. The instrument will be properly grounded if the plug is connected to a properly grounded three-prong receptacle. If a three prong to two prong adapter is used, be sure that the extra lead from the adapter is grounded.

If the unit is equipped with option 01 (battery), it can be operated independently of the power line. The internal supplies are low voltage and no danger is present in the 1034A itself when in the battery mode. However, without the power cord connected, the unit will not be grounded and the chassis will assume the potential of the device to which it is connected. Many types of microwave sources operate with potentially lethal internal voltages. For this reason, it is extremely important for the operator to be sure that the device to which the 1034A is connected is safely grounded.

2.5 DETECTOR HANDLING

Caution: Before handling the detector included with the 1034A, read the "Handling Precautions" at the bottom of the "Detector Element and Tracking Resistor" Technical Information sheet located at the end of Section 1 (preceding).

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 housing. The coaxial detector used with the 1034A has a maximum rating of 200mW (+23dBm). It should be determined prior to testing that the power output of the device under test will not exceed that specification.

2.6 ACCESSORIES

The following accessories are supplied with the 1034A:

1 ea	P/N 12356	Power Cord
1 ea	P/N 14166	Operating & Maintenance Manual

There is a storage compartment in the top of the case. Normally, the instrument will be ordered with the RF detector and possibly a 50 to 75 ohm adapter. These items and the power cord should be found in this compartment.

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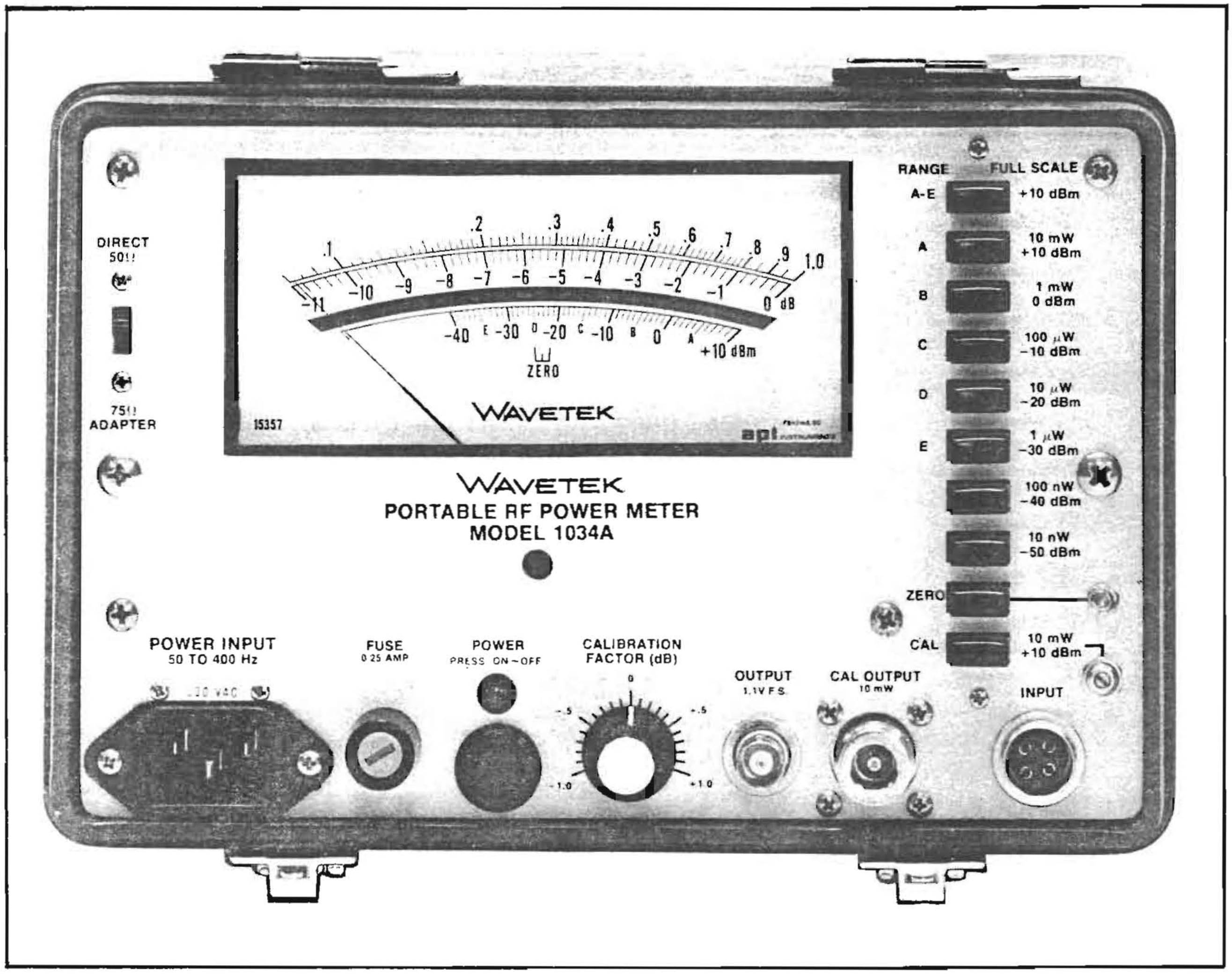

Figure 3-1. Model 1034A Front Panel

3. OPERATION

3.1 FRONT PANEL CONTROLS

The following controls are located on the front panel of the 1034A. For reference, a photograph of the front panel is shown on the attached page in Figure 3-1.

3.1.1 Power Switch

This push-push switch is arranged so that power will be ON when the switch is out. When the cover is placed on the instrument case a plastic rod forces the switch in, ensuring that the power is off and the battery is not being drained. The fastest way to recharge the battery is with the unit connected to the ac line with the power switch off. A pilot light adjacent to the switch indicates if the instrument is turned on, but will not light during charging only.

3.1.2 Meter Range Push Buttons

Eight of the ten buttons on the right side of the meter control the ranges that can be selected for the meter. The top button (A-E) selects the bottom dBm scale of the meter, covering the range from -40 to +10dBm. This range is useful if the power being measured will be varying over a wide range; for example, when adjusting a filter or an antenna at the start of the adjustment procedure. It is also useful to determine the approximate power delivered by a source to the meter so that the proper range limit button can be selected. Between the major divisions of this scale are the letters A through E, indicating the appropriate expanded range for the power being measured. Below -40dBm there is no accurate indication of power so that a selection of the bottom two expanded ranges must be made by trial. The seven expanded range scales are selected by the buttons below the top one (A-E). The values for the full-scale readings on the two uppermost scales of the meter are indicated to the right of each of the buttons. The top indication of the two is for the top scale of the meter (linear values), and the bottom indication refers to the next scale down (dB). The expanded scales provide the best resolution and the accuracy specified for the instrument. If a reading greater than +10dBm is indicated, the power to the detector should be reduced without delay because the +23dBm (200mW) destruction point of the detector diode could be generated by the power source.

3.1.3 Zero Button & Screwdriver Adjustment

Pressing the ZERO button causes the meter to indicate the correct zero signal balance adjustment for the input circuits of the instrument. With no RF power applied to the detector and the ZERO button depressed, the screwdriver adjustment adjacent to the ZERO button is set to cause the meter to read in the small range marked "Zero" in the center of the meter's scale.

3.1.4 Cal Button & Screwdriver Adjustment

Pressing the CAL button turns the calibration oscillator on, disconnects the CAL FACTOR control, selects the DIRECT 50Ω position, and puts the meter on the "A" scale. When the detector is then connected to the CAL OUTPUT connector, the CAL screwdriver adjustment can be set to cause the instrument to indicate exactly 10mW, or full scale.

3.1.5 Calibration Factor Control (dB)

This control adjusts the sensitivity of the instrument to compensate for variations in detector sensitivity with changes in frequency. A calibration chart is provided with the detector that gives the correct setting of the CALIBRATION FACTOR control for a number of discrete frequencies within the operating range of the detector. The control should be set to correspond to the point on the detector's calibration chart closest to the operating frequency. If the detector is being used in conjunction with a directional coupler or attenuator of known calibration, the control can be set to compensate for both the detector and the additional device. The meter will then read directly.

3.1.6 Direct 50Ω/75Ω Adapter Switch

Normally, this switch will be left in the 50Ω - position. If a 50 to 75Ω adapter is connected in front of the detector, the switch can be set to 75Ω to correct the reading for a 1.76dB adapter loss.

3.2 INTERNAL CONTROL, LINE VOLTAGE SWITCH

The 1034A can be operated on various line voltages as well as the internal battery. See Section 2.3 on page 2-1 for a complete discussion of the line voltage settings available.

3.3 FRONT PANEL METER

The mirror-backed front panel meter indicates power readings on three scales. The bottom scale covers a 50dB range, and is selected by the top button on the panel. The top two scales are selected by the buttons below the top button. These scales cover 11dB, which allows a 1dB overlap for each 10dB range. In addition to the power indicating ranges, there is a center scale marking which shows the correct zero adjustment range. Just below the mirror-backed meter there is a mechanical zero adjustment provided to screwdriver-adjust the position of the pointer on the meter. This adjustment should be made with the instrument placed in the position in which it will be operated (laying down or standing up). The adjustment is correct when the pointer moves in the same direction as the adjustment screw, and lies on the scale markings at the left edge of the scale when the instrument is turned off.

3.4 FRONT PANEL CONNECTORS

The following connectors are located on the front panel of the 1034A, as shown in Figure 3-1:

3.4.1 Power Input

This three prong male jack is used to supply power to the instrument when it is operating from the ac line or the battery is being recharged. The connector conforms to I. E. C. specifications for six ampere connectors with a grounding pin. Be sure that the instrument is connected to a properly grounded ac supply. See the Warning of Section 2.3 on page 2-1.

3.4.2 Output BNC Connector

This connector supplies a voltage corresponding to the meter reading. The full-scale voltage is 1.1V. Since the expanded 10dB ranges cover 11dB on the meter scale, this would be equal to 0.1V/dB on those ranges. On the -40 to +10dBm range, the coefficient is 16.7mV/dB or 60dB per volt. The output impedance is approximately 10K ohms. This output is provided to drive recorders or plotters with inputs isolated from ground. If the output is connected to grounded devices, ground currents can occur which will give low-level power measurements with grossly inaccurate readings.

3.4.3 Cal Output 10mW, Type N Connector

The internal calibration oscillator supplies 10mW ±1.5% of RF power when the CAL button is pressed. The source impedance is 50 ohms ±2% (SWR less than 1.04), and harmonics are down 50dB with respect to the signal level. When the detector is connected to the CAL OUTPUT and the CAL button is pressed, the CAL screwdriver adjustment is used to cause the instrument to read full-scale. This will adjust the calibration for all ranges.

3.5 OPERATING PROCEDURE

WARNING: Continuous or peak power levels in excess of +23dBm (200mW) can damage or destroy the diode power sensing device of the detector. Always take precautions to ensure that the power applied to the detector will be well below this level before connecting the detector to any RF power source.

1. Connect the line cord if the instrument is to be run from the ac line or if the battery is to be recharged. Be sure to observe the Warning of Section 2.4 on page 2-1.

2. Turn the 1034A ON by pressing the POWER switch and allowing it to pop out. The pilot light will illuminate when power is applied. If the condition of the battery charge is not known, connect the detector to the CALIBRATION OUTPUT and press the CAL button. If the same detector is being used that was last used with the instrument, the meter reading should be within a few tenths of a dB of full-scale. If not, a

discharged battery should be suspected. The best method of determining that the battery is fully charged is to connect the instrument to a source of line power for 16 hours or more (such as overnight). The battery will then be ready for 10 hours of use. There is no danger of overcharging the battery.

3. Check the calibration by connecting the detector to the CALIBRATOR OUTPUT. Adjust the CAL screwdriver adjustment to obtain full-scale deflection of the meter. This step can be combined with the battery check of step 2 if desired.

4. If it is possible to turn off the RF power source that will be measured, do so and connect the detector to the source. If the source cannot be turned off, leave the detector on the CALIBRATOR OUTPUT. Press the ZERO button and adjust the ZERO screwdriver adjustment so that the meter reads in the "Zero" range.

5. Consult the calibration factor chart on the detector and set the CAL FACTOR control to the value given for the frequency nearest the frequency of the power source. If the power of the source is not approximately known, connect enough attenuation to be sure that the power will be below +10dBm. Press the top button (A-E) and read the power on the -40 to+10dBm scale. The approximate power level can then be determined so that the amount of attenuation required (if any) can be selected.

6. To measure power, first press the top button. Since the lower scale covers the entire range of the instrument, it is convenient to use if precise measurements are not required. If a precise determination is required, observe the letter lying between the same two major divisions as the pointer. Press the button corresponding to the indicated letter and read the power on the top scales. If the power is below -40dBm, try the -40 or -50dBm scales to obtain the best reading. If a reading greater than full-scale on the top range is obtained, reduce the input power without delay because the meter will not indicate any further increases in power that could be great enough to destroy the detector.

If low power levels are being measured, periodically check the ZERO adjustment. This is particularly important for a period of one hour after turn on or when there has been a change in the ambient temperature in which the instrument is operating. The CAL adjustment should not require rechecking unless the ambient temperature has changed by several degrees. The CAL adjustment must be rechecked whenever detectors are changed.

3.5.1 Use of the Analog Output

The analog OUTPUT connection can be used for driving recorders and plotters. See Section 3.4.2 on page 3-5 for the description of this feature.

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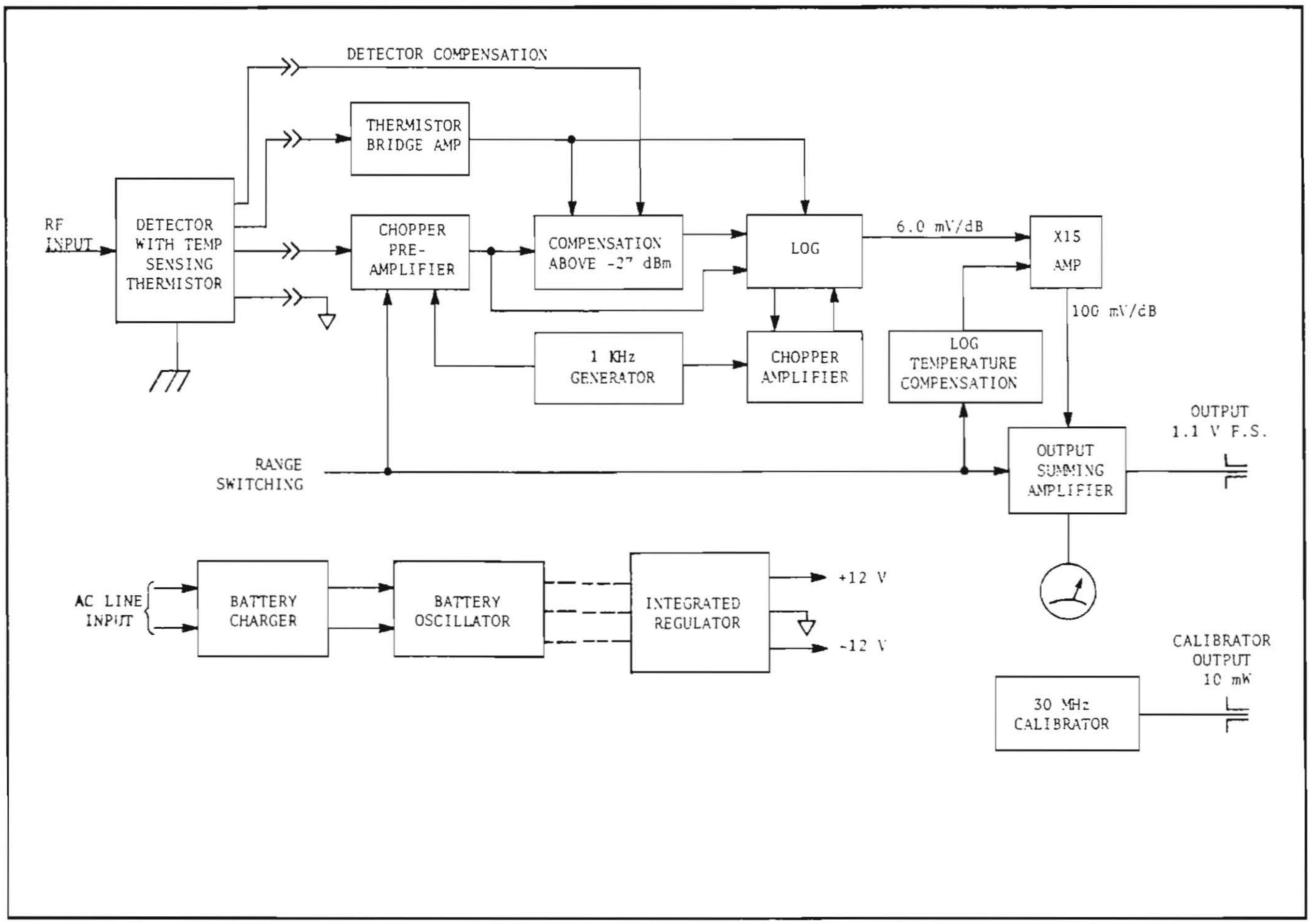


Figure 4-1. Model 1034A Block Diagram

4. ELECTRICAL DESCRIPTION

4.1 INTRODUCTION

Figure 4-1 on the attached page shows a block diagram of the major circuits contained in the 1034A. The block diagram will be described first, and then the circuits within the blocks will be described in detail. To better understand the discussion of the circuits shown within the blocks of the diagram, refer to the schematic diagrams of Section 7.

4.2 BLOCK DIAGRAM DESCRIPTION

4.2.1 RF Detector

To use the power meter, an RF detector must be connected to its input for sensing the various power levels of a device under test. The detector converts the RF power incident upon it to a dc voltage. This voltage is proportional to power at very low RF 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 square (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. Also, there are slight differences in sensitivity from one detector to the next. For this reason, a resistor with a factory-determined value related to the sensitivity of each specific detector is mounted in the detector assembly. Four leads come from the detector. These consist of a common lead tied to the detector housing, a power sensing lead, a lead from the thermistor, and a lead from the detector sensitivity compensating resistor. The thermistor is mounted inside the detector housing and is in intimate contact with the brass shell of the housing.

