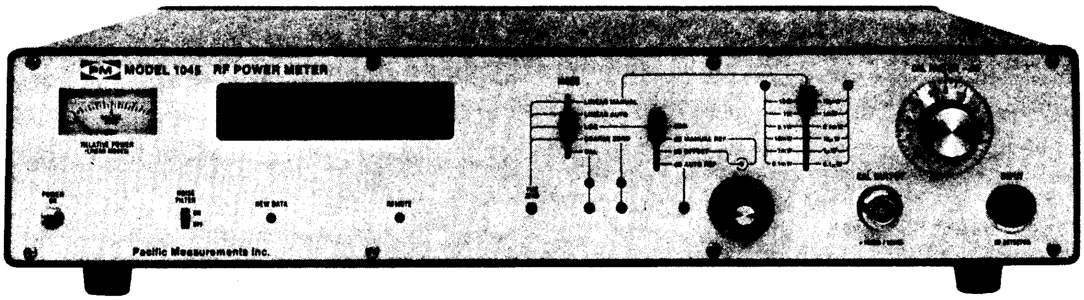
OPERATING AND MAINTENANCE MANUAL



RF POWER METER

MODEL 1045/01

SERIAL NUMBER 1509175

WAVETEK PACIFIC MEASUREMENTS INCORPORATED

488 TASMAN DRIVE, SUNNYVALE, CALIFORNIA 94086

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

1499—14176
Code 18 (5-84)

CERTIFICATION

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

ONE YEAR LIMITED WARRANTY

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

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

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

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

WARRANTY PROCEDURE AND SHIPPING INSTRUCTIONS

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

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

b. On receipt of shipping instructions, ship the instrument transportation prepaid to WPM. The instrument should be shipped in the original shipping carton, or if damaged or not available, in a suitable rigid container with the instrument wrapped in paper or plastic and surrounded with at least four (4) inches of cushioning material on all sides. If under Warranty, the instrument will be repaired and returned transportation prepaid.

RECEIVING INSTRUCTIONS

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

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List of Illustrations (Tables and Figures)

SECTION 1

GENERAL INFORMATION

1.1 THE WAVETEK PACIFIC MEASUREMENTS MODEL 1045 RF POWER METER

The Model 1045 RF Power Meter is designed to measure the RF power incident on RF detectors at frequencies from 1 MHz to 26.5GHz. The meter has a built-in multiplexer to allow up to four detectors to be used with the instrument. The Model 1045 can be controlled from the front panel or, with the addition of an optional interface board designed for use with the IEEE Bus, it can be remotely controlled and transmit data to a remote terminal or calculator. Up to four devices can be measured remotely and remote control, when enabled, overrides local control from the front panel.

The Model 1045 has the following modes of operation:

a. LINEAR MANUAL MODE, where one of six ranges are selected from 10 Watts to 0.1 microwatts by the operator, locally or remotely.

b. LINEAR AUTO MODE, where the optimum power range is selected by the Model 1045 internal circuits.

c. LOG MODE, where the measurement may be in dB or dBm, selected locally or remotely by the operator, with a range of +10 to -50 dB or dBm with low power detectors, or +40 to -20 dB or dBm with high power detectors.

d. dB AUTO MODE, where any input level can be stored and used as the zero reference for other measurements. This is particularly useful where a comparison of the four inputs is required.

The RF power meter automatically detects the presence of a 30 dB pad in the detector.

A calibration factor control allows the sensitivity of the instrument to be set for variations in detector calibration factors. The calibration factor setting is obtained from a chart on the detector and compensates for variations due to frequency.

There is a small variation in the detected level due to temperature. The detector is equipped with a temperature sensor which compensates for this effect, but there may be some small residual variation. To compensate for this a test signal is available from the CAL OUTPUT connection on the front panel to enable the detected level to be adjusted precisely. The test signal is very stable with respect to temperature variations, has low harmonic output and is matched to 50 ohms exactly. This adjustment is required only in the linear mode and dBm mode.

A noise filter may be switched in, locally or remotely, which stabilizes the digital display

TABLE 1-1

DETECTORS AVAILABLE WITH THE MODEL 1045

PART #	CONNECTOR	POWER RANGE	FREQUENCY RANGE	RETURN LOSS To 2 GHz	RETURN LOSS To 12 GHz	RETURN LOSS Above 12 GHz
13786	N plug	-50 dBm to +10 dBm	1 MHz to 18 GHz	25 dB	18 dB	14 dB
13787	APC-7	-50 dBm to +10 dBm	1 MHz to 18 GHz	25 dB	18 dB	14 dB
14139	N plug	-20 dBm to +40 dBm	1 MHz to 18 GHz	25 dB	18 dB	14 dB
15271	APC-3.5*	-50 dBm to +10 dBm	1 MHz to 26.5 GHz	25 dB	18 dB	14 dB

*Compatible with SMA connectors

at low level measurements.

There is a control (dB MANUAL REF) allowing the RF reference level to be set to any level manually. When an oscilloscope is connected to the output, the output can be offset with the dB OFFSET control from the original reference level to set a particular point on the swept trace to zero. The offset required to do this is shown on the digital display on the front panel.

The RATIO/MARKER INPUT adds two features to the Model 1045. An input from a sweep generator can put a marker on the trace at a preselected frequency. The RATIO/MARKER INPUT can also be used for a reference input from another RF Power Meter. The detector input is read against this reference, and the output is the difference between the reference and detector inputs.

Other controls and indicator lamps for minor functions are fully explained in the operating section.

The measurements made may be seen on the front panel, or transmitted to a remote terminal via an IEEE bus. In addition, the Model 1045 can display a 60 dB dynamic range on a conventional oscilloscope; the display is linear in dB. If slower sweep speeds are used, the same output may be used to produce a permanent record on a plotter.

The instrument operates from a line source of 100-240 Vac, at a frequency of 50-400 Hz. The instrument may be turned on or off only at the front panel.

1.2 POWER DETECTOR UNITS

A range of power detectors are available, all are 50 ohm input impedance. They should be selected for use depending on the power range and frequency to be measured. Table 1-1 gives the detectors available, their power and frequency range and the WPM part number. Maximum input power (peak or average) before burnout is +23 dBm (200 mW). A 1.5 meter (5 foot) detector cable is included with the Model 1045.

1.3 OPTIONS

There are three options available, as shown in Table 1-2.

TABLE 1-2

OPTIONS AVAILABLE WITH THE MODEL 1045

OPTION 02	APC7 connector at the CAL OUTPUT. Compatible with the APC7 connector on detector 13787, but does not include coupling nut.
OPTION 04	BCD data output
OPTION 05	IEEE STD 488-1978 interface bus

Option 02 will provide an APC7 connector on the CAL OUTPUT.

Option 04 provides a BCD output via the INTERFACE INPUT-OUTPUT connector on the rear panel. Logic levels are TTL compatible with positive true logic.

Option 05 has an IEEE STD 488-1975 bus interface, which provides a complete input and output control and data interface to a remote controller or calculator. The bus connection is via the INTERFACE INPUT-OUTPUT connector on the rear panel.

The instrument responds to commands which address it as a Talker, or a Listener, or require it to trigger. It is able to issue a Service Request, and participate in a Serial Poll. When remote control is called for, the controls on the front panel are inactive. The user has the option of retaining the function of the CAL FACTOR control during remote operation by making an internal switch selection.

When active as a listener, the instrument will accept data which selects its function and range. One data byte selects its function, another selects the detector (if Option 01 is included in the instrument) and a third supplies a trigger. (Alternatively, the Group Execute Trigger bus function can be used.) Thus, only three bytes are needed to completely control the instrument and cause it to take a reading. As soon as it has data it will issue a Service Request; then, when addressed as a talker it will respond to the serial poll and when an active talker, send the measured data automatically. Eleven bytes of data are output. The last two bytes are for the Carriage Return and Line Feed. All data are defined according to the American Standard Code for Information Interchange (ASCII).

Inside the instrument on the interface board are two sets of switches. One group of five selects the listener address and another group of five selects the talker address as shown in Paragraph 3.5. In order to allow some flexibility in the way the instrument is used under program control, four additional switches allow the following capabilities: The Service Request feature can be disabled. The trigger function can be set to be from the bus, from an external source or internal to the instrument. The front panel CAL FACTOR switch can be made active even under remote control. Finally, the instrument can be set for Talk Only operation. When set in the Talk Only mode, the instrument outputs data as it becomes available. This is useful when driving just one peripheral device, such as a printer.

The instrument is capable of making up to 500 measurements per second. Data can be transmitted on the bus at 200K bytes per second if the listener/controllers on the bus can accept data at that rate.

1.4 PERFORMANCE SPECIFICATIONS

The specifications for the Model 1045 are given in Table 1-3.

TABLE 1-3

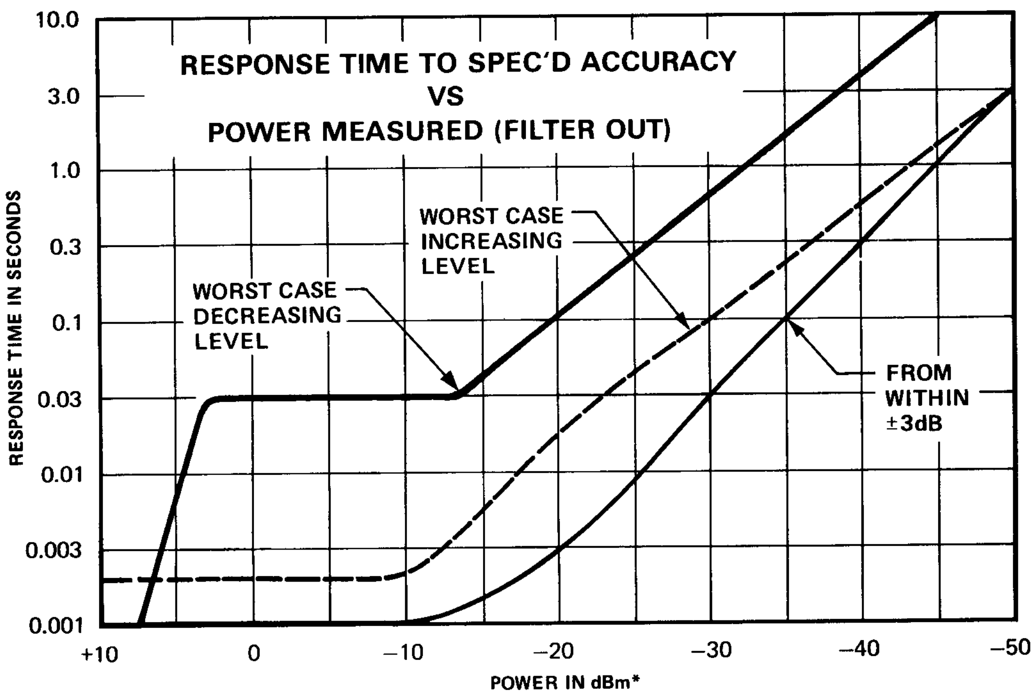
PERFORMANCE SPECIFICATIONS

FREQUENCY RANGE	1Mhz to 26.5GHz (from 100kHz on special order)	
POWER RANGES	Low Power Detectors	High Power Detectors
dB or dBm, Single Range	-50 dBm to +10 dBm	-20 dBm to +40 dBm
Watts, Decade Ranges	.1 µW to 10 mW	.1 mW to 10 W
Range Selection	Manual or Automatic	
DATA DISPLAY		
Digital	4 Digit, LED	

(Continued)

TABLE 1-3 SPECIFICATIONS (Contd)

Annunciators	dB, dBm, W, mW, μW, Over-range
Indicators	Cal, Zero, Remote, New Data, Detector Power Range
Analog Meter	For tuning, watt ranges and coarse zero only
SPEED	
Reading Rate - Internal Trigger	4 readings/sec
Reading Rate - External Trigger	Up to 500 readings/sec
Auto Ranging Time, maximum	10 milliseconds
RESPONSE TIME	



The analog response time of the instrument is determined by three factors:

1. The power level measured (higher power-faster response)
2. The power change from the previous reading (smaller change-faster response)
3. The direction of change from the previous reading (increasing response faster than decreasing response)

To optimize testing speed in automatic systems programs should be written which minimize the power change from one reading to the next and where large changes are in the increasing direction.

A delay should be programmed after the measured signal has been connected to the detector (or has settled to its desired value) and before the instrument is triggered.

(Continued)

TABLE 1-3 SPECIFICATIONS (Contd)

INSTRUMENT ACCURACY (INCLUDES DETECTOR LINEARITY)	15-35°C	0-15° & 35-50°C
+10 dBm to 0 dBm*	±0.15 dB	±0.25 dB
0 dBm to -35 dBm*	±0.1 dB	±0.2 dB
-35 dBm to -50 dBm*	±0.3 dB	±0.4 dB
10 mW to 1 mW*	4% of reading	6% of reading
1 mW to 0.316 μW*	2% of reading	5% of reading
0.316 μW to 10 nW*	7% of reading	10% of reading
CALIBRATION FACTOR		
Uncertainty	±0.1 dB to 12 GHz ±0.2 dB to 18 GHz	
Resolution	.02 dB	
Range	±1 dB	
ZERO SET		
Automatic (Fine)	Front panel button	
Coarse	Front panel screwdriver control	
REFERENCE SET		
Automatic	Front panel button	
Manual	Front panel knob	
ANALOG OUTPUT, < 1 ohm output impedance 3 mA max.		
dBm Ranges	100 mV/dB, ±1% (0 V for 0 dB) 60 dB dynamic range	
Watt Ranges	1.0 V per 1000 counts, ±1%	
CALIBRATOR	30 MHz, 10 mW, ±1.5%, 50 Ω, harmonics < -50 dB, return loss <25 dB.	
PHYSICAL PROPERTIES		
Operating Temperature Range	0-50°C	
Power Requirements	100, 120, 220, 240 VAC ± 10% 50-440 Hz, 24 VA	
DIMENSIONS	8.9 cm H x 43.3 cm W x 48.3 cm D (3-1/2" H x 17" W x 19" D)	
WEIGHT	9.5 kg (21 lbs.)	
SHIPPING WEIGHT	11.3 kg (25 lbs.)	
REAR CONNECTORS		
External Trigger Input	TTL Pulse > 0.2 μsec wide will trigger new reading. BNC.	
Analog Output	See above. BNC.	
Ratio/Marker Input	Allows 2 Model 1045's to be used together to display ratio of 2 signals. Allows insertion of marker. BNC.	
RF Blanking Output	TTL *Low* level during coarse or fine zero process available to turn off RF source. BNC.	
GPIB Connector	If Option 05 is ordered, the connector is compatible with IEEE STD 488.	
Detector Inputs (4)	If Option 01 is ordered, 4 position selector switch replaces front panel detector input.	

*For Low Power Detector; add 30 dB (X1000 for watt ranges) if High Power Detector is used.

1.5 ACCESSORIES

A list of accessories is given in Table 1-4. These include a rack adapter and additional cables.

TABLE 1-4

LIST OF ACCESSORIES

Model 1047	Rack Adapter (with slides)
P/N 14052	IEEE 488 Cable, 2 meters long
P/N 13937-1	Detector Cable, 1.5 meters (5 feet)
P/N 13937-2	Detector Cable, 3 meters (10 feet)
P/N 13937-3	Detector Cable, 7.5 meters (25 feet)
P/N 13937-4	Detector Cable, 15 meters (50 feet)
P/N 13937-5	Detector Cable, 30 meters (100 feet)

WAVETEK PACIFIC MEASUREMENTS, INC.

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TECHNICAL INFORMATION

DETECTORS FOR USE WITH WAVETEK PACIFIC MEASUREMENTS (WPM) SCALAR ANALYZERS AND 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 WPM scalar analyzer systems and power meters. Parameters common to each of the three detector configurations are defined first, and then individual detector specifications are shown.

WPM offers three different types of detectors for their swept measurement 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 frequency ranges from 1MHz to 18.5GHz or 1MHz to 26.5GHz (useful to 34GHz). One version of the single diode detector (used with the WPM 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 (+20dBm), 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 WPM single diode detector include the following:

- 70dB Dynamic Range
- Temperature Compensated
- Linearity Compensated
- 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
- 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.)
- 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.
- Measurement Accuracy: Figures 4 6, and 7 show the measurement accuracy for single diode detectors used with power meters and swept measurement systems except the Model 1038-H/V system. Single diode detectors specified for the 1038-H/V system have a measurement accuracy of 0.1dB/10dB plus 0.5dB at -50dBm

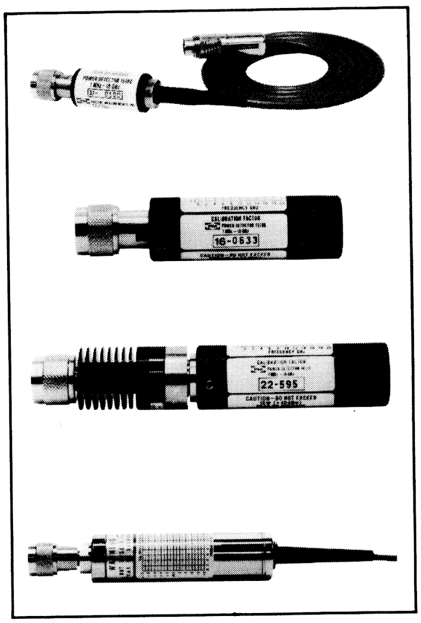

Figure 1. Typical Configurations of Wavetek Pacific Measurements Single Diode Detectors

BALANCED (DUAL DIODE) DETECTOR FEATURES AND SPECIFICATIONS

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

- 76dB Dynamic Range
- Effects of even harmonics are reduced, thereby increasing measurement accuracy
- Absorbs low level dc offset voltages
- Very low thermal drift
- Temperature Compensated
- Linearity Compensated
- Input Impedance: 50 ohms, nominal
- Frequency Response Curve Data Accuracy: The uncertainty of calibration for the balanced detector is 3% to 18GHz and 5% to 26.5GHz
- 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
- 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.
- Measurement Accuracy: See Figure 4

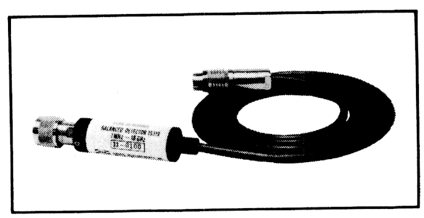

Figure 2. Wavetek Pacific Measurements Patented Balanced (Dual Diode) Detector

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.

WAVEGUIDE DETECTOR FEATURES AND SPECIFICATIONS

Further features and specifications for the WPM 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

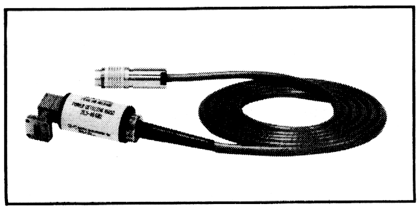

Figure 3 Wavetek Pacific Measurements Balanced Element Waveguide Detector

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 WPM detectors. Some specifications can be slightly different due to the characteristics of the instrument with which the detector is used. These deviations include the following: (all other specifications are as given on the reverse side of this sheet)

Model 1038-N10/NS20 Systems

Flatness: Flatness of the single diode coaxial detector (maximum total variation) is 1.0dB from 1MHz to 18GHz, 2.0dB to 26.5GHz and, with an APC3.5 connector, 3.0dB to 34.0GHz

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
15181	1MHz to 26.5GHz*	200mW	APC3.5**	Single	15363
15237	1MHz to 18.5GHz	200mW	Type N	Single	15362
15284	1MHz to 18.5GHz	200mW	APC7	Single	15362
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

*Useable to 34GHz **Compatible with SMA connector

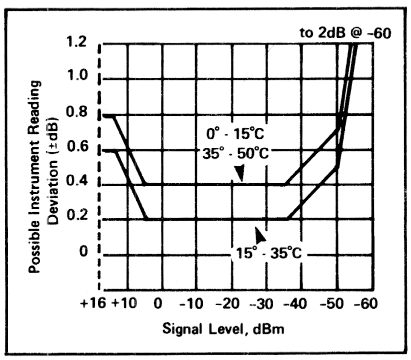

Figure 4 Model 1038-N10 and NS20 System Coaxial Detector Accuracy from 30MHz to 26.5GHz. (An additional 0.2dB is added to the deviation reading for operation from 1 to 30MHz)

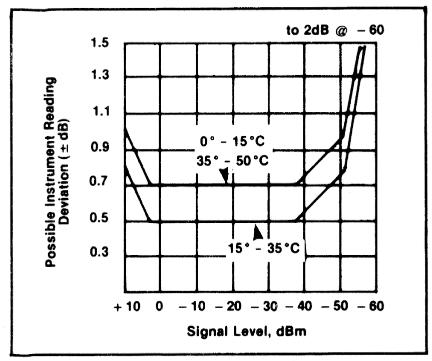

Figure 5 Model 1038-N10, NS20, and H/V Systems Waveguide Detector Accuracy from 26.5GHz to 40GHz

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

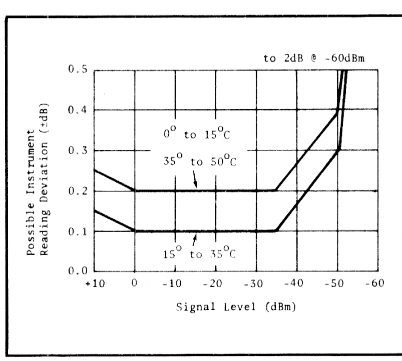

Figure 6 Model 1045 Detector Measurement Accuracy from 1MHz to 26.5GHz

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

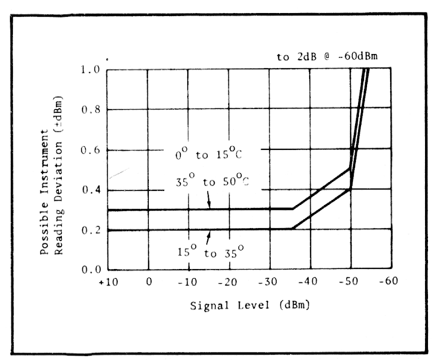

Figure 7 Model 1034A Detector Measurement Accuracy from 1MHz to 10GHz. (Add 0.2dB to the above for frequencies from 10GHz to 18GHz)

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TECHNICAL INFORMATION

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.

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.

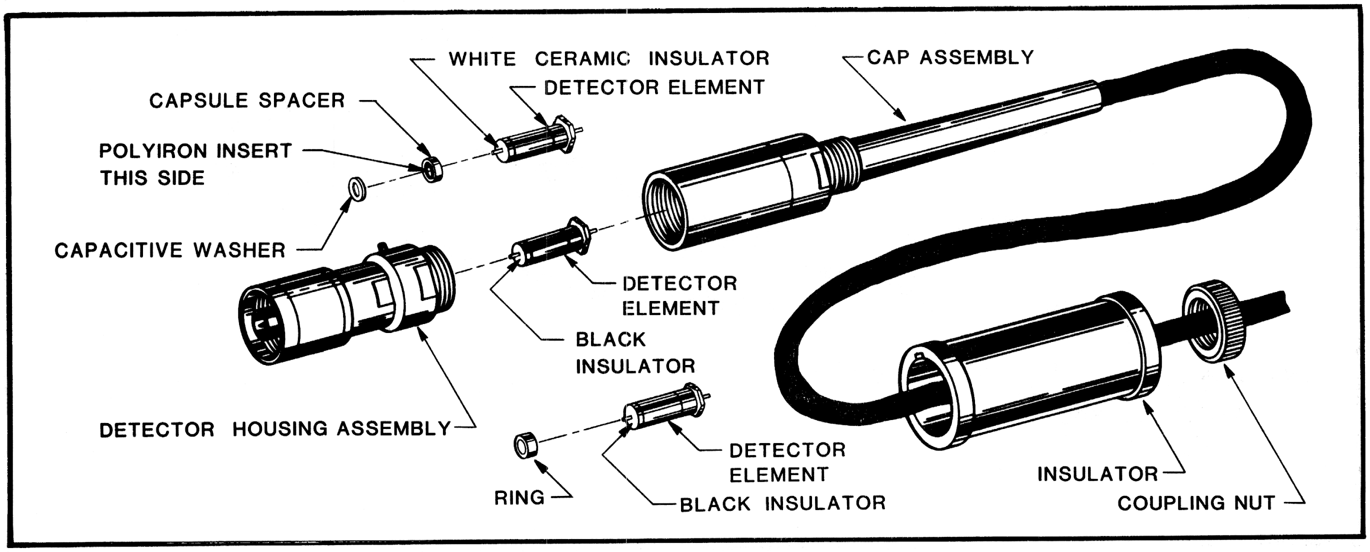


Figure 1. Element Replacement for Detectors Used With the 1038-H/V and 1034A Units

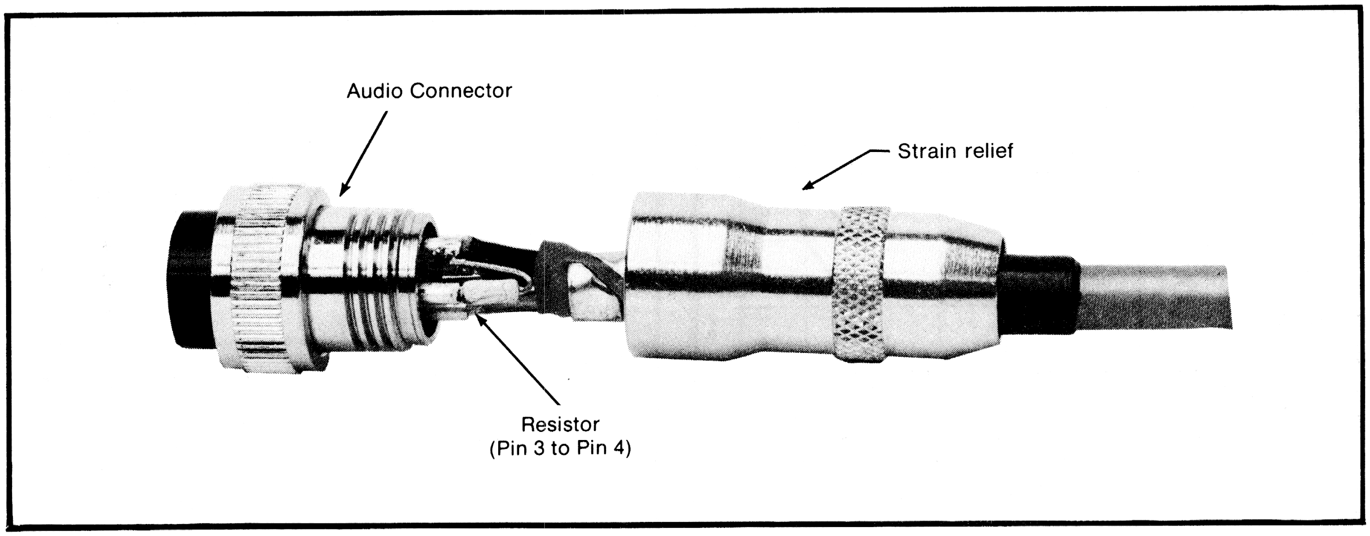


Figure 2. Resistor Replacement for Detectors Used With the 1034A Units

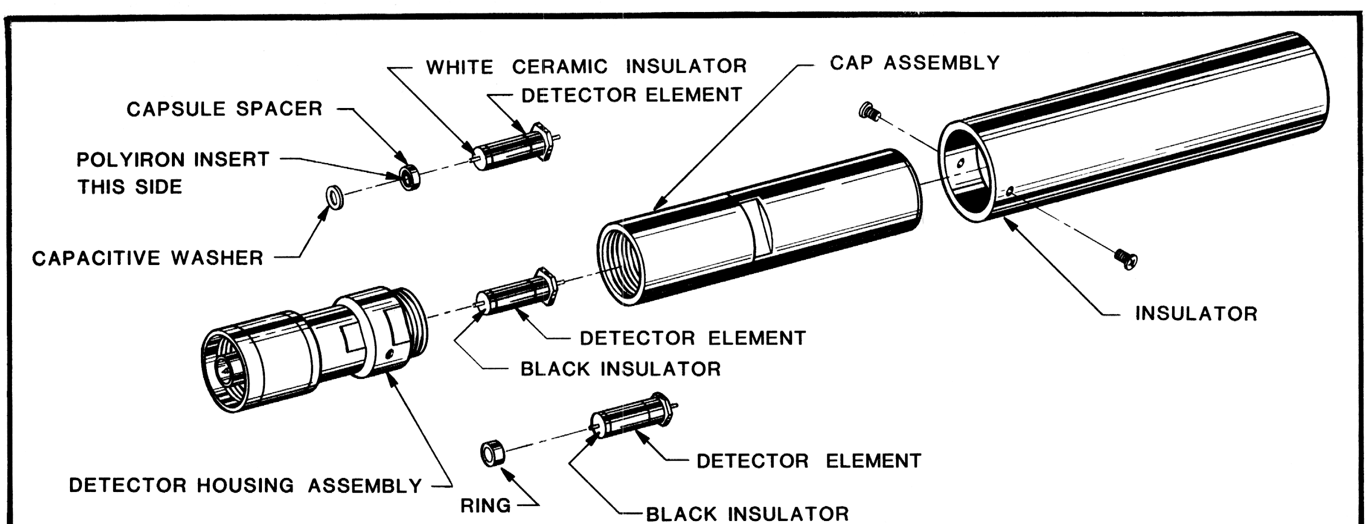


Figure 3. Element Replacement for Detectors Used With the Model 1045 Unit

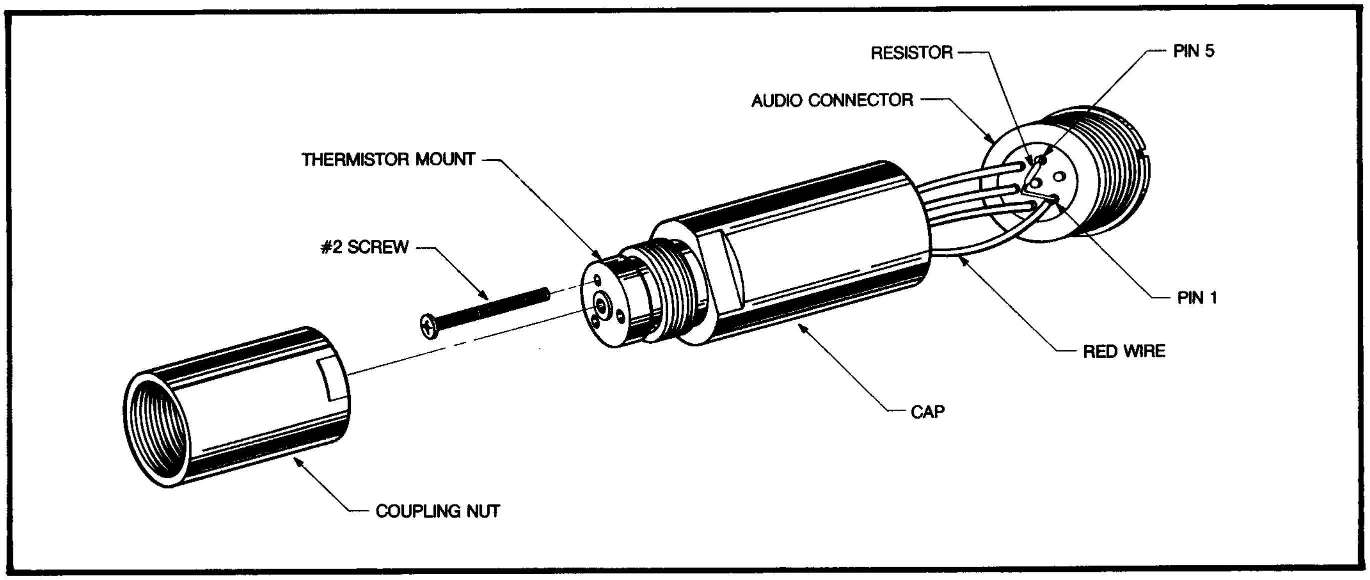


Figure 4. Resistor Replacement for Detectors Used With the Model 1045 Unit

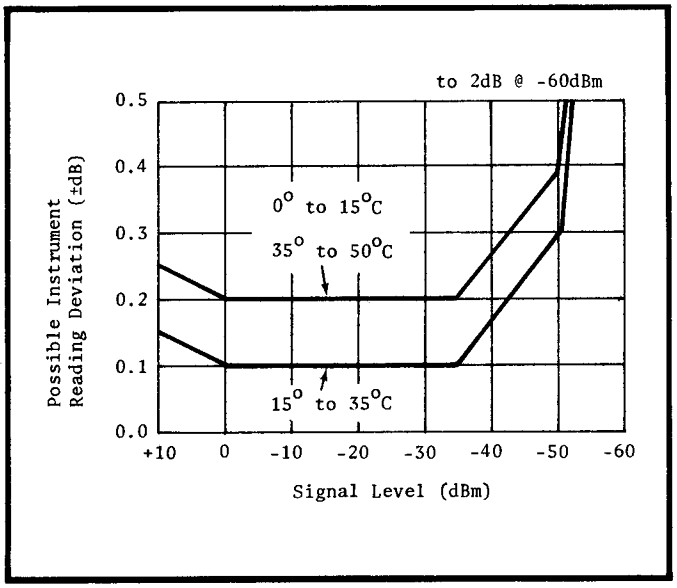


Figure 5. Model 1045 Detector Measurement Accuracy from 1MHz to 26.5GHz.