4.2.2 Thermistor Bridge Amplifier

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 instrument will be correct regardless of the detector temperature.

4.2.3 Preamplifier

The preamplifier is a high impedance, low noise amplifier. It is chopper stabilized to reduce drift to an absolute minimum. A 1kHz integrated circuit oscillator provides drive voltages for both the input chopper amplifier and the stabilizing chopper amplifier used for the log amplifier circuitry. The gain of the preamplifier is switched; for ranges below -20dBm full scale it is 100, and for ranges above and including -20dBm it is 10. The preamplifier feeds the log amplifier directly for all ranges. In addition, it feeds the log amplifier indirectly through the compensation circuit on the ranges above -30dBm full scale.

4.2.4 Compensation Circuit

The compensation circuit starts to become active when the RF power input level reaches approximately -27dBm. At the output of the preamplifier, this level will be amplified to about 15mV using the gain of 10 of the -20dBm range. At this 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 preamplifier at the input to the log amplifier. At high signal levels the detector output voltage deviates from square-law, but the current from the compensation circuit increases so that the total current still corresponds to a correct square-law signal. The amount of compensation required depends upon both the temperature and the characteristics of the particular detector. To cause the circuitry to respond properly to changes in temperature and the use of different detectors, connections are made to the thermistor bridge amplifier and the factory-selected resistor contained in the detector assembly.

4.2.5 Logarithmic Amplifier

The logarithmic (log) amplifier has a very wide dynamic range; from less than 0.5mV to greater than an equivalent input of 100V. In order to be free of drift over that range, it is chopper stabilized. A transistor is used as the logging element. Its output is temperature dependent and must therefore be compensated for changes in temperature. An amplifier following the logging circuit provides a gain of 15, thus raising the signal level to 100mV/dB.

4.2.6 Full-Scale Range Changing

The Model 1034A uses three methods to change the full-scale range of the instrument. These consist of: (1) Changing the gain of the input preamplifier; (2) Changing the current supplied to the temperature compensation circuit, and; (3) supplying differing offset currents to the output summing amplifier. The selection of the size of the span of the range (i.e. whether the scale covers 11dB or from -40 to +10dBm) is dependent upon the gain of the output summing amplifier. A more complete discussion of the range changing arrangement follows in the description of the individual circuit blocks.

4.3 INDIVIDUAL CIRCUIT BLOCK DESCRIPTIONS

The following descriptions refer to the schematic diagrams (SD) located in Section 7. Unless otherwise indicated, the majority of the discussion refers to SD 12932 and the reference designators mentioned in the discussion should be prefixed with A2.

4.3.1 Input Preamplifier

The input preamplifier is a chopper amplifier. It consists of an input chopper to convert the input dc voltage to square wave, a high gain ac amplifier, a synchronous detector to convert the amplified square wave back to dc, and a dc amplifier to provide additional gain and low output impedance. An oscillator circuit provides the switching waveforms required to drive the chopper and synchronous detector. Overall feedback determines the gain and makes the amplifier less dependent upon the parameters of the circuit components than an open loop amplifier would be.

Integrated circuit U2 is a combination oscillator and frequency divider chain. The oscillator runs at 64kHz and the six stage divider divides the frequency down to 1kHz. Outputs from the 2 and 4kHz dividers are combined in U3 to provide narrow pulses to drive the synchronous detector. Figure 6-1 on page 6-7 shows a timing diagram for this circuit. Square wave signals of opposite phase are supplied to Q1 and Q2, alternately turning on one and then the other. The result is that the input of the ac amplifier is first connected to the input signal, and then to the feedback resistor. The ac amplifier consists of the transistors Q5 through Q10. It has sufficient bandwidth so that the signal at the emitter of Q10 is essentially a square wave with an amplitude proportional to the difference between the input and the signal fed back from the output of U1. Q11 and Q12 are turned on briefly at alternate ends of the square wave period. Transient signals that occur due to the switching of the inputs to the amplifier have decayed by the time the output switches are turned on at the end of the cycle. The feedback resistive divider is selected to allow a gain of 100 for ranges of -30dBm and below. For ranges above and including -20dBm, the divider is set for a gain of 10. Q13 short circuits the unused resistor of the divider when a gain of 100 is selected. This keeps leakage currents from the range switch out of the amplifier. Q4 and Q7 generate a gating action which turns the amplifier off during the instant of switching, thereby reducing the effect of the switching transient.

4.3.2 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 of the transistor is proportional to the log of the collector current over many decades of current values. At 25°C, the emitter-base voltage changes by 60mV for each factor of ten that the collector current changes. This factor is directly proportional to the absolute temperature so that for each degree C of temperature variation, the factor will change by about 0.3%. This change with temperature is compensated for by using a thermistor, RT1, to shunt the amount of current caused by the increase in temperature away from the input summing amplifier, A1U1.

The operational amplifier segment of the log conversion circuit is chopper stabilized by using an amplifier similar to the one used in the input preamplifier. Since the sensitivity is not as great, the circuit is simpler. The integrated amplifier, U8, receives ac signals directly through C34. DC signals are routed through the chopper amplifer and go to pin 3 of U8. The current summing junction is common to the chopper amplifier and to C34. If the summing junction is not at zero dc potential, the chopper switching transistor, Q14, will convert the potential to an ac signal. The ac amplifier, U7, amplifies the signal and supplies it to the synchronous demodulator, Q15 and Q16, where it is converted to dc. A low pass filter, R76 and C35, removes the ac component and the dc correction signal goes to pin 3 of U8. This causes the output of U8 to change the current through the logging transistor to bring the summing junction back to zero.

In addition to the logging factor changing with temperature, the saturation current of the logging transistor also changes. To compensate for this effect, an additional transistor is supplied with a fixed current (for a given range), and a differential amplifier amplifies the difference in the emitter-base potential between the logging and compensation transistors. The two transistors are mounted in the same package, Q18. The differential amplifier is U10. U9 is an operational amplifier, with the compensating transistor providing the feedback so that the emitter-base potential of the transistor is the log of the current supplied to the summing point at pin 2. Range switching for the top three ranges is accomplished by changing the current supplied to the compensating transistor (by a factor of ten) for each range.

4.3.3 Square-Law Compensating Circuit

Above about -27dBm, the detector begins to significantly depart from square law. Since the instrument is required to be linear in power, compensation is required. This is so that the total current supplied to the logging circuit summing junction continues to be square law at all levels over the total range of the instrument. This is accomplished by generating a signal proportional to the square of the input signal and adding it to the input at the log amplifier summing junction. This signal is negligable at low input levels, and is many times larger than the input signal at high input levels. The squaring function is implemented by first logging the input signal, amplifying the logged signal by a factor of two, and then taking the antilog.

Integrated amplifier U4 has feedback supplied by the diode connected to pin 8 of U5. The voltage at pin 8 of U5 will be proportional to the log of the input voltage at levels above -27-dBm. The circuit will be inactive at low levels due to the offsetting action of R40. The diode connected to pin 11 of U5 acts merely to limit the voltage excursion of U4 when the circuit is inactive. The diode connected to pin 5 of U5 transmits the signal to U6, and compensates for changes in saturation current in the logging diode due to changes in temperature. Amplifier U6 has a gain of 2 (slightly adjustable by R48), and supplies the amplified voltage to the diode connected to pin 2 of U5 causing the antilog function to become active. The diode connected to pin 3 of U5 compensates the antilogging diode for changes in saturation current due to temperature changes. All of the diodes in U5's circuitry are essentially identical because they are part of an integrated circuit. The current from pin 1 of U5 is thus proportional to the square of the input voltage, and it adds directly with the current from the input preamplifier at the input summing junction of the log amplifier. The circuit is switched off for ranges below -20dBm full scale to avoid the possibility of leakage currents causing errors below the levels where compensation is required.

4.3.4 Temperature Compensation

Amplifier U11 supplies temperature compensating signals to the square law compensation circuit by way of R61 to correct for shifts in detector sensitivity caused by temperature changes, *and to the output amplifier, A1U1, to correct* for changes in overall sensitivity. The signal supplied to the compensation circuit corrects only for linearity, so additional correction is required at A1U1. U11 is arranged as a bridge amplifier fed from a high impedance thermistor. The output of the amplifer is very nearly proportional to temperature over the temperature range of 0° to 50°C.

4.3.5 Range Switching

The range of the 1034A is controlled by three parameters as described in Section 4.2.6 on page 4-5. The operation of the switching action can be seen in Table 4-A on the next page. The equivalent dB values are selected so that the sum of the full scale signal signal and the dB values will be zero for each range except for the -40 to +10dBm (A-F) range. This corresponds to the meter dB reading at full scale. On the (A-F) range the gain of the output amplifier is decreased by a factor of six so that a normal full scale reading of +10dBm would only deflect it 11dB up scale. The scale is arranged for 66dB for full scale, so an offset of 55dB is required. Note that increasing the log compensating current has the effect of decreasing the magnitude of the signal from the differential amplifier, U9.

Table 4-A. Range Switching Gains & Offsets

RANGE	PRE-AMP. GAIN		LOG. COMP. CURRENT		OUTPUT OFFSET CURRENT	
dBm	No.	EQ.dB	μA	EQ.dB	μA (9.5 μA/dB)	EQ.dB
+10	10	+10	380	-20	0	0
0	10	+10	38	-10	0	0
-10	10	+10	3.8	0	0	0
-20	10	+10	3.8	0	95	+10
-30	100	+20	3.8	0	95	+10
-40	100	+20	3.8	0	190	+20
-50	100	+20	3.8	0	285	+30
+10 (A-F)	10	+10	380	-20	523	+55

4.3.6 Calibrator Oscillator

Referring to SD 13065, transistor A1Q1 is arranged in a ground based oscillator circuit with feedback supplied to its emitter through A1-C14. It feeds the CALIBRATOR OUTPUT connector through a 5 pole low pass filter and a 4dB attenuator to assure freedom from harmonics and a good source match at the output. The diode A1CR5 rectifies the peak voltage supplied to A1R32, thereby generating a dc voltage proportional to the RF voltage from the oscillator. Amplifier A1U2 compares this voltage to a stable dc signal derived from the -12V power supply and supplies just enough current to the emitter of A1Q1 to maintain oscillation at the correct level. Diodes A1CR3 and A1CR4 compensate the circuit for changes in the rectification characteristics of A1CR5 when there is a change in temperature.

4.3.7 Power Supply

An ac voltage drives the rectifiers CR10 through CR13 to supply unregulated dc voltages to the filter capacitors C46 and C47. Regulated dc voltages are derived from these by integrated circuit regulators, U12 and U13. The regulators are provided with circuits to limit the current to a safe value and prevent damage in the event of a short circuit of short duration. For operation from the ac line, a transformer supplies the ac voltage to the rectifiers. Battery option instruments have an oscillator supply which generates an ac voltage for the rectifiers. The battery supply generates the ac voltage by a modified form of multivibrator A3Q3 through A3Q6. The circuit oscillates at 30kHz to supply power to the rectifiers through A3T2. Charging of the battery occurs whenever the line voltage is connected to the instrument. Integrated circuit A3U1 maintains the peak of the rectified line frequency waveform at a constant value regardless of the input line voltage. A3RT1 causes the voltage to vary with temperature in accordance with the battery's requirements. Current from the regulator is limited to a safe value.

5. PERFORMANCE VERIFICATION TESTS

5.1 GENERAL

The purpose of this section of the manual is to provide a means of verifying proper operation of the Model 1034A for receiving inspection and when making periodic performance evaluations. If the instrument passes the tests given in this section, it can be assumed to be operating properly and used with confidence. These tests do not check the operation of the power detector as they are only intended to check the health of the indicating instrument. The power detector can be checked using a properly calibrated 1034A as an indicating unit. Alternatively, the detector can be checked by using the Detector Performance Evaluation Procedure given on page 2 of the "Detector Element and Tracking Resistor Replacement Procedures" Technical Information sheet located at the end of Section 1 in this manual.

5.2 EQUIPMENT REQUIRED

The following equipment is required to perform the measurements given in this section.

a. A precision dc power supply capable of 0.01% accuracy and with the ability to be set to 70uV. It is possible to use a precision voltage divider constructed of 0.01% resistors with an attenuation factor of 100 (40dB) to obtain the voltages called for in the first three lines of Table 5-A. Such a divider can be made from 990 ohm and 10 ohm 0.01% resistors. In order to apply voltages to the input of the instrument an adapter must be constructed. Figure 5-2 shows a diagram for the fixture. The resistors shown can be conveniently positioned within the male plug mating with the instrument. In addition, a 50 ohm 0.1% resistor will required when checking the calibrator output. The resistor should be placed in an adapter box with a connector mating with the power supply on one side and a Type N female connector on the other side. Suitable boxes can be obtained from most electronic parts distributers. The resistor should be connected from the high side of the power supply connector to the center pin of the Type N connector. The low side of the power supply and the shell of the Type N connector should be tied together.

b. A digital voltmeter (DVM) with 0.01% accuracy and 1uV resolution. If it is not planned to check the output of the Calibrator, 1mV resolution and 0.1% accuracy will be satisfactory.

Table 5-A. Tracking Performance Tests

INPUT VOLTAGE	RANGE	METER READING	OUTPUT VOLTAGE	RANGE	METER READING	OUTPUT VOLTAGE
-70 μV	-40 dBm	0 dB ±0.2	1.1±0.02	-30 dBm	-10 dB ±0.2	0.1 ±0.02
-0.70 mV	-30 dBm	0 dB ±0.1	1.1±0.01	-20 dBm	-10 dB ±0.1	0.1 ±0.01
-6.65 mV	-20 dBm	0 dB ±0.1	1.1±0.01	-10 dBm	-10 dB ±0.1	0.1 ±0.01
-48.6 mV	-10 dBm	0 dB ±0.1	1.1±0.01	0 dBm	-10 dB ±0.1	0.1 ±0.01
-0.228 V	0 dBm	0 dB ±0.1	1.1±0.01	+10 dBm	-10 dB ±0.1	0.1 ±0.01
-0.885 V	+10 dBm	0 dB ±0.1	1.1±0.01	-------		

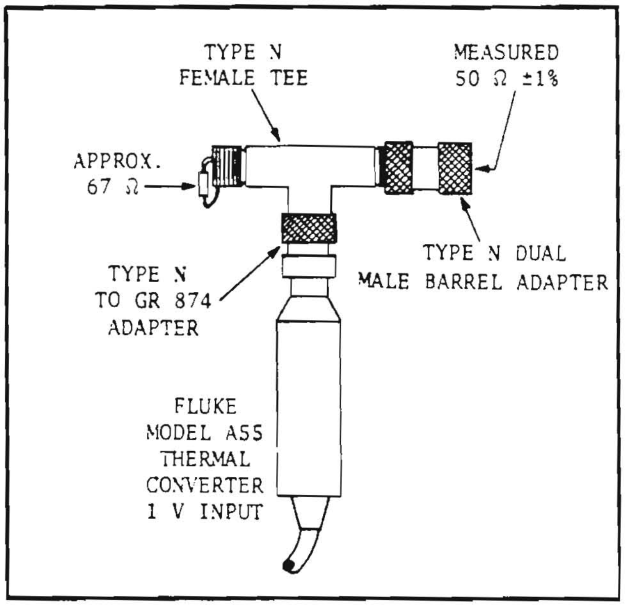


Figure 5-1. Modified Thermal Converter for Checking the Calibrator Output

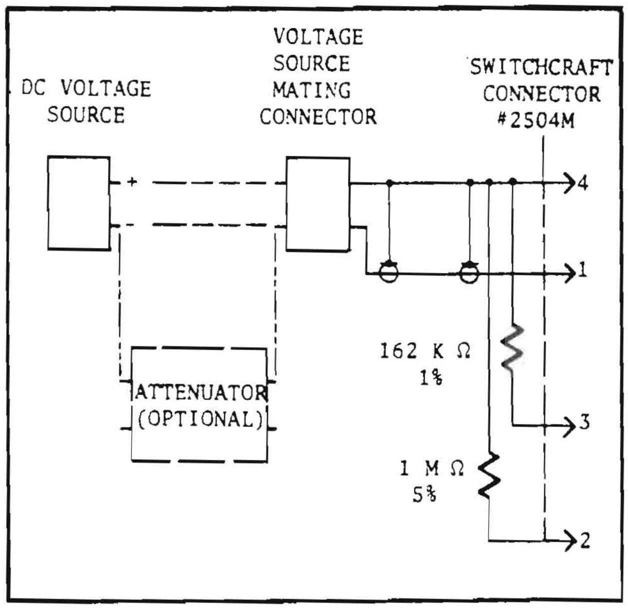


Figure 5-2. Fixture for Applying DC Voltage to the Model 1034A

c. For checking the Calibrator output, a Thermal Voltage Converter will be needed to be used as a transfer standard. The maximum voltage range is 1V. A unit such as the Fluke Model A55 Thermal Transfer Standard or equivalent is recommended. It is required that this device be matched to 50 ohms. The impedance of the converter is approximately 200 ohms, so it is necessary to measure its resistance very accurately (within 0.1%) and select a value of resistance to place in parallel with it to make its value become 50 ohms ±1%. Make all connections very short, preferably soldering the resistor across the end of a Type N Tee connector as shown in Figure 5-1. Be careful not to apply a voltage in excess of 1V to the Converter when measuring its resistance or the Converter could be destroyed.

5.3 TRACKING WITH DC VOLTAGE

In order to operate correctly with a power detector connected to its input, the instrument must respond as shown in Table 5-A. If the precision dc power supply being used does not have adequate low level accuracy or stability, the measurements given in the first three lines of Table 5-A must be made with the attenuator described in Section 5.2.a in place. In any case, the instrument ZERO setting must be adjusted after connecting the power supply or attenuator and just before the measurements called for in Table 5-A are made. To do this, set the power supply to zero volts and follow the procedure given in Section 3.5 on page 3-5. Also, the CAL setting must be adjusted by setting the power supply to 0.7mV, pressing the -30dBm button, and adjusting the CAL setting so that 1.1V ±1mV is measured at the OUTPUT connector. The voltages called for in Table 5-A can now be applied.

Two sets of observations must be made at each input voltage level except the last one. Take the readings indicated for both settings of the range buttons at each input level.

5.4 CALIBRATOR OUTPUT LEVEL CHECK

Set the precision power supply to 1.414V and connect the 50 ohm resistor assembly to the output of the supply. Connect the DVM to the output of the converter. Connect the converter (modified for 50 ohm impedance as previously described) to the resistor at the output of the supply. Record the reading of the DVM, reading it to a precision of 1uV. Reverse the polarity of the power supply and record the new reading with the same 1uV precision. Press the CAL button and connect the converter assembly to the CALIBRATOR OUTPUT. Read the DVM. Compare the reading with the average reading obtained when the converter was connected to the power supply. If the two differ by more than 1%, reconnect the converter to the supply and set the supply so that the voltage from the converter is the same as it was when connected to the CALIBRATOR OUTPUT.

Note the reading of the supply, reverse the polarity, and again set the supply so that the thermal converter output matches what it had been when attached to the CALIBRATOR OUTPUT. Average the two supply voltages. When this is done, the supply voltage should be between 1.425V and 1.403V. It may be necessary to repeat the procedure several times in order to get consistent results.

This completes the Performance Verification Tests for the Model 1034A. If the instrument does not meet one or more of the performance criteria, it should be calibrated according to the procedures given in Section 6, the next 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 (such as being dropped). In such cases, more frequent maintenance is indicated (immediate, if severely abused or dropped).

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 leads are properly seated on their PC board pins.

c. Make a performance check in accordance with the procedures of Section 5. If the performance is within specifications no further service is required.

6.2 INTERNAL ADJUSTMENTS AND TEST POINTS

The following is a listing of the various internal adjustments and the functions of the major test points for ready reference. Do not attempt to make any adjustments until the material of Section 6.3 on page 6-2 has been carefully read. It is also recommended that the Electrical Description given in Section 4 be read to better understand how the instrument operates.

6.2.1 Description of Adjustments

The function of each adjustment is as follows: (Reference the schematic diagrams of Section 7 for the location within the circuitry. The reference designations A1, A2, and A3 specify the proper schematic as shown on page 7-1, and the R numbers and names will be shown on the schematic.)

a. A1R9, CAL OUTPUT
Used to adjust the voltage divider feeding the OUTPUT BNC connector to obtain 1.1V for a full scale signal.

b. A1R12, METER CAL
Used to set the meter drive resistive divider so that its reading changes by 10dB when the instrument's range is changed from -10 to -20dBm with -20-dBm applied to the instrument's input.

c. A1R19, CAL FACTOR ADJUST
Used to adjust the CAL FACTOR panel scale to correspond to the change it causes to occur at the output.

d. A1R22, 10mW OUTPUT CAL
Adjusts the calibrator to supply exactly 10mW to a 50 ohm load.

e. A1R36, -30dBm CAL
Used to adjust the output amplifier for a correct voltage when 0.7mV is applied to the input.

f. A2R48, COMP AMP GAIN
Adjusts the compensation circuit for proper operation between 0dBm and -10dBm.

g. A2R57, MEDIUM LEVEL CAL
Used to adjust the compensation circuit for proper operation near 0dBm.

h. A2R70, SECOND STAGE NULL
Used to adjust the second stage amplifier for zero offset.

i. A2R81, HIGH LEVEL COMP
Adjusts the log amplifier for correct operation near +10dBm.

j. A2R83, +10dBm TRACKING
Used to cause the meter reading at 0dBm to be the same on both the 0dBm and +10dBm scales.

k. A2R88, 0dBm TRACKING
Causes the meter reading at -10dBm to be the same on both the -10 and 0dBm scales.

l. A2R102, LOG CAL
Used to set the gain of the output amplifier for the correct coefficient.

m. A3R4, 3.58V ADJ
Sets the charging current for the battery.

h. A2J9 (TP29), GROUND
Used to connect TP24 to ground in the calibration procedure.

i. A3J1 (TP31), 3.58V
Used to set the 6.9V charging voltage on battery option instruments.

6.2.2 Description of Test Points

The signals available at each of the various test points or the functions of the test points are as follows:

a. A2J1 (TP21), REFERENCE COMMON
The common reference point for voltage measurements.

b. A2J2 (TP22), CHOPPER FREQUENCY
This is a logic output signal greater than 5V p-p. It can be measured with a high input impedance counter; frequency 1kHz ±100Hz.

c. A2J3 (TP23), INPUT AMPLIFIER OUTPUT
Permits the gain and zero condition of the input amplifier to be measured.

d. A2J4 (TP24), COMPENSATION CIRCUIT OUTPUT
Permits the point at which the compensation circuit becomes active to be independently determined.

e. A2J5 (TP25), SECOND STAGE SUMMING JUNCTION
Allows currents to be injected into the summing junction for calibration purposes.

f. A2J6 (TP26), +12V
Measures the +12V supply voltage. Voltage should be within ±0.2V of +12V.

g. A2J7 (TP27), -12V
Measures the -12V supply voltage. Voltage should be within 5mV of -12V.

6.3 CALIBRATION

6.3.1 Equipment Required

The following equipment is required to calibrate the Model 1034A. Specifications given for the equipment are minimum. Equipment capable of better performance can, of course, be used.

a. A digital voltmeter (DVM) with 0.03% accuracy and four digit resolution with 20% over-range capability. On the most sensitive range the least significant digit must be 10uV or less. Recommended is the Fluke Model 8600A Digital Multimeter or equivalent.

b. A precision power supply covering the range between 7uV and 1V with accuracy and resolution of 0.1%. At the 7uV level, it is only necessary for the supply to have 1% accuracy for changes in voltage setting. A small, fixed offset of a few microvolts is acceptable. In order to achieve satisfactory low level performance from some manufacturer's models, it may be desireable to make a voltage divider consisting of a 990 ohm and a 10 ohm ±0.01% resistor. This will attenuate the output by 40dB (100:1) and permit the supply to operate at high level even when a small output is required. A recommended instrument that will not require a divider is the Digitec Model 3110 Precision Voltage/-Current Source or equivalent.

c. An ac to dc Thermal Voltage Converter similar to the Fluke Model A55 or equivalent. The Model A55 has approximately 200 ohms input resistance. When used, it is required to measure its input resistance and connect enough resistance across its input to change it to 50 ohms ±1%. See Figure 5-1 on page 5-2 for an illustration of this arrangement. In addition, an adapter is needed to connect the assembly to the output of the calibrator.

d. An adapter box with double banana plugs on one side and a Type N female connector on the other side. A 50 ohm ±0.1% resistor should be used to connect the center pin of the Type N to the high side of the double banana plug. The low side of the double banana should tie to the Type N shell.

e. A frequency counter capable of counting 30MHz from a 50 ohm source with a 1.1V open circuit output. The counter should be able to count 1kHz while presenting an impedance of 1M ohm shunted by a few pF for use in measuring the chopper frequency. The signal level for this is greater than 5V.

6.3.2 Calibration Procedure

The components used in the Model 1034A are extremely reliable and generate little heat. Consequently, there is little drift due to component aging, and adjustments are rarely required. It is strongly recommended that if measurements indicate that an adjustment is set within the specified range, that is not attempted to put it "right on". It is often the case that variations in the equipment being used to conduct the test account for small differences in measured values. Since many adjustments are interactive, **be absolutely sure that an adjustment is really required before making it.**

If a component is replaced, depending upon its location in the circuitry, only certain of the calibration steps need be performed. In general, only those steps shown in the section pertaining to the specific circuit that has been repaired need be carried out.

Since the detectors used with the Model 1034A are interchangeable, the entire test procedure makes use of standardized dc voltages applied to the input in lieu of a detector. In order to simulate the detector temperature compensating thermistor and individual calibration resistors, resistors must be connected to pins within the instrument. Connect a 1M ohm ±5% resistor between pins 14 and 12 on the A2 board, and a 162K ohm ±1% resistor between pins 9 and 12 on the A2 board. If a number of instruments are going to be calibrated, it will be worthwhile to make a connector to fit on the front panel INPUT connector with these resistors permanently installed. See Figure 5-2 on page 5-2. In this case, the 1M ohm resistor is installed between connector pins 2 and 4 and the 162K ohm resistor between pins 3 and 4. A shielded pair of wires can be brought out from pins 1 (center conductor) and 4 (shield). This is useful for supplying dc calibration voltages to the input (corresponding to pins 15 and 16 of A2). A connector to mate with the front panel jack is available from WMI under part number 13357 or can be purchased locally as Switchcraft Part Number 2504M.

Before applying power to the instrument, adjust the mechanical zero of the meter so that the pointer is at the left edge of the scale. This should be done with the instrument in the position in which it is normally used (standing up or lying down). Set the 50/75 ohm switch to 50 ohms, set the CAL FACTOR switch to 0 (center), and remove the RF detector. With the exception of Step 1, following, and when the voltage at the output connector is measured, voltages are to be measured with respect to the common test point, TP21.

The following steps must be carried out in the order listed. It will be helpful to read the entire procedure through once before starting. Allow at least one-half hour of warm up time, with the instrument connected to the ac line, before starting.

Step 1. Check and adjust the battery charging voltage by connecting the voltmeter between chassis ground and TP31. Set A3R4 to 3.58V ±0.01V.

Step 2. Check the positive and negative 12V supplies. Connect the voltmeter low side to common, TP21. Connect the high side to TP27 and verify -12.000V ±0.5V. Move the voltmeter's high lead to TP26, and verify +12.000V ±0.5V.

Step 3. Connect the counter between common, TP21, and TP22. Check to see that the frequency is 1kHz ±100Hz. Disconnect the counter.

Step 4. Check to see that the ZERO control has sufficient range. Connect the voltmeter to TP23 and set the front panel ZERO control so that the voltmeter reads 0V ±1mV with the -30-dBm button pressed. Move the voltmeter to A2 pin 13 and measure the voltage. It should be less than about ±8V. If it is not, trouble with the input amplifier is to be expected.

Step 5. Check the mechanical centering of the knob for the CAL FACTOR control. Connect the voltmeter to pin 2 of A2 and set the CAL FACTOR control to obtain 0V as close as possible. If the knob does not indicate 0 within less than one-quarter of a division, loosen the two allen screws and reset it so that it does. **Reset the CAL FACTOR control to 0 for all of the following steps.**

Step 6. Check the gain tracking of the input preamplifier. Using the precision power supply, apply -1.00mV to pin 15 of A2 with the grounded side of the supply connected to pin 16 of A2. Connect the DVM to TP23 and press the -30dBm button. The DVM should read approximately 100mV. Now turn the supply off and adjust the front panel ZERO control so that the DVM reads 0.00mV ±100uV. Press the -20-dBm button and check that the DVM reads 0.00mV ±30uV. Readjust the ZERO control if necessary to simultaneously obtain both conditions. Once again apply 1mV from the power supply. Check and note the DVM readings for both the -30dBm and -20dBm buttons pressed. The voltages should be very nearly 100mV and 10mV respectively. The ratio of the two voltages must be 10.00 ±0.5%. If this is not the case, check to be sure the measurement has been correctly made. If it is established that the ratio is not within tolerance, trouble is indicated in the input amplifier or its feedback circuit. If correct, disconnect the power supply.

Step 7. Using a clip lead, short pins 15 and 16 of A2 together. Move the power supply to TP25 and adjust the power supply to give -15mV. Connect the DVM to the front panel OUTPUT connector and adjust the front panel 10mW CAL control to cause the DVM to read 0.000V ±1mV with the -10dBm button pressed. Press the -20dBm button and adjust (1) A1R9 (CAL OUTPUT) to obtain 1.000V ±1mV, and (2) A1R12 (METER CAL) to obtain a meter deflection of -1dBm.

Step 8. Attach the power supply to TP25 and set for -15mV. Press the -10dBm button and adjust the front panel CAL control so that the DVM reads 0.000V ±1mV. Apply -150mV and adjust A2R102 (LOG CAL) so that the voltage changes by 1.000V ±1mV. It will be required to alternate between -15 and 150mV, resetting the pot each time until the adjustment is satisfactory.

Step 9. Set the power supply for -150mV into TP25. Press the -10dBm button and adjust the front panel CAL control so that the DVM reads 1.000V ±1mV. Press the 0dBm button and adjust A2R88 (0dBm TRACKING) to obtain 0.000V ±1mV.

Step 10. Set the power supply for -1.5V into TP25. Press the 0dBm button and adjust the front panel CAL control so that the DVM reads 1.000V ±1mV. Press the +10dBm button and adjust A2R83 (+10dBm TRACKING) to obtain 0.000V ±1mV. Disconnect the power supply from TP25.

Step 11. Press the -30dBm button. Connect the DVM to TP23 and adjust the front panel ZERO control to cause a reading of 0.00mV ±100uV. Remove the short circuit from the input terminals that was placed there in Step 7. Connect a short circuit clip lead from TP29 to TP24. Connect the power supply to the input terminals and set it for 0.7mV. Move the DVM to the output connector and adjust the front panel CAL control to give 1.1V ±1mV. Press the -20dBm button and adjust A2R70 (SECOND STAGE NULL) to obtain 0.1V ±1mV. Go back to the -30dBm button, reset the front panel control, and repeat the procedure if necessary until both voltages are within ±1mV. Remove the short circuit clip lead.

Step 12. Set the front panel CAL control to its extreme counter-clockwise limit and be sure that the CAL FACTOR control is set to center (0). Set the power supply to apply -0.7mV to the input terminals. Connect the voltmeter to the OUTPUT connector and adjust A1R36 (-30dBm RANGE CAL) to obtain 0.950V ±1mV.

The following three steps involve setting adjustments that interact with each other. After proceding through Steps 13, 14, and 15, go back to Step 13 and repeat the procedure as many times as is required to obtain the results specified in the procedures. The process converges to the correct results rather rapidly. After going through the procedure several times, the required adjustments should be able to be accomplished without difficulty.

Step 13. Set the power supply to provide -0.7mV to the input. Connect the voltmeter to the OUTPUT connector. Press the -30dBm button and adjust the front panel CAL control to obtain 1.100V ±1mV. Reset the power supply to provide -0.228V to the input. Press the 0dBm button and set A2R57 (MED LEVEL CAL) to obtain 1.100V ±1mV.

Step 14. Set the power supply to provide 48.6mV to the input. Press the 0dBm button and adjust A2R48 (COMP AMP GAIN) to obtain 0.1V ±1mV.

Step 15. Set the power supply to provide 0.855V to the input. Press the +10dBm button and adjust A2R81 (HIGH LEVEL COMP) to give 1.1V ±1mV at the output.

Step 16. Set the power supply to provide -0.228V to the input. Press the +10dBm button and adjust the front panel CAL control so that 0.100V is obtained at the OUTPUT connector with the CAL FACTOR control set to 0. Set the CAL FACTOR control to -1dB and +1dB noting the reading at each point. Adjust A1R19 (CAL FACTOR ADJ) so that the readings are as close to 0.000V and 0.200V as possible. Be careful when setting the CAL FACTOR control to be sure that the knob lines up exactly with the panel mark. There might be some residual difference between the setting of A1R19 to obtain 0V and that required to obtain 0.2V. The correct adjustment in this case will result in equal (and opposite) errors at both ends of the CAL FACTOR range.

Step 17. Reset the CAL FACTOR knob so that 0.000V is read at the OUTPUT connector. Set the 50/75 ohm switch to 75 ohms. The DVM should read 0.276V ±12mV. If not, trouble is indicated in the switch circuit.

Step 18. For a final check of the calibration of the instrument, check the tracking of the power ranges. Using the power supply, apply the voltages given in the table below and note the readings obtained by the voltmeter connected to the OUTPUT connector. Set the 50/75 ohm switch to 50 ohms.

Voltage	Range	Reading	Comment
0	ZERO	ZERO SET	Adjust ZERO control so meter pointer is on the zero set point.
0.7mV	-30dBm	1.100V	Adjust CAL FACTOR control to obtain reading of ±1mV
70uV	-40dBm	1.100V	±30mV
6.65mV	-20dBm	1.100V	±10mV
48.6mV	-10dBm	1.100V	±10mV
228mV	0dBm	1.100V	±10mV
855mV	+10dBm	1.100V	±10mV

Step 19. Using the values given in the above table, apply the voltages. With the A-F button pressed, check the tracking of the -40 to +10dBm meter scale. Tracking should be within 0.5dB down to -30dBm, and within 2dB to -40dBm.

Step 20. Press the CAL button and connect the frequency counter to the CALIBRATOR OUTPUT connector. The frequency should measure 30MHz ±3MHz. If not, and it is fairly close, it can be adjusted by slightly bending the oscillator coil, A1L1, to change the spacing between the turns. Otherwise, check for out-of-tolerance components in the oscillator circuit.

Step 21. The purpose of this adjustment is to set the output of the calibrator to 10mW ±1.5%. This constitutes a very high degree of accuracy for a power measurement at 30MHz. Accordingly, the procedure must be performed with great care. If the proper equipment is not available, do not attempt to make the adjustment.

Set the precision power supply to 1.414V. Connect the adapter described in Section 6.3.1.d to the output of the supply, and connect the Thermal Converter to the output of the adapter. Read the dc output of the Thermal Converter to a precision of 0.1%. Reverse the polarity of the supply and repeat the reading. Record the average of the two voltages. Turn the calibrator on by pressing the CAL button. Attach the Thermal Converter to the CAL OUTPUT and adjust A1R22 (10mW OUTPUT CAL) so that the converter has the same output voltage as it did when it was connected to the power supply. Reconnect the Converter to the supply through the 50 ohm adapter and check to see that the output is the same as before. If there is significant difference in the reading before and after the calibrator measurement, repeat the procedure. This last step is important because the Converter has a tendency to drift with changes in temperature.

This completes the calibration procedure.