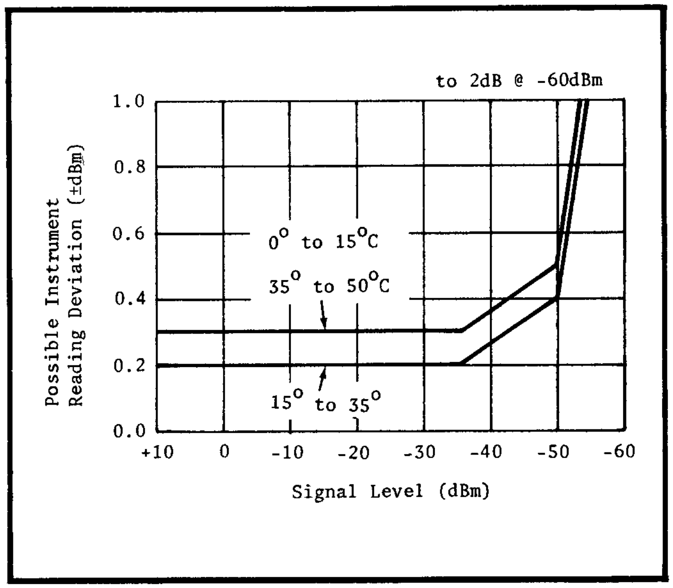


Figure 6. Model 1034A Detector Measurement Accuracy from 1MHz to 10GHz. (Add 0.2dB to the curve for frequencies from 10GHz to 18GHz.)

SECTION 2

INITIAL INSTRUCTIONS

2.1 RECEIVING INSPECTION

Inspect the instrument for shipping damage. See the receiving instruction under "Warranty" on page i at the beginning of the manual.

2.2 POWER REQUIREMENT

NOTE

Before applying power to the instrument from the line, be sure that the instrument is set for the correct line voltage.

The unit is normally set at the factory for operation at the normal supply voltage for the country in which it is sold. The input must be 50-400 Hz. The combination of the module and transformer design allows instrument operation on 100, 120, 220, or 240 volts. Conversion from one voltage to another may be made by changing the voltage selection p.c. board. See Figure 2-1.

2.3 CHASSIS GROUNDING

The instrument is supplied with a three-conductor NEMA type power cord. The instrument will be properly grounded if the plug is connected into a properly installed three-prong receptacle. If a three-prong to two-prong adapter is used, be sure that the pigtail lead of the adapter is grounded.

WARNING

Failure to properly ground the instrument can allow dangerous voltages to build up on the chassis which could become dangerous to operating personnel.

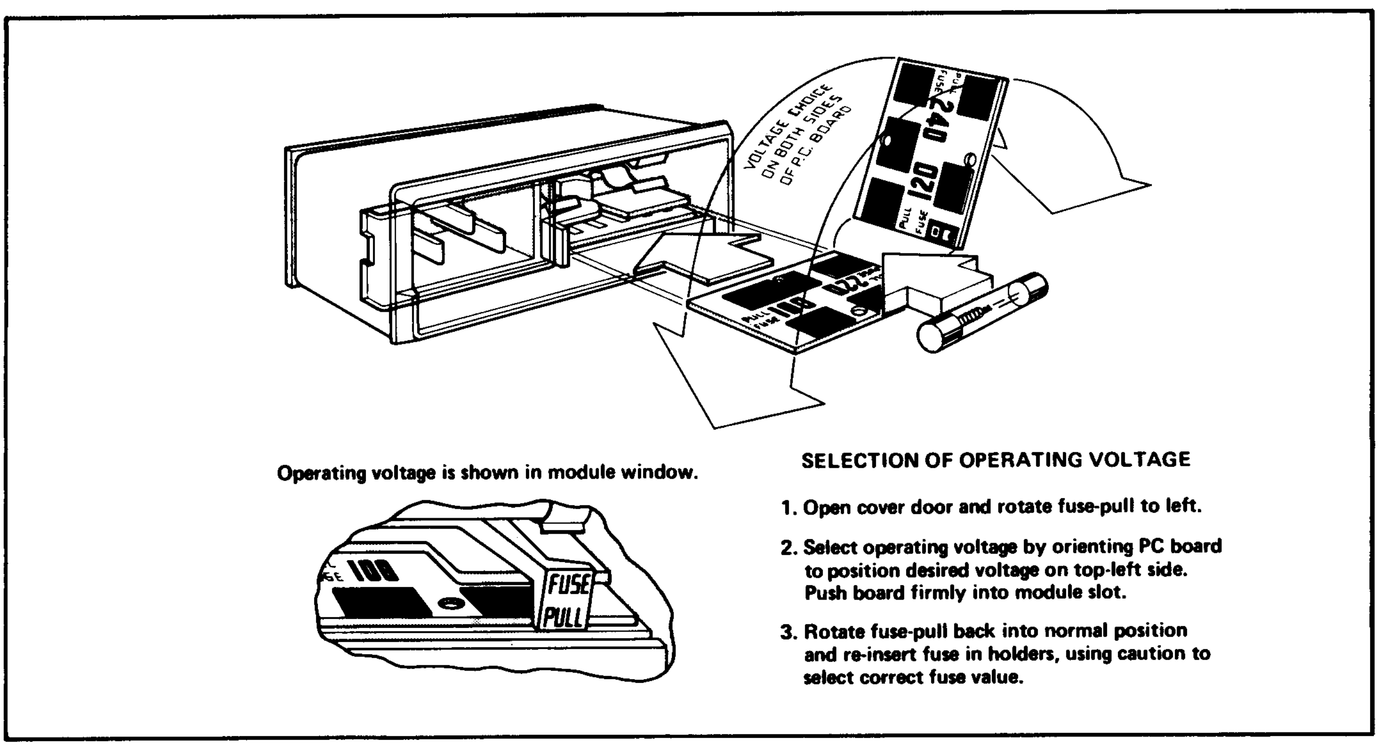
2.4 RETURNING THE INSTRUMENT

If it should be necessary to return the instrument to Wavetek Pacific Measurements, see the shipping instructions under "Warranty" on page i at the front of the manual.

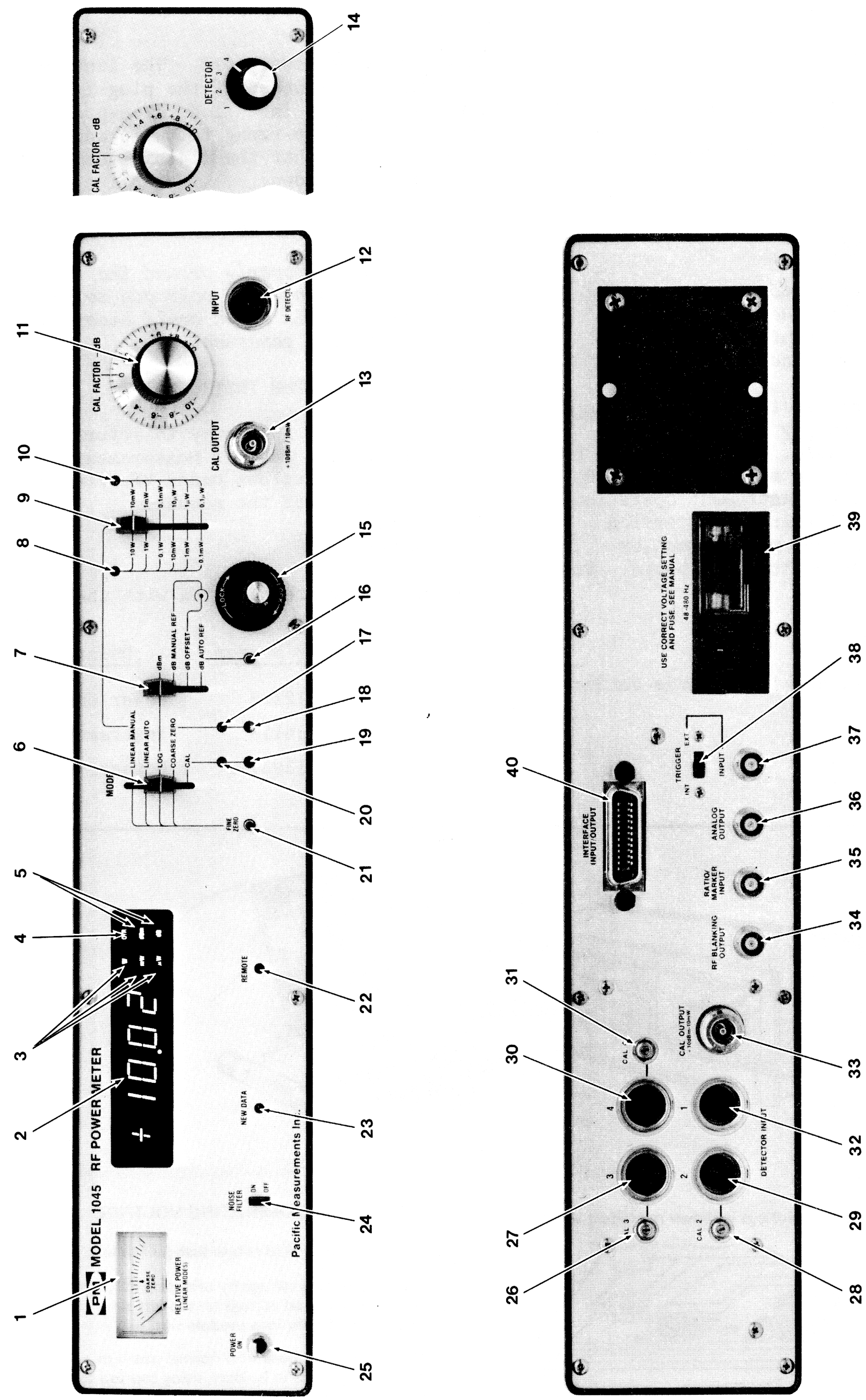
2.5 ACCESSORIES

The following are supplied with the instruments:

Qty	Part Number	Description
1	12356	Power Cord
1	14176	Instruction Manual
1	13937-1	Detector Cable, 1.5 m



VOLTAGE SELECTION
FIGURE 2-1



FRONT AND REAR PANELS
FIGURE 3-1

SECTION 3

OPERATION

3.1 CONTROLS, CONNECTIONS AND INDICATORS

The features on the front and rear panels are described here. The item numbers that are listed below refer to the callouts in Figure 3-1. There are six equipment options noted here; refer to 1.3 for a description of these options.

3.2 LIST OF FRONT PANEL FEATURES

1. ANALOG METER. Provides a display of the relative power for making power peaking adjustments of RF source in LINEAR mode. Also used for COARSE ZERO ADJUSTMENT.

2. DIGITAL DISPLAY. 4 digit LED display with sign and decimal point.

3. WATT RANGE LIGHTS. Enunciator for W, mW and µW, only selected in the LINEAR mode.

4. OVERRANGE LIGHT. Indicates that RF input power level is too large to be measured on the selected range.

5. dB/dBm LIGHT. Enunciator for dBm or dB, only selected in the LOG mode.

6. MODE. The switch to select the mode of RF input power measurement or calibration.

7. LOG. The switch to select the dBm, dB MANUAL REF, dB AUTO REF MODE or dB OFFSET in Log measurement of RF input power.

8. HI-PWR DET. LIGHT. Indicates the High Power detector is connected at the input and the instrument will measure from -20 to +40 dBm. Also indicates that the left column of LINEAR MANUAL ranges is selected.

9. LINEAR MANUAL. The switch to select the 10 mW (W), 1 MW (W), 0.1 mW (W), 10 µW (mW), 1 µW (mW) or 0.1 µW (mW) scale in Linear measurement of RF input power. The high or low ranges are automatically selected by sensing whether a high or low power detector is being used.

10. LO-PWR DET. LIGHT. Indicates the Low Power detector is connected at the input and the instrument will measure from -50 to +10 dBm. Also indicates that the right column of LINEAR MANUAL ranges is selected.

11. CAL FACTOR. Precision potentiometer which compensates for mismatch losses and efficiency of the Power Detector. A chart of CAL FACTOR (dB) versus frequency is imprinted on each Power Detector Assembly.

12. INPUT DETECTOR. Provides input connection for power Detector through the low noise Cable.

13. CAL OUTPUT. Provides RF output of 10 dBm (mW) for system calibration.

14. DETECTOR 1,2,3,4. Selects the detector connected to the DETECTOR INPUT connector 1 through 4 on the rear panel, Option 01 only.

15. dB MANUAL REF and dB OFFSET. These are two concentric adjustments and a lock ring. The outer control is a multi-turn pot used to manually set an RF input as a reference for a dB relative measurement. When used with an oscilloscope connected to the ANALOG OUTPUT connector on the rear panel, a point on the scope trace can be offset to zero using the inner control and a direct reading of the level at that point on the curve is displayed on the Model 1045 digital display.

16. dB AUTO STORE. Spring loaded pushbutton switch used to set an RF input automatically as the reference for dB relative measurement.

17. COARSE ZERO LIGHT. Indicates COARSE ZERO mode.

18. COARSE ZERO. Screwdriver adjustment for correcting the input offset errors of the Power Meter and the Power Detector in coarse zeroing operation.

19. CAL. Screwdriver adjustment for calibrating the Power Meter and the Power Detector to a known standard, generally the CAL OUTPUT.

20. CAL LIGHT. Indicates the CALIBRATION mode.

21. FINE ZERO. Spring loaded pushbutton switch for auto correcting the drift error of Power Meter and the Power Detector in fine zeroing operation.

22. REMOTE LIGHT. Indicates the front panel controls are disabled and the instrument is under the control of the IEEE Interface Bus.

23. NEW DATA LIGHT. This lamp flashes each time a new data is applied to the digital display. At high trigger rates, the light will appear to glow continuously.

24. NOISE FILTER. The slide switch which when turned on will provide more filtering of the noise in the amplifiers, so as to pro-

vide more stable digital readings. Particularly useful for low level measurements.

25. POWER ON/OFF. A toggle switch to apply AC line power to Power Meter when turned on.

3.3 LIST OF REAR PANEL FEATURES

26. FINE CAL #3. Screwdriver adjustment during the Calibrate mode to set Power Detector #3 with respect to Power Detector #1.

27. INPUT DETECTOR #3. Input connection for Power Detector #3.

28. FINE CAL #2. Screwdriver adjustment during the Calibrate mode to set Power Detector #2 with respect to Power Detector #1.

29. INPUT DETECTOR #2. Input connection for Power Detector #2.

30. INPUT DETECTOR #4. Input connection for Power Detector #4.

31. FINE CAL #4. Screwdriver adjustment during the Calibrate mode to set Power Detector #4 with respect to Power Detector #1.

32. INPUT DETECTOR #1. Input connection for Power Detector #1.

33. CAL OUTPUT. Takes the place of the front panel CAL OUTPUT connector.

34. RF BLANKING OUTPUT. The TTL open collector output is driven low during Coarse and Fine Zeroing operations, so it can be used to turn off the RF input signal.

35. RATIO/MARKER INPUT. The Connector may be used to inject a signal into the Power Meter for taking the ratio of two RF signals (in dB), or for providing video frequency Markers. The input sensitivity is -10 dB/V. This input is active only in the LOG mode.

36. ANALOG OUTPUT. Provides an analog output which can be used for Swept Frequency measurements. The output is 100 mV/dB in LOG mode, and is 1 V/1000 counts of Digital Display in LINEAR mode.

37. TRIGGER INPUT. The Connector for triggering the Digital Display by an external source when the TRIGGER switch is in EXT position. The Display may be triggered at any rate from 0 to 500 reading per second. A minimum pulse width of 0.2 μ sec is required.

38. INT/EXT TRIGGER. The slide switch selects either the internal triggering at 4 times a second, or the external triggering from TRIGGER INPUT. The trigger is used to start a new data conversion for the Digital Display.

39. LINE POWER CONNECTOR AND SELECTOR. Connection for the input power. The number visible on the card (100, 120, 220, or 240 Vac) indicates which of the nominal line voltage to which the instrument must be connected. See 2.2 and Figure 2.1 for instructions to change for the input voltage.

40. INTERFACE CONNECTOR. Connection for the IEEE Interface Bus Cable to a remote Controller, or the cable for the BCD output.

3.4 OPERATING PROCEDURE

The item numbers that are in parenthesis refer to the callouts in Figure 3-1 on page 2-2.

CAUTION

Measuring continuous or peak levels of +23 dB (200 mW) or greater can damage the detector semi-conductor diode. Always ensure that the RF power is below this level before connecting the Model 1045 to the RF power source.

a. Set up. Connect the power cord. Ensure that the correct voltage is selected at the power input jack (39). Switch the power switch (25) up (on).

b. Calibrate the Model 1045. Connect the RF detector input to the CAL OUTPUT connector. (For maximum accuracy, an external 30 MHz, 10 mW calibrator should be used when detector model #14139 is being used.) Select DETECTOR INPUT #1. Set the MODE switch (6) to CAL and screwdriver adjust (19) to read +10.00 dBm on the display. Disconnect the cable from CAL OUTPUT. Select each of the other detectors to be used and adjust the appropriate FINE CAL adjustment on the rear panel for a reading of +10.00 dBm.

c. Set COURSE ZERO ADJ. Disconnect or turn off any RF input. Set NOISE FILTER (24) to OFF. Adjust 18 so the analog meter needle (1) is centered.

d. CAL FACTOR -dB ADJUSTMENT. Set the CAL FACTOR -dB ADJUSTMENT (11) according to the printed chart of the calibration factor (dB) versus the frequency shown on each detector. This control is only connected during the linear and dBm measurement.

e. Set the FINE ZERO. Disconnect the RF power source and press the FINE ZERO button (21). If the instrument is in the COARSE ZERO mode, the LED will go out while the machine calibrates itself, and comes back on when the function is completed, about 4 seconds. This may be necessary about each 5 minutes of operation at low power levels (-30 to -50 dBm).

f. Making an RF POWER MEASUREMENT. Connect the RF detector, or, if Option 01, detectors to the RF power source, or sources. Select the mode desired on the MODE switch (6). If the LINEAR MANUAL is selected, the range must be selected by (9). The high or low range is selected automatically, and the LED (8) or (10) indicates which is selected. The OVERRANGE LED (4) lights to indicate a range change. In the LINEAR AUTO mode, the instrument selects the range automatically.

   In the LOG mode, the instrument measures in dBm or dB. Switch (7) must then be set to select the mode, dBm, dB MANUAL REF, dB AUTO REF, or dB OFFSET.

g. Fluctuating Readings at Low Power Levels. Switch the NOISE FILTER switch (24) on to stabilize the display.

h. Using an RF Input for a Relative Measurement. If it is required to use one RF level as a reference, the difference between that level and another level can be displayed directly. Set the instrument in the LOG dB AUTO REF mode with switches (6) and (7). Press the dB AUTO STORE button (16) when the reference level is being displayed. Any subsequent measurement will be measured relative to this level. To cancel, switch out of the dB AUTO REF mode.

i. Making a Measurement Using the Offset Feature. Set the MODE switches to LOG (6) and dB MANUAL REFERENCE (7). Connect a sweep generator to a DETECTOR INPUT, which has the desired reference CW Power applied to it. Connect an oscilloscope to the ANALOG OUTPUT (36) and with the dB MANUAL REFERENCE control set the scope display to a zero reference. Lock the control. Set the MODE control (7) to dB OFFSET, and the source to sweep. Rotate the control until the desired part of the sweep is at zero level. The offset required for this is displayed on the meter.

j. Putting a Marker on an Oscilloscope Trace. Connect the sweep generator and oscilloscope as described in (i) above. Connect the marker output of the generator to the RATIO/MARKER INPUT (35). Set the frequency of the marker at the generator. The marker will sit on the trace at the frequency selected.

3.5 SET UP FOR OPERATION VIA THE IEEE BUS (OPTION 05)

a. Set the Listen Switch Array (S1, 1 thru 5) on the Interface Board as shown in Table 3-1. The switch location is shown in Figure 3-2

TABLE 3-1

ADDRESS SWITCH SETTING EXAMPLES

Switch #	Binary #	1	2	3	4	5
Address 1	00001	open				
Address 10	01010		open		open	

   1. Set switch #6 open if an external trigger is to be supplied. Connect the trigger source to the EXT TRIG connector (38) on the rear panel. If the unit is to be triggered remotely from the calculator, set S6 closed.

   2. Set switch #7 open if the CAL FACTOR control is required. If this function is to be performed by the calculator as part of the processing when the results have been retrieved from the Model 1045, close S6.

b. Set the TALK SWITCH ARRAY (S2, 1 thru 5) on the Interface Board for the talk address required. See Table 3-1.

   1. Set switch #6 open if the instrument is to generate a service request when data is received.

   2. Set switch #7 open if the instrument is to listen and talk on the IEEE bus. Set to closed if it is to talk only.

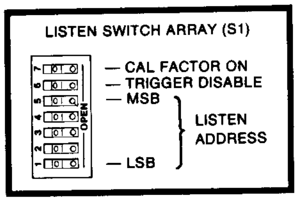


Figure 1

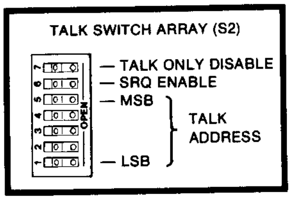


Figure 2

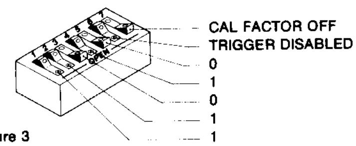


Figure 3

To set a true value for a bit, the corresponding switch must be opened. To do this, press down on the small dimple closest to the legend "open." A small screwdriver or ball-point pen is useful for this. To set a false condition, press the side opposite the legend "open."

Example: Assume it is desired to set the following conditions on switch S1:

Cal Factor off
Trigger Disabled
Listen Address = 11 (binary 01011)

To do this, set bit 1, 2, 4, and 6 open, and bit 3, 5, and 7 closed. Figure 3 is an oblique view of S1 set in the above conditions.

OPTION 05 IEEE 488 INTERFACE SELECTOR SWITCHES OPERATION

FIGURE 3-2

SECTION 4

PERFORMANCE CHECKS

4.1 GENERAL

The purpose of this section is to provide a means of verifying proper operation on incoming inspection and when making periodic performance evaluations. If the instrument passes the tests listed below it may 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 operation of the indicating instrument. The power detector may be checked using a properly calibrated Model 1045 as an indicating unit. The procedure for checking power detectors is included in the instructions for the detector.

4.2 EQUIPMENT REQUIRED FOR PERFORMANCE EVALUATION

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

a. A step attenuator with 10 dB steps to 60 dB. The accuracy must be known to ±0.02 dB at 30 MHz.

b. A 30 MHz, 10 mW ± 0.5% power source, low distortion (harmonic and non-harmonic spurious signals better than 50 dB down) and well matched (VSWR less than 1.06).

c. A 30 MHz power measuring device with an accuracy better than 0.5% such as a Fluke A-55 thermal converter, or an accurately known (0.5%) 30 MHz, 10 mW, low distortion, well-matched source (< 1.065).

d. A DVM with 0.03% accuracy and up to 0.1 mV resolution.

e. A precision power supply with 0.03% accuracy and 6 volts output at low current (< 10 ma).

f. A low power detector (see Table 1-1).

NOTE

1. *Allow a 30 minute warm-up period before performing these tests.*

2. *If the instrument does not meet the tolerances given here, go to Section 6 for re-calibration.*

4.3 PERFORMANCE TESTS

The item numbers that are in parenthesis refer to the callouts in Figure 3-1.

a. Power tracking check.

1. Connect the step attenuator to the 30 MHz, 10 mW source and connect the 1045 detector to the attenuator. Select DETECTOR #1 and connect the RF detector to DETECTOR INPUT #1.

2. Set the attenuator to OFF if it has such a position or turn off the RF power if not.

3. Select the COARSE ZERO mode (6). Set NOISE FILTER (24) to OFF. Adjust the COARSE ZERO (18) until the ANALOG meter (1) reads approximately center scale.

4. Press FINE ZERO (21) and wait until the COARSE ZERO light (17) is on again.

5. Select the LOG and dBm mode and turn on attenuator. Apply +10 dBm to the detector. Adjust the front panel CAL control (19) for a reading of +10.00 dBm on the display.

6. Decrease the power in 10 dB steps to -30 dBm and at each step check that the 1045 reads the correct power ±0.1 dB. Be sure to correct for the error in the step attenuator.

7. Reduce the power to -40 dBm and then -50 dBm and at each step check that the correct power ±0.3 dB is displayed.

b. Function checks.

1. Apply 0 dBm (10 dB atten.) and select the LINEAR AUTO range (6). The display should indicate 1.000 mW ± 2%.

2. Select the LINEAR MANUAL mode (6). Set the scale to 10 mW and check the display is 01.00 mW ±0.03 mW.

3. Select LOG, dB MANUAL REF mode (7). Verify that the control allows adjustment from more than -10 to more than +50 dB.

4. Select LOG, dB AUTO REF mode (7). Press dB AUTO REF button (16) and check that the display indicates 0 dB ±.05 dB.

5. Select LOG, the dB OFFSET mode (7). Connect the DVM to the analog output and adjust the dB OFFSET control (15)

for 00.00 dB on the display. If the analog output voltage is not zero, set it to zero with the dB MANUAL REF control (15).

NOTE

Do not rotate the inner dB OFFSET control or the display will be affected.

Lock the dB MANUAL REF control. Set the dB OFFSET control (15) for a reading of 50.00 dB on the display. Check that the analog output voltage is 5.00 volts ±0.01 volts. Disconnect the DVM.

6. Select the LOG, dB MANUAL REF mode (7). Connect the precision power supply to the RATIO/MARKER INPUT (35). Adjust the dB MANUAL REF control for a reading of 00.00 with the precision supply set to zero volts. Set the precision supply to 6.00 volts and check that the display reads 60.00 dB ±0.13 dB. Disconnect the power supply.

c. Calibrator.

1. Connect the precision power measuring device (see 4.2c) to the calibrator output. Select CAL mode (6). The power output should be 10.00 mW ±0.16 mW ± the accuracy of the measuring device. If a thermal converter with an accuracy of 0.1% is used, the additional error due to its use can be ignored.

2. Alternatively:

   a. Connect the 1045 detector to the 30 MHz source, select the dBm mode and adjust the front panel CAL control (19) for exactly +10.00 dBm ±0.01 dBm. (Be sure the CAL FACTOR control (11) is set to exactly 0 dB.)

   b. Remove the detector from the external power source and connect it to the CAL OUTPUT (13).

   c. Select the CAL mode and check that the reading on the display is 10.00 dBm ±0.07 dB ± the accuracy of the precision source.

SECTION 5

CIRCUIT DESCRIPTION

5.1 INTRODUCTION

A block diagram of the 1045 is given in Section 8. This figure shows the basic instrument with local control and a single input. The interface (GPIB) option is shown on the block diagram, but this will only apply to the -05 version. A description of each circuit is given in this section and the schematics are shown in Section 8. The item numbers that are in parenthesis refer to the callouts in Figure 3-1.

5.2 THE MODEL 1045 BLOCK DIAGRAM

The unit is divided into two parts, isolated input and circuits grounded to the chassis. All circuits before the Isolation Amplifier have a floating ground to prevent unwanted currents in the signal ground leads from affecting the sensitivity of the measuring circuits. A floating power supply provides an isolated dc power source. A differential amplifier transmits the signal from the isolated input circuits to the output circuits. The isolated circuits are described first.

The RF detector inside the Detector Assembly converts the RF power incident upon it to a dc voltage, which is proportional to the input power at low levels, and gradually becomes proportional to RF voltage at the higher levels. The sensitivity at low levels and the point where the change from power to voltage detection begins depend on the detector temperature. The detector temperature is monitored by a thermistor in the detector and the output used as a correction factor. The thermistor is mounted in contact with the detector shell. Since sensitivity will vary with each detector, a selected resistor is also mounted in the detector to compensate for these individual characteristics. A logic signal level is also generated by the detector to allow the power meter to distinguish between a low power or a high power detector (with a 30 dB pad).

The Detector Temperature Compensation Amplifier takes the high impedance signal from the thermistor, and outputs a low impedance signal proportional to the temperature for the Square-Law Compensation Circuit and Isolation Amplifier.

The Pre-amplifier (Chopper Amplifier) is a non-inverting chopper stabilized low-noise amplifier. This circuit reduces the thermal drift to an absolute minimum and provides a very high input impedance. A 1 kHz RC oscillator provides the drive voltages for both the chopper pre-amplifier and the stabilizing chopper amplifier for the Log Amplifier circuit. The Pre-amplifier has a gain of 13 and it feeds directly to the Log Amplifier and indirectly through the Square-Law Compensation circuit.

This Compensation Circuit becomes active for an RF input above approximately -27 dBm. It generates a current nearly proportional to the square of the input voltage. This current is summed in with the current from the Pre-amplifier at the input to the Log Amplifier. At high signal levels, the detector output voltage departs from the Square-Law, but the current from the Compensation Circuit increases in such a way so that the total current still corresponds to a Square-Law signal. In this way, variations due to temperature and detector characteristics are compensated for.

The Chopper Logarithmic Amplifier has a very wide dynamic range, from less than 90μV to greater than an equivalent input of 90 V. In order to be free of drift over this 60 dB dynamic range, it is chopper stabilized. A PNP transistor in the temperature-stable oven is used as the logging element. A filtering network is connected in the feedback path of the Log Amplifier to reduce the noise and can be switched in (Filter Control) to stabilize the display at low power levels. An amplifier following the logging circuit provides a gain of 15 to raise the signal level to 100 mV/dB.

The FINE ZERO circuit samples the output of the X15 Amplifier, and provides an offsetting signal for the Pre-amplifier to correct for any drift in the amplifier chain.

A Differential Amplifier provides a means of transferring the signal from the isolated circuit to a ground referenced signal. It has a high input impedance for good isolation and good common-mode voltage rejection so that parasitic signals appearing on the bench ground to which the detector is attached will be ignored. Potential ground-loop currents are kept negligible by a current mirror arrangement. The output of the Isolation Amplifier is then fed into the Summing Amplifier.

The Control Multiplexer is a multiplex circuit on the control board that takes a control input from either the front panel or the interface board option (when installed) and generates the necessary control levels for the operation of the instrument, and lights the indicator lamps. This board also selects one of the four RF detector inputs either from the front panel or the IEEE Bus Interface control where both the multi-detector and IEEE Bus options are installed. The input selected determines the level of the bias current that will be supplied to the Summing Amplifier. The RATIO/MARKER INPUT allows summing a reference input independently of the Summing Amplifier.

The Auto Reference Sample and Hold circuit samples the output of the Summing Amplifier and holds it for the dB AUTO REF measurement. The Meter Amplifier drives the analog meter for peaking and coarse zeroing.

The output of the Summing Amplifier is fed to the Display Multiplexer where it is available at the ANALOG OUTPUT connector. The Summing Amplifier output also goes to the Anti-Log Amplifier where it is converted into linear form. This signal is transmitted via the Display Multiplexer to the Analog-to-Digital Converter, where it is converted to BCD format. This drives the instrument's DIGITAL DISPLAY, and is also available for the IEEE Bus.

The IEEE Bus input and output requires an interface board which decodes the inputs from the bus and sends the measured RF data in ASCII form to the remote calculator. All control and handshake signals are provided for.

An accurate 30 MHz 10 milliwatt output is provided for from the CAL OUTPUT connector on the front panel used to verify the calibration of the instrument. A Local/Remote control from the IEEE Bus disables the front controls whenever the instrument is addressed by the remote controller.

5.3 THE CONTROL BOARD

Refer to the circuit diagram 13456 (4 sheets) in Section 8. The Control Board contains a multiplex circuit that accepts inputs from the front panel controls or the IEEE Bus via the IEEE Interface Board, (when this option is installed) and other automatic inputs (Trig Auto, Autoranging). Depending on the input selected, the correct level of bias is supplied to the Summing Amplifier, and the correct indicators, enunciators and decimal point position is lit. It also contains the Sample and Hold circuit for the AUTO dB functions.

5.3.1 MODE SWITCH SELECTION (Sheet 1)

Inputs from the MODE switch and LOG switch positions are shown at the top of the drawing. Inputs from the IEEE Bus are identified with the suffix 'B'. Inputs from these sources are NOR'ed, the bus input taking precedence over local control. The output from the NOR gate lights the related indicators on the front panel, and supplies a HI or LO logic level output as shown on the schematic. Note that A5S2 is only active when A5S1 is set in position 3. A5S5 causes the instrument to store a reference level and also (from Sheet 4 via the RF OFF inputs to A1U3C) enables the RF Blanking, and via A1U9B disables the FILTER switch on the front panel. A5S6 selects the noise filter to give greater stability at very low power levels. $\overline{\text{FIL B}}$ allows this function from the bus.

5.3.2 RANGE SELECTION (Sheet 2)

These circuits select the range of the instrument thus determining the position of the decimal point, (A12, 13, 16) and lighting the LED to indicate high (mW) or low (μW) range selected. This selection is made automatically from the PAD ID input from the detector which makes either $\overline{\text{mW}}$ or $\overline{\mu\text{W}}$ true. The ranges are selected in one of the following ways:

a. LINEAR MANUAL. The range is selected by the setting of A5S3.

b. IEEE Bus. The range is selected from the remote controller via the bus, and via inputs $\overline{\text{10 mWB}}$ thru $\overline{0.1\ \mu\text{WB}}$.

c. LINEAR AUTO Mode. Selected on the front panel, an over or underrange is detected (see Sheet 4) and the range selected is controlled via $\overline{\text{C0}}$ thru $\overline{\text{C5}}$. The output from A1U8D (11) selects the Linear Mode when $\overline{\text{LIN MODE}}$ is true, or LOG Mode when it is false.

5.3.3 OUTPUT BIAS SELECT (Sheet 3).

The Output Bias provides an offset voltage level to the Summing Amplifier on the Analog Board to suit the input and range selected. Inputs from the range selection and the MAN ZERO, CAL FACTOR, MAN dB REF, $\overline{\text{MAN ZERO}}$, and AUTO REF dB inputs from Sheet 1 switch the transistor of a transistor-FET pair. The FET, through a precision resistor, provides the required bias level.

5.3.4 FET SWITCH LOGIC

The following is a list of logic expressions that drive the FET switches. "+" is the OR operator, "•" is the AND operator. The subscript B indicates bus control.

MAN ZERO OFFSET (A1Q6) = COARSE ZERO MODE

CAL FACTOR (A1Q7) = LINEAR MODE + dBM + "CAL FACTOR ON" • REMOTE

MAN REF dB (A1Q8) = dB MANUAL REF MODE + dB OFFSET MODE

CAL (A1Q9) = $\overline{\text{COARSE ZERO MODE}}$

AUTO, dB REF (A1Q10) = dB AUTO MODE

(A1Q18) = 0.1 μW

(A1Q19) = 1 μW + 10 μW + HI-PWR

(A1Q20) = 0.1 mW + 1 μW + HI-PWR

(A1Q21) = $\overline{\text{10 mW}}$

THERMISTOR (A2Q23) = $\overline{\text{COARSE ZERO MODE}}$

AUTO ZERO (A2Q29) = $(\text{AUTO ZERO})_B$ + $\overline{\text{COARSE ZERO}}$ + COARSE ZERO • ZERO SAMPLED

ZERO OFFSET (A2Q30) = COARSE ZERO MODE + ZERO SAMPLED

ANALOG METER (A2Q38 & Q39) = COARSE ZERO MODE + LINEAR MODE

FILTER ON (A2Q45) = $(FIL)_B$ + FILTER · $\overline{\text{ZERO SAMPLED}}$

LIN MODE (A2Q43) = LINEAR MANUAL MODE + LINEAR AUTO MODE

dB MODE (A2Q50) = LOG MODE + COARSE ZERO MODE + CAL MODE

Other levels are determined from the controls on this sheet of the schematic. The CAL FACTOR -dB, dB AUTO REF, dB OFFSET and CAL levels are also supplied via an FET when the respective transistor is turned on.

5.3.5 AUTO dB SAMPLE AND HOLD (Sheet 3)

A1U1 on Sheet 4 controls this function. When the AUTO dB STORE (A5S7 on Sheet 1) is pressed, the Trig 1 input to A1U1 sends $\overline{\text{REF SAMPLED}}$ true. AUTO dB COMP is true for about 60 milliseconds turning on A1Q23 and A1Q26 for this period so that the AUTO dB COMP on the Analog Board can charge A1C5 to a reference voltage. At the end of this period, A1U23 supplies this reference voltage to the Summing Amplifier. Both A1U23 and A1Q23 are low-leakage devices to minimize the drift of this reference voltage. During this holding period, A1Q24 is turned on to ensure that A1Q26 will not be accidentally driven into conduction by the comparator.

5.3.6 LEVEL DECODER (Sheet 4)

Detector inputs through A1, A3 and A4 are from the display A1U13, A1U14 and detect an over or underrange, which sends A1U13D (12) LO. If $\overline{\text{RANGE HOLD}}$ B is true, a range hold cannot take place. When AUTO RANGE is true and $\overline{\text{AUTO LIN}}$ B is false, a range change is requested and the range is triggered to zero. A1U4 then counts from zero upwards in binary, synchronized by the Auto Clock from the A-D Converter. This drives decoder A1U5 which sweeps through outputs $\overline{C0}$ thru $\overline{C5}$. This will eventually select a range in which there is neither an over or underrange and the instrument will remain in that range. $\overline{C0}$ thru $\overline{C5}$ selects the range through the multiplexer on Sheet 1.

5.3.7 NEW DATA (Sheet 4)

The Trig 1 input drives one-shot A1U1, which pulses the NEW DATA LED. The duration of each pulse is 10 milliseconds controlled by RC network A1R90-A1C12, and there are about four pulses per second when the INTERNAL TRIGGER is operating the LED.

5.3.8 FINE ZERO (Sheet 4)

The Fine Zero timing is generated by one-shot A1U24. The FINE ZERO button is pressed, the RF BLANKING OUTPUT is driven LO, A1Q25 is switched off and A1C8 charges to the level of the B input at A1U24 in approximately 4 seconds. This error voltage is stored and used to correct the drift error at the front end amplifiers on the Analog Board.

5.3.9 OVERRANGE LED (Sheet 4)

The Overrange (OR) lamp turns on when the display exceeds 6999 or when the amplifiers saturate at approximately +10.5 dBm. The lamp is blanked for about 400 microseconds when an A-to-D conversion is initiated.

5.3.10 COARSE ZERO AND CALIBRATE (Sheet 1)

These functions are selected on the front panel, or MAN ZERO B and CAL B signals from the bus respectively. $\overline{\text{SELF TRIG}}$ is driven LO during this mode to gate the internal oscillator to trigger the A-to-D converter. In either the CALIBRATE and COARSE ZERO modes a trigger is required even if the INTERNAL TRIGGER is disabled. This is supplied via NOR gate A1U20A which goes LO when either of these modes is selected.

5.4 ANALOG BOARD

Refer to the circuit diagram 13510 (4 sheets) in Section 8. The Analog Board contains the Input Pre-amplifier, Log Conversion Circuit, Square-Law Compensation Circuit, Zeroing Circuit, Oven Controller, Offset Circuit, Potpourri Circuits and Anti-Log Circuit.

5.4.1 INPUT PRE-AMPLIFIER

The Input Pre-amplifier is a non-inverting chopper stabilized 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 a 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 components than an open loop amplifier would be.

Integrated circuit A2U1 (Sheet 1) is a combination oscillator and frequency divider chain. The oscillator runs at 64 kHz and the Six-stage divider divides the frequency down to 1 kHz. Output from the 2 and 4 kHz dividers are combined in A2U2 to provide narrow pulses to drive the synchronous detector. Fig. 6-1 shows a timing diagram for this circuit. Square wave signals of opposite phase are supplied to A2Q1 and A2Q2, alternatively turning one on then the other. The result is that the input of the ac amplifier is first connected to the input signal then to the feedback resistor. The ac amplifier consists of the transistors A2Q3 through A2Q11. It has sufficient bandwidth so that the signal at the emitter of A2Q11 is essentially a square wave with an amplitude proportional to the difference between the input and the signal fed back from the output of the amplifier A2U3. A2Q12 and A2Q13 are turned on briefly at alternate ends of the square wave period. Transient signals due to the switching of the input to the amplifier have decayed by the time output switches are turned on at the end of the period. The feedback resistive divider is selected to allow a gain of 12.8. For high frequency signals, A2C20 and A2C22 provide the chopper bypassing so the pre-amplifier can respond faster to the input signal.

5.4.2 LOG CONVERSION CIRCUIT (Sheet 2)

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 A2Q24 is proportional to the log of the collector current over many decades of current values. To maintain the logarithmic coefficient independent of ambient temperature, the logging transistor A2Q24 is mounted in a temperature controlled oven and held at 60°C; at this temperature the emitter-base voltage changes by 66.5 mV for each factor of ten that the collector current changes. Since a factor of 10 represents 10 dB, this is 6.65 mV/dB. The amplifier A2U9B follows the log transistor with a gain of 15, raising the level to 100 mV/dB.

The operational amplifier part of the log conversion circuit is also chopper stabilized to minimize the effect of drift. Since the sensitivity is not as great as the pre-amplifier, the circuit is simplier. The op-amp A2U9A receives ac signal directly through A2C46; dc signals are routed through the chopper amplifier A2U7 and go to the non-inverting input of A2U9A. The current summing junction is common to the chopper input and A2C46. If at any time the summing junction is not at zero dc potential, the chopper switching transistor A2Q18 will convert this potential to an ac signal. The ac amplifier A2U7 amplifies the signal and supplies it to the synchronous demodulator A2Q19 and A2Q20 where it is converted back to dc. A low pass filter, A2R77 and A2C49, removes the ac component and the dc correction signal causes the output of A2U9A to change the current through the logging transistor in order to bring the summing junction back to zero. The 1 kHz drive for the chopper comes from the circuit driving the input chopper, Chopper Switching input.

In addition to the logging factor changing with temperature, the saturation current of the logging transistor also changes. To compensate for this effect, the other half of the matched transistor pair A2Q24 is supplied with a fixed current and a differential amplifier A2U9B amplifies the difference in the emitter base potential between the logging and compensating transistors.

To reduce the noise at low input levels, two switchable filter networks (Sheet 4) are shunted across the feedback path of Log amplifier A2U9A. The filter networks are high order circuits that shrink the bandwidth of the amplifier as input levels drop lower. Only one of the filter network will be engaged at any time; when the NOISE FILTER is switched on, A2Q49 is turned off and A2Q45 is turned on, and vice versa. The filter network connected to A2Q45 provides much more noise suppression than the filter network connected to A2Q49, so the digital display is more stable when NOISE FILTER is ON.

5.4.3 SQUARE-LAW COMPENSATION CIRCUIT

Above -27 dBm the detector begins to depart significantly from square-law and becomes linear. Since the instrument is required to be linear in power, compensation is required so that the total current supplied to the logging circuit summing junction A2U9B (8) continues to be square-law at all levels within the 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 negligible at low input level and is many times larger than input signal at high levels. The squaring function is implemented by first logging the input signal, amplifying the logged signal by a factor of 2 and taking the anti-log.

Integrated amplifier A2U5 has feedback supplied by the diode connected to pin 8 of A2U6. The voltage at pin 8 of A2U6 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 A2R51. The diode connected to pin 11 of A2U6 acts merely to limit the voltage excursion of A2U6 when the circuit is inactive. The diode connected to pin 5 of A2U6 transmits the signal to A2U8 and compensates for the changes in saturation current with temperature of the logging diode. Amplifier A2U8 has a gain of 2 (slightly adjustable by A2R68) and supplies the amplified voltage to the diode connected to pin 2 of A2U6 which generates the anti-log function. The diode connected to pin 3 of A2U6 compensates the anti-logging diode for changes in saturation current with temperature. All of the diodes in A2U6 are essentially identical because they are part of an integrated circuit. The current from pin 1 of A2U6 is thus proportional to the square of the input voltage and it adds with the current fed directly from the input pre-amplifier at the input summing junction of the log amplifier.

5.4.4 TEMPERATURE COMPENSATION

Amplifier A2U10A supplies temperature compensating signals to the square-law compensation circuit by way of A2R97 to correct for shifts in detector sensitivity with temperature and to the output amplifier. The signal supplied to the compensation circuit corrects only for linearity so additional correction is required at A1U1 to correct for changes in overall sensitivity. This is accomplished by injecting current through A2R95 from A2U10A to the input of the isolation amplifier A2U16B. A2U10A is arranged as a bridge amplifier fed from a high impedance thermistor. The output of the amplifier is very nearly proportional to temperature from 0 to 50°C.

5.4.5 ZEROING CIRCUIT

The Zeroing Circuit corrects for the small offset and drift of front-end amplifiers. With the RF source turned off, a constant voltage through A2Q30 provides a small offset to the input pre-amplifier during coarse and fine zeroing. This offset corresponds to equivalent input level of approximately -55 dBm, so it can be used to calibrate the instrument for low level measurements.

During fine zeroing operation, the output of A2U9B is compared with a reference voltage set corresponding to this zero offset signal, the error voltage from the output of the comparator A2U10D is then sampled by A2Q31 and hold by A2C71. This voltage is buffered by a voltage follower A2U13 before being injected to the summing junction of the input pre-amplifier. So the whole front-end amplifier chain is essentially an error correcting feedback system.

5.4.6 OVEN CONTROLLER

The oven temperature is regulated and maintained at 60°C by the oven control circuit. A power transistor A2Q33 serves to heat the oven and a thermistor mounted in the oven senses temperature. When the oven is at its correct temperature, the two inputs to the amplifier A2U14 are equal. If the oven cools slightly, the value of the thermistor increases causing the output of A2U14 to become more positive and increase the current through A2Q32 and A2Q33. This causes A2Q33 to generate more heat, returning the oven to the correct temperature so that the thermistor circuit is once more in balance. At equiliberium, the circuit is just slightly off balance and the transistor supplies just enough heat to account for the heat loss to the surroundings.

5.4.7 OFFSET CIRCUIT

A differential amplifier A2U16B transfers the logarithmic signal from the floating ground circuits to the chassis ground circuits. Its inputs are connected to the output of the log conversion circuit and the isolated signal common. Since it has a good common mode rejection, only the signal between the log conversion circuit's output and isolated common will be amplified. This differential amplifier acts as an unity gain isolation amplifier; its output feeds the offset summing junction through A2R186. In order to minimize current flows between the isolated common and the chassis common, a current-mirror amplifier A2U16D provides a return path for the current injected by the isolation amplifier.

Several other signals from control board A1 are applied to the summing junction; each signal independently offsets the summing amplifier A2 U17B an amount corresponding to the current applied. These signals consist of (1) CAL, (2) CAL FACTOR, (3) MANUAL dB REF, (4) LINEAR OFFSETS, (5) COARSE ZERO and (6) AUTO dB REF. The output of summing amplifier feeds the Anti-log circuit, Auto dB comparator, Meter amplifier and the Ratio amplifier.

5.4.8 POTPOURRI CIRCUITS

The Meter amplifier drives the analog meter to show the relative power and coarse zeroing. FET A2Q39 switches on in LINEAR mode and A2Q38 switches on in COARSE ZERO mode. Diode A2CR13 protects the meter by limiting the meter movement.

Comparator A2U16A sets the overrange condition when input levels exceed 10.5 dBm.

The RATIO/MARKER INPUT is buffered by the voltage follower A2U17D before it is combined with the output of the summing amplifier at inverter A2U17C. This arrangement allows two Model 1045 units to be used together for ratioing (taking the difference in dB) two RF signals without the need for any adjustment. It can also provide a video frequency marker. A positive going signal in this input causes a negative going output signal.

Two sets of reference voltages are provided on the board. Each pair of these reference voltages derives its reference from a temperature stable Zener diode. A2U10A and A2U10B supply the -12 V and +12 V isolated reference voltage to the floating ground circuits. A2U15B and A2U15C supply the -10 V and +10 V reference voltage to the chassis ground circuits.

In the LOG mode, FET switch A2Q43 is turned on to measure the input RF signals in terms of dB; vice versa, switch A2Q50 is turned on in the LINEAR mode to measure the input RF signals in terms of Watts.

5.4.9 ANTI-LOG CIRCUIT

An Anti-Log Circuit is used to get the linear watt output from the log signal. Amplifier A2U15C drives the emitter of A2Q46 (pin 3) in proportion to the input voltage. The collector current of A2Q46 (pin 1) varies exponentially with the emitter-base voltage. This current is converted to voltage by amplifier A2U15D. To maintain the coefficient of exponential independent of ambient temperature, the transistor is mounted in the same oven as the logging transistor. Since the saturation current of a transistor varies in a wide range, it is desirable to eliminate the effects of this variation by supplying the other half of the matched transistor pair A2Q46 with a fixed current, so the output voltage is directly proportional to this fixed current instead of the saturation current.

5.5 DISPLAY LOGIC AND CALIBRATOR

Refer to the circuit diagram 13422 (4 Sheets) in Section 8. The Digital Display is used to convert the analog signal developed by the instrument into digital form for readout using 7 segment LED's. In addition, it generates a Binary Coded Decimal (BCD) signal, which can be used with data acquisition systems or the IEEE Standard Digital Interface for Programmable Instrumentation. In this instrument, the analog to digital (A to D) process is performed by a successive approximation method for high speed operation. For display purpose, the internal analog voltage of 1.0 volt corresponds to a decimal output of 1000.

For descriptive purposes, the Digital Display unit can be broken down into five functional elements.

The "Absolute Value Circuit" converts signals of either polarity from the Sample and Hold circuit into a negative voltage signal and a sign bit signal. It also isolates the rest of the instrument from noise generated in the digitizing process.

The "Reference Voltage Supply" which provides a stable standard of reference for comparison with the input analog signal in the A to D circuit. It also provides the necessary offset voltage so the diode switches in the approximation circuit can be turned on and off by TTL level signals.

The "Approximation Circuit", which successively increments the current through the precision resistor network until it balances the current supplied by the input signal through the absolute value circuit.

The "Comparator", which generates a control signal for the Approximation Circuit.

The "Logic Control Circuit" which provides the control information to enable an orderly and sequential conversion process.

In the Pacific Measurements' Digital Display, the process of approximation is carried out in a BCD sequence, starting from the most significant digit. The information is retained in four BCD counters. At the start of each conversion process, the decimal counters are set to 0999. The decimal counter units' (DCU's) states are determined successively from the most significant digit to the least significant. The final answer in the Digital Display has an accuracy of ± 1/2 LSB (least significant bit). For each decade, the numbers from zero to nine are formed as an appropriate combination of binary weighted numbers 1, 2, 4, and 8.

In order to form the 4 digit display, a total of fifteen BCD bits is required. The approximation circuit consists of 15 precision resistors connected to 15 diode switches. The other end of each diode is tied to a common point leading to the comparator input. If a switch is activated, it will supply a precise amount of current corresponding to its bit position. Each switching diode is controlled by the digital output of the BCD counters. Whenever the current supplied by the resistor network is less than the current required by the input signal, the comparator output will be high and the currently active BCD counter will be incremented, which will then actuate the corresponding switches for additional current through the resistor network. Viceversa, when the current through the resistor network is greater than the current required by the input signal, the comparator output will be low, and the incrementing BCD counter will stop counting and retain the correct digital information.

5.5.1 ABSOLUTE VALUE CIRCUIT (Sheet 3)

Since the approximation process operates in one direction only, the input signals of both polarities have to be reconditioned to one polarity only. If a positive voltage is applied to the input of the Digital Display, A3U23A becomes a voltage follower and it applies a positive voltage to A3R41. Transistor A3Q9 is turned on so A3U19B can set the "+" signal line high. Conversely if a negative voltage is applied, diode A3CR5 will not conduct. The output of A3U23C becomes positive and it supplies the current through diode A3CR7 to A3R41 and A3R40. Transistor A3Q9 is turned off so A3U19B can set the "+" signal line low. The differential amplifier A3U23B inverts the input signal, so the voltage applied to A3R48 is always negative.

5.5.2 REFERENCE VOLTAGE SUPPLY

The Reference Voltage Supply is formed by a temperature stable Zener diode A3CR8 and a resistive network consisting of A3R61, A3R62, and A3R64. A3U23D uses the voltage across the Zener diode to obtain the reference for the approximation circuit and A3C25 stabilizes this reference voltage. The diode in the feedback path of A3U23D, A3U25 (pins 11 and 12) compensates for any temperature variation of current through the precision resistor A3R64. The Zener diode A3CR8 and the comparator are referenced off-ground so that TTL level voltages can switch the diode array in the approximation circuit. In order to insure long term stability, the Zener diode is aged for several days prior to installation. If a replacement Zener is installed, the + Bal pot A3R72 and + F.S. pot A3R61 may have to be readjusted after a few days of operation because during the first few hours of operation, there may be an appreciable voltage change across the Zener diode. Further voltage changes are slight and occur at a very slow rate.

5.5.3 APPROXIMATION CIRCUIT

The approximation circuit consists of an array of precision resistors and diodes in combination, operated as current switches driven from the decimal counters A3U3, A3U9, A3U14 and A3U18 on Sheet 1. When a bit is high, a fixed amount of current will flow to the comparator A3U24 through the corresponding current switch; vice-versa, when it is low, the current will be sinked by the corresponding decimal counter. Very precise resistors, well-matched diode arrays and pots are used in the most significant bits to insure the accuracy of A to D conversion. Outputs via A3J1 are transmitted to the Front Panel Control and Display Circuit.

5.5.4 COMPARATOR

A fast comparator A3U24 monitors the summing of the approximation circuit. Since the input analog signal is always negative at A3R48 and the feedback signal from the approximation circuit is always positive, the comparator will have a negative output voltage if the current supplied by the approximation circuit is greater than the input current, and a positive output voltage if the current supplied by the approximation circuit is less than the input current. The output of the comparator is latched by A3U19A after it has had time to settle; in this way the effect of comparator noise is minimized.

5.5.5 LOGIC CONTROL CIRCUIT

It is necessary to generate control signals which successively let through the incremental current from the approximation circuit, starting with the most significant digit and continuing down through the least significant. On Sheet 1, A3U15A and A3U15B, together with A3R1, A3C2, A3C3, and A3Q1 form the clocking circuit for the system. The clock cycle is approximately 8 µs long. A3U5 and A3U10 form a forty decade state-counter and A3U1 forms the state decoder. A3U3, A3U9, A3U14 and A3U18 are the decimal counter units (DCU's).

When a positive trigger pulse is received by A3U17B (Sheet 2) it resets the state-counter A3U1 to zero, enables the clocking circuit, sets the digital register to 0999, and latches the polarity signal. From count 2 to count 8, the most significant digit will be determined by incrementing the DCU at each clock pulse until the comparator output becomes low. This will disable the clock to DCU until it is started again by a new trigger pulse. At the 9th clock pulse, the next DCU will be reset to 0. From count 10 to count 18, the next significant digit will be determined, and so on. The display will be blanked during the conversion period (approximately 320 µs), to eliminate flicker.

The EXTERNAL TRIGGER signal is clamped between +0.7 V to +4.3 V by A3CR1 & A3CR2. This signal is fed to a Schmitt-trigger One-shot to provide sharp & clean pulses for the Display Trigger circuit. The INTERNAL TRIGGER signal is provided by A3U20 Timer at 4 times a second. During the auto ranging, a new pulse is generated at the end of a conversion by A3U7 until the correct range B has been obtained. The Display can also be triggered by the IEEE Interface Bus signal through A3U12C. During the COARSE ZERO and CALIBRATION modes, the Display is automatically triggered through A3U12D which overrides any other trigger. In order to minimize the effect of chopper noise in the analog signal, the Sample and Hold circuit A3U22 is synchronized with the chopper pulse through an opto-isolator A3U21. At the end of each sample period, the One-shot A3U8 is triggered so it can start the conversion process of the analog signal.

5.5.6 CALIBRATION OSCILLATOR (Sheet 4)

The Calibration Oscillator is located on the same board as the Digital Display logic. The transistor A3Q15 is arranged in a grounded base oscillator circuit around A3L1, with the ac voltage across A3C37 fed back to the emitter to cause oscillation. It feeds the CAL OUTPUT connector through a low pass filter and a 4 dB attenuator in order to get a harmonic free signal and a good source match at the output. The diode A3CR32 rectifies the peak voltage supplied to A3R104, thereby generating a dc voltage proportional to the RF voltage from the oscillator. The Amplifier A3U28 compares this voltage to a stable voltage derived from the Zener diode A3CR31, and supplies just enough current to the emitter of A3Q15 to maintain oscillations at the correct level set by A3R91 (OSC ADJ). This current is turned on by A3Q16 when the control signal CAL ON is high. Diode A3CR30 compensates the circuit for changes in the rectification characteristic of A3CR32 with temperature variation.

5.6 FRONT PANEL CONTROL AND DISPLAY LOGIC

Refer to the circuit diagram 13806 (2 Sheets) in Section 8. This board contains the front panel switches and indicator lamps. The functions of these controls and indicators have already been described in the Control Board circuit description; however this drawing will be useful since it gives the pin numbers for the connectors on the front panel.

5.6.1 THE DISPLAY LOGIC

Sheet 2 of the schematic shows the latches and drivers for the Digital Display. A5U7 thru 10 are the decoder-drivers for the display. The a thru g outputs refer to the segments of each display. A5U1 is for the sign, and A5U2 thru 5 are the display modules and the decimal point displays.

5.7 DETECTOR MULTIPLEXER

Refer to the circuit diagram 14109 in Section 8. This board is installed in conjunction with the Multi-Detector Board 13865. This schematic is useful for the connector pin identification that it shows. The functions of the controls are described in the Multi-Detector Board description, Section 5.8.