6.4 TROUBLESHOOTING

In order to localize the source of trouble in an instrument such as the 1034A, it is important to have a detailed working knowledge of the instrument. Section 4, Electrical Description, should be carefully read and the schematics in Section 7 should be used. Relevant dc voltages are shown on the schematics, and are typical of values to be found in normal operation. Data shown on the schematics was taken with a digital voltmeter with 10M ohm input impedance. The front controls were set as follows:

POWER:	ON
RANGE:	CAL
CALIBRATION FACTOR:	CENTERED (0)
50/75 ohm SWITCH:	DIRECT 50 ohms

The detector was connected to the CALIBRATOR OUTPUT and the CAL control set so that the meter read full-scale.

The only significant ac signals present in the instrument are those in the chopper circuit. A timing diagram for those signals is shown in Figure 6-1.

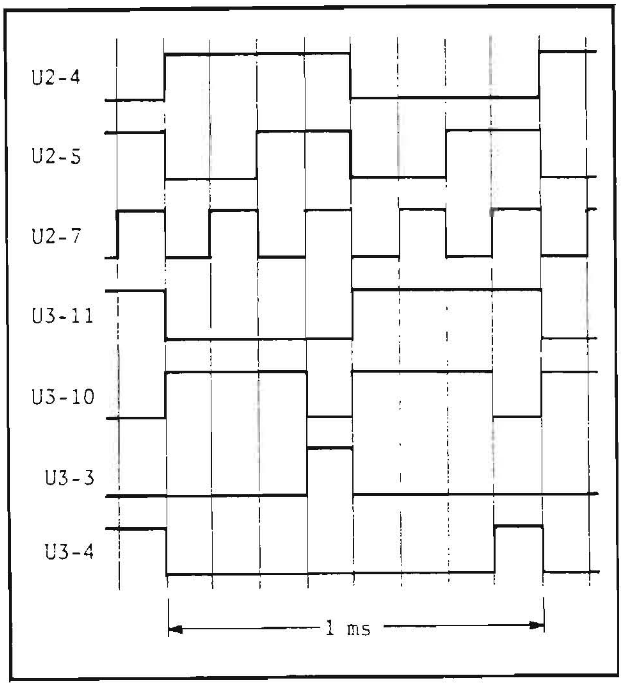


Figure 6-1. Chopper Circuit Timing Diagram

6.5 SEMICONDUCTOR DEVICES

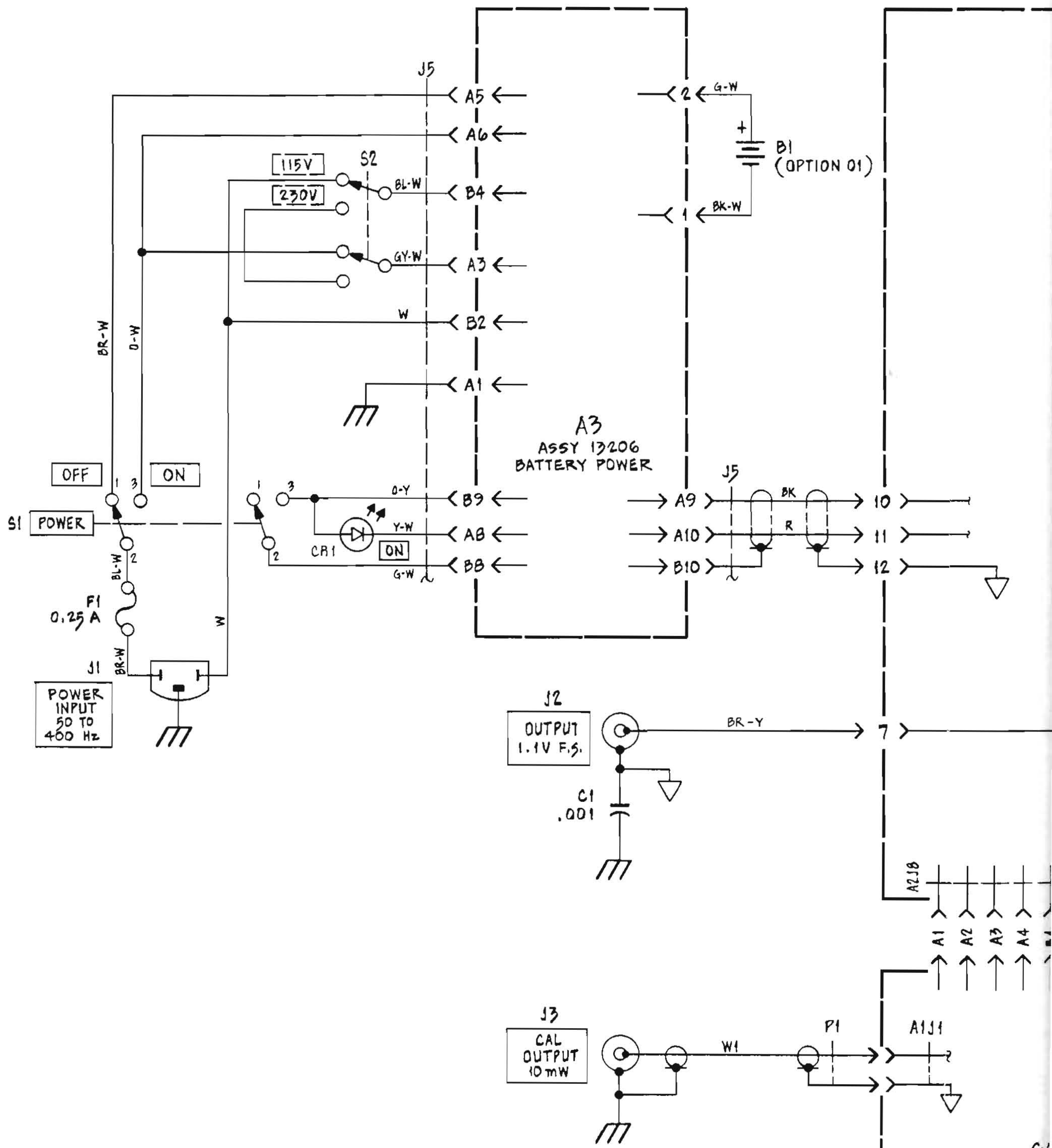
A variety of semiconductor devices are used in this instrument. The type numbers shown on the schematics are either EIA registered device numbers or manufacturer's numbers. Devices meeting the corresponding specifications can be used for replacement purposes, and can probably be obtained locally. Individual 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

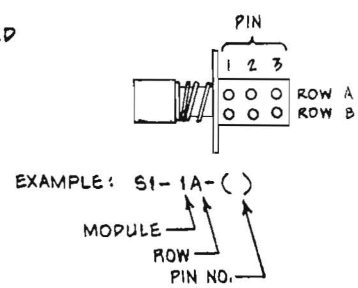
To gain access to the internal components, remove the two screws underneath the case and then return the case to an upright position (panel up). Remove the two large screws at the left and right edges of the panel. These last two screws will be somewhat difficult to turn because they are screwed into elastic nuts. Pressure should be applied to the screwdriver so that it will not slip and mar the panel.

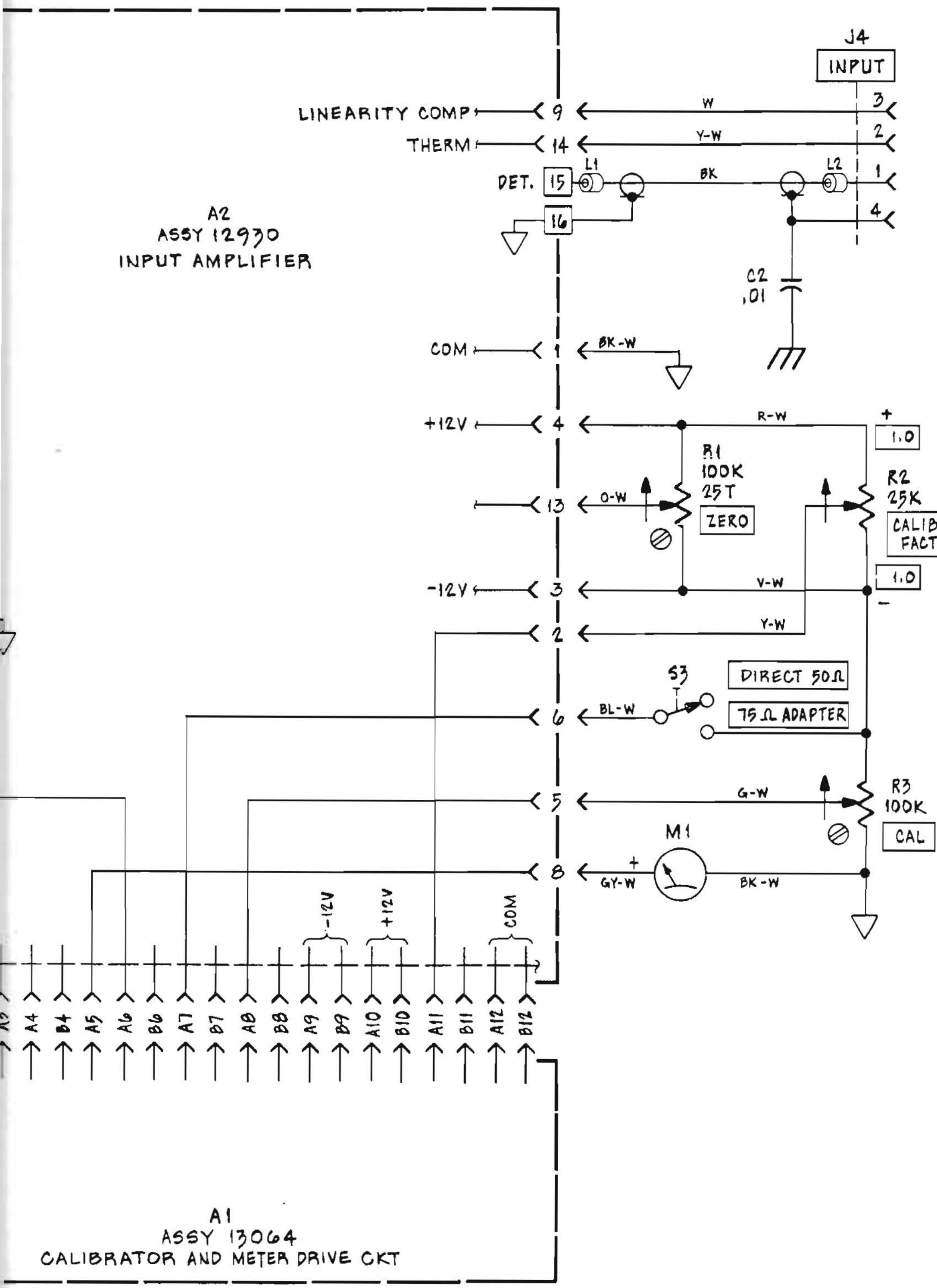
SECTION 7

SCHEMATIC DIAGRAMS



NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5% 1/4W. CAPACITOR VALUES ARE IN MICROFARADS.
2. TERMINAL NUMBERING FOR SWITCH S1 IS REFERENCE ONLY. TERMINALS IS SHOWN IN DIAGRAM AT RIGHT. SWITCH IS VIEWED WITH BUTTON AT OUT POSITION.
3. POTENTIOMETER ARROW INDICATES CW ROTATION.





SYM	REVISION	ECO	DATE

ITEM	REQD	PART NO.	DESCRIPTION

LIST OF MATERIAL

NEXT ASSY

FINISH OR TREATMENT

UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES

TOLERANCE
.XX ± .015
.XXX ± .005

SCALE

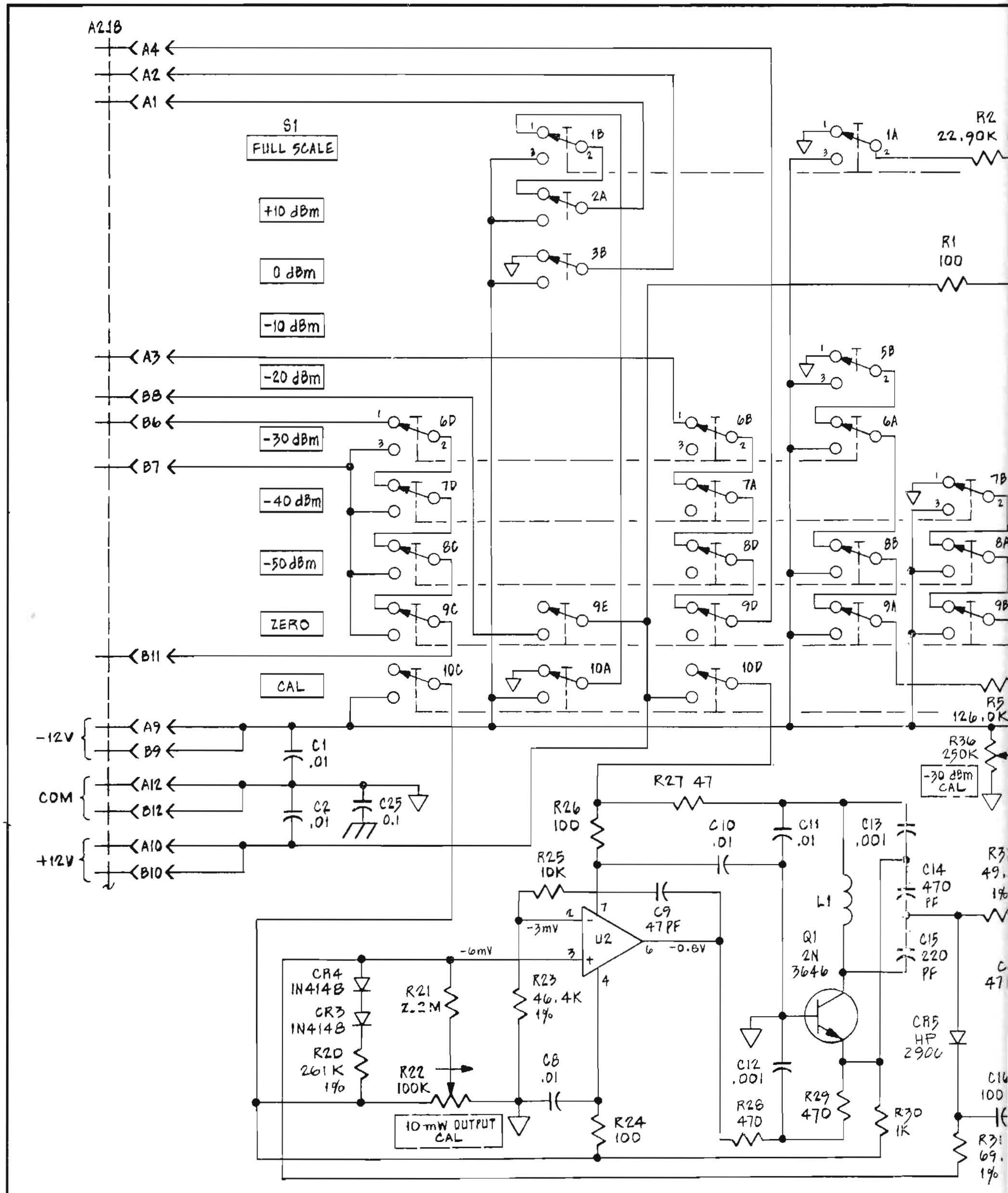
		DATE
DRAWN	V.Y.I	1-27-76
ENG	RB	10-1-76
PROD		

PM PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

PORTABLE RF POWER METER
MODEL 1034A

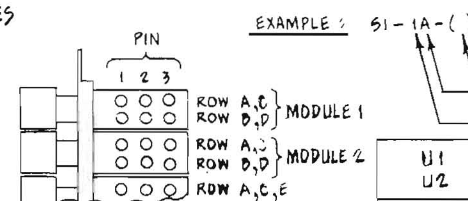
DRAWING NO. 13216 REV C

SHEET 1 OF 1



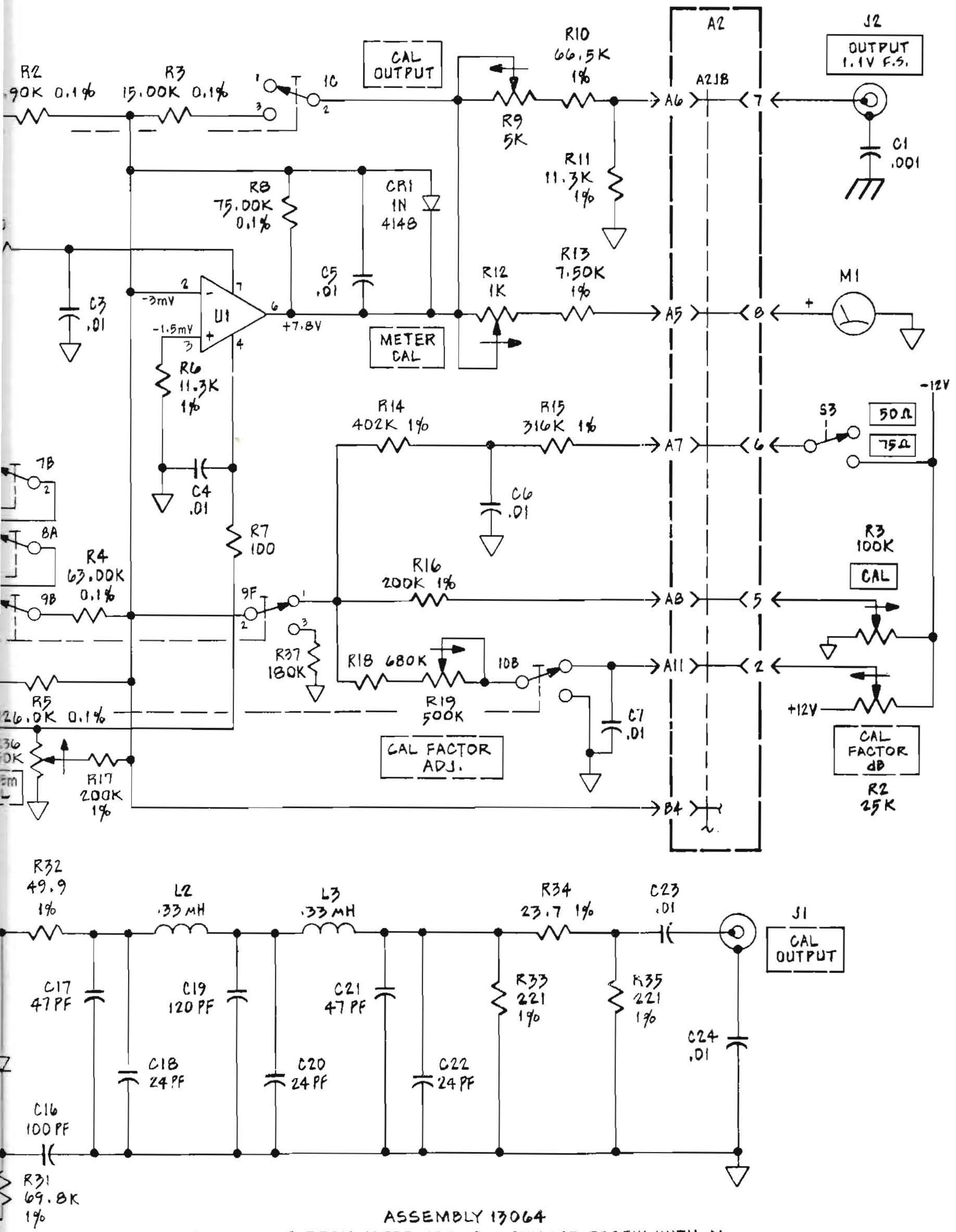
NOTES:

1. UNLESS SPECIFIED OTHERWISE RESISTOR VALUES ARE IN OHMS AND ARE ±5% 1/4W. CAPACITOR VALUES ARE IN MICROFARADS.
2. TERMINAL NUMBERING FOR SWITCH S1 IS REFERENCE ONLY. RELATIVE LOCATION OF TERMINALS IS SHOWN IN DIAGRAM AT RIGHT. SWITCH IS SHOWN VIEWED FROM RIGHT-SIDE.