5.8 MULTI-DETECTOR BOARD

Refer to the circuit description 13865 in Section 8. A detector input can be selected manually by the switch on the front panel, or remotely through the IEEE Bus if option 05 is installed. All inputs from the RF detectors are selected; RF Power and Common Inputs, Temperature Compensation, Linear Compensation, and High or Low Power Identification. DETECTOR INPUT #2, 3, and 4 can also be adjusted with respect to DETECTOR INPUT #1 to provide balance for these inputs. The switched input is transmitted to the Analog Board.

5.8.1 DETECTOR INPUTS

Relays A12K1, A12K2, A12K3 and A12K4 select DETECTOR INPUT #1, 2, 3 and 4 respectively, together with the common ground. The relay contacts are connected to the floating ground. The relay selects the required detector under the control of multiplexer A12U1, which allows either the front panel or the bus input to be used. When the bus input is selected, A12U1 (16) is LO thus disabling the front panel switch.

5.8.2 HIGH-LOW POWER DETECTOR INDICATION

NAND gates A12U2 decode the detector pad signal; the A12U2 outputs go LO if a low power detector is connected to the instrument.

5.8.3 DETECTOR AND TEMPERATURE COMPENSATION

A12U4 and A12U5 are optical couplers which isolate the circuits around A12U1 and A12U2 from the linear and thermistor compensation switches that, together with the relay contacts, have a floating ground.

5.8.4 DETECTOR INPUT BALANCE

FINE CAL 2, 3 and 4 are adjusted through the rear panel and balance the three inputs against DETECTOR INPUT #1. The transistor-FET pairs are normally off, but one is switched on by U1 to transmit the thermistor and linear correction voltage from the detector selected to the Analog Board.

5.9 THE IEEE INTERFACE BOARD, OPTION 05

Refer to the circuit diagram 13660 (5 Sheets) in Section 8. The IEEE Interface Board is installed as an option when the instrument is to be controlled from a remote location and transmit measured data to the remote location. The instrument has the standard IEEE Bus or GPIB connections. The Model 1045 can operate as a LISTENER and allow the controller to select the mode or function, calibrate and zero the instrument, select a particular range or autoranging, and select an input if four inputs are installed. As a talker the instrument is able to transmit the readings taken back to the controller, or to a printer. When the instrument is addressed remotely the REMOTE lamp on the front panel lights and the front panel controls are disabled. All functions can be controlled remotely except POWER ON, dB OFFSET and dB AUTO REF. The CAL FACTOR can be set locally but this is usually done as a controller processing function.

5.9.1 ADDRESSING THE MODEL 1045 AS A TALKER OR A LISTENER

The LISTEN and TALK Address Selectors are shown on Sheet 3. Switches A11S1 and A11S2 #1 thru #5 set the address as described in paragraph 3.5 in this manual. The switch is open for a '1' and closed for a '0' logic level. The address is recognized by exclusive NOR gates A11U9, A11U10, A11U11 which form the address comparator, whose outputs are all HI when a successful comparison occurs. The address is received on inputs DI01 thru DI08. When an address is recognized, MLA (LISTEN) or MTA (TALK) go HI. Two switches in each block provide these additional functions:

a. CAL FACTOR ON. When open, the CAL FACTOR control on the front panel can be used. When closed this control is disabled.

b. TRIG DISABLE. When closed, the INTERNAL TRIGGER is overridden and the instrument is triggered from the remote controller. The INTERNAL TRIGGER always operates in the COARSE and FINE ZERO modes.

c. TALK ONLY DISABLE. This is closed whenever the instrument is connected to a local printer, and it will only output data. It is not possible to command the instrument remotely.

d. SRQ ENABLE. When this switch is open the instrument will transmit a service request on the bus when data is ready.

5.9.2 COMMANDING THE INSTRUMENT AS A LISTENER

A11U22 on Sheet 2 is a 4-bit binary to 16 output decoder, which takes commands from Data Input/Output DI01 thru DI04 and selects the appropriate output. A11U42, A11U43 and A11U44 latch this data and feed them to the Control Board via A7J2. Note that there are seventeen outputs; the TRIG AUTO ZERO is not latched but taken directly from the decoder. There are three additional latches, A11U1B, A11U41A and A11U41B, which maintain the outputs to functions NOISE FILTER, AUTO ZERO, LINEAR AUTO and RANGE HOLD until they are disabled.

5.9.3 REMOTE/CLEAR (Sheet 2)

These functions are generated from the bus inputs. IFC, Interface Clear, is gated by A11U30A. The other input to pin 4 of this gate generates a clear at POWER ON. Pin 6 goes HI, inverted by A11U13D (10) which is the CLRN signal. This is AND'ed at A11U40C with the REM, Remote signal which resets the binary to decimal decoder. A11U22, A11U19B and A11U19C clock the latches after a short delay due to A11C4, A11R16 and A11R17. Similarly, REN, Remote Enable, Sheet 4, is inverted by A11U14D, and gated to A11U49B which latches the remote function. The output from this latch resets A11U22 as described for CLRN above. The output also is transmitted via A7J3 to disable the front panel controls.

5.9.4 HANDSHAKE CONTROLS FOR DATA ACCEPTANCE (Sheet 2)

The timing sequence for data acceptance is fully described in IEEE STD 488 Appendix B. These signals are shaped by A11U6 and latched by A11U7.

5.9.5 HANDSHAKE FOR DATA TRANSMISSION (Sheet 1)

The inputs via A7J3 are the data in BCD form from the A-D Converter, which is the same signal that drives the Digital Display on the front panel. There are 15 inputs for four digits since the most significant digit only goes to seven and only three BCD lines are required. These inputs are multiplexed as follows:

a. A11U35 and A11U36 select the range, high or low.

b. A11U37 outputs the decimal point and range code corresponding to the designator μW or mW.

c. A11U21 outputs the carriage return and line feed commands.

d. A11U5A and A11U5B; A11U4B and A11U4C; A11U18A and A11U18B encode the sign, and the dB/dBm enunciator for the bus.

e. A11U15A, A11U15B, A11U15C, A11U15D and A11U15F output "," and "-".

The data is driven out onto the bus via A11U5, A11U25, and A11U45 on sheet 5.

5.9.6 DATA OUTPUT CONTROL (Sheet 1)

There are nine bytes of data transmitted plus one byte each for the carriage return and line feed. This sequence is controlled by the state decoder A11U17. The RF BLANKING INPUT is LO for 400 microseconds during the A-to-D conversion; at the end of this period the bistable A11U1A is clocked and the state counter driven by the clock A11U16A which advances each time a byte is received by the controller. A11U17 selects each of the bytes in sequence.

5.9.7 SERVICE REQUEST OUTPUT (Sheet 5)

If the instrument is not being addressed as a talker, TALKER ADDRESS (TAD) is false. The instrument must request service at the output of A11U27B through A11U12D. A11U23B and A11U23C also forms a bistable and is set which sets DI07 HI through A11U25A. In response to this service request the controller will transmit a Serial Poll Enable (SPE) which is latched and clocked at A11U27A, causing the instrument to go into the Serial Poll mode. The controller then addresses the instrument as a talker TADN gating A11U26A, which results in the Serial Poll Action (SPA) state, which clears A11U27B and the SRQ signal. A11U23B and A11U23C is also cleared which sends DI07 LO. The controller matches the $\overline{\text{TACN}}$ signal with the address it has just transmitted, and identifies the instrument on the bus with data ready to transmit.

5.9.8 DETECTOR SELECTION (Sheet 5)

DETECTOR INPUTS I1, 2, 3, and 4 from the bus are applied to U52. This decodes the detector selected, which is latched by A11U54. One output DET 1, 2, 3, or 4 becomes true, and this detector input is measured.

5.9.9 DATA OUTPUT (Sheet 5)

The inverters and drivers A11U5, A11U24, A11U25, and A11U45 take the prepared and drive it out on the bus to the controller.

SECTION 6

MAINTENANCE

6.1 PERIODIC MAINTENANCE

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

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

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

c. Make a performance check in accordance with the procedure of Section 3. If the performance is within specifications no further service is required.

6.2 INTERNAL ADJUSTMENTS AND TEST POINTS

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

NOTE

Allow a 1 hour warm-up period before performing these adjustments.

6.2.1 DESCRIPTION OF ADJUSTMENTS

The function of each adjustment is described below.

a. A1R83, CAL FACTOR ADJUSTMENT. Sets range of CAL FACTOR control.

b. A2C5, CHOPPER BALANCE. Minimize low level chopper noise.

c. A2R61, SECOND STAGE NULL. Sets output of LOG amp to zero for zero input.

d. A2R68, COMP AMP GAIN. Sets proper tracking at -10 dBm.

e. A2R73, MED. LEVEL CAL. Sets proper tracking at 0 dBm.

f. A2R89, HI LEVEL COMP. Sets proper tracking at +10 dBm.

g. A2R92, LOG CAL. Sets LOG gain for 100 mv/dB.

h. A2R117, dBm REF ADJ. Sets output of isolation amp to zero volts for -10 dBm input.

i. A2R125, -10 V REF ADJ. Sets -10 volt supply.

j. A2R127, +10 V REF ADJ. Sets +10 volt supply.

k. A2R145, -12 V REF ADJ. Sets -12 volt supply.

l. A2R159, +12 V REF ADJ. Sets +12 volt supply.

m. A2R167, AUTO ZERO ADJ. Balances offsets in auto zero loop.

n. A2R212, AUTO dB OFFSET. Sets AUTO dB REF to 0 dB.

o. A2R216, LINEAR GAIN. Sets gain of antilog amplifier.

p. A2R219, LINEARITY. Sets gain of antilog amp.

q. A2R232, LINEAR ZERO. Sets offset of antilog post amplifier.

r. A2R255, OFFSET NULL. Sets offset amp summing junction to 0 volts.

s. A3R29, S/H OFFSET. Zero adj. for Sample and Hold amplifier.

t. A3R36, -F.S. ADJ. Set gain of inverting amp.

u. A3R44, -BAL. Zero adjust for inverting amp.

v. A3R61, +F.S. ADJ. Sets reference voltage for D/A conv.

w. A3R66, 40 ADJ. Sets size of the 40 step of D/A conv.

x. A3R69, 20 ADJ. Sets size of the 20 step conv.

y. A3R72, +BAL. Overall zero adjust.

z. A3R91, OSC ADJ. Set 10 mW power level of calibrator.

a.a. A4R1, +15 V ADJ. Sets +15 volt supply.

a.b. A4R6, -15 V ADJ. Sets -15 volt supply.

a.c. A4R10, +15 V ISOL. ADJ. Sets +15 volt isolated supply.

a.d. A4R14, -15 V ISOL. ADJ. Sets -15 volt isolated supply.

6.2.2 DESCRIPTION OF TEST POINTS

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

a. No test points on A1.

b. A2J1 (TP201). DETECTOR VOLTAGE.

c. A2J2 (TP202). DETECTOR COMMON AND ISOLATED COMMON.

d. A2J3 (TP203). PREAMP OUTPUT.

e. A2J4 (TP204). CHOPPER FREQUENCY.

f. A2J5 (TP205). +15 VOLTS ISOLATED.

g. A2J7 (TP207). -15 VOLTS ISOLATED.

h. A2J8 (TP208). LOG AMP SUMMING JUNCTION.

i. A2J9 (TP209). +10 VOLTS.

j. A2J10 (TP210). -10 VOLTS.

k. A2J11 (TP211). +12 VOLTS.

l. A2J12 (TP212). -12 VOLTS.

m. A2J13 (TP213). OVEN CURRENT (1/2 A/VOLT).

n. A2J16 (TP216). ISOLATION AMP OUTPUT.

o. A2J17 (TP217). +15 VOLTS.

p. A2J18 (TP218). 15 VOLT COMMON.

q. A2J19 (TP219). -15 VOLTS.

r. A2J20 (TP220). SUMMING AMP OUTPUT.

s. A2J21 (TP221). ANTILOG AMP OUTPUT.

t. A2J22 (TP222). DPM INPUT.

u. A2J24 (TP224). SUMMING AMPLIFIER SUMMING JUNCTION.

v. A3J1 (TP301). +5 VOLTS.

w. A3J2 (TP302). CLOCK.

x. A3J3 (TP303). $\overline{\text{NEW DATA}}$

y. A3J4 (TP304). 5 VOLT COMMON.

z. A3J5 (TP305). DPM INPUT COMMON.

a.a. A3J6 (TP306). S/H OUTPUT.

a.b. A3J7 (TP307). DPM PREAMP OUTPUT.

a.c. A3J8 (TP308). DPM REFERENCE COMMON.

a.d. A3J9 (TP309). CALIBRATOR CONTROL AMP OUTPUT.

a.e. A4J2 (TP402). +15 VOLTS.

a.f. A4J3 (TP43). 15 VOLT COMMON.

a.g. A4J4 (TP44). -15 VOLTS.

a.h. A4J5 (TP45). +5 VOLTS.

a.i. A4J6 (TP46). +15 VOLTS ISOLATED.

a.j. A4J7 (TP47). 15 VOLT ISOLATED COMMON.

a.k. A4J8 (TP48). -15 VOLTS ISOLATED.

6.3 CALIBRATION

The item numbers that are in parenthesis refer to the callouts in Figure 3-1.

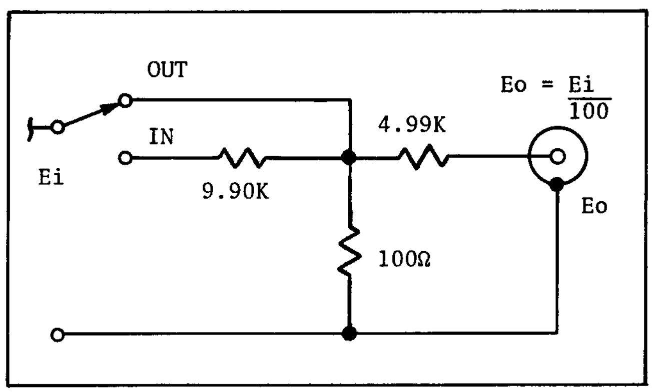
6.3.1 EQUIPMENT REQUIRED FOR CALIBRATION

a. DVM 4 1/2 digit, 1 µV resolution with an accuracy of ± 0.002%.

b. Frequency Counter with 4 digit resolution to measure 1 kHz to 30 MHz.

c. Precision power supply (digital) able to supply up to 20 V and 10 ma. At 100 mV, must have 4 digit resolution and an accuracy of ± 0.03%

d. DC attenuator for the supply in c above, as shown with 0.1% resistors.



DC ATTENUATOR WITH A DIVISION RATIO OF 100

FIGURE 6-1

e. Device to measure 30 MHz with an accuracy of ± 0.5% (Fluke A55 Thermal Converter or equivalent).

f. Calibration Fixture WPM part # 14194.

g. Low power detector, shown in Table 1-1.

h. Calibration Fixture WPM part #14372.

6.3.2 CALIBRATION PROCEDURE

NOTE

First check the levels and indications, and only adjust where these are out of tolerance.

a. POWER SUPPLIES (Board A4).

1. Check the unregulated -15 V supply at A4C3 as follows for a line voltage of 115 V.

LINE VOLTAGE JUMPER SETTING	APPROXIMATE VOLTAGE AT A4C3
100	31 V
120	26 V
220	14 V
240	12 V

2. Check the +15 Vdc at TP42 (+) and TP43 (common). Adjust A4R1 for +15 V ± 20 mV.

3. Check the -15 Vdc at TP44 (-) and TP43 (common). Adjust A4R6 for -15 V ± 20 mV.

4. Check +15 V (isolated) at TP46 (+) and TP47 (common). Adjust A4R10 for +15 V ± 20 mV.

5. Check -15 V (isolated) at TP48 (-) and TP47 (common). Adjust A4R14 for -15 V ± 20 mV.

6. Check the 5 V LOGIC SUPPLY. TP45 (+) and TP47 (common). Check for 5 V ±0.25 V.

b. READOUT (Board A3).

1. Select TEST position of A3S1.

2. Connect the precision power supply to TP311 with Low side to TP305. The Low side should be grounded.

3. Switch TRIGGER to INTERNAL on rear panel and connect the DVM from TP306 to TP305 (Low).

4. Momentarily short test points SEG TEST to COM (Mother Board A7) and note DPM reads 88.88. With precision supply set to zero volts, adjust S/H OFFSET A3R29 for zero volts ±0.2 mV at TP306. Disconnect the DVM.

5. Apply +10 mV and adjust +BAL A3R72 for a reading of +00.10 on DPM.

6. Apply -10 mV and adjust -BAL A3R44 for a reading of -00.10 on DPM.

7. Apply +1.000 volts and adjust +F.S. A3R61 for a reading of 10.00 on DPM.

8. Apply +2.01 volts and adjust 20 ADJ A3R69 for a reading of 20.10 on DPM.

9. Apply +4.01 volts and adjust 40 ADJ A3R66 for a reading of 40.10 on DPM.

10. Apply +7.01 volts and adjust +F.S. A3R61 for a reading of +70.10 on the DPM.

11. Apply -7.01 volts and adjust -F.S. A3R36 for a reading of -70.10 on the DPM.

12. Repeat steps 5 thru 11.

13. Check each digit for all numbers by applying a voltage corresponding to the value of each digit.

14. Note if the O.R. light goes on at 7000.

15. Disconnect the precision power supply and select the SYNC position of A3S1.

c. ANALOG (Board A2)

Remove the Multi-Detector Board, A12, and replace it with the Calibration Fixture, WPM part number 14372, and use DETECTOR #1 input.

1. Connect the detector input using the 14194 fixture to the precision power supply and set the voltage to zero. Use the dc attenuator and set the switch to "IN".

2. Check the voltage at TP213 at turn on. It should be approximately -13.5 V. Watch for approximately a minute to see that it stabilizes at approximately -14.9 volts. Note: Use TP202 for low side of voltage measurements.

3. Check the +10 V at TP209 (+) and TP218 (common). Adjust A2R127 for +10 V ± 1 mV.

4. Check the -10 V at TP210 (-) and TP218 (common). Adjust A2R125 for -10 V ± 1 mV.

5. Check the +12 V at TP211 (+) and TP202 (common). Adjust A2R159 for +12 V ± 1 mV.

6. Check the -12 V at TP212 (-) and TP202 (common). Adjust A2R145 for -12 V ± 1 mV.

7. Check chopper frequency at TP204 for 1 KHz ± 100 Hz.

8. Set the detector input voltage to 0 with attenuator switch "IN". Select COARSE ZERO. Measure voltage at TP203. Set front panel COARSE ZERO (18) for -30 μ volts ± 10 μV. Set A2R61 (SECOND STAGE BAL) for center scale reading on Relative Power meter. Press FINE ZERO (21) and note that COARSE ZERO LED goes off for approximately 4 seconds.

9. Set the detector input voltage to -0.228 volts with attenuator switch "OUT" and note the voltage at TP203 = 2.90 to 2.96 V.

10. Set the detector input voltage to -0.007 volts with attenuator switch "IN" and adjust CHOPPER BAL A2C5 for minimum amplitude 1 KHz at TP216 (approximately 20 mV P.P.).

11. Set the detector input voltage to 0 with attenuator switch "IN" and apply -150 mV to TP208. Adjust A2R117 (dBm ADJ) for zero volts ± 1 mV at TP216. Move low side of DVM from TP212 to TP218.

12. Apply -.015 V to TP208 and adjust A2R92 (LOG CAL) for -1.00 volts ± 2 mV. Apply 1.5 mV and note that the voltage at TP216 is -2.00 volts ± 10 mV. If not, reset A2R167, apply 0 volts, press FINE ZERO and repeat steps 11 & 12. Disconnect the precision supply.

13. Set detector input voltage to 0 with attenuator switch "IN" and press FINE ZERO. Set detector input voltage to -0.070 volts with attenuator switch "IN" and adjust A2R117 (dBm ADJ) for -2.00 volts ± 1 mV at TP216.

14. Set detector input voltage to -0.228 volts with attenuator switch "OUT" and adjust A2R73 (MED LEVEL) for +1.00 volts ± 1 mV at TP216.

15. Set detector input voltage to -0.0486 volts with attenuator switch "OUT" and adjust A2R68 (COMP AMP GAIN) for 0.00 volts ± 1 mV at TP216. Repeat steps 14 & 15 as required.

16. Set detector input voltage to -0.850 volts with attenuator "OUT" and adjust A2R89 (HIGH LEVEL COMP) for +2.00 volts ± 1 mV at TP216.

17. Repeat steps 14-17 as required.

18. Measure the voltages at TP224 with respect to TP218. Adjust A2R255 for zero volts + 200 μV.

19. Connect the DVM to the ANALOG OUTPUT (36).

20. Set detector input voltage to -0.228 volts with attenuator switch "OUT", and adjust the front panel CAL pot (19) for zero volts ± 1 mV at the ANALOG OUTPUT.

21. Set detector input voltage to 0 with attenuator switch "IN". Press FINE ZERO and wait 5 seconds.

22. Set detector input voltage to -0.070 volts with attenuator switch "IN" and adjust A2R92 (LOG CAL) for -3.00 volts ± 1 mV. Disconnect the DVM from the ANALOG OUTPUT.

23. Set detector input voltage to -0.228 volts with attenuator switch "OUT". Adjust the front panel CAL control (19) for a reading of 00.00 dBm on the display. Select LINEAR MANUAL mode (6). Select 1 mW scale (9). Adjust A2R216 LINEAR GAIN for 1.000 mW ± 0.002 mW on the display.

24. Set the detector input voltage to -0.5 volts with the attenuator switch "OUT". (Be sure the supply is grounded.)

25. Note the reading on the display. It should be very near 3.9 mW. Select the 10 mW scale (9) and adjust A2R219 (LINEARITY) for exactly the same reading as obtained on the 1 mW scale (at 1/10 the resolution).

26. Set the detector input voltage to 0 V with attenuator switch "IN". Select 1 mW range (9). Adjust A2R232 (LINEAR ZERO) for 0.000 mW on readout.

27. Repeat steps 23-26 as required.

28. Set MODE switch to LOG (6) and select the dBm mode. Set the detector input voltage to -0.228 volts with attenuator switch "OUT". With CAL FACTOR (11) set to 0, set the front panel CAL control (19) for a reading of 00.00 dBm.

29. Set the CAL FACTOR (11) to +1.0 dB and adjust A1R83 (CAL FACTOR ADJ) for 01.00 dBm ± 0.01 dB.

30. Set the CAL FACTOR (11) to -1.0 dB and note the reading on the readout. It should be -01.00 dBm. Reset A1R83 for the best compromise readings at each end of the CAL FACTOR dial.

31. Select LOG, dB MANUAL REF mode (7) and verify that the range of the dB MANUAL REF control is < -10 to > +50 dB (so that any input from +10 dBm to -50 dBm can be set to 0 dB).

32. Connect a DVM to the ANALOG OUTPUT (36). Adjust the dB MANUAL REF control (15) for zero volts at the output.

33. Select the LOG, dB OFFSET mode (7). Set the dB OFFSET control (15) for 00.00 dB on the display. If the ANALOG OUTPUT is not zero volts ± 1 mV, set it with the dB MANUAL REF control. Then lock the dB MANUAL REF control.

34. Rotate the dB OFFSET control (15) full CW. The readout must indicate > -60 dB.

35. Rotate the dB OFFSET control (15) full CCW. The readout must indicate > +60 dB.

36. Set the dB OFFSET control (15) for exactly +60.00 dB on the readout and note that the ANALOG OUTPUT is -6.00 volts ± 12 mV.

37. Select LOG, dB AUTO REF mode and press the dB AUTO REF button. If the readout does not indicate 00.00 dB ± 0.03 dB, adjust A2R212 (AUTO dB OFFSET) while repeatedly pressing the dB AUTO REF button, until the readout indicates 00.00 dB ± .01 dB.

38. Select the LOG, dBm mode (7). Set the detector input voltage to approximately -0.9 volts with attenuator switch "OUT", adjust this voltage up or down until the OR light comes on. The readout must indicate < 10.8 dBm.

39. Set the detector input voltage to -0.228 volts with attenuator switch "OUT". Press the detector I.D. button on the Calibration Fixture # 14194 and note the reading increases 30.00 dB ± 03 dB.

40. Select the 1 mW range and LINEAR MANUAL mode (9). Press the detector I.D. button and note the scale indicator changes from mW to W. Note the yellow LED indicator over the linear scale switch changes from low to high power scale (8).

41. Set the detector input voltage to -0.007 volts with attenuator switch "IN," and select the LINEAR AUTO mode (6). Note the reduction in readout noise when the NOISE FILTER is turned on. Press the detector I.D. button and note the scale indicator changes from µW to mW.

42. Select the LOG mode (6). Connect the WPM detector and Model 1045 in place of the # 14194 fixture. Apply 0 dBm at 30 MHz; readout should be approximately 00.00 dBm. Select dB MANUAL REF mode (7). Connect the precision supply without the attenuator to the RATIO INPUT (35). Set the supply to 0 V and adjust the dB MANUAL REF control for 00.00 dB on the display.

43. Set the precision power supply to +6.00 volts. The display should indicate -60.00 dB ± .12 dB. This checks the operation of the RATIO INPUT. Remove the precision supply.

44. Remove the RF from the detector input. Measure the voltage at the RF BLANKING OUTPUT (34). It should indicate between +2.4 and +5.2 volts.

45. Press FINE ZERO (21). The RF BLANKING OUTPUT should drop to < 0.4 volts for approximately 3 seconds and return to its previous value.

46. Remove the Calibration Fixture, WPM part #14372, and replace the Multi-Detector Board, A12.

END OF TEST.

6.4 TROUBLE SHOOTING

In order to localize the source of trouble in an instrument such as this you must have a detailed working knowledge of the instrument. You are urged to read Section 5, Circuit Description and to make use of the circuit diagrams found in Section 8. Relevant dc voltages are shown on the schematic diagrams and are typical of values to be found during normal operation. The data was taken with a digital voltmeter with 10 MΩ input impedance. The front panel controls were set as follows:

POWER	ON
RANGE	CAL
CALIBRATION FACTOR	CENTERED (0)

The detector was connected to the CALIBRATOR OUTPUT and the CAL control set for a reading of 10.00 dBm.

The only significant ac signals in the instrument are those in the chopper circuit. A timing diagram for these signals is shown in Figure 6-2.

6.5 SEMICONDUCTOR DEVICES

A variety of semiconductor devices are used in this instrument. The type numbers shown 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

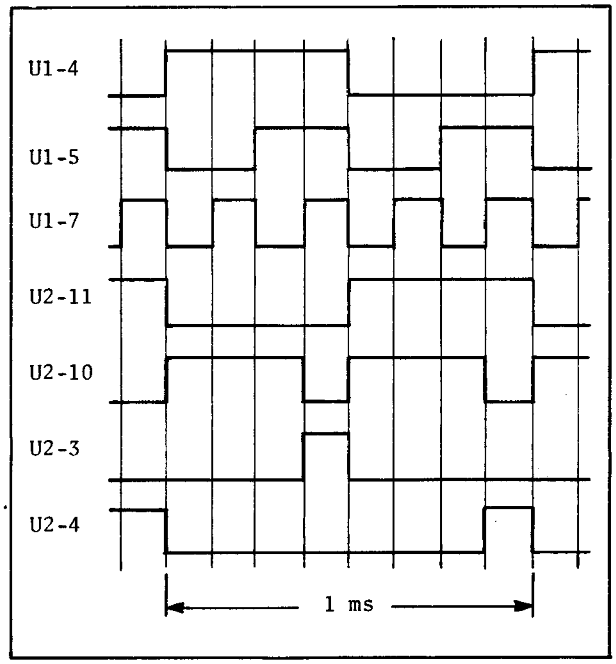
To gain access to internal components, remove the six screws on each of the top and bottom covers. The unit must be removed from the rack if it is rack-mounted.

6.6.1 ACCESS TO PARTS ON THE FRONT PANEL

To gain access to the front panel components, remove the eight screws at the top and bottom edges of the panel. Carefully pull the panel straight out from the rest of the instrument. Remove the nine screws holding the circuit board to the panel and carefully rest the board.

6.6.2 ACCESS TO PLUG-IN PRINTED CIRCUIT BOARDS

To gain access to the plug-in printed circuit boards, lift the instrument onto its side and from the bottom remove the two screws on each card cage. Swing the card cage out and remove the five screws holding each card cage cover.



CHOPPER CIRCUIT TIMING

FIGURE 6-2

SECTION 7

INTERFACE BUS, OPTION 05 (IEEE 488-1978)

7.1 CONTROLLING THE MODEL 1045 FROM A REMOTE LOCATION

When the IEEE Interface Board (Option 05) is installed it is possible to select the mode of operation and receive measured data from the Model 1045. A remote controller can be connected to several units on the same bus. The circuit description for the IEEE Interface Board should be studied for details of the operation of this feature; this section describes the program inputs required to operate the instrument remotely.

When the control function is assumed at the remote location, the REMOTE lamp on the front panel lights and all front panel controls except POWER ON and OFF and CAL FACTOR, if selected, are disabled. All other functions can be controlled remotely except dB MANUAL REF and dB OFFSET and CAL FACTOR. SRQ ENABLE, TRIG DISABLE, TALK ONLY OFF and CAL FACTOR must be set locally before the instrument is selected for remote operation. This is fully described in Section 3. Also the Model 1045 has two switch arrays to set up the LISTEN and TALK ADDRESS to enable the controller to identify the instrument on the bus.

The command and data transmissions are all in Standard ASCII code; a copy of this is shown in Figure 7-1.

7.2 PROGRAMMING THE FUNCTIONS WITH THE INSTRUMENT AS A LISTENER

When the instrument is addressed as a LISTENER, the function, range, and detector (Option 01) is selected by sending the codes that are given in Table 7-2.

If the TRIG DISABLE switch (#6 on the LISTENER ADDRESS switch) is OPEN, the rear panel TRIGGER function and internal trigger are disabled and the triggering must be initiated by one of these methods:

(SENT AND RECEIVED WITH ATN=1)

b_7 b_6 b_5 →						0 0 0	MSG (1)	0 0 1	MSG	0 1 0	MSG	0 1 1	MSG	1 0 0	MSG	1 0 1	MSG	1 1 0	MSG	1 1 1	MSG
Bits (2)	b_4	b_3	b_2	b_1	ROW ↓ / COLUMN →	0		1		2		3		4		5		6		7	
	0	0	0	0	0	NUL		DLE		SP	MLA ASSIGNED TO DEVICE	0	MLA ASSIGNED TO DEVICE	@	MTA ASSIGNED TO DEVICE	P	MTA ASSIGNED TO DEVICE		MEANING DEFINED BY PCG CODE	p	MEANING DEFINED BY PCG CODE
	0	0	0	1	1	SOH	GTL	DC1		!		1		A		Q		a		q	
	0	0	1	0	2	STX		DC2		"		2		B		R		b		r	
	0	0	1	1	3	ETX		DC3		#		3		C		S		c		s	
	0	1	0	0	4	EOT		DC4		$		4		D		T		d		t	
	0	1	0	1	5	ENQ		NAK		%		5		E		U		e		u	
	0	1	1	0	6	ACK		SYN		&		6		F		V		f		v	
	0	1	1	1	7	BEL		ETB				7		G		W		g		w	
	1	0	0	0	8	BS	GET	CAN	SPE	(		8		H		X		h		x	
	1	0	0	1	9	HT		EM	SPD	)		9		I		Y		i		y	
	1	0	1	0	10	LF		SUB		*		:		J		Z		j		z	
	1	0	1	1	11	VT		ESC		+		;		K		[		k		{	
	1	1	0	0	12	FF		FS		,		<		L		\		l		¦	
	1	1	0	1	13	CR		GS		−		=		M		]		m		}	
	1	1	1	0	14	SO		RS		.		>		N		^		n		~	
	1	1	1	1	15	SI		US		/		?	UNL	O		—	UNT	o		DEL	

Column 0: ADDRESSED COMMAND GROUP (ACG). Column 1: UNIVERSAL COMMAND GROUP (UCG). Columns 2–3: LISTEN ADDRESS GROUP (LAG). Columns 4–5: TALK ADDRESS GROUP (TAG). Columns 0–5: PRIMARY COMMAND GROUP (PCG). Columns 6–7: SECONDARY COMMAND GROUP (SCG). Columns 2–5: (4)

NOTES: (1) MSG = INTERFACE MESSAGE
(2) b_1 = DIO1...b_7 = DIO7
(3) REQUIRES SECONDARY COMMAND
(4) DENSE SUBSET (COLUMN 2 THROUGH 5)

MULTILINE INTERFACE MESSAGES: ISO-7 BIT CODE REPRESENTATION

FIGURE 7-1

Reproduced from *IEEE Standard 488-1978* by permission of the Institute of Electrical and Electronics Engineers.

a. Transmitting "GET" (Group Execute Trigger), or

b. Transmitting data word "?"

The AUTO ZERO function is latched ON once it has been programmed and at the same time it performs the function of correcting the zero adjustment for the instrument. This takes approximately 5 s, during which no power may be applied to the detector. To allow adjustment of COARSE ZERO control, "MAN ZERO" must be programmed.

The FILTER ON function is also latched ON once it is programmed, it is returned automatically to OFF by programming the AUTO ZERO function.

To automatically re-zero the instrument to compensate for thermal drift or when another detector has been selected (Option 01 only) follow this procedure:

a. Address the instrument as a listener,

b. Send data character "L", (Wait 5 sec)

c. Send data character "M" if the filter is required,

d. Send the Unlisten command "UNL".

The RANGE HOLD function will hold the last range selected when in AUTO LINEAR mode.

To make AUTO dB measurement, first program the dB AUTO (REF) to set the reference at 0 dB, then program the dB AUTO (REL) to get the relative dB from the stored reference.

TABLE 7-1

INSTRUMENT FUNCTIONS AND THEIR CORRESPONDING ASCII CODES

FUNCTION	CODE	FUNCTION	CODE
0.1 µW range	"A"	MAN ZERO	"K"
1 µW range	"B"	AUTO ZERO	"L"
10 µW range	"C"	FILTER ON	"M"
0.1 mW range	"D"	CALIBRATION	"N"
1 mW range	"E"	RANGE HOLD	"O"
10 mW range	"F"	DETECTOR #1	"Ø"
AUTO LINEAR	"G"	DETECTOR #2	"1"
dBm	"H"	DETECTOR #3	"2"
dB AUTO (REF)	"@"	DETECTOR #4	"3"
dB AUTO (REL)	"I"	TRIGGER	"?"
dB MAN	"J"		

DETECTOR #1 is automatically selected when the POWER is turned ON.

7.3 FETCHING DATA FROM THE INSTRUMENT AS A TALKER

When the instrument is addressed as a TALKER, it delivers data in an eleven-byte sequence as follows:

Data	Code	Meaning
$(DAB)_0$	"+"-"," "	polarity/space
$(DAB)_1$	"0" to "7"	most significant digit
$(DAB)_2$	"0" to "9"	2nd digit
$(DAB)_3$	"0" to "9"	3rd digit
$(DAB)_4$	"0" to "9"	least significant digit
$(DAB)_5$	","	delimiter
$(DAB)_6$	"-"	minus
$(DAB)_7$	"2", "3", "4"	exponent of 10
$(DAB)_8$	"!", "#", "$", "%", "&"	mode scale

Data	Code	Meaning
$(DAB)_8$	"!"	Watts
$(DAB)_8$	"#"	mW
$(DAB)_8$	"$"	µW
$(DAB)_8$	"%"	dBm
$(DAB)_8$	"&"	dB
$(DAB)_9$	CR	Carriage Return
$(DAB)_{10}$	LF	Line Feed

NOTE: EOL made ture when $(DAB)_{10}$ is sent

7.4 MODEL 1045 MEASURING AND TRANSMITTING SPEED

The instrument can make up to 500 measurements per second, and transmit the measurements at that rate. The routine bus control functions are hardware controlled and take less than 3 µs. Transmission speed may be limited by the speed at which the remote controller can receive the data.

7.5 SERIAL POLL

When the SRQ ENABLE switch is OPEN, the instrument sends out an SRQ (interrupt) message whenever new data is ready to send but the instrument has not been addressed as a TALKER. The controller then polls all instruments on the bus and locates the one ready to send, and enables it to transmit the data.

7.6 EXAMPLE OF INTERACTIVE PROGRAM FOR 1045 PROGRAMMING

This program can be run without understanding programming. The user needs only to enter the information requested on the display and the desired measurement data will be delivered on the printer or CRT terminal. The program is written both for HP9825 Calculator and TEK 4051 Graphic Terminal. It shows the complete capability of the 1045 for IEEE Interface applications. For the proper operation the INTERNAL LISTEN ADDRESS switch should be set to 01 and TALK ADDRESS should be set to 02. The TRIG and SRQ switches should be CLOSED. $\overline{\text{TLK}}$ switch should be OPEN.

The program asks for Detector #, then it will ask for RANGE CODE and output the data. Type Range = Q to reselect detector # and type Range = P to activate Front Panel Control. After adjusting the COARSE ZERO or CAL, hit RETURN key to restart.

In order to interface the 1045 and run the above programs with HP9825, the following configuration should be used:

DESCRIPTION	PRODUCT NO.
Desktop Calculator	9825A
String ROM	98210A
General 1/0 - Extended 1/0 ROM	98213A
HP-1B Interface Card	98034A

EXAMPLE: Using the HP9825 Calculator, let's suppose the LISTEN ADDRESS is set to 01 and the TALKER ADDRESS is set to 02. The following programming statements select the DETECTOR #2; set the dBm function; then trigger the display and read the data. A delay is required between the statement selecting the detector and range and the trigger statement. The time required is at least 10 ms; longer will be required if going from a high signal level to a lower one. (See Table 1-3)

```
wrt 701, "1H"
wait 10
wrt 701, "?"
red 702, A$
wrt 16, A$
```

Suppose the RF power input is at 10.02 dBm, then it will print the data on its printer as "+1002,-2%".

Using the TEK 4051 Graphic Terminal, the same program will be written as follows:

```
PRINT @1: "1H"
FOR N=1 to 100
NEXT N
PRINT @1: "?"
INPUT @2: A$
PRINT A$
```

7.7 HP 9825 PROGRAM

```
Ø:  dim A$(1), B$(3), D$(1), S$(1), T$(1)
1:  "START":ent "DETECTOR #", S$; num(S$)-1→S;
    char(S)→T$
2:  fmt 3, c1
3:  wrt 7Ø1.3, T$
4:  "LOOP": ent "RANGE =", A$
5:  if A$="Q"; gto "START"
6:  if A$="P"; gto "PANEL"
7:  wrt 7Ø1.3, A$
8:  if A$="K"; gto "CZR"
9:  if A$="N"; gto "CAL"
10: "ENTRY":trg 7Ø1
11: fmt 2, f5, 1x, f2, c1
12: wait 500
13. red 7Ø2.2, B, D, D$
14: B *1Ø↑D→B
15: if D$="!"; "W"→B$; jmp 5
16: if D$="#"; "mW"→B$; jmp 4
17: if D$="$"; "µW"→B$; jmp 3
18: if D$="%"; "dBm"→B$; jmp 2
19: if D$="&"; "dB"→B$
20: fmt 4, "Pwr @ Det #", c1,"=", f8.4, c3,/
21: wrt 16.4, S$,B,B$; gto "LOOP"
22: "PANEL":  dsp "front panel is active"
23: lcl 7Ø1; gto "ENTRY"
24: "CZR":  dsp "turn RF off, adj. COARSE ZERO";
    stp; gto "LOOP"
25: "CAL": dsp "connect CAL OUTPUT, adj. CAL";
    stp; gto "LOOP"
26: end
```

7.8 TEK 4051 PROGRAM

```
4 GO TO 100
100 PRINT "DETECTOR #";
110 INPUT S$
120 S=VAL(S$)-1
130 T$=STR(S)
140 PRINT @1:T$
150 PRINT "RANGE =";
```

```
160 INPUT A$
170 IF A$="Q" THEN 100
180 IF A$="P" THEN 460
190 PRINT @1:A$
200 IF A$="K" THEN 490
210 IF A$="N" THEN 510
220 WBYTE @33,8,63:
230 FOR A=1 TO 100
240 NEXT A
250 INPUT @2:B,C$
260 D$=SEG(C$,2,2)
270 D=VAL(D$)
280 B=B*10↑D
290 D$=SEG(C$,4,1)
300 IF D$="!" THEN 350
310 IF D$="#" THEN 370
320 IF D$="$" THEN 390
330 IF D$="%" THEN 410
340 IF D$="&" THEN 430
350 B$=" W"
360 GO TO 440
370 B$=" MW"
380 GO TO 440
390 B$=" UW"
400 GO TO 440
410 B$=" DBM"
420 GO TO 440
430 B$=" DB"
440 PRINT "PWR @ DET#";S$;"=";B;B$
450 GO TO 150
460 WBYTE @33,1,63:
470 PRINT "FRONT PANEL IS ACTIVE, PRESS RETURN
    TO CONTINUE."
475 INPUT A$
480 GO TO 150
490 PRINT "TURN RF OFF, ADJ. COARSE ZERO";
500 GO TO 520
510 PRINT "CONNECT CAL OUTPUT, ADJ. CAL";
520 INPUT A$
530 GO TO 150
540 END
```

7.9 HP 9825 PROGRAM ON SERIAL POLL

```
1∅:  if bit (7,rds(7)); jmp 2
11:  jmp - 1; dsp "SRQ disabled"; stp
12:  if bit (6,rds(7∅2)); jmp "DEV#2"
13:  if bit (6,rds (7∅3)); jmp "DEV#3"
14:  dsp "error"; stp
15:  "DEV#2":  fmt "T addr. of PM1045=",f2
16:  wrt 16.1, T-7∅∅
 |
 |
 |
8∅:  "DEV#3":
```

7.10 TEK 4051 PROGRAM ON SERIAL POLL

```
150 ON SRQ THEN 190
160 WAIT
170 PRINT "SRQ DISABLED"
180 STOP
190 POLL M,W;2;3
200 GO TO M OF 210, 310
210 PRINT "T ADDR. OF PM1045="; M
 |
 |
 |
310
```

SECTION 7A

BCD INTERFACE, OPTION 04

(If your 1045 is not equipped with option 04, please disregard this section.)

7A.1 GENERAL

If the Model 1045 is equipped with option 04, this means that the instrument can provide data that is indicated on its display to a rear panel connector in Binary Coded Decimal (BCD) format. The following signals will appear on the terminals of the 24 pin connector:

Pin Number	Signal (defined true)
1	Plus Sign
2	"40"
3	"20"
4	"10"
5	"8"
6	"4"
7	"2"
8	"1"
9	Decimal "1"
10	Decimal "2"
11	Trigger Input
12	Shield (Chassis)
13	".8"
14	".4"
15	".2"
16	".1"
17	".08"
18	".04"
19	".02"
20	".01"
21	Range "1"
22	Range "2"
23	Data Ready
24	Logic Common

7A.2 SPECIFICATIONS

Logic Levels:

One . . . . 2.4V at 0.5mA

Zero . . . . 0.4V sinking 8mA (Standard TTL Logic)

Data Format . . . . . . A logical one implies true data and positive (+) polarity. A transition to a logical one occurs when new data becomes ready. When the display is collecting new data, a zero is output on the "Data Ready" line.

Conversion Period . . . Data will have been collected and the "Data Ready" line will become true less than 1.5ms after the display has been triggered.

Trigger . . . . If the interface is used to trigger the instrument, the instrument will not take data as long as a "zero" is supplied to the Trigger line. When a positive transition occurs, data will be taken.

Trigger Pulse Width . . 1.0μs minimum
0.1s maximum

Connector . . . . 24 pin Amphenol #57-40240

Mating Connector . . . 24 pin Amphenol #57-30240

7A.3 ACCESSORY

A mating connector for the Input/Output connection is supplied with option 04. This connector is Wavetek Pacific Measurements part number 1060-10757.

7A.4 MODIFICATION FOR OPTION 04

The BCD Interface Board Assembly 14266 has been installed in the upper left hand location in the instrument. Connection to the rear panel connector is made by a ribbon cable terminated in a 24 pin integrated-circuit type connector that mates with a socket on the interface board. Machine screws are used to fasten the rear connector and its associated spring clips to the rear panel.

7A.5 OPERATING INFORMATION

7A.5.1 Data Output

Data is output in a true format. Refer to the connector pin list for the types of output signals. Data from the display is standard BCD with the decimal location output as follows:

Display	Decimal "1" and "2" Binary	Decimal
.NNNN	00	0
N.NNN	01	1
NN.NN	10	2

Note that the above can be thought of as the format .NNNN x 10^D where D = Decimal representation of Decimal "1" and "2" lines. The range corresponding to the annunciators to the right of the display is as follows:

Range	Binary "2", "1"	Range "1" & "2" Decimal
dB	00	0
μW	01	1
mW	10	2
W	11	3

The "Data Ready" line indicates when new data has become available. The line drops to logic zero whenever the display starts a conversion, and returns to a logic one when the conversion has finished and new data is available on the data lines. The period for conversion varies, depending upon when the trigger is received relative to the internal clock used to start the conversion, but the period will not exceed 1.5ms or be less than 0.3ms. It is recommended that the rising edge of the "Data Ready" signal be used to actuate a device connected to the interface.

7A.5.2 Triggering

If pin 11 of the Interface Connector is left unconnected or supplied with a steady "One", the instrument will trigger normally. Normally means approximately four times per second on Internal Trigger or, if the rear switch is set to "External", whenever a triggering signal is received at the rear panel BNC Trigger connector.

Alternatively, pin 11 can be used to supply the trigger. When a "zero" is supplied, the instrument will be inhibited from triggering in the normal way described above. When a transition from a zero to a one occurs, the instrument will trigger. The trigger signal must stay at "one" for at least 1μs, but no longer than 0.1s. Repetition rate must be below 500Hz.

The instrument will trigger internally at a 4Hz rate even if triggering is inhibited in the CAL or COARSE ZERO modes.

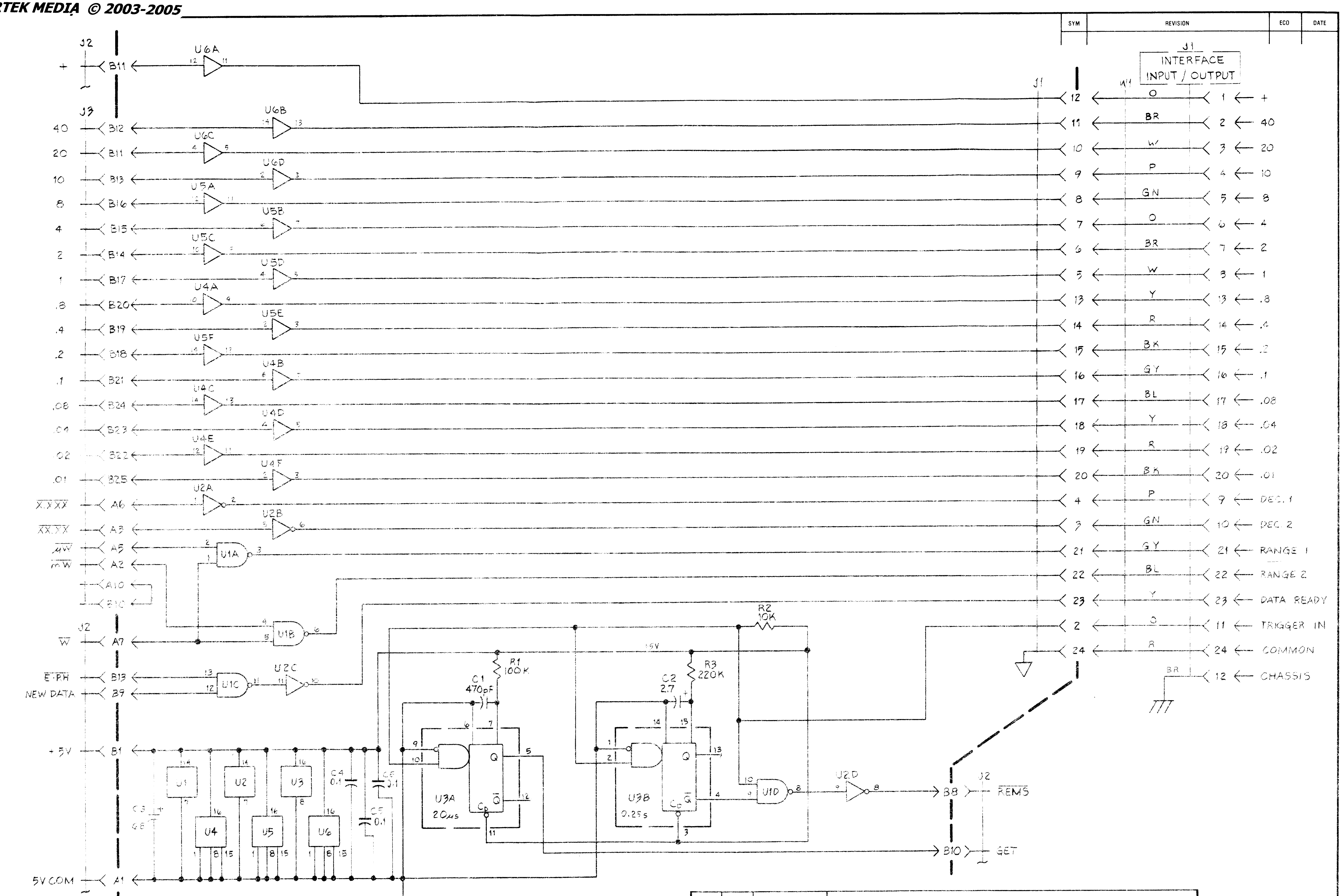
BCD INTERFACE, OPTION 04

REPLACEABLE PARTS LISTING

BCD Interface Board Assembly #14266 (Board #A14)

Circuit Reference	Description	Wavetek Part Number
J1	Part of W1, BCD Cable Assy 14281	-----------
A14C1	Capacitor, Ceramic 470pF ±20% 1000V	10000-3
A14C2	Capacitor, Tantalum 2.7μF ±20% 15V	10787-6
A14C3	Capacitor, Tantalum 68μF ±20% 15V	10787-4
A14C4	Capacitor, Ceramic 0.1μF ±20% 100V	10000-10
A14C5	Capacitor, Ceramic 0.1μF ±20% 100V	10000-10
A14C6	Capacitor, Ceramic 0.1μF ±20% 100V	10000-10
A14J1	Receptacle, 24 pins	10978-3
A14R1	Resistor, Carbon Film 100KΩ ±5% 1/4W	10013-49
A14R2	Resistor, Carbon Film 10KΩ ±5% 1/4W	10013-57
A14R3	Resistor, Carbon Film 220KΩ ±5% 1/4W	10013-53
A14U1	Integrated Circuit, SN74LS00	13470-1
A14U2	Integrated Circuit, SN74LS04	13470-4
A14U3	Integrated Circuit, SN74LS123	13470-17
A14U4	Integrated Circuit, SN74LS367	13470-38
A14U5	Integrated Circuit, SN74LS367	13470-38
A14U6	Integrated Circuit, SN74LS367	13470-38

(Reference SD 14267, following this page)



ASSEMBLY 14266
REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A14.

NOTE:
1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS AND ARE ±5%, ¼ W. CAPACITOR VALUES ARE IN MICROFARADS.

REF. DESIG	TYPE
U4, U5, U6	SN74LS367N
U3	SN74LS123N
U2	SN74LS04N
U1	SN74LS00N

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

DRAWN DAN WATSON DATE 7-28-78
ENG
PROD

PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

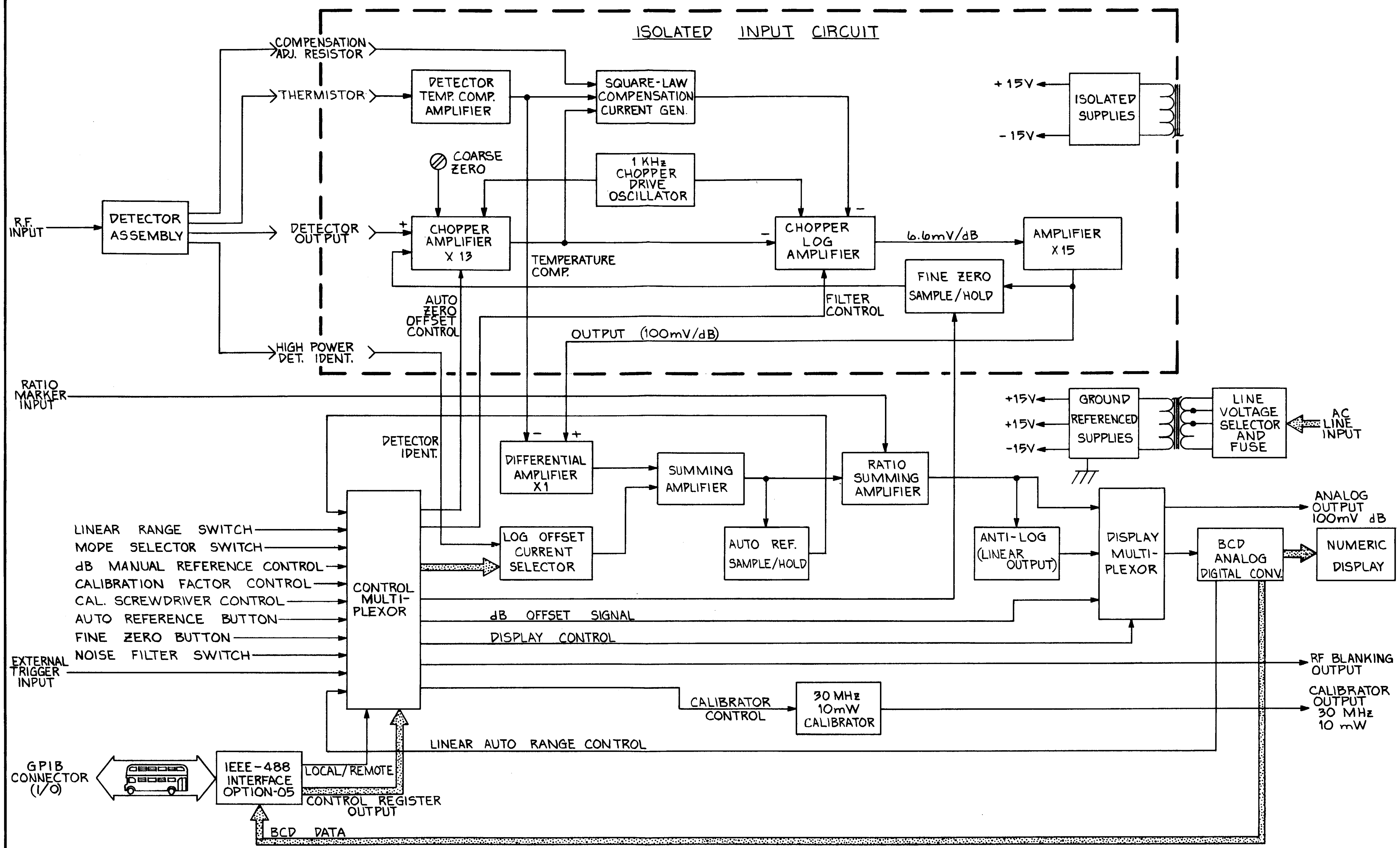
BCD INTERFACE

DRAWING NO 14267 REV A

SHEET 1 OF 1

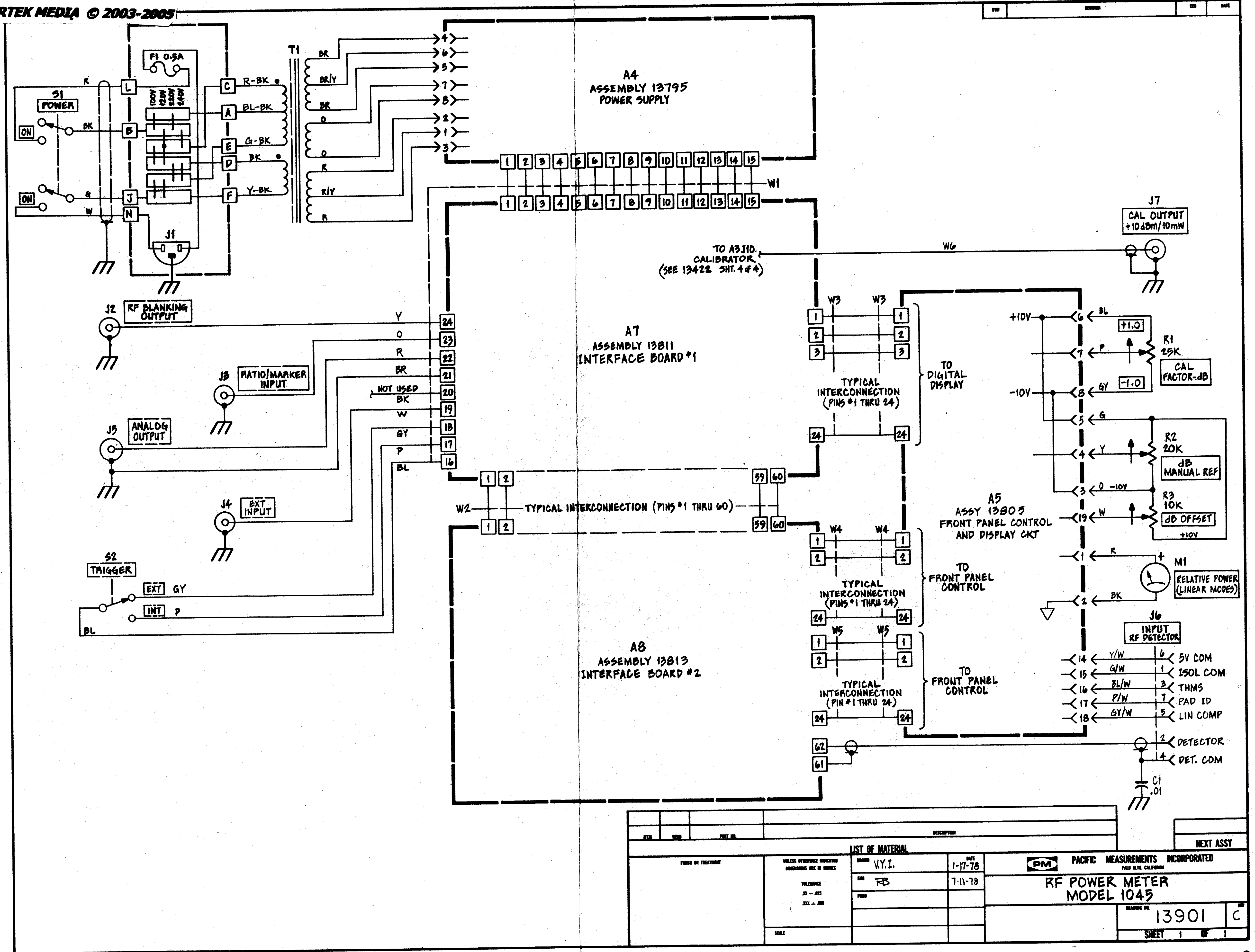
SECTION 8

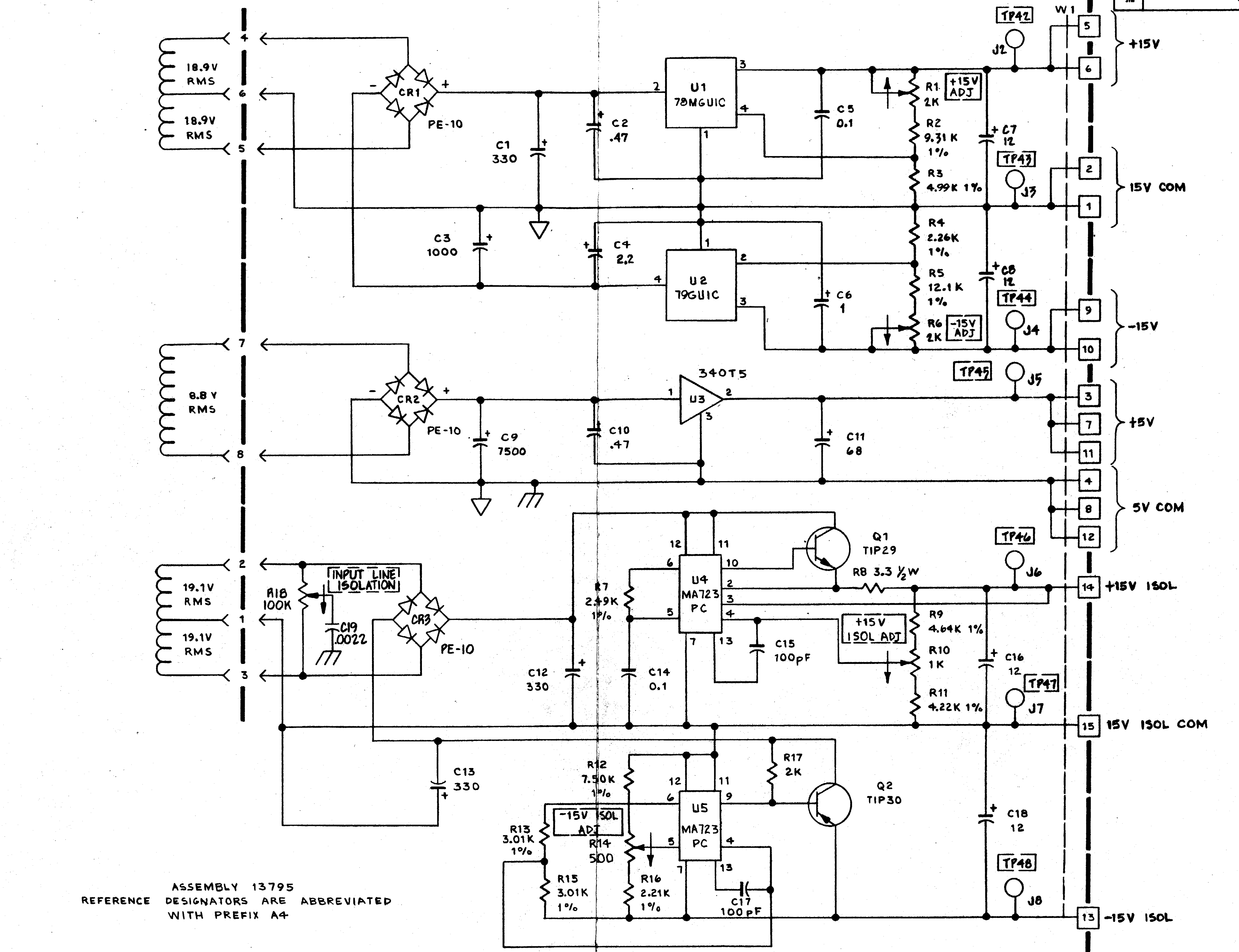
BLOCK AND SCHEMATIC DIAGRAMS



SYM	REVISION	ECO	DATE

DRAWN DAN WATSON	DATE 6-7-78	PACIFIC MEASUREMENTS INCORPORATED PALO ALTO, CALIFORNIA	
ENG FB	7-11-78	BLOCK DIAGRAM	
PROD		DRAWING NO. 14239	REV
		SHEET 1 OF 1	


F1 0.5A
S1 POWER
ON
ON
T1
J1
A4
ASSEMBLY 13795
POWER SUPPLY
W1
J7
CAL OUTPUT +10dBm/10mW
TO A3510 CALIBRATOR (SEE 13422 SHT. 4 & 4)
W6
J2 RF BLANKING OUTPUT
J3 RATIO/MARKER INPUT
J5 ANALOG OUTPUT
J4 EXT INPUT
S2 TRIGGER
EXT GY
INT P
NOT USED
A7
ASSEMBLY 13811
INTERFACE BOARD #1
W2
TYPICAL INTERCONNECTION (PINS #1 THRU 60)
W3
TYPICAL INTERCONNECTION (PINS #1 THRU 24)
TO DIGITAL DISPLAY
W4
TYPICAL INTERCONNECTION (PINS #1 THRU 24)
TO FRONT PANEL CONTROL
W5
TYPICAL INTERCONNECTION (PIN #1 THRU 24)
TO FRONT PANEL CONTROL
A8
ASSEMBLY 13813
INTERFACE BOARD #2
A5
ASSY 13805
FRONT PANEL CONTROL AND DISPLAY CKT
+10V
-10V
R1 25K
CAL FACTOR-dB
+1.0
-1.0
R2 20K
dB MANUAL REF
R3 10K
dB OFFSET
M1
RELATIVE POWER (LINEAR MODES)
J6
INPUT RF DETECTOR
5V COM
ISOL COM
THMS
PAD ID
LIN COMP
DETECTOR
DET. COM
C1 .01
LIST OF MATERIAL
PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA
RF POWER METER
MODEL 1045
V.Y.I. 1-17-78
RB 7-11-78
13901 C
SHEET 1 OF 1
NEXT ASSY



ASSEMBLY 13795
REFERENCE DESIGNATORS ARE ABBREVIATED
WITH PREFIX A4

NOTE:
1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ± ¼W. CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. POTIENTIOMETER ARROW INDICATES CW ROTATION.