U1 U2	741C
REF DESIG	TYPE

STM	REVISION	ECO	DATE



ASSEMBLY 13064

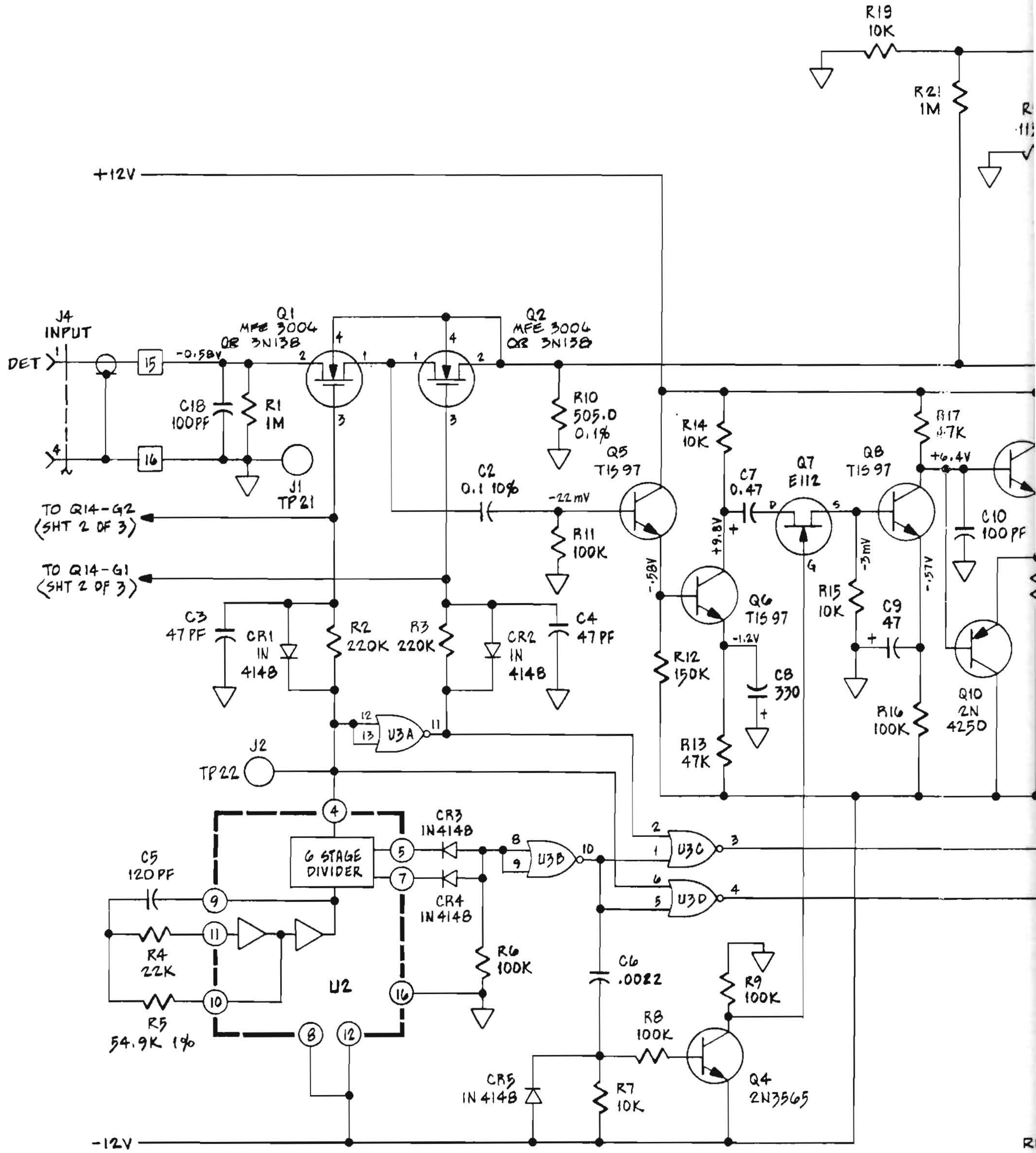
REFERENCE DESIGNATOR ARE ABBREVIATED PREFIX WITH A1

REQD	PART NO	DESCRIPTION

LIST OF MATERIAL

NEXT ASSY

FINISH OR TREATMENT	UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES TOLERANCE .XX = .015 .XXX = .005	DRAWN V.Y.I	DATE 1-28-76	PACIFIC MEASUREMENTS INCORPORATED PALO ALTO, CALIFORNIA
		ENG RB	10-1-76	CALIBRATOR & METER DRIVE CKT
		PROD		DRAWING NO. 13065 REV 6
	SCALE			SHEET 1 OF 1

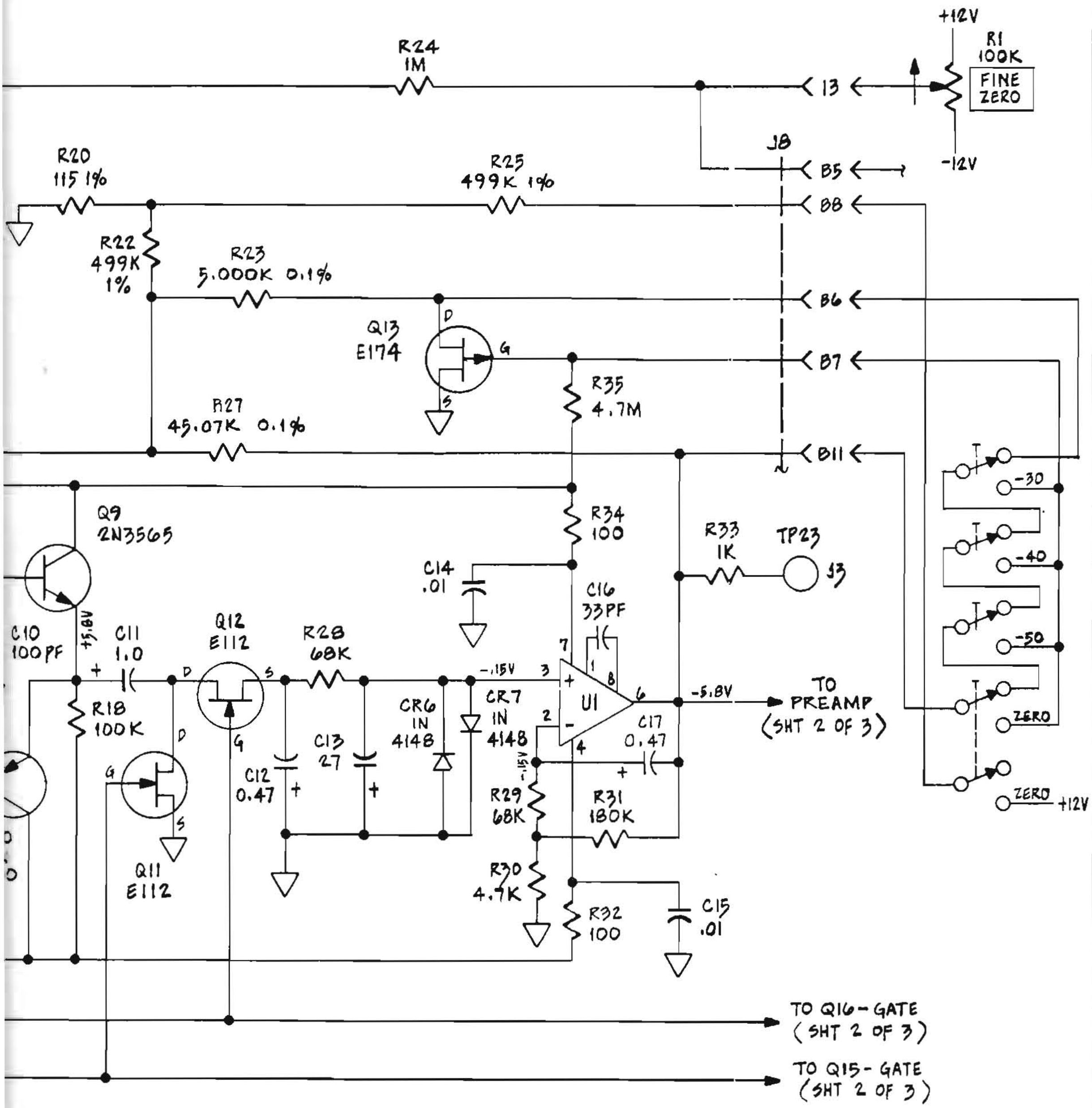


NOTES:

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

REF DESIG	TYPE
U3	CD 4001AE
U2	CD 4060AE
U1	LM 301A

SYM	REVISION	ECO	DATE



ASSEMBLY 12930

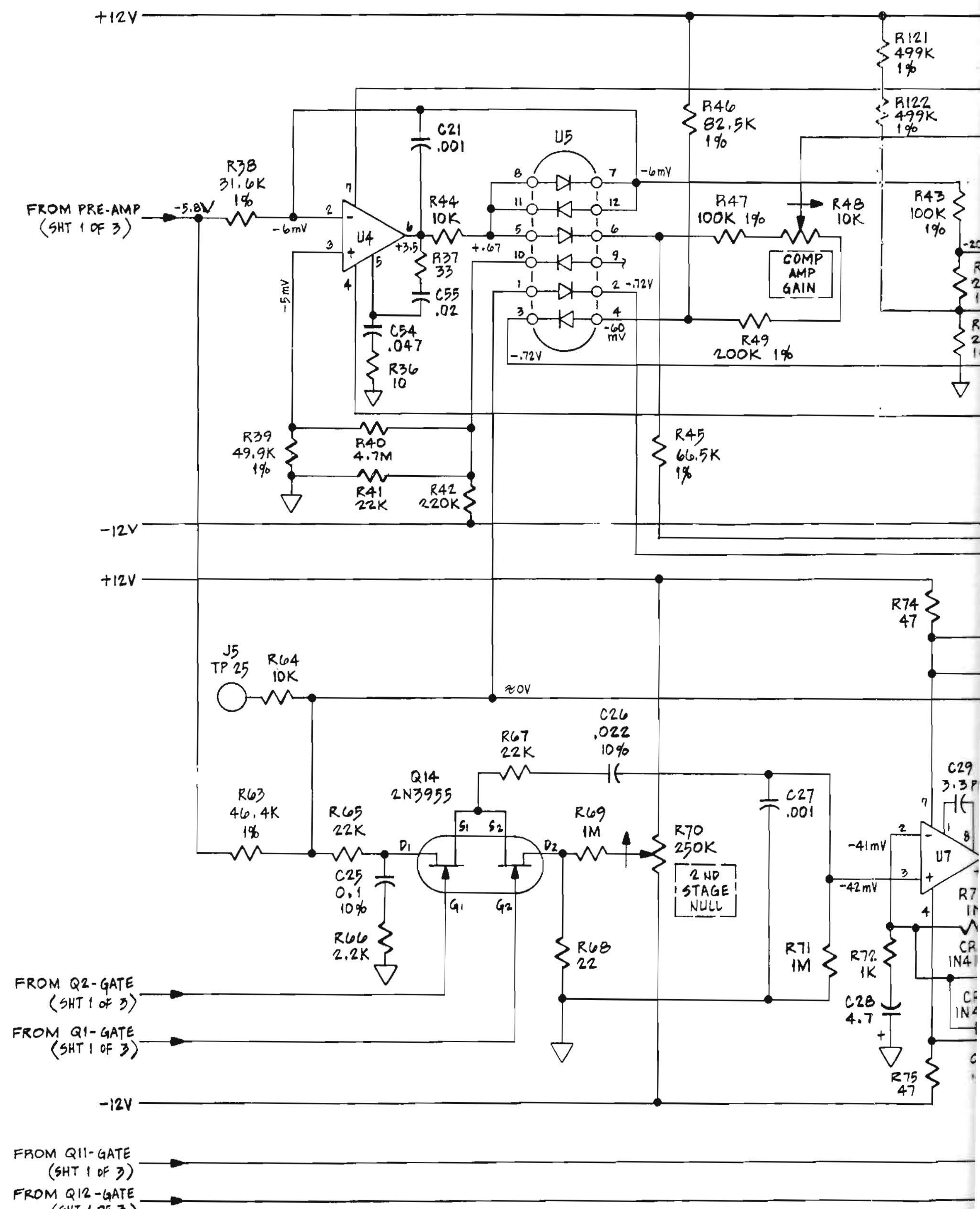
REFERENCE DESIGNATORS ARE ABBREVIATED PREFIX WITH A2

REQD	PART NO.	DESCRIPTION

LIST OF MATERIAL

NEXT ASSY

FINISH OR TREATMENT	UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES		DATE	
	TOLERANCE .XX ± .015 .XXX ± .005	DRAWN V.Y.I.	1-20-76	PACIFIC MEASUREMENTS INCORPORATED PALO ALTO, CALIFORNIA
		ENG RB	10-1-76	INPUT AMPLIFIER
	SCALE	PROD		DRAWING NO. 12932 REV J
				SHEET 1 OF 3

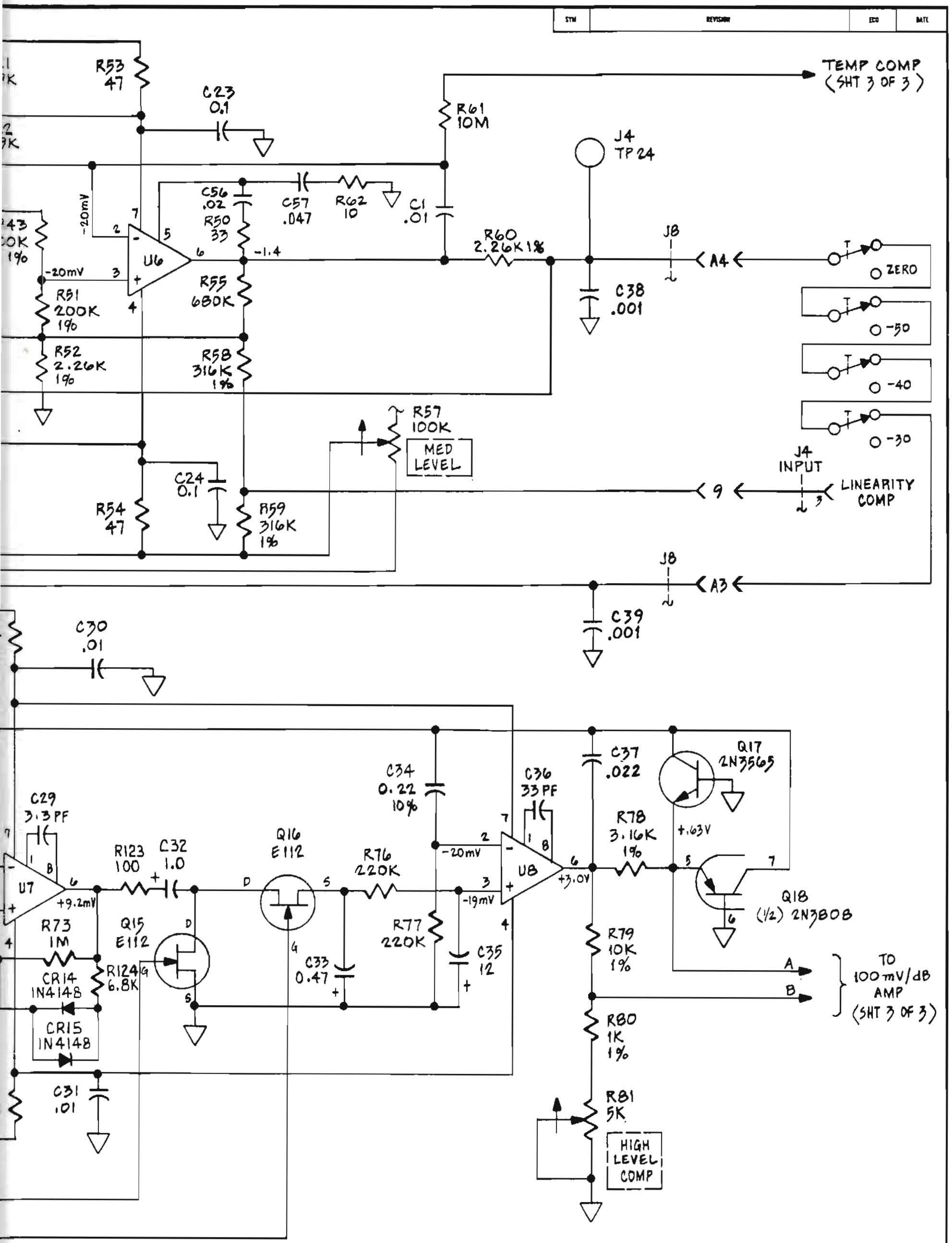


ASSEMBLY 12930
REFERENCE DESIGNATORS ARE ABBREVIATED PREFIX WITH A2

NOTE:

1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5%, 1/4W. CAPACITOR VALUES ARE IN MICROFARADS.
2. * FACTORY SELECTED VALUE. NOMINAL VALUE IS SHOWN.