LIST OF MATERIAL

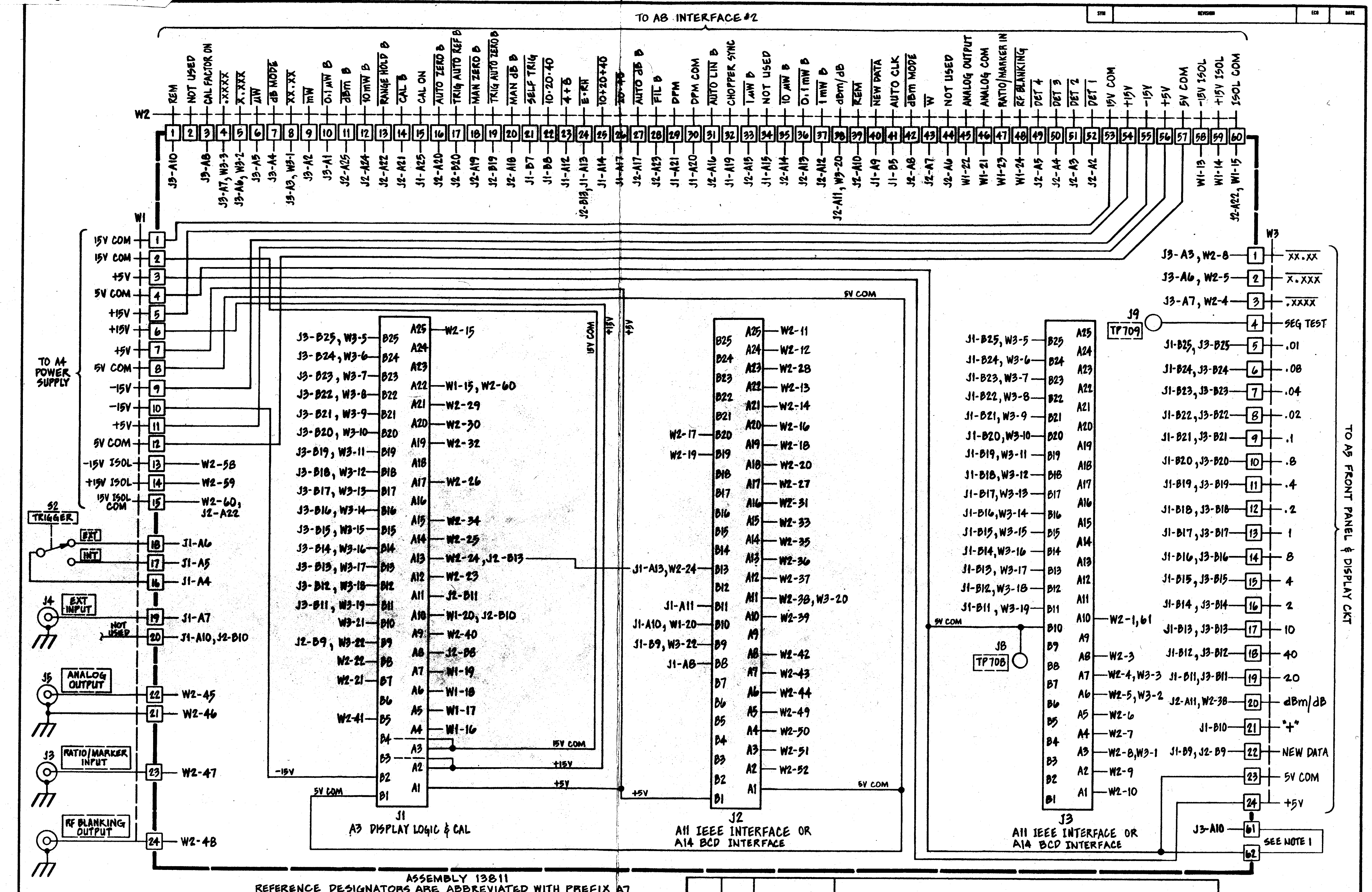
NEXT ASSY

DRAWN AN 10/24/77
CHK RB 7-1-78

PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

POWER SUPPLY

DRAWING NO. 13796 REV B
SHEET 1 OF 1



NOTE

1. JUMPER IS REMOVED WHEN A11 IEEE INTERFACE PCB OR A14 BCD INTERFACE IS INSTALLED.

LIST OF MATERIAL

DRAWN	V.Y.I. 1-11-78
ENG	RB 7-11-78

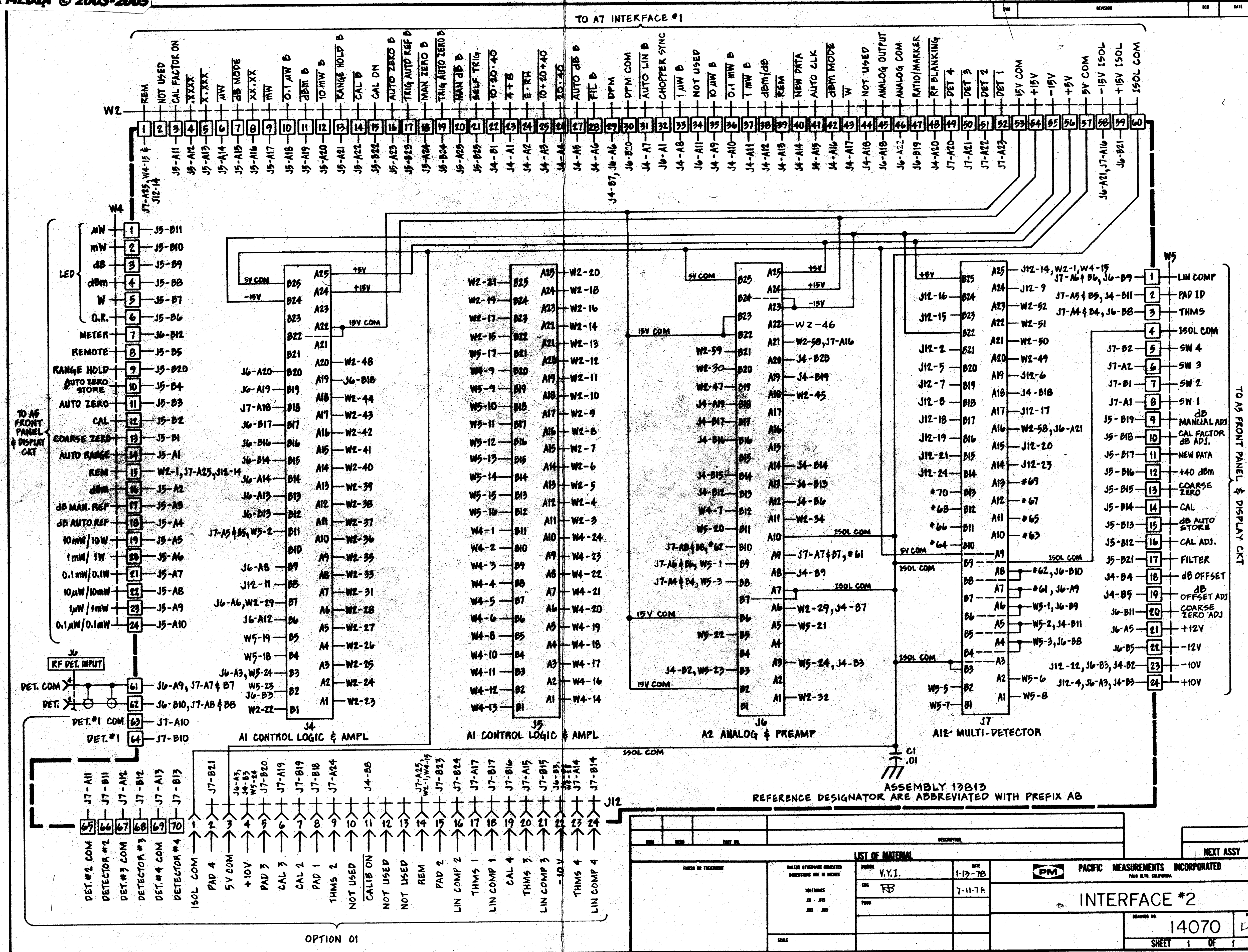
NEXT ASSY

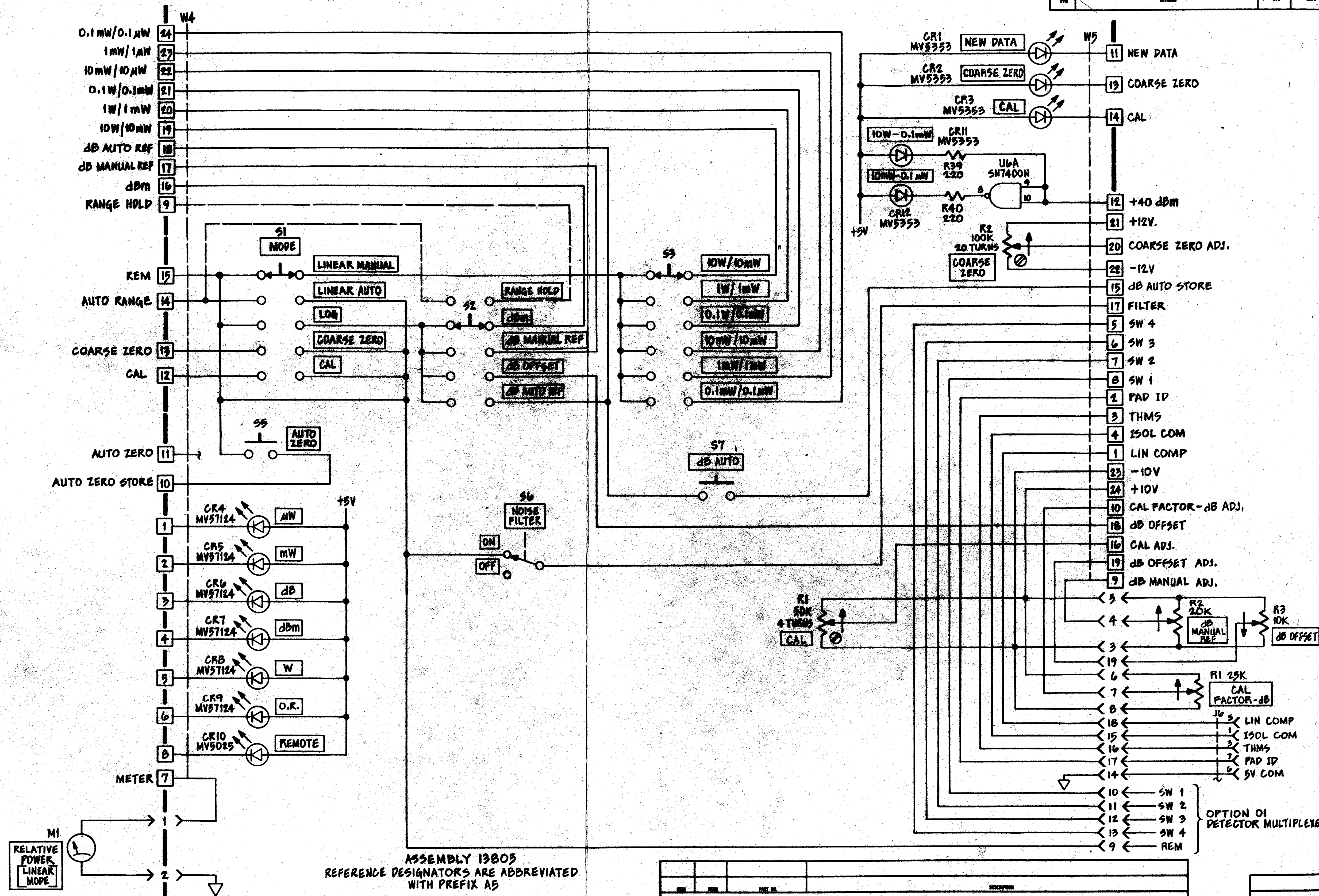
PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

INTERFACE #1

DRAWING NO. 14069 REV B

SHEET 1 OF 1


TO A7 INTERFACE #1
W2
W4
W5
LED
TO A5 FRONT PANEL & DISPLAY CKT
TO A5 FRONT PANEL & DISPLAY CKT
RF DET. INPUT
DET. COM
DET.
DET.#1 COM
DET.#1
J4
A1 CONTROL LOGIC & AMPL
J5
A1 CONTROL LOGIC & AMPL
J6
A2 ANALOG & PREAMP
J7
A12 MULTI-DETECTOR
ISOL COM
C1
.01
ASSEMBLY 13813
REFERENCE DESIGNATOR ARE ABBREVIATED WITH PREFIX AB
J12
OPTION 01
LIST OF MATERIAL
V.Y.I.
1-13-78
7-11-78
PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA
INTERFACE #2
14070
SHEET 1 OF 1
NEXT ASSY



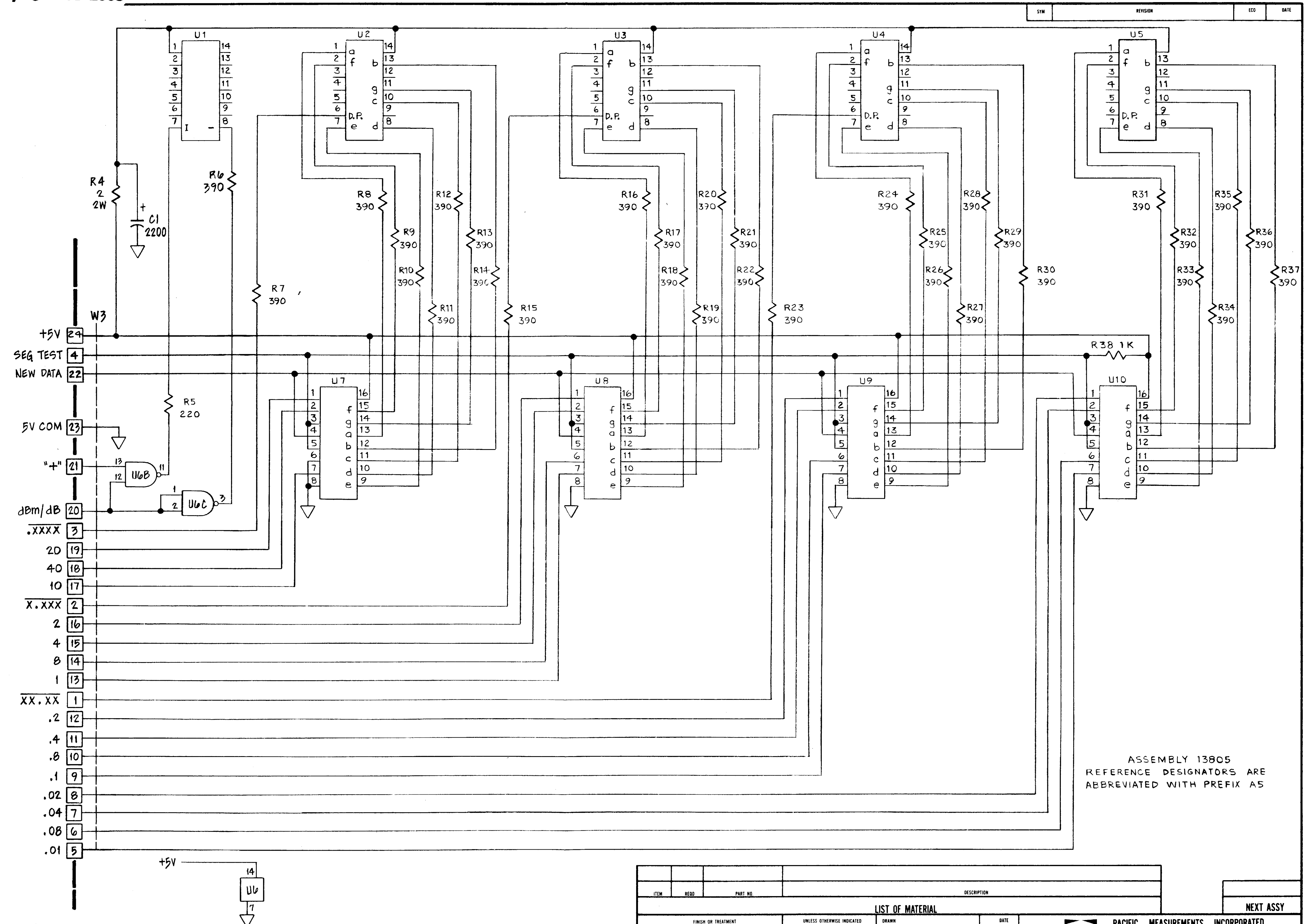
ASSEMBLY 13805
REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A5

NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS ARE ±5% 1/4W.
2. POTENTIOMETER ARROW INDICATES CW ROTATION.
3. DASH-LINE CIRCUITRY : FOR SPEC. UNIT ONLY ADD RANGE HOLD POSITION OF SWITCH S2.

LIST OF MATERIAL

NEXT ASSY

V.Y.I.	DATE 1-17-78	PACIFIC MEASUREMENTS INCORPORATED, PALO ALTO, CALIFORNIA
RB	7-11-78	FRONT PANEL CONTROL AND DISPLAY CKT
		13806 A
		SHEET 1 OF 2



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

REF DESIG	TYPE
U1	HP5082-7652
U2,U3,U4,U5	HP5082-7650
U6	SN7400N
U7,U8,U9,U10	SN74LS247N

LIST OF MATERIAL

NEXT ASSY

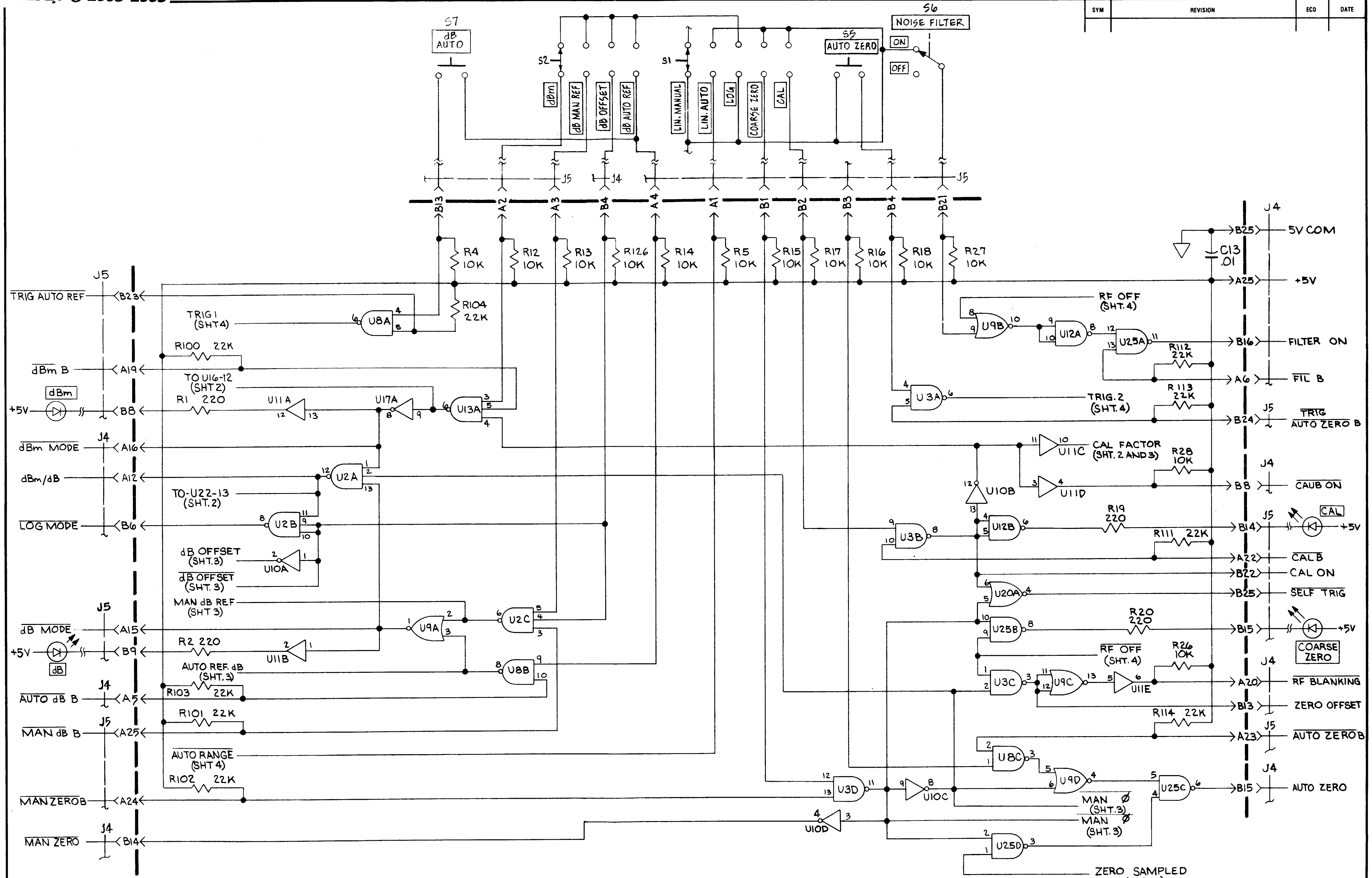
PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

FRONT PANEL CONTROL AND DISPLAY CKT

DRAWING NO 13806 REV A

SHEET 2 OF 2

SYM	REVISION	ECO	DATE



ASSEMBLY 13455
REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A1

NOTE:
1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS AND ARE ¼W ±5%. CAPACITOR VALUES ARE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.

REF. DES.	TYPE
U2, U13	SN74LS10N
U10, U17	SN74LS04N
U9, U20	SN74LS02N
U8, U25	SN74LS00N
U11	SN7407
U3, U12	SN7400N

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	DAN WATSON	4-22-78
ENG	RB	7-11-78
PROD		

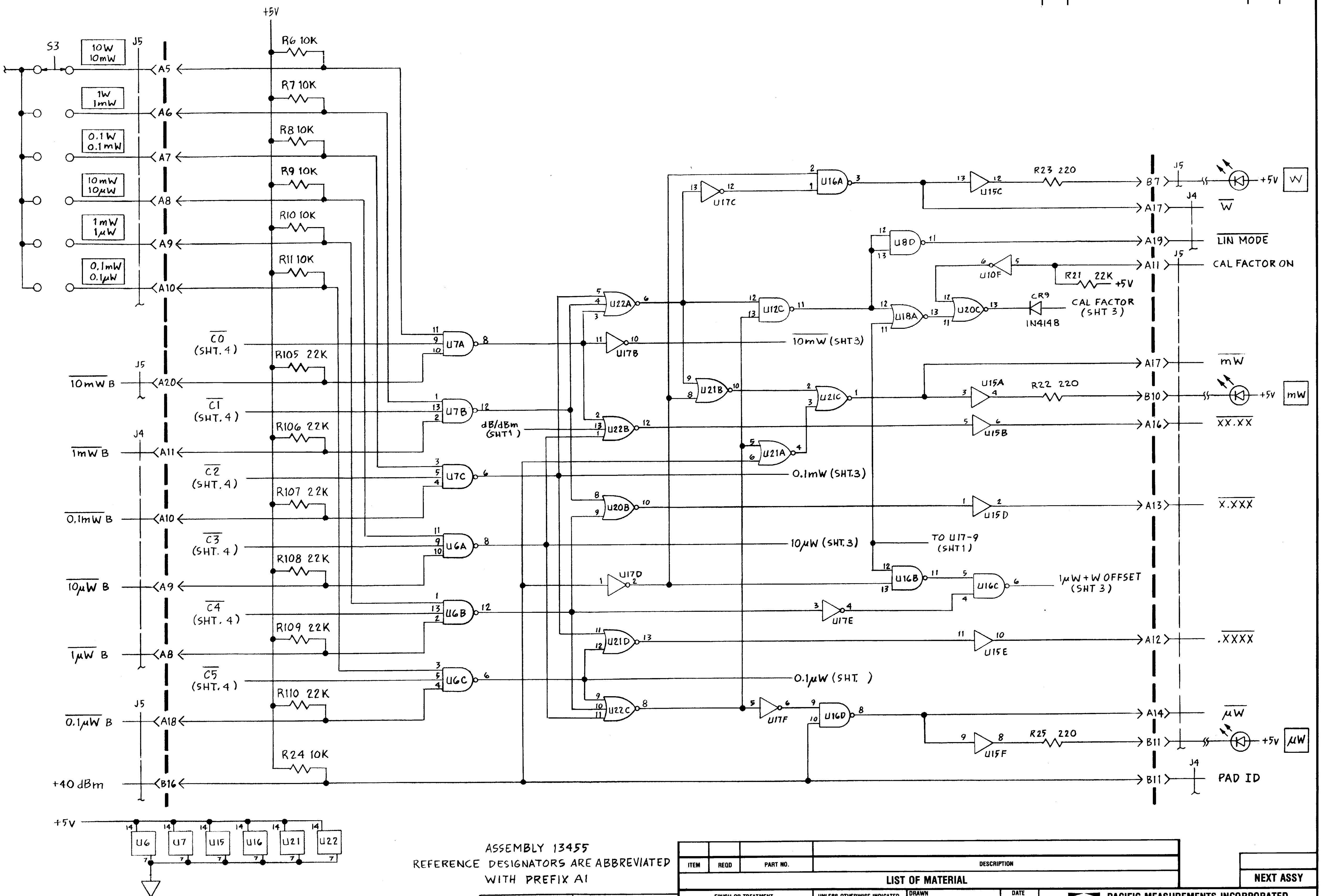
PM PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

CONTROL BOARD

DRAWING NO. 13456 REV B

1 OF 4

SYM	REVISION	ECO	DATE



ASSEMBLY 13455
REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A1

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

REF DESIG	TYPE
U12	SN7400N
U22	SN74LS27N
U21	SN74LS02N
U16	SN74LS00N
U15	SN7407N
U6, U7	SN74LS10N

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	HS	4-4-78
ENG	RB	7-11-78
PROD		

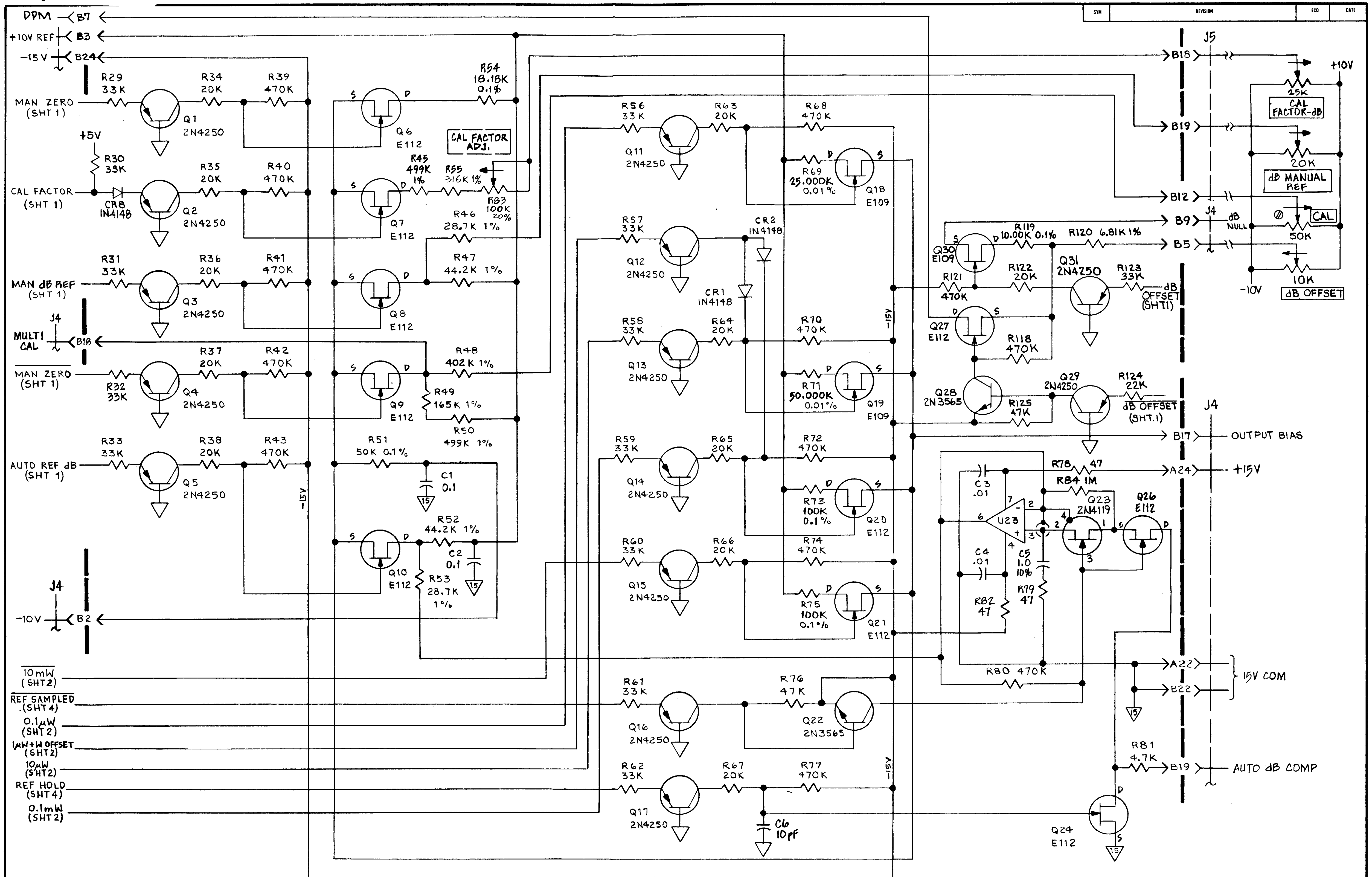
PM PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

CONTROL BOARD

DRAWING NO. 13456 REV B

2 OF 4

SYM	REVISION	ECO	DATE



ASSEMBLY 13455
REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A1

NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE 1/4W, ±5%. CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. POTIENTIOMETER ARROW INDICATES CW ROTATION.

U23	CA 3140T
REF DESIG	TYPE

ITEM	REQD	PART NO.	DESCRIPTION

LIST OF MATERIAL

NEXT ASSY

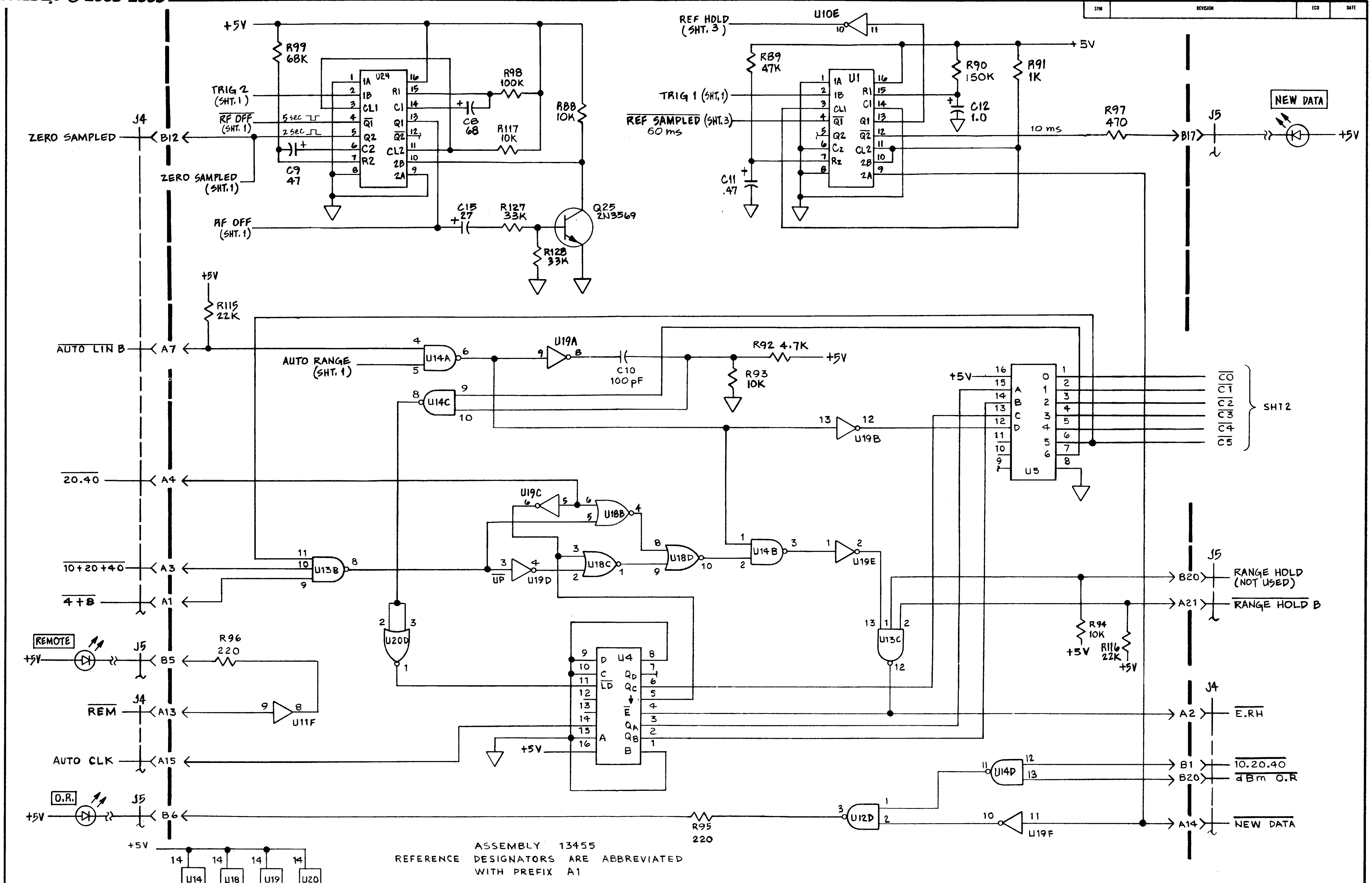
FINISH OR TREATMENT	UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES			DATE
R29 - R82 C1 - C5 CR1 - CR2	TOLERANCE .XX ± .015 .XXX ± .005	DRAWN	AN	11-30-77
		ENG	RB	7-11-78
	SCALE	PROD		

PM PACIFIC MEASUREMENTS INCORPORATED PALO ALTO, CALIFORNIA

CONTROL BOARD

DRAWING NO 13456 REV C

SHEET 3 OF 4



ASSEMBLY 13455
REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A1

REF DESIG	TYPE
U12	SN7400N
U24	SN74LS221N
U11	SN7407N
U1	SN74LS123N
U4	SN74LS190N
U5	SN74LS42N
U13	SN74LS10N
U14, U25	SN74LS00N
U18, U20	SN74LS02N
U19, U10	SN74LS04N

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

LIST OF MATERIAL

ITEM | REQD | PART NO. | DESCRIPTION

FINISH OR TREATMENT

R87 - R97
C9 - C14
CR7

UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES
TOLERANCE
XX ± .015
XXX ± .005
SCALE

DRAWN AN 11-30-77
ENG RB 7-11-78
PROD

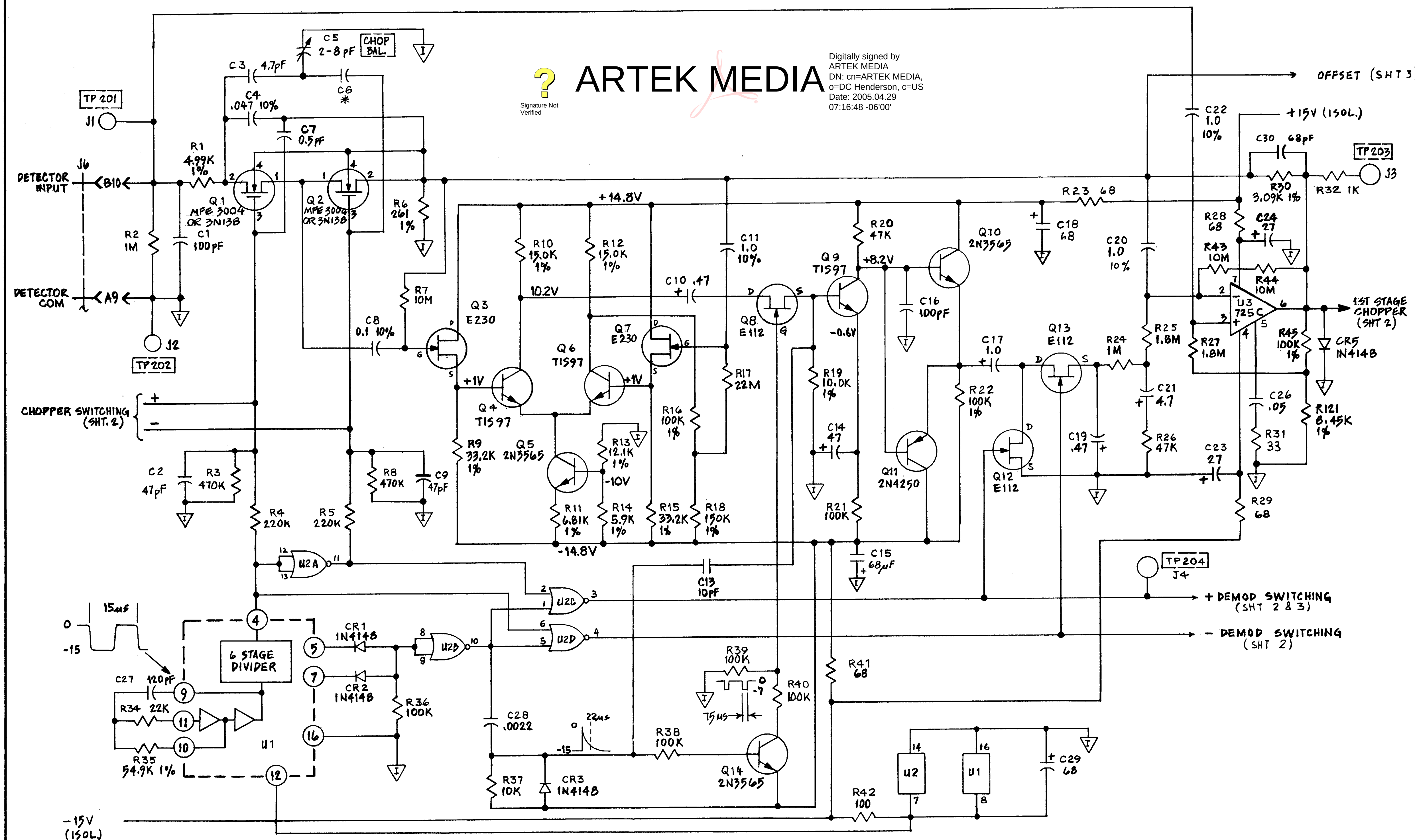
NEXT ASSY

PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

CONTROL BOARD

DRAWING NO. 13456 REV C

SHEET 4 OF 4



ASSEMBLY 13509
REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A2

NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5% 1/4W. CAPACITOR VALUES ARE IN MICROFARADS.
2. Q1 AND Q2 MUST COME FROM SAME MFR.

* FACTORY SELECTED VALUE

REF DESIG	TYPE
U3	725C
U1	CD4060AE
U2	CD4001AE

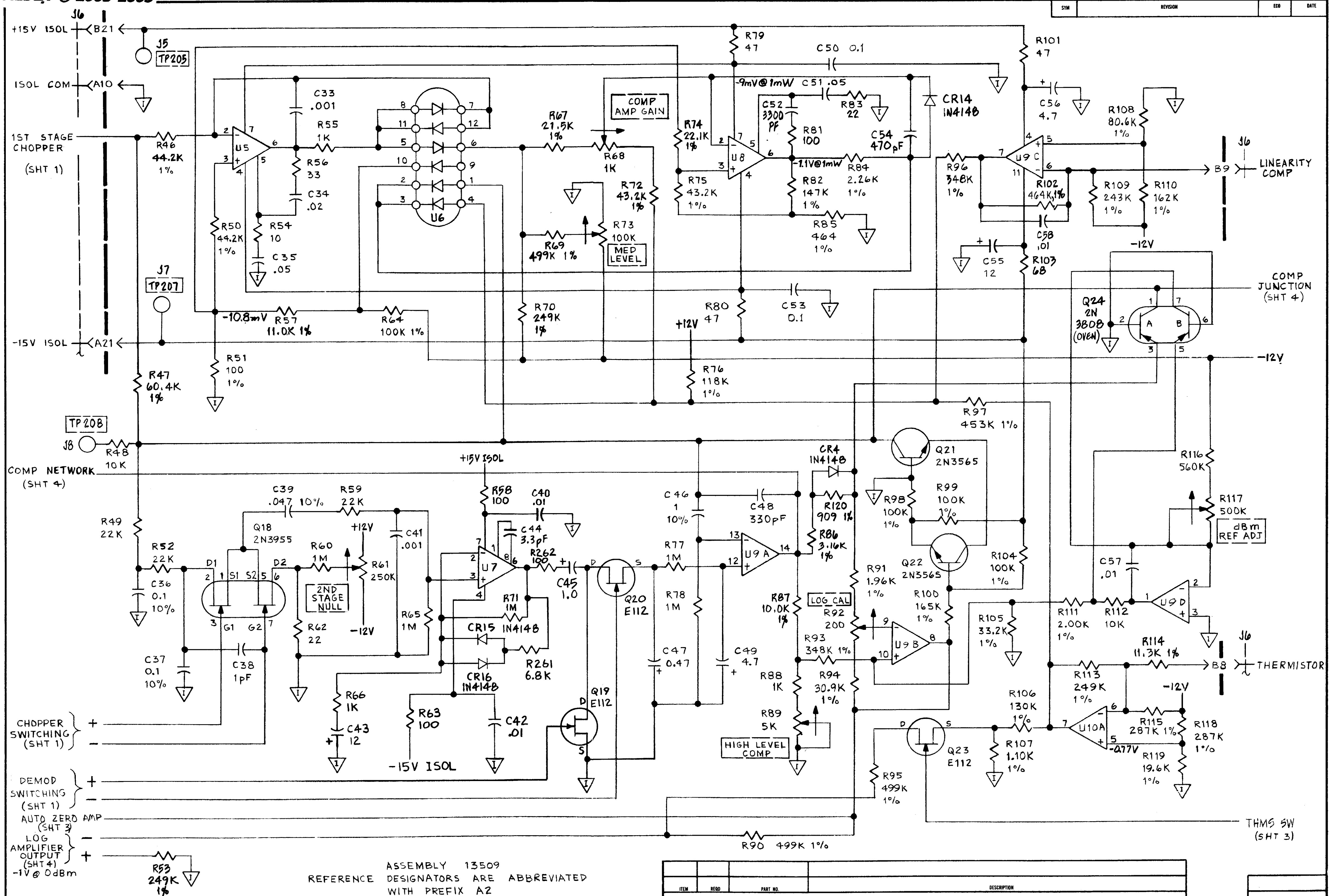
LIST OF MATERIAL

ITEM	REQD	PART NO.	DESCRIPTION

NEXT ASSY

DRAWN Y.O.	DATE 4-1-77	PACIFIC MEASUREMENTS INCORPORATED PALO ALTO, CALIFORNIA
ENG RB	7-11-78	ANALOG BOARD
PROD		DRAWING NO. 13510 REV C

UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES
TOLERANCE .XX = .015 .XXX = .005
FINISH OR TREATMENT
SCALE
SHEET 1 OF 4



ASSEMBLY 13509 REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A2

NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5%, 1/4W. CAPACITOR VALUES ARE IN MICROFARADS.
2. POTIENTIOMETER ARROW INDICATES CW ROTATION.

REF DESIG	TYPE
U9	TL074
U7	LM301A
U6	CA3039
U5,U8	LM725C

LIST OF MATERIAL

ITEM	REQD	PART NO.	DESCRIPTION

NEXT ASSY

FINISH OR TREATMENT

UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES
TOLERANCE .XX ± .015 .XXX ± .005

SCALE

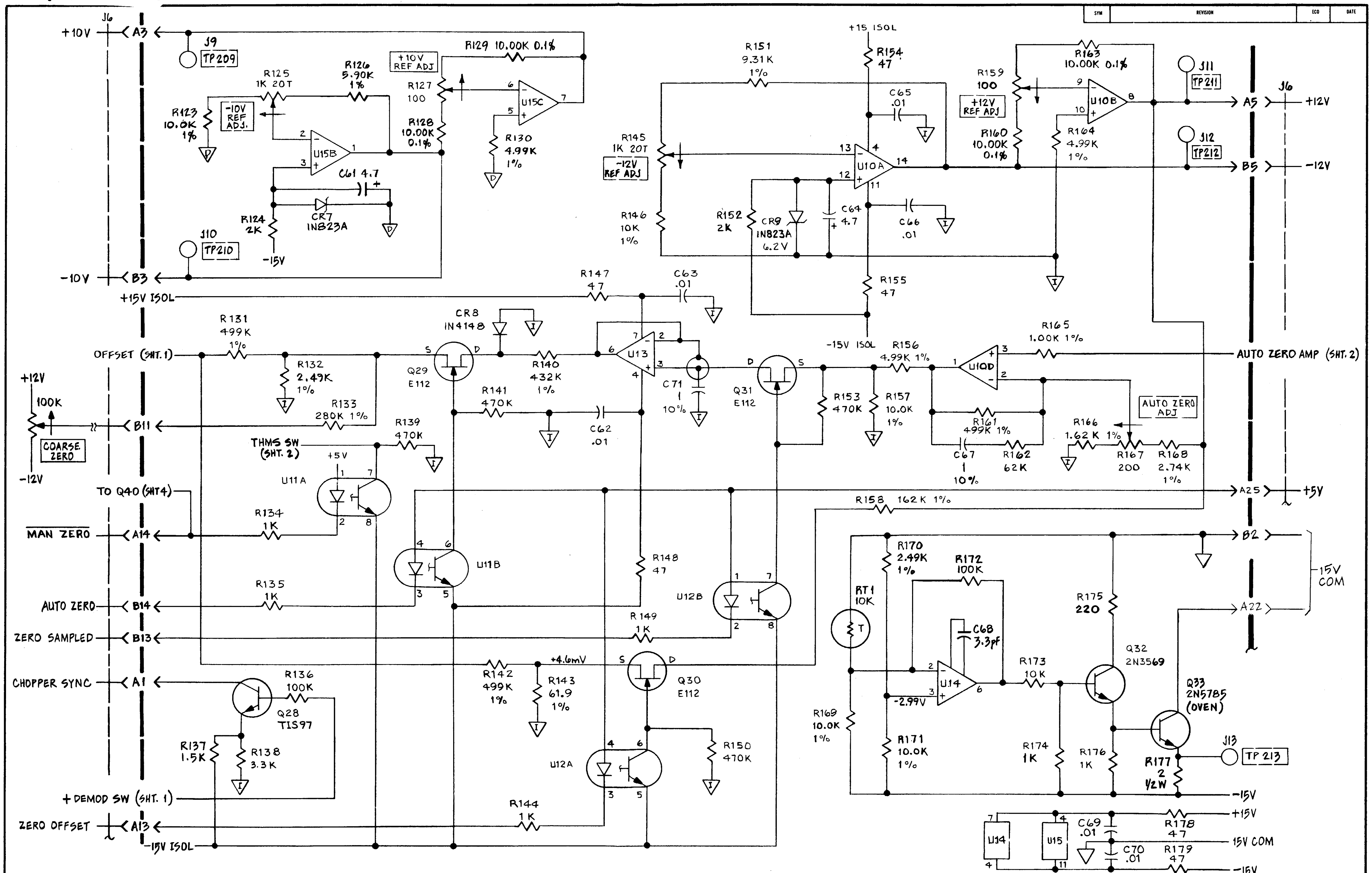
DRAWN AN 11-14-77
ENG RB 7-11-78
PROD

PM PACIFIC MEASUREMENTS INCORPORATED PALO ALTO, CALIFORNIA

ANALOG BOARD

DRAWING NO. 13510 REV G

SHEET 2 OF 4



ASSEMBLY 13509
REFERENCE DESIGNATORS ARE ABBREVIATED
WITH PREFIX A2

NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ± 1/4 W. CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. POTIENTIOMETER ARROW INDICATES CW ROTATION.

REF DESIG	TYPE
U13	CA3140T
U10, U15	LM324
U11, U12	MCT-6
U14	LM301

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

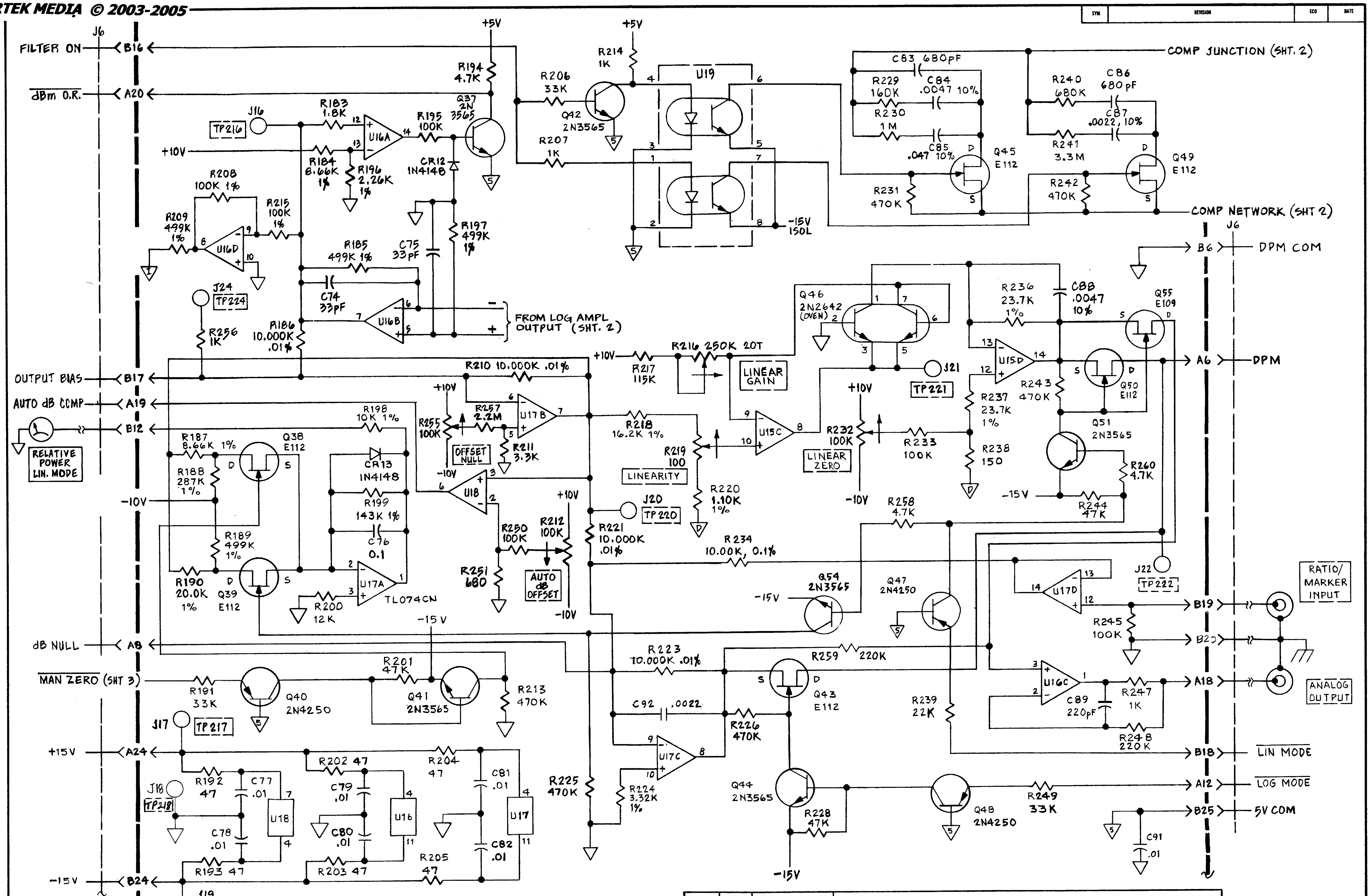
DRAWN AN 11-14-77
ENG RB 7-11-78
PROD

PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

ANALOG BOARD

DRAWING NO. 13510 REV B

SHEET 3 OF 4



ASSEMBLY 13509
REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A2

NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±1/4 W. CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED
2. POTIENTIOMETER ARROW INDICATES CW ROTATION.