U5	CA3039
U7, U8	LM 301A
U4, U6	725C
REF DESIG	TYPE



ITEM	REQD	PART NO.	DESCRIPTION

LIST OF MATERIAL

NEXT ASSY

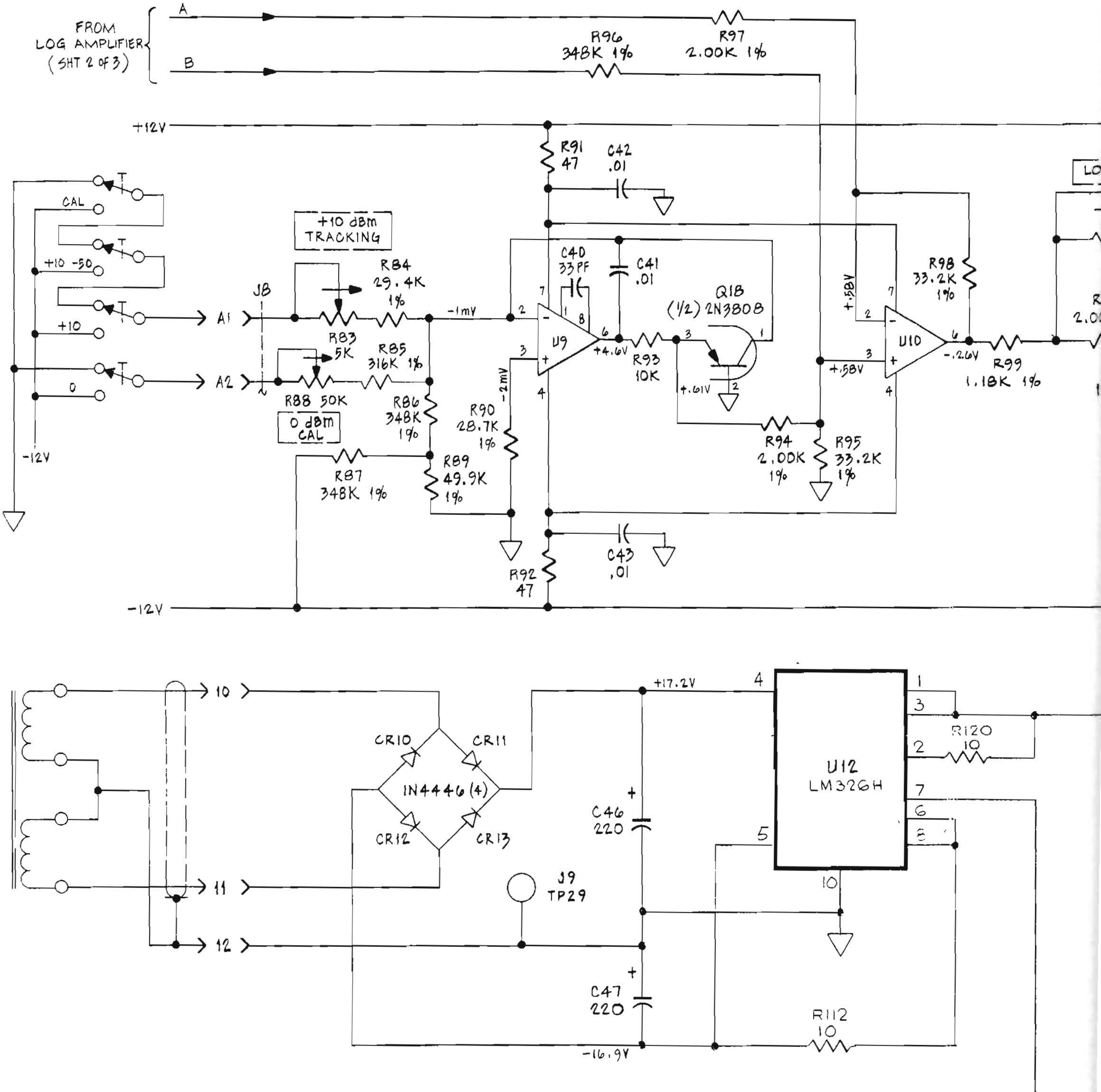
FINISH OR TREATMENT	UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES TOLERANCE .XX ± .015 .XXX ± .005	DRAWN V.Y.I	DATE 1-20-76
		ENG RB	10-1-76
		PROD	
	SCALE		

PM PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

INPUT AMPLIFIER

DRAWING NO. 12932 REV

SHEET 2 OF 3



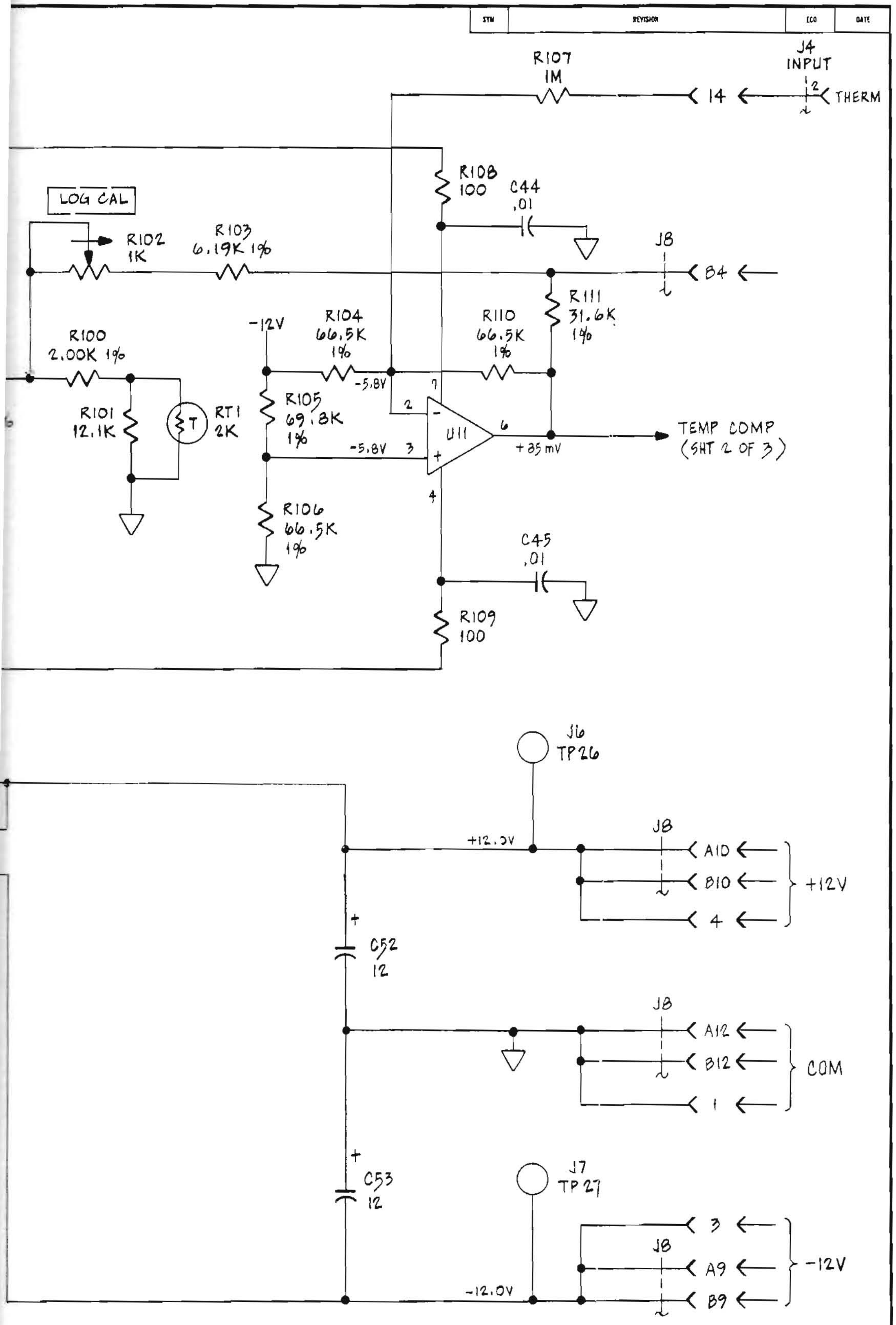
ASSEMBLY 12930
REFERENCE DESIGNATORS ARE ABBREVIATED
PREFIX WITH A2

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

REF DESIG	TYPE
U12	LM 326H
U10, U11	741C
U9	LM 301A

ITEM	REQD	PART NO.

FINISH OR TREATMENT



PART NO	DESCRIPTION

LIST OF MATERIAL

NEXT ASSY

UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES

TOLERANCE
.XX = .015
.XXX = .005

SCALE

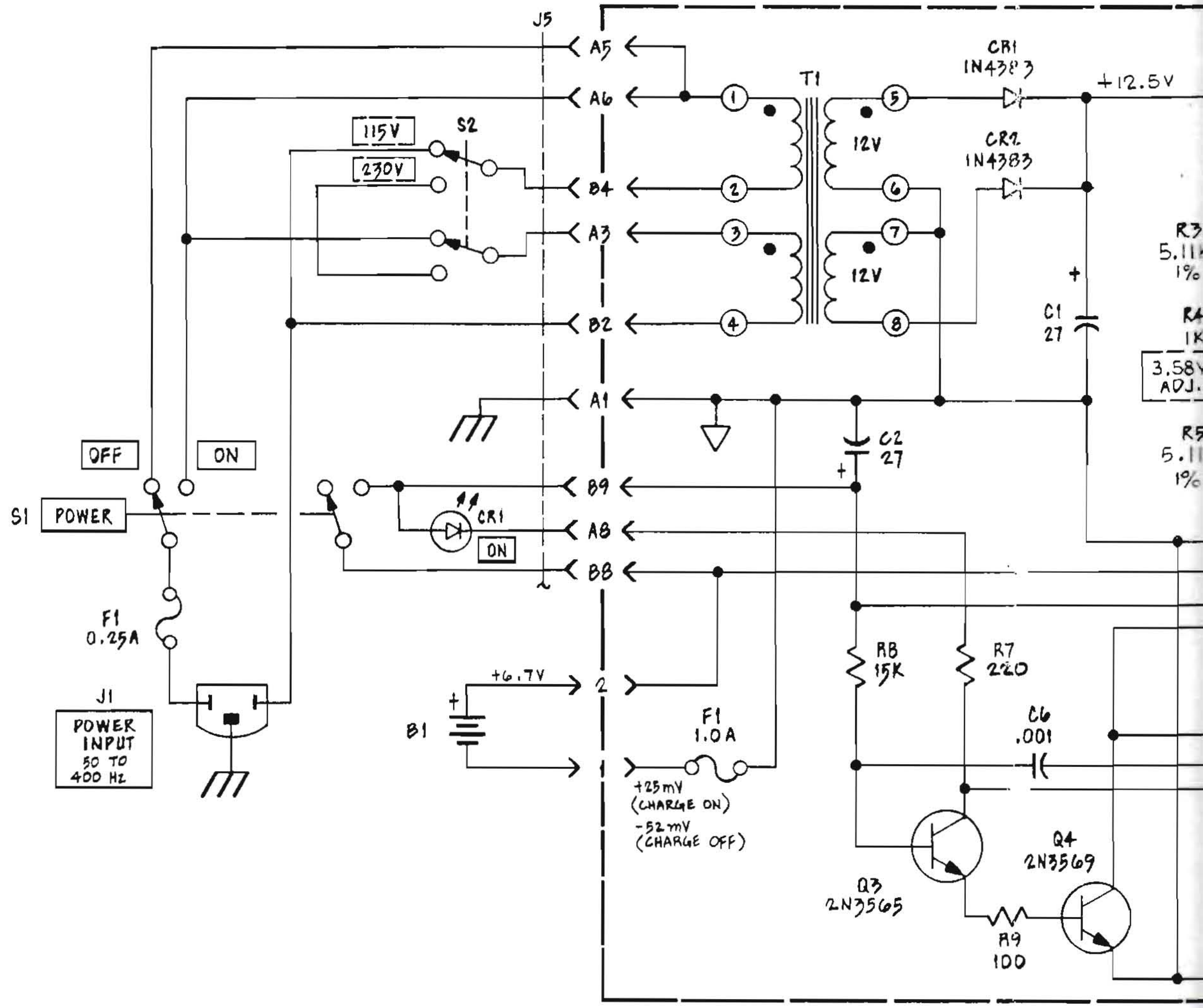
		DATE
DRAWN	V.Y.I	1-20-76
ENG	RB	10-1-76
PROD		

PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

INPUT AMPLIFIER

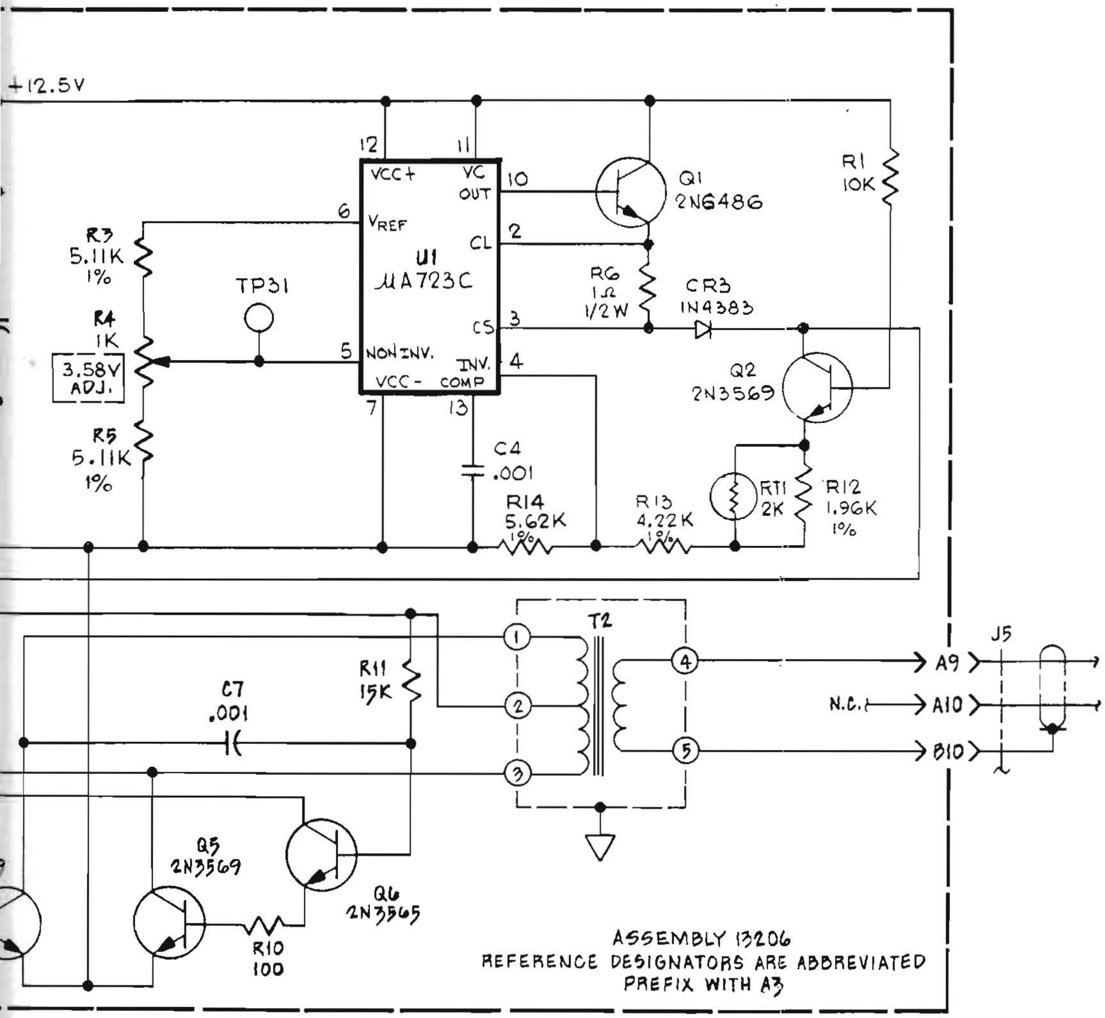
DRAWING NO. 12932 K

SHEET 3 OF 3



NOTE:

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



SYM	REVISION	ECO	DATE

ITEM	REQD	PART NO.	DESCRIPTION

LIST OF MATERIAL

NEXT ASSY

FINISH OR TREATMENT

UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES

TOLERANCE
.XX ± .015
.XXX ± .005

SCALE

		DATE
DRAWN	V.Y.I	1-28-76
ENG	RB	10-1-76
PROD		

PM PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

POWER SUPPLY

DRAWING NO. 13207 REV D

SHEET 1 OF 1

SECTION 8

REPLACEABLE PARTS LISTINGS

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
		CHASSIS ASSEMBLY #13214			
C1	10000-4	Capacitor, Ceramic	.001μF	±20%	1000V
C2	10000-11	Capacitor, Ceramic	.01μF	±20%	1000V
CR1	12389	Diode, Light Emitting			
F1	10064-7	Fuse, 0.25A, Slo-Blo, 250V			
J1	12355	Connector, AC Receptacle, 3 pin			
J2	11689	Connector, Insulated, BNC			
J3	10821	Connector, N (Part of 13289)			
J4	13358	Connector, Audio Jack, 4 Contact			
J5	13242-1	Connector, PC Edge 10/20 Contact (Part of cable harness 13286)			
L1	10182	Shield Bead			
L2	10182	Shield Bead			
M1	15357	Meter, Panel			
R1	11688-1	Resistor, Variable	100KΩ	±20%	25 turn
R2	12233-2	Resistor, Variable	25KΩ	±10%	
R3	11676-1	Resistor, Variable	100KΩ	±20%	1/2W
S1	13260	Switch, Pushbutton			
S2	11160	Switch, Slide, 115-230V			
S3	10059	Switch, Slide, DPDT			
P1	10366	Connector, Snap-On Plug (Part of 13289)			
W1	13289	Cable Assembly			
		CALIBRATOR AND METER DRIVE CIRCUIT PC BOARD ASSEMBLY #13064			
A1C1	10000-11	Capacitor, Ceramic	.01μF	±20%	100V
A1C2	10000-11	Capacitor, Ceramic	.01μF	±20%	100V
A1C3	10000-11	Capacitor, Ceramic	.01μF	±20%	100V
A1C4	10000-11	Capacitor, Ceramic	.01μF	±20%	100V
A1C5	10000-11	Capacitor, Ceramic	.01μF	±20%	100V
A1C6	10000-11	Capacitor, Ceramic	.01μF	±20%	100V
A1C7	10000-11	Capacitor, Ceramic	.01μF	±20%	100V
A1C8	10000-11	Capacitor, Ceramic	.01μF	±20%	100V

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A1C9	10001-6	Capacitor, Ceramic	47pF	±5%	1000V
A1C10	10000-11	Capacitor, Ceramic	.01 μF	±20%	100V
A1C11	10000-11	Capacitor, Ceramic	.01 μF	±20%	100V
A1C12	10585-5	Capacitor, Ceramic	.001 μF	±5%	1000V
A1C13	10585-5	Capacitor, Ceramic	.001 μF	±5%	1000V
A1C14	10677-13	Capacitor, Mica	470pF	±5%	500V
A1C15	10677-2	Capacitor, Mica	220pF	±5%	500V
A1C16	10001-7	Capacitor, Ceramic	100pF	±5%	1000V
A1C17	10677-5	Capacitor, Mica	47pF	±5%	500V
A1C18	10677-19	Capacitor, Mica	24pF	±5%	500V
A1C19	10677-9	Capacitor, Mica	120pF	±5%	500V
A1C20	10677-19	Capacitor, Mica	24pF	±5%	500V
A1C21	10677-5	Capacitor, Mica	47pF	±5%	500V
A1C22	10677-19	Capacitor, Mica	24pF	±5%	500V
A1C23	10000-11	Capacitor, Ceramic	.01μ F	±20%	100V
A1C24	10000-11	Capacitor, Ceramic	.01μ F	±20%	100V
A1C25	11501-2	Capacitor, Ceramic	0.1μ F	±20%	50V
A1CR1	10043-2	Diode	1N4148		
A1CR2		Not Used			
A1CR3	10043-2	Diode	1N4148		
A1CR4	10043-2	Diode	1N4148		
A1CR5	11345	Diode	HP2900		
A1J1	13271	Connector, SMB			
A1L1	14314	RF Coil			
A1L2	10631-11	RF Coil	.33μ H	±10%	
A1L3	10631-11	RF Coil	.33μ H	±10%	
A1Q1	10018	Transistor	2N3646		
A1R1	10013-13	Resistor, Carbon Film	100 Ω	±5%	1/4W
A1R2	12449-49	Resistor, Metal Film	22.90K Ω	±0.1%	1/4W
A1R3	12449-48	Resistor, Metal Film	15.00K Ω	±0.1%	1/4W
A1R4	11485-13	Resistor, Metal Film	63.00K Ω	±0.1%	1/4W
A1R5	11485-14	Resistor, Metal Film	126.0K Ω	±0.1%	1/4W
A1R6	10015-81	Resistor, Metal Film	11.3K Ω	±1%	1/8W
A1R7	10013-13	Resistor, Carbon Film	100 Ω	±5%	1/4W
A1R8	12449-15	Resistor, Metal Film	75.00K Ω	±0.1%	1/4W
A1R9	10046-4	Resistor, Variable Comp	5K Ω	±20%	1/4W
A1R10	10015-191	Resistor, Metal Film	66.5K Ω	±1%	1/8W
A1R11	10015-81	Resistor, Metal Film	11.3K Ω	±1%	1/8W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A1R12	10046-7	Resistor, Variable Comp	1K Ω	±20%	1/4W
A1R13	10015-206	Resistor, Metal Film	7.50KΩ	±1%	1/8W
A1R14	10015-63	Resistor, Metal Film	402KΩ	±1%	1/8W
A1R15	10015-141	Resistor, Metal Film	316KΩ	±1%	1/8W
A1R16	10015-62	Resistor, Metal Film	200KΩ	±1%	1/8W
A1R17	10015-62	Resistor, Metal Film	200KΩ	±1%	1/8W
A1R18	10013-59	Resistor, Carbon Film	680KΩ	±5%	1/4W
A1R19	10046-12	Resistor, Variable Comp	500KΩ	±20%	1/4W
A1R20	10015-219	Resistor, Metal Film	261KΩ	±1%	1/8W
A1R21	10013-65	Resistor, Carbon Film	2.2MΩ	±5%	1/4W
A1R22	10046-10	Resistor, Variable Comp	100KΩ	±20%	1/4W
A1R23	10015-24	Resistor, Metal Film	46.4KΩ	±1%	1/8W
A1R24	10013-13	Resistor, Carbon Film	100Ω	±5%	1/4W
A1R25	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A1R26	10013-13	Resistor, Carbon Film	100Ω	±5%	1/4W
A1R27	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A1R28	10013-21	Resistor, Carbon Film	470Ω	±5%	1/4W
A1R29	10013-21	Resistor, Carbon Film	470 Ω	±5%	1/4W
A1R30	10013-25	Resistor, Carbon Film	1KΩ	±5%	1/4W
A1R31	10015-120	Resistor, Metal Film	69.8K Ω	±1%	1/8W
A1R32	10015-3	Resistor, Metal Film	49.9 Ω	±1%	1/8W
A1R33	10015-197	Resistor, Metal Film	221Ω	±1%	1/8W
A1R34	10015-231	Resistor, Metal Film	23.7 Ω	±1%	1/8W
A1R35	10015-197	Resistor, Metal Film	221 Ω	±1%	1/8W
A1R36	10046-11	Resistor, Variable Comp	250K Ω	±20%	1/4W
A1R37	10013-52	Resistor, Carbon Film	180KΩ	±5%	1/4W
A1S1	13217	Switch, Pushbutton			
A1U1	11539	Integrated Circuit	741C		
A1U2	11539	Integrated Circuit	741C		
		INPUT AMPLIFIER PC BOARD ASSEMBLY #12930			
A2C1	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A2C2	10007-7	Capacitor, Mylar	0.1µF	±10%	200V
A2C3	10001-6	Capacitor, Ceramic	47pF	±5%	1000V
A2C4	10001-6	Capacitor, Ceramic	47pF	±5%	1000V
A2C5	10001-16	Capacitor, Ceramic	120pF	±5%	1000V
A2C6	10000-5	Capacitor, Ceramic	.0022µF	±20%	1000V
A2C7	10787-8	Capacitor, Tantalum	.47µF	±20%	15V
A2C8	11173-1	Capacitor, Tantalum	330µF	±20%	6V

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A2C9	10787-9	Capacitor, Tantalum	47µF	±20%	15V
A2C10	10000-1	Capacitor, Ceramic	100pF	±20%	1000V
A2C11	10787-5	Capacitor, Tantalum	1.0µF	±20%	15V
A2C12	10787-8	Capacitor, Tantalum	.47µF	±20%	15V
A2C13	10787-3	Capacitor, Tantalum	27µF	±20%	15V
A2C14	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A2C15	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A2C16	10001-5	Capacitor, Ceramic	33pF	±5%	1000V
A2C17	10787-8	Capacitor, Tantalum	.47µF	±20%	15V
A2C18	10000-1	Capacitor, Ceramic	100pF	±20%	1000V
A2C19		Not Used			
A2C20		Not Used			
A2C21	10000-4	Capacitor, Ceramic	.001µF	±20%	1000V
A2C22		Not Used			
A2C23	11501-2	Capacitor, Ceramic	0.1µF	±10%	50V
A2C24	11501-2	Capacitor, Ceramic	0.1µF	±10%	50V
A2C25	10007-7	Capacitor, Mylar	0.1µF	±10%	200V
A2C26	10007-5	Capacitor, Mylar	.022µF	±10%	200V
A2C27	10000-4	Capacitor, Ceramic	.001µF	±20%	1000V
A2C28	10787-1	Capacitor, Tantalum	4.7µF	±20%	15V
A2C29	10001-12	Capacitor, Ceramic	3.3pF	±5%	1000V
A2C30	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A2C31	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A2C32	10787-5	Capacitor, Tantalum	1.0µF	±20%	15V
A2C33	10787-8	Capacitor, Tantalum	.47µF	±20%	15V
A2C34	10007-8	Capacitor, Mylar	.22µF	±10%	200V
A2C35	10787-2	Capacitor, Tantalum	12µF	±20%	15V
A2C36	10001-5	Capacitor, Ceramic	33pF	±5%	1000V
A2C37	10000-8	Capacitor, Ceramic	.022µF	±20%	500V
A2C38	10000-4	Capacitor, Ceramic	.001µF	±20%	1000V
A2C39	10000-4	Capacitor, Ceramic	.001µF	±20%	500V
A2C40	10001-5	Capacitor, Ceramic	33pF	±5%	1000V
A2C41	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A2C42	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A2C43	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A2C44	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A2C45	10000-11	Capacitor, Ceramic	.01µF	±20%	100V
A2C46	10003-6	Capacitor, Electrolytic	220µF	+50% -10%	35V
A2C47	10003-6	Capacitor, Electrolytic	220µF	+50% -10%	35V
A2C48		Not Used			
A2C49		Not Used			
A2C50		Not Used			
A2C51		Not Used			
A2C52	10787-2	Capacitor, Tantalum	12µF	±20%	15V
A2C53	10787-2	Capacitor, Tantalum	12µF	±20%	15V
A2C54	10000-14	Capacitor, Ceramic	.047µF	±20%	50V
A2C55	10000-8	Capacitor, Ceramic	.02µF	±20%	100V
A2C56	10000-8	Capacitor, Ceramic	.02µF	±20%	100V

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A2C57	10000-14	Capacitor, Ceramic	.047 µF	±20%	50V
A2CR1	10043-2	Diode	1N4148		
A2CR2	10043-2	Diode	1N4148		
A2CR3	10043-2	Diode	1N4148		
A2CR4	10043-2	Diode	1N4148		
A2CR5	10043-2	Diode	1N4148		
A2CR6	10043-2	Diode	1N4148		
A2CR7	10043-2	Diode	1N4148		
A2CR8		Not Used			
A2CR9		Not Used			
A2CR10	11715	Diode	1N4466		
A2CR11	11715	Diode	1N4466		
A2CR12	11715	Diode	1N4466		
A2CR13	11715	Diode	1N4466		
A2CR14	10043-2	Diode	1N4148		
A2CR15	10043-2	Diode	1N4148		
A2J1	14320-2	Test Jack, Stamped			
A2J2	14320-2	Test Jack, Stamped			
A2J3	14320-2	Test Jack, Stamped			
A2J4	14320-2	Test Jack, Stamped			
A2J5	14320-2	Test Jack, Stamped			
A2J6	14320-2	Test Jack, Stamped			
A2J7	14320-2	Test Jack, Stamped			
A2J8	13267-1	Connector, 15 contact			
A2J9	14320-2	Test Jack, Stamped			
A2Q1	10896	Transistor	3N138		
A2Q2	10896	Transistor	3N138		
A2Q3		Not Used			
A2Q4	10019	Transistor	2N3565		
A2Q5	11507	Transistor	TIS97		
A2Q6	11507	Transistor	TIS97		
A2Q7	12591	Transistor	E112		
A2Q8	11507	Transistor	TIS97		
A2Q9	10019	Transistor	2N3565		
A2Q10	11119	Transistor	2N4250		
A2Q11	12591	Transistor	E112		
A2Q12	12591	Transistor	E112		
A2Q13	14203	Transistor	E174		
A2Q14	11432	Transistor	2N3955		
A2Q15	12591	Transistor	E112		
A2Q16	12591	Transistor	E112		
A2Q17	10019	Transistor	2N3565		

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A2Q18	13249-1	Transistor	2N3808		
A2Q19		Not Used			
A2R1	10013-61	Resistor, Carbon Film	1M Ω	±5%	1/4W
A2R2	10013-53	Resistor, Carbon Film	220KΩ	±5%	1/4W
A2R3	10013-53	Resistor, Carbon Film	220KΩ	±5%	1/4W
A2R4	10013-41	Resistor, Carbon Film	22K Ω	±5%	1/4W
A2R5	10015-117	Resistor, Metal Film	54.9K Ω	±1%	1/8W
A2R6	10013-49	Resistor, Carbon Film	100K Ω	±5%	1/4W
A2R7	10013-37	Resistor, Carbon Film	10K Ω	±5%	1/4W
A2R8	10013-49	Resistor, Carbon Film	100KΩ	±5%	1/4W
A2R9	10013-49	Resistor, Carbon Film	100KΩ	±5%	1/4W
A2R10	12449-47	Resistor, Metal Film	505.0 Ω	±0.1%	1/4W
A2R11	10013-49	Resistor, Carbon Film	100K Ω	±5%	1/4W
A2R12	10013-51	Resistor, Carbon Film	150K Ω	±5%	1/4W
A2R13	10013-45	Resistor, Carbon Film	47K Ω	±5%	1/4W
A2R14	10013-37	Resistor, Carbon Film	10K Ω	±5%	1/4W
A2R15	10013-37	Resistor, Carbon Film	10K Ω	±5%	1/4W
A2R16	10013-49	Resistor, Carbon Film	100K Ω	±5%	1/4W
A2R17	10013-45	Resistor, Carbon Film	47K Ω	±5%	1/4W
A2R18	10013-49	Resistor, Carbon Film	100K Ω	±5%	1/4W
A2R19	10013-37	Resistor, Carbon Film	10K Ω	±5%	1/4W
A2R20	10015-138	Resistor, Metal Film	115 Ω	±1%	1/8W
A2R21	10013-61	Resistor, Carbon Film	1M Ω	±5%	1/4W
A2R22	10015-45	Resistor, Metal Film	499KΩ	±1%	1/8W
A2R23	12449-26	Resistor, Metal Film	5.00K Ω	±0.1%	1/4W
A2R24	10013-61	Resistor, Carbon Film	1M Ω	±5%	1/4W
A2R25	10015-45	Resistor, Metal Film	499KΩ	±1%	1/8W
A2R26		Not Used			
A2R27	12449-63	Resistor, Metal Film	47.07KΩ	±0.1%	1/4W
A2R28	10013-47	Resistor, Carbon Film	68K Ω	±5%	1/4W
A2R29	10013-47	Resistor, Carbon Film	68KΩ	±5%	1/4W
A2R30	10013-33	Resistor, Carbon Film	4.7K Ω	±5%	1/4W
A2R31	10013-52	Resistor, Carbon Film	180KΩ	±5%	1/4W
A2R32	10013-13	Resistor, Carbon Film	100 Ω	±5%	1/4W
A2R33	10013-25	Resistor, Carbon Film	1KΩ	±5%	1/4W
A2R34	10013-13	Resistor, Carbon Film	100 Ω	±5%	1/4W
A2R35	10013-69	Resistor, Carbon Film	4.7M Ω	±5%	1/4W
A2R36	10013-1	Resistor, Carbon Film	10 Ω	±5%	1/4W
A2R37	10013-7	Resistor, Carbon Film	33 Ω	±5%	1/4W
A2R38	10015-14	Resistor, Metal Film	31.6K Ω	±1%	1/8W
A2R39	10015-133	Resistor, Metal Film	49.9K Ω	±1%	1/8W
A2R40	10013-69	Resistor, Carbon Film	4.7M Ω	±5%	1/4W
A2R41	10013-41	Resistor, Carbon Film	22K Ω	±5%	1/4W
A2R42	10013-53	Resistor, Carbon Film	220K Ω	±5%	1/4W
A2R43	10015-13	Resistor, Metal Film	100K Ω	±1%	1/8W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A2R44	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A2R45	10015-191	Resistor, Metal Film	66.5KΩ	±1%	1/8W
A2R46	10015-33	Resistor, Metal Film	82.5K Ω	±1%	1/8W
A2R47	10015-13	Resistor, Metal Film	100K Ω	±1%	1/8W
A2R48	10046-8	Resistor, Variable	10K Ω	±20%	1/4W
A2R49	10015-62	Resistor, Metal Film	200K Ω	±1%	1/8W
A2R50	10013-7	Resistor, Carbon Film	33 Ω	±5%	1/4W
A2R51	10015-62	Resistor, Metal Film	200KΩ	±1%	1/8W
A2R52	10015-78	Resistor, Metal Film	2.26KΩ	±1%	1/8W
A2R53	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A2R54	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A2R55	10013-59	Resistor, Carbon Film	680K Ω	±5%	1/4W
A2R56		Not Used			
A2R57	11711-2	Resistor, Variable	100KΩ	±20%	1/2W
A2R58	10015-141	Resistor, Metal Film	316KΩ	±1%	1/8W
A2R59	10015-141	Resistor, Metal Film	316KΩ	±1%	1/8W
A2R60	10015-78	Resistor, Metal Film	2.26KΩ	±1%	1/8W
A2R61	10013-73	Resistor, Carbon Film	10M Ω	±5%	1/4W
A2R62	10013-1	Resistor, Carbon Film	10Ω	±5%	1/4W
A2R63	10015-24	Resistor, Metal Film	46.4K Ω	±1%	1/8W
A2R64	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A2R65	10013-41	Resistor, Carbon Film	22KΩ	±5%	1/4W
A2R66	10013-29	Resistor, Carbon Film	2.2K Ω	±5%	1/4W
A2R67	10013-41	Resistor, Carbon Film	22K Ω	±5%	1/4W
A2R68	10013-5	Resistor, Carbon Film	22 Ω	±5%	1/4W
A2R69	10013-61	Resistor, Carbon Film	1MΩ	±5%	1/4W
A2R70	10046-11	Resistor, Variable	250KΩ	±20%	1/4W
A2R71	10013-61	Resistor, Carbon Film	1M Ω	±5%	1/4W
A2R72	10013-25	Resistor, Carbon Film	1K Ω	±5%	1/4W
A2R73	10013-61	Resistor, Carbon Film	1M Ω	±5%	1/4W
A2R74	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A2R75	10142-8	Resistor, Carbon Comp	47 Ω	±5%	1/4W
A2R76	10013-53	Resistor, Carbon Film	220KΩ	±5%	1/4W
A2R77	10013-53	Resistor, Carbon Film	220KΩ	±5%	1/4W
A2R78	10015-31	Resistor, Metal Film	3.16KΩ	±1%	1/8W
A2R79	10015-7	Resistor, Metal Film	10KΩ	±1%	1/8W
A2R80	10015-19	Resistor, Metal Film	1K Ω	±1%	1/8W
A2R81	10046-4	Resistor, Variable	5K Ω	±20%	1/4W
A2R82		Not Used			
A2R83	10046-4	Resistor, Variable	5K Ω	±20%	1/4W
A2R84	10015-95	Resistor, Metal Film	29.4K Ω	±1%	1/8W
A2R85	10015-141	Resistor, Metal Film	316K Ω	±1%	1/8W
A2R86	10015-109	Resistor, Metal Film	348KΩ	±1%	1/8W
A2R87	10015-109	Resistor, Metal Film	348KΩ	±1%	1/8W
A2R88	10046-3	Resistor, Variable	50KΩ	±20%	1/4W
A2R89	10015-133	Resistor, Metal Film	49.9KΩ	±1%	1/8W
A2R90	10015-118	Resistor, Metal Film	28.7KΩ	±1%	1/8W
A2R91	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A2R92	10142-8	Resistor, Carbon Comp	47Ω	±5%	1/4W
A2R93	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A2R94	10015-74	Resistor, Metal Film	2.00KΩ	±1%	1/8W
A2R95	10015-188	Resistor, Metal Film	33.2KΩ	±1%	1/8W
A2R96	10015-109	Resistor, Metal Film	348KΩ	±1%	1/8W
A2R97	10015-74	Resistor, Metal Film	2.00KΩ	±1%	1/8W
A2R98	10015-188	Resistor, Metal Film	33.2KΩ	±1%	1/8W
A2R99	10015-172	Resistor, Metal Film	1.18KΩ	±1%	1/8W
A2R100	10015-74	Resistor, Metal Film	2.00KΩ	±1%	1/8W
A2R101	10015-96	Resistor, Metal Film	12.1KΩ	±1%	1/8W
A2R102	10046-7	Resistor, Variable	1KΩ	±20%	1/4W
A2R103	10015-105	Resistor, Metal Film	6.19KΩ	±1%	1/8W
A2R104	10015-191	Resistor, Metal Film	66.5KΩ	±1%	1/8W
A2R105	10015-120	Resistor, Metal Film	69.8KΩ	±1%	1/8W
A2R106	10015-191	Resistor, Metal Film	66.5KΩ	±1%	1/8W
A2R107	10013-61	Resistor, Carbon Film	1MΩ	±5%	1/4W
A2R108	10013-13	Resistor, Carbon Film	100Ω	±5%	1/4W
A2R109	10013-13	Resistor, Carbon Film	100Ω	±5%	1/4W
A2R110	10015-191	Resistor, Metal Film	66.5KΩ	±1%	1/8W
A2R111	10015-14	Resistor, Metal Film	31.6KΩ	±1%	1/8W
A2R112	10013-1	Resistor, Carbon Film	10Ω	±5%	1/4W
A2R113		Not Used			
A2R114		Not Used			
A2R115		Not Used			
A2R116		Not Used			
A2R117		Not Used			
A2R118		Not Used			
A2R119		Not Used			
A2R120	10013-1	Resistor, Carbon Film	10 Ω	±5%	1/4W
A2R121	10015-45	Resistor, Metal Film	499K Ω	±1%	1/8W
A2R122	10015-45	Resistor, Metal Film	499K Ω	±1%	1/8W
A2R123	10013-13	Resistor, Carbon Film	100 Ω	±5%	/14W
A2R124	10013-35	Resistor, Carbon Film	6.8K Ω	±5%	1/4W
A2RT1	13266	Thermistor	2K Ω	±10%	
A2U1	11627	Integrated Circuit	LM301A		
A2U2	13253-2	Integrated Circuit	CD406AE		
A2U3	13253-1	Integrated Circuit	CD4001AE		
A2U4	12445	Integrated Circuit	725C		
A2U5	11118-1	Integrated Circuit	CA3039		
A2U6	12445	Integrated Circuit	725C		
A2U7	11627	Integrated Circuit	LM301A		
A2U8	11627	Integrated Circuit	LM301A		
A2U9	11627	Integrated Circuit	LM301A		

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A2U10	11539	Integrated Circuit	741C		
A2U11	11539	Integrated Circuit	741C		
A2U12		Not Used			
A2U13		Not Used			
		BATTERY POWER PC BOARD ASSEMBLY #13206			
A3C1	10787-3	Capacitor, Tantalum	27μF	±20%	25V
A3C2	10787-3	Capacitor, Tantalum	27μF	±20%	25V
A3C3		Not Used			
A3C4	10000-4	Capacitor, Ceramic	.001 μF	±20%	1000V
A3C5		Not Used			
A3C6	10000-4	Capacitor, Ceramic	.001μF	±20%	1000V
A3C7	10000-4	Capacitor, Ceramic	.001μF	±20%	1000V
A3CR1	10044-1	Diode	1N4383		
A3CR2	10044-1	Diode	1N4383		
A3CR3	10044-1	Diode	1N4383		
A3F1	10064-3	Fuse, 1.0A, 250V			
A3J1	14320-2	Test Jack, Stamped			
A3Q1	14622	Transistor	2N6486		
A3Q2	10017	Transistor	2N3569		
A3Q3	10019	Transistor	2N3565		
A3Q4	10017	Transistor	2N3569		
A3Q5	10017	Transistor	2N3569		
A3Q6	10019	Transistor	2N3565		
A3R1	10013-37	Resistor, Carbon Film	10KΩ	±5%	1/4W
A3R2		Not Used			
A3R3	10015-36	Resistor, Metal Film	5.11KΩ	±1%	1/8W
A3R4	10046-7	Resistor, Variable Comp	1KΩ	±20%	1/4W
A3R5	10015-36	Resistor, Metal Film	5.11KΩ	±1%	1/8W
A3R6	10241-5	Resistor, Carbon Comp	1.0 Ω	±5%	1/2W
A3R7	10013-17	Resistor, Carbon Film	220 Ω	±5%	1/4W
A3R8	10013-39	Resistor, Carbon Film	15K Ω	±5%	1/4W
A3R9	10013-13	Resistor, Carbon Film	100 Ω	±5%	1/4W
A3R10	10013-13	Resistor, Carbon Film	100 Ω	±5%	1/4W
A3R11	10013-39	Resistor, Carbon Film	15KΩ	±5%	1/4W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION			
A3R12	10015-72	Resistor, Metal Film	1.96KΩ	±1%	1/8W
A3R13	10015-221	Resistor, Metal Film	4.22KΩ	±1%	1/8W
A3R14	10015-104	Resistor, Metal Film	5.62KΩ	±1%	1/8W
A3RT1	13266	Thermister, Disc	2KΩ		
A3T1	13262	Transformer, Power			
A3T2	13275	Transformer			
A3U1	13893	Integrated Circuit	uA723C		
B1	13261	Battery			

PART NUMBER CROSS REFERENCE		
PART NO.	MFGR. CODE	MFGR. PART NO.
10000-1	56289	5GA-T10
10000-3	56289	5GA-T47
10000-4	56289	5GA-D10
10000-5	56289	5GA-D22
10000-8	56289	5GAS-S20
10000-9	56289	5GA-550
10000-11	72982	805-000-X5V0-1032
10001-5	56289	10TCC-Q33
10001-6	56289	10TCC-Q47
10001-7	56289	10TCC-T10
10001-8	56289	10TCC-Q15
10001-12	56289	10TCC-V33
10001-13	56289	10TCC-Q12
10001-15	56289	10TCC-T15
10001-16	56289	10TCC-T12
10001-17	56289	10TCC-Q82
10003-6	25088	B41010-220/40/8212
10007-5	01002	75F1R2A223
10007-7	01002	75F3R2A104
10007-8	01002	75F6R2A224
10013-1	80031	B803 104NB 100
10013-5	80031	B803 104NB 220
10013-7	80031	B803 104NB 330
10013-9	80031	B803 104NB 470
10013-13	80031	B803 104NB 101
10013-21	80031	B803 104NB 471
10013-23	80031	B803 104NB 681
10013-25	80031	B803 104NB 102
10013-29	80031	B803 104NB 222
10013-31	80031	B803 104NB 332
10013-33	80031	B803 104NB 472
10013-37	80031	B803 104NB 103
10013-41	80031	B803 104NB 223
10013-45	80031	B803 104NB 473
10013-47	80031	B803 104NB 683
10013-49	80031	B803 104NB 104
10013-51	80031	B803 104NB 154
10013-52	80031	B803 104NB 184
10013-53	80031	B803 104NB 224
10013-59	80031	B803 104NB 684
10013-61	80031	B803 104NB 105
10013-65	80031	B803 104NB 225
10013-69	80031	B803 104NB 475
10013-73	01121	CB1065

PART NUMBER CROSS REFERENCE		
PART NO.	MFGR. CODE	MFGR. PART NO.
10015-3	24546	RN55D 49.9Ω 1%
10015-7	24546	RN55D 10.0KΩ 1%
10015-13	24546	RN55D 100KΩ 1%
10015-14	24546	RN55D 31.6KΩ 1%
10015-19	24546	RN55D 1KΩ 1%
10015-24	24546	RN55D 46.4KΩ 1%
10015-31	24546	RN55D 3.16KΩ 1%
10015-33	24546	RN55D 82.5KΩ 1%
10015-36	24546	RN55D 5.11KΩ 1%
10015-40	24546	RN55D 43.2KΩ 1%
10015-43	24546	RN55D 121Ω 1%
10015-45	24546	RN55D 499KΩ 1%
10015-62	24546	RN55D 200KΩ 1%
10015-63	24546	RN55D 402KΩ 1%
10015-74	24546	RN55D 2KΩ 1%
10015-78	24546	RN55D 2.26KΩ 1%
10015-81	24546	RN55D 11.3KΩ 1%
10015-85	24546	RN55D 287KΩ 1%
10015-91	24546	RN55D 90.9KΩ 1%
10015-95	24546	RN55D 29.4KΩ 1%
10015-96	24546	RN55D 12.1KΩ 1%
10015-98	24546	RN55D 13.3KΩ 1%
10015-105	24546	RN55D 6.19KΩ 1%
10015-106	24546	RN55D 6.81KΩ 1%
10015-109	24546	RN55D 348K Ω 1%
10015-115	24546	RN55D 57.6KΩ 1%
10015-117	24546	RN55D 45.9KΩ 1%
10015-118	24546	RN55D 28.7KΩ 1%
10015-120	24546	RN55D 69.8KΩ 1%
10015-133	24546	RN55D 49.9KΩ 1%
10015-138	24546	RN55D 115 Ω 1%
10015-141	24546	RN55D 316Ω 1%
10015-172	24546	RN55D 1.18KΩ 1%
10015-178	24546	RN55D 17.4KΩ 1%
10015-188	24546	RN55D 33.2KΩ 1%
10015-191	24546	RN55D 66.5KΩ 1%
10015-197	24546	RN55D 221Ω 1%
10015-206	24546	RN55D 7.5KΩ 1%
10015-213	24546	RN55D 178KΩ 1%
10015-214	24546	RN55D 374KΩ 1%
10015-231	24546	RN55D 23.7 Ω 1%

PART NUMBER CROSS REFERENCE		
PART NO.	MFGR. CODE	MFGR. PART NO.
10018	07263	2N3646
10019	07263	2N2565
10043-2	09214	1N4148
10046-3	71450	X201R503B
10046-4	71450	X201R502B
10046-7	71450	X201R102B
10046-8	71450	X201R103B
10046-10	71450	X201R104B
10046-11	71450	X201R254B
10046-12	71450	X201R504B
10059	79727	GF126
10064-7	75915	312-250
10140-1	74970	105-0852-001
10140-2	74970	105-0857-001
10140-3	74970	105-0853-001
10140-4	74970	105-0860-001
10366	15558	1102-118
10399	07263	2N4360
10585-5	56289	CO28A102J102J
10631-11	99800	1025-08
10677-2	84171	DM15F221J500V
10677-5	84171	DM15F470J500V
10677-9	84171	DM15F121J500V
10677-13	84171	DM15F471J500V
10677-19	84171	DM15F240J500V
10787-1	56289	196D475X0035JA1
10787-2	56289	196D126X9020JA1
10787-3	56289	196D276X9025LA3
10787-5	56289	196D105X0035HA1
10787-8	56289	196D474X0035HA1
10787-9	56289	196D476X0020LA3
10821	02660	82-97
10896	02735	3N138
11118-1	02735	CA93039
11119	07263	2N4250
11160	22753	SW-422-GK115/230
11173-1	56289	196D337X0006TE4
11432	27014	2N3955
11485-13	14298	REA C-2 63.0K 0.1%
11485-14	14298	REA C-2 126K 0.1%

PART NUMBER CROSS REFERENCE		
PART NO.	MFGR. CODE	MFGR. PART NO.
11501-2	72982	8131-050-651-104M
11507	01295	TIS97
11539	07263	741HC
11627	07263	LM301AH
11676-1	01121	WA1G012S104MZ
11688-1	71450	185PC-104B-HDRWKT185
11689	24931	28JR106-6
11711-2	73138	66WR Series, 100K
11711-4	73138	66WR Series, 1K
11711-5	73138	66WR Series, 250K
11715	07263	1N446
12233-2	28821	12233-2
12355	82389	EAC-301
12389	76541	MV5025
12445	07263	725C
12449-15	14298	EE 1/8 C2 75.00K 0.1%
12449-26	14298	EE 1/8 C2 5.00K 0.1%
12449-47	14298	EE 1/8 C2 505 0.1%
12449-48	91637	MFF 1/8 T2 15.00K 0.1%
12449-49	91637	MFF 1/8 T2 22.9K 0.1%
12449-50	14298	EE 1/8 C2 45.41K 0.1%
12591	17856	E112
12722	28821	12722
13217	28821	13217
13226	28821	13226
13242-1	31223	MPO 100-10-DS-1
13249-1	07263	2N3808
13250	04713	MC1463G
13251	04713	MC1469G
13253-1	02735	CD4001 AE
13253-2	02735	CD4060 AE
13260	28821	13260
13262	28821	13262
13266	83186	32D4
13267-1	31223	MPO 100-15-DS-4
13271	16733	700209
13289	28821	13289
13358	82389	2504FP
14314	28821	14314

FEDERAL SUPPLY CODES FOR MANUFACTURERS

The following five-digit code numbers are listed in numerical sequence along with the name and location of the manufacturer to which the code has been assigned. The Federal Supply Code has been taken from Cataloging Handbook H 4-1, Name to Code.

00303	Shelly Associates El Segundo, California
00656	Aerovox Corp. New Bedford, Massachusetts
00779	AMP Inc. Harrisburg, Pennsylvania
01002	General Electric Co. Capacitor Dep't. 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 Electric Corp. Broadview, Illinois
02735	Radio Corp. of America Semiconductor & Materials Div. Somerville, New Jersey
04062	Elmenco Products Co. New York, New York
04713	Motorola, Inc. Semiconductor Products Div. Pheonix, Arizona
05035	Ayer Manufacturing Co. Chicago Heights, Illinois
05245	Corcom, Inc. Chicago, Illinois
07126	Digitran Co. Pasadena, California
07263	Fairchild Camera & Inst. Corp. Semiconductor Div. Mountain View, California
07910	Continental Device Corp. Hawthorne, California
09214	General Electric Co. Semiconductor Products Dep't. 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
15558	Micon Electronics, Inc. Garden City, New York
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. New Cumberland, Pennsylvania
24546	Corning Glass Works Electronic Components Div. Raleigh, North Carolina
24931	Specialty Connector Co., Inc. Indianapolis, Indiana
25085	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	Wavetek Microwave, 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 Manufacturing Co. Skokie, Illinois
50625	Revere Corp. of America Wallingford, Connecticut
56289	Sprague Electric Co. North Adams, Massachusetts
70903	Belden Manufacturing Co. Chicago, Illinois
71034	Bliley Electric Co. Erie, Pennsylvania
71400	Bussman Manufacturing Div. of McGraw-Edison Co. St. Louis, Missouri
71450	CTS Corp. Elkhart, Indiana
71590	Centralab Electronics Milwaukee, Wisconsin
72982	Erie Technical 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 Manufacturing Co. Crystal Lake, Illinois
79727	Continental-Wirt Electronics Co. Philadelphia, Pennsylvania
80031	Mepco/Electra, Inc. A North American Phillips Co. Morristown, New Jersey
80294	Bourns, Inc. Trimpot Division Riverside, California
81073	Grayhill, Inc. La Grange, Illinois

81095	Traid Transformer Co. 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 Division 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 Division Freeport, Illinois
94144	Raytheon Co. Components Division 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

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
13	None		