REF DESIG	TYPE
U19	MCT-6
U18	741C
U16, U17	TL074

ITEM	REQD	PART NO.	DESCRIPTION

LIST OF MATERIAL

FINISH OR TREATMENT

UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES
TOLERANCE .XX ± .015 .XXX ± .005

DRAWN AN 11-14-77
ENG RB 7-11-78
PROD

SCALE

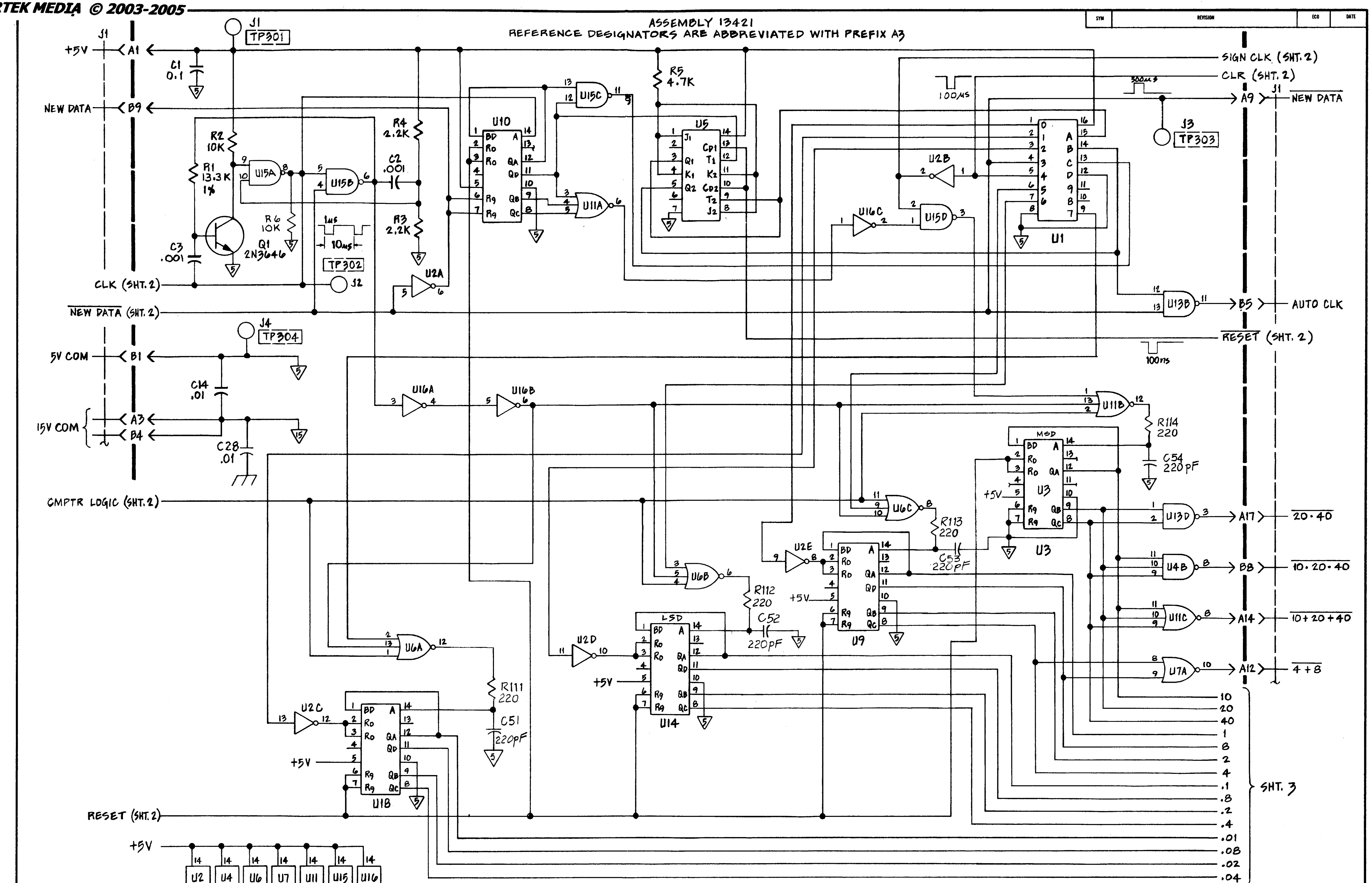
NEXT ASSY

PM PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

ANALOG BOARD

DRAWING NO. 13510 REV G

SHEET 4 OF 4



REF DESIG	TYPE
U13, U15	SN74LS00N
U7	SN74LS02N
U6, U11	SN74LS27N
U5	SN74LS107N
U4	SN74LS10N
U3, U9, U10, U14, U18	SN74LS90N
U2, U16	SN74LS04N
U1	SN74LS42N

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

LIST OF MATERIAL

ITEM	REQD	PART NO.	DESCRIPTION

NEXT ASSY

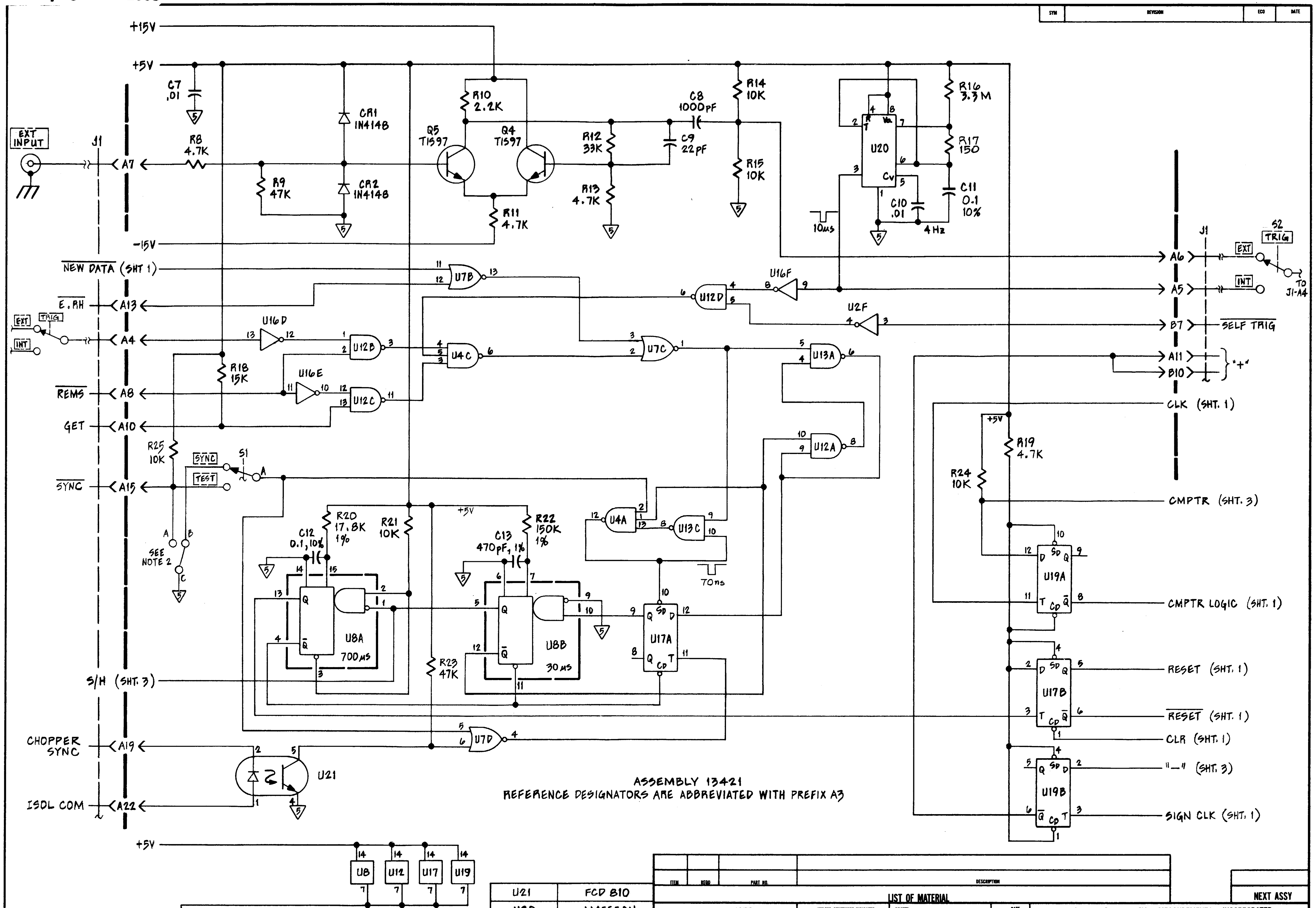
DRAWN V.Y.I. 1-25-78
ENG RB 7-11-78

PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

DISPLAY LOGIC & CALIBRATOR

DRAWING NO. 13422 REV G

SHEET 1 OF 4



NOTES:
1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS AND ARE ±5% 1/4W. CAPACITOR VALUES ARE IN MICROFARADS.
2. CHANGE JUMPER TO 'A-B' WHEN HI-LEVEL IS NOT IN SYNC WITH CHOPPER.

REF DESIG	TYPE
U21	FCD 810
U20	LM555CN
U17, U19	SN 74LS74N
U12	SN 74LS00N
U8	SN 74LS123N

LIST OF MATERIAL

NEXT ASSY

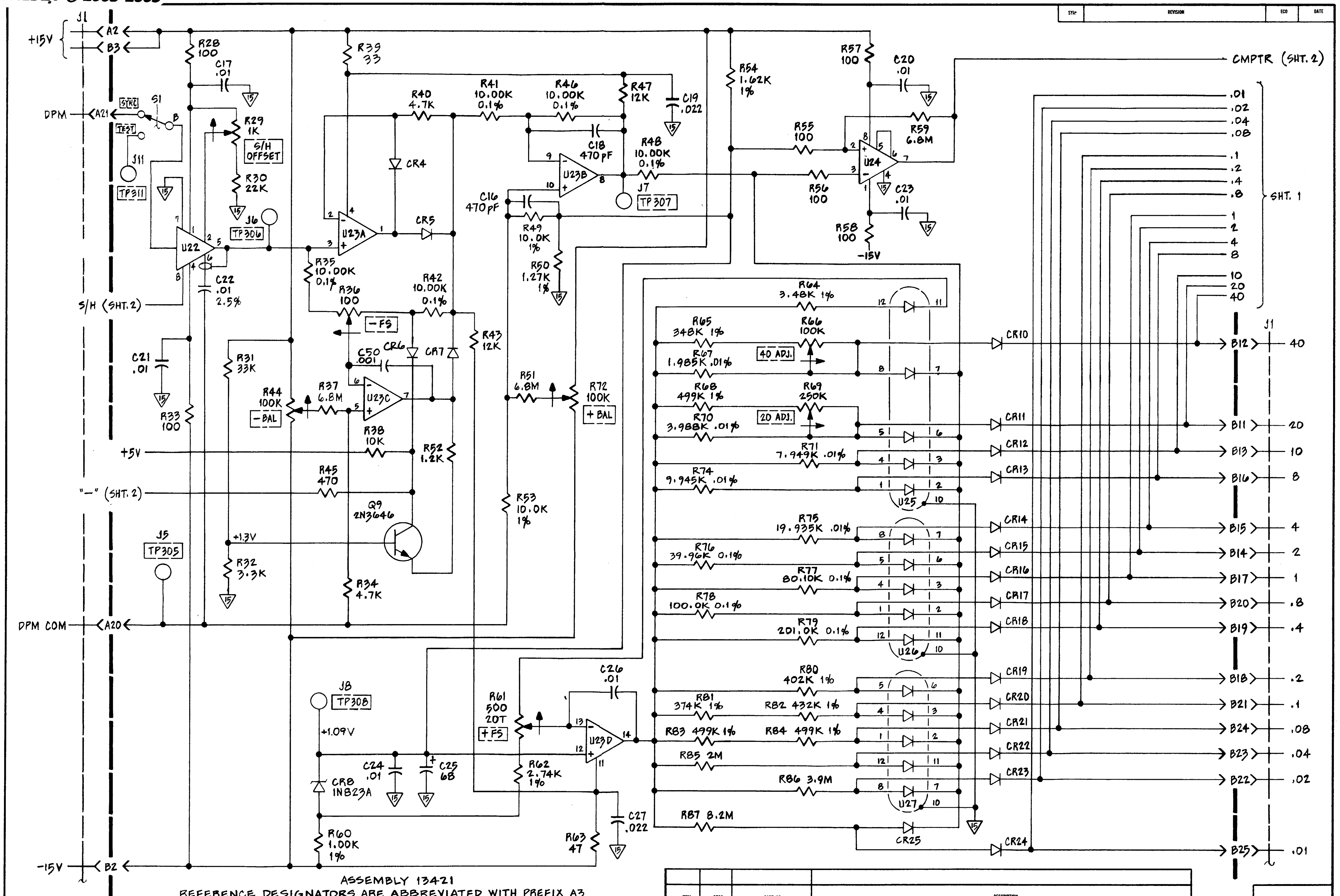
DRAWN V.Y.I. 1-25-78
ENG RB 7-11-78

PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

DISPLAY LOGIC & CALIBRATOR

DRAWING NO. 13422 REV C

SHEET 2 OF 4



ASSEMBLY 13421
REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A3

NOTES:
1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS AND ARE ±5%, 1/4W. CAPACITOR VALUES ARE IN MICROFARADS.
2. UNLESS OTHERWISE SPECIFIED DIODES ARE 1N4148.

REF DESIG	TYPE
U25, U26, U27	CA3039
U24	LM311H
U23	LM324C
U22	LF398H

LIST OF MATERIAL

DRAWN V.Y.I. DATE 1-25-78
ENG FB 7-11-78

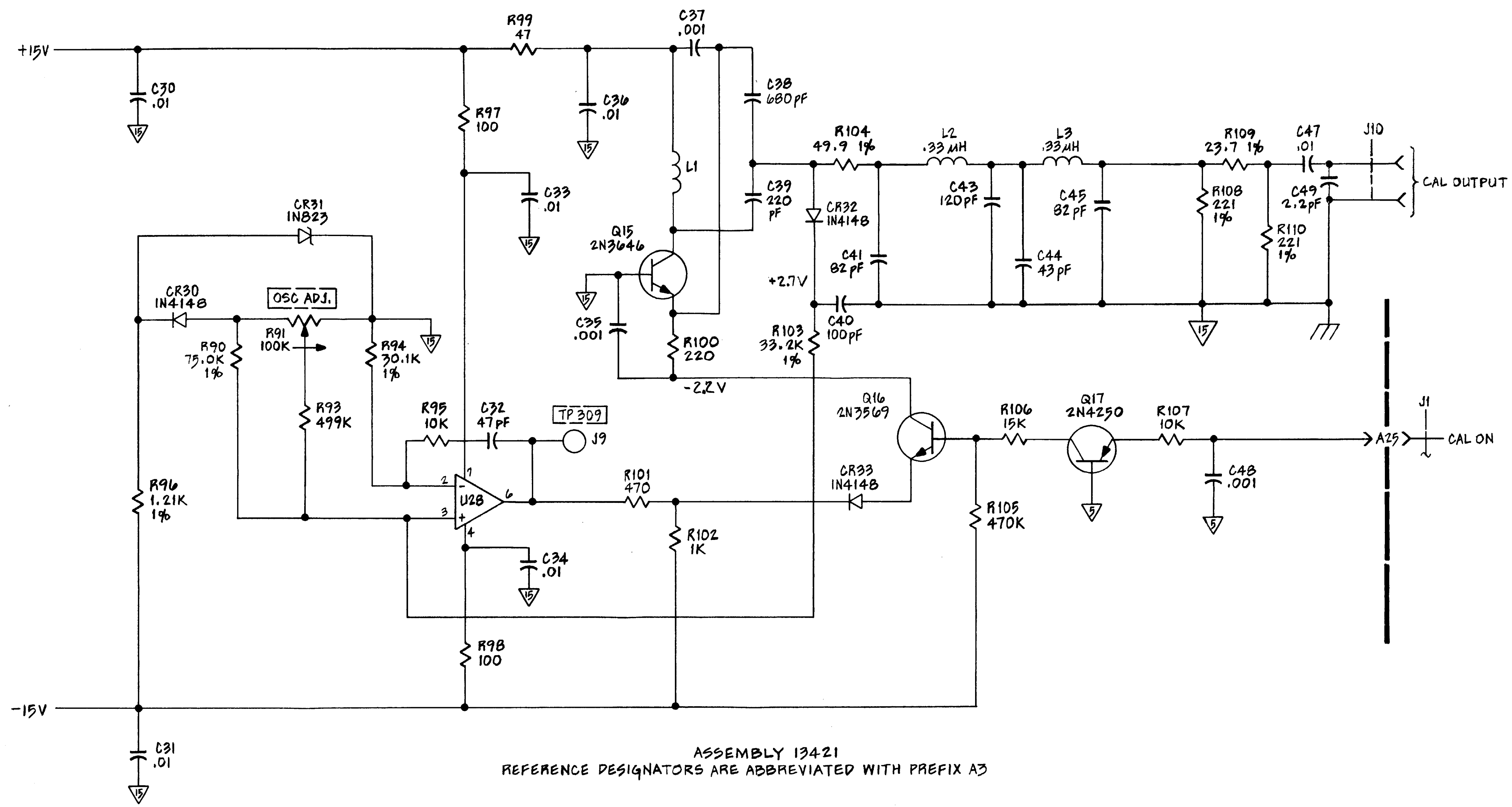
PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

DISPLAY LOGIC & CALIBRATOR

DRAWING NO. 13422 REV E

SHEET 3 OF 4

SYM	REVISION	ECO	DATE



ASSEMBLY 13421
REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A3

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

REF DESIG	TYPE
U28	LM741C

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

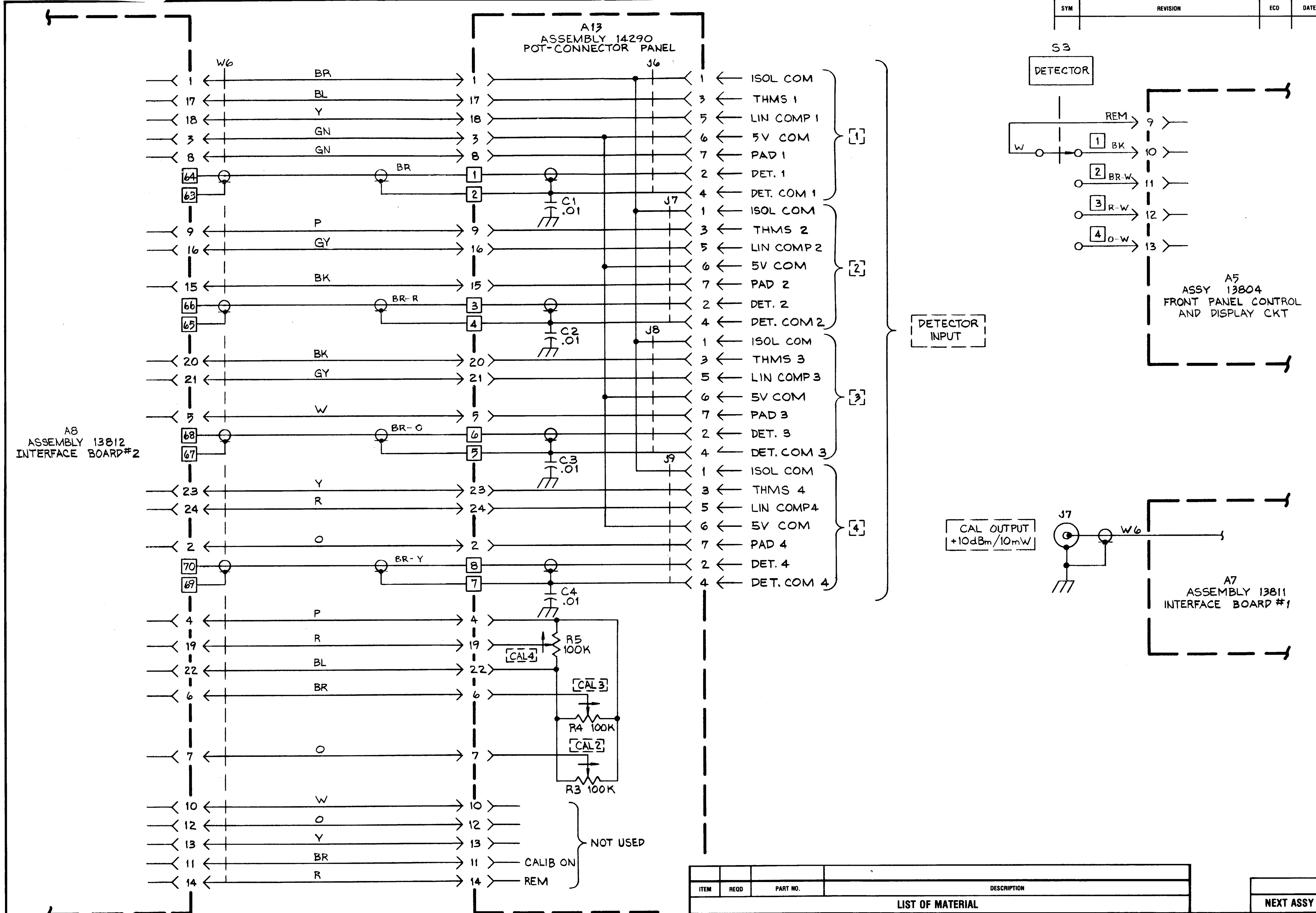
DRAWN V.Y.I. DATE 1-25-78
ENG RB 7-11-78
PROD

PM PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

DISPLAY LOGIC & CALIBRATOR

DRAWING NO. 13422 REV G

SHEET 4 OF 4



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

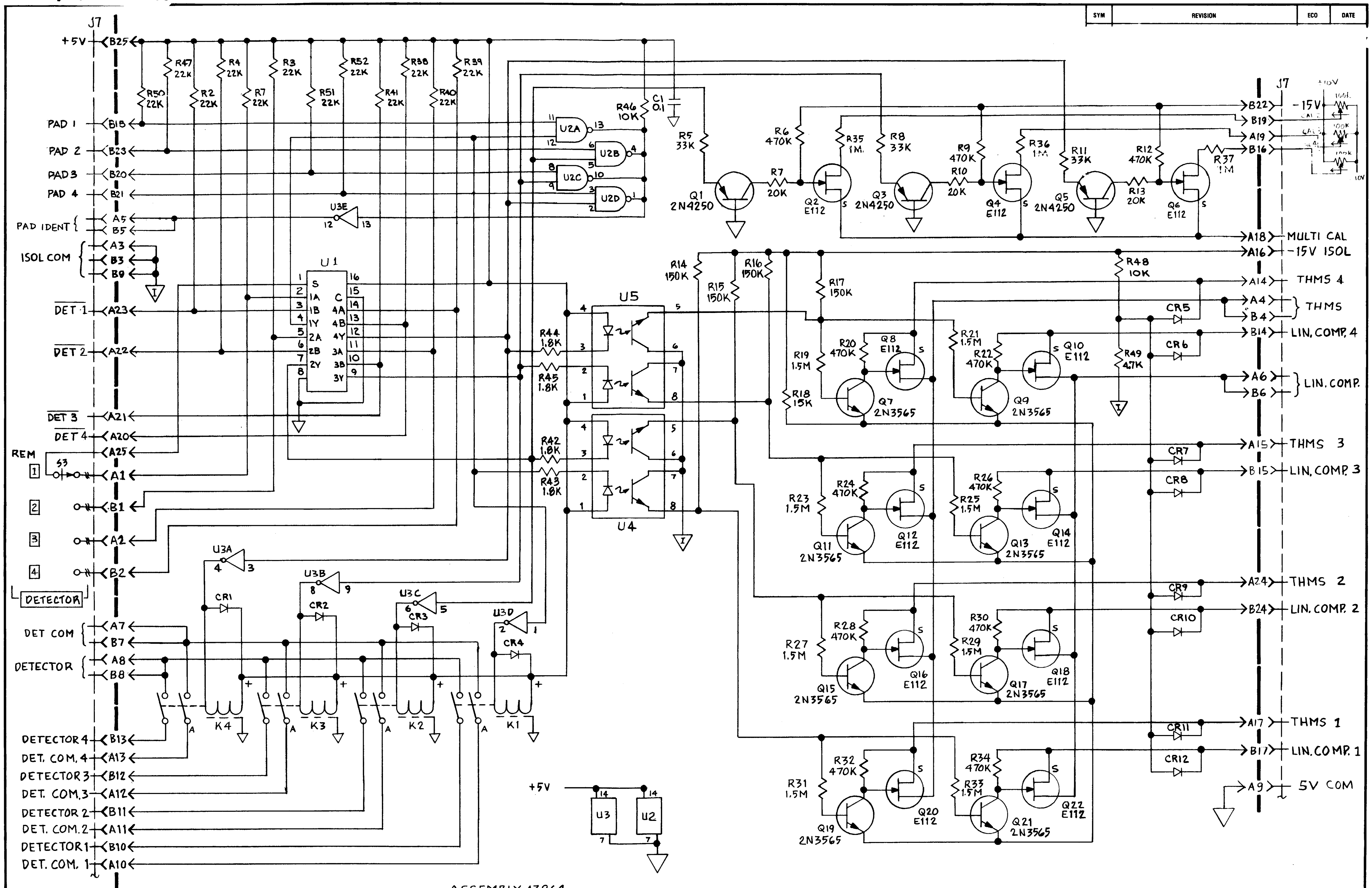
DRAWN DAN WATSON — DATE 8-16-78
ENG
PROD

PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

DETECTOR MULTIPLEXER

DRAWING NO. 14109 — REV

SHEET 1 OF 1



ASSEMBLY 13864
REFERENCE DESIGNATORS ARE ABBREVIATED
WITH PREFIX A12

NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5% 1/4 WATT. CAPACITOR VALUES ARE IN MICROFARADS.
2. ALL DIODES ARE IN4148'S.

REF DESIG	TYPE
U2	SN74LS01N
U1	SN74LS258
U3	SN74LS05
U4 & U5	MCT 6

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 HS — DATE 2-27-78
ENG RB — 7-11-78
PROD
SCALE

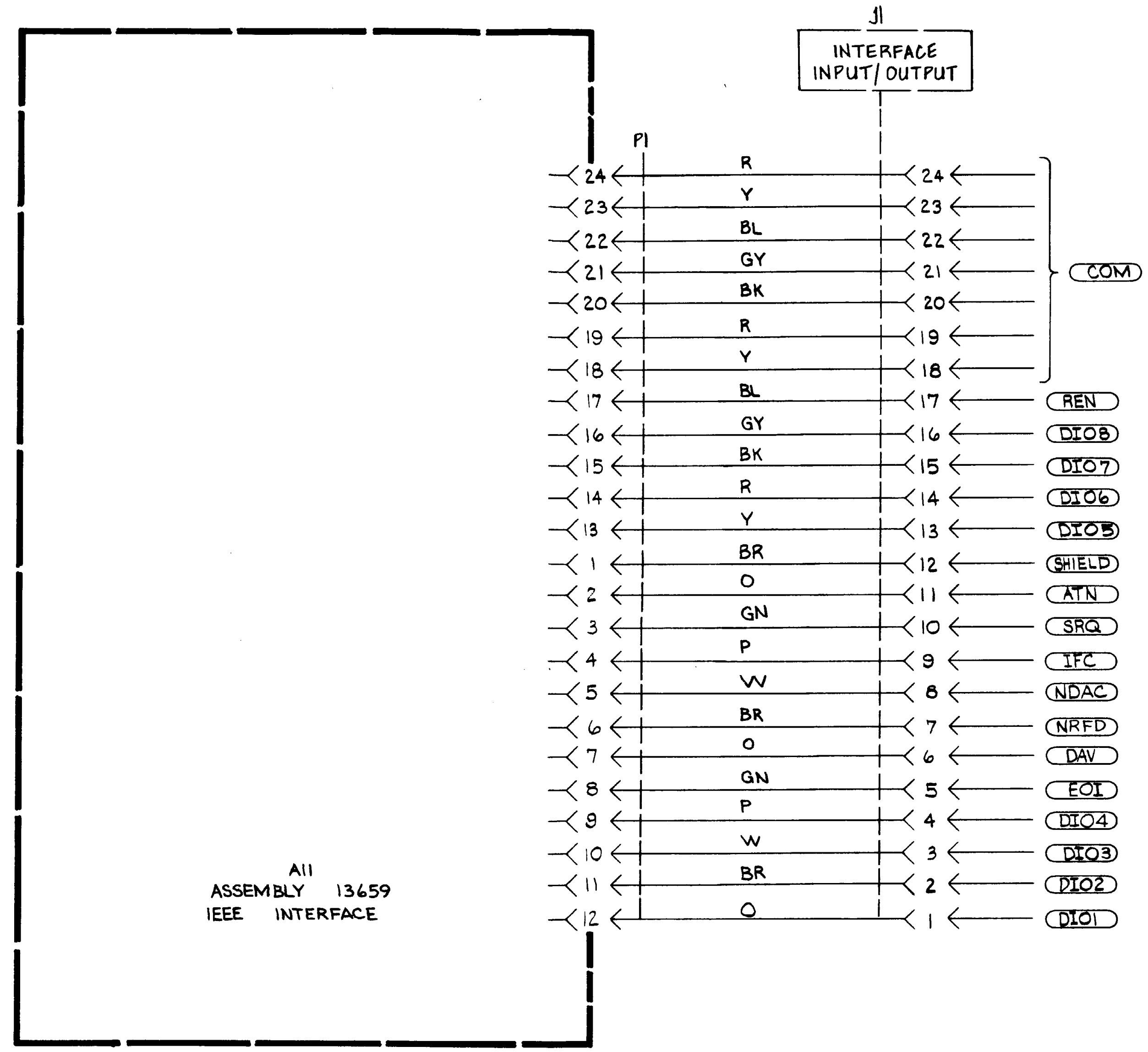
PACIFIC MEASUREMENTS INCORPORATED, PALO ALTO, CALIFORNIA

MULTI DETECTOR BOARD

DRAWING NO. 13865 — REV D

SHT 1 OF 1

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

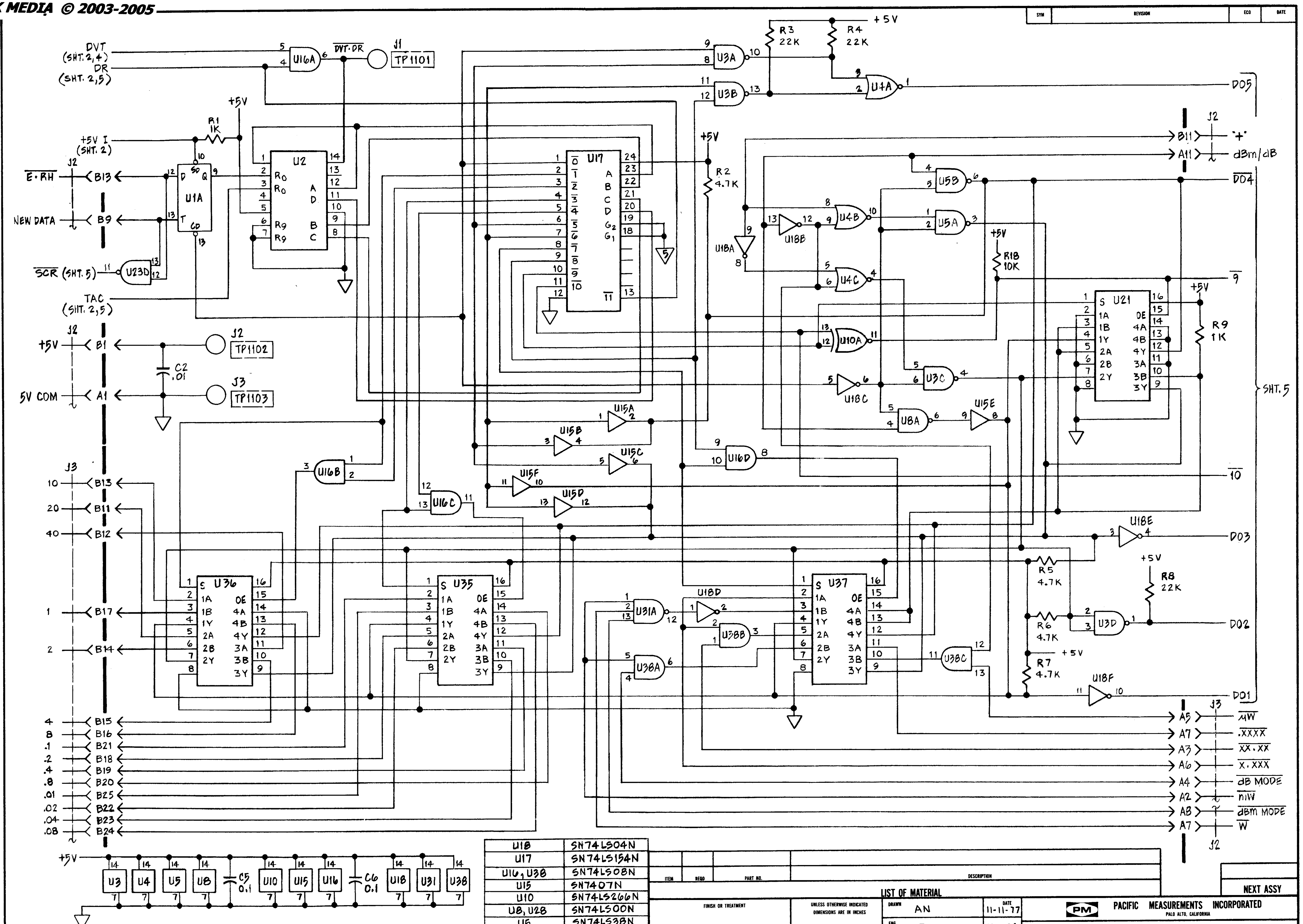
		DATE
DRAWN	DAN WATSON	4-26-78
ENG	FB	7-11-78
PROD		

PM PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

IEEE INTERFACE BUS

DRAWING NO. 14099 REV

SHEET 1 OF 1



REF DESIG	TYPE
U18	SN74LS04N
U17	SN74LS154N
U16, U38	SN74LS08N
U15	SN7407N
U10	SN74LS266N
U8, U28	SN74LS00N
U5	SN74LS38N
U4	SN74LS02N
U3	SN74LS01N
U2	SN7493N
U1	SN74LS74N

REF DESIG	TYPE
U35, U36	SN74LS258N
U31	SN74LS10N
U21, U37	SN74LS257N

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

LIST OF MATERIAL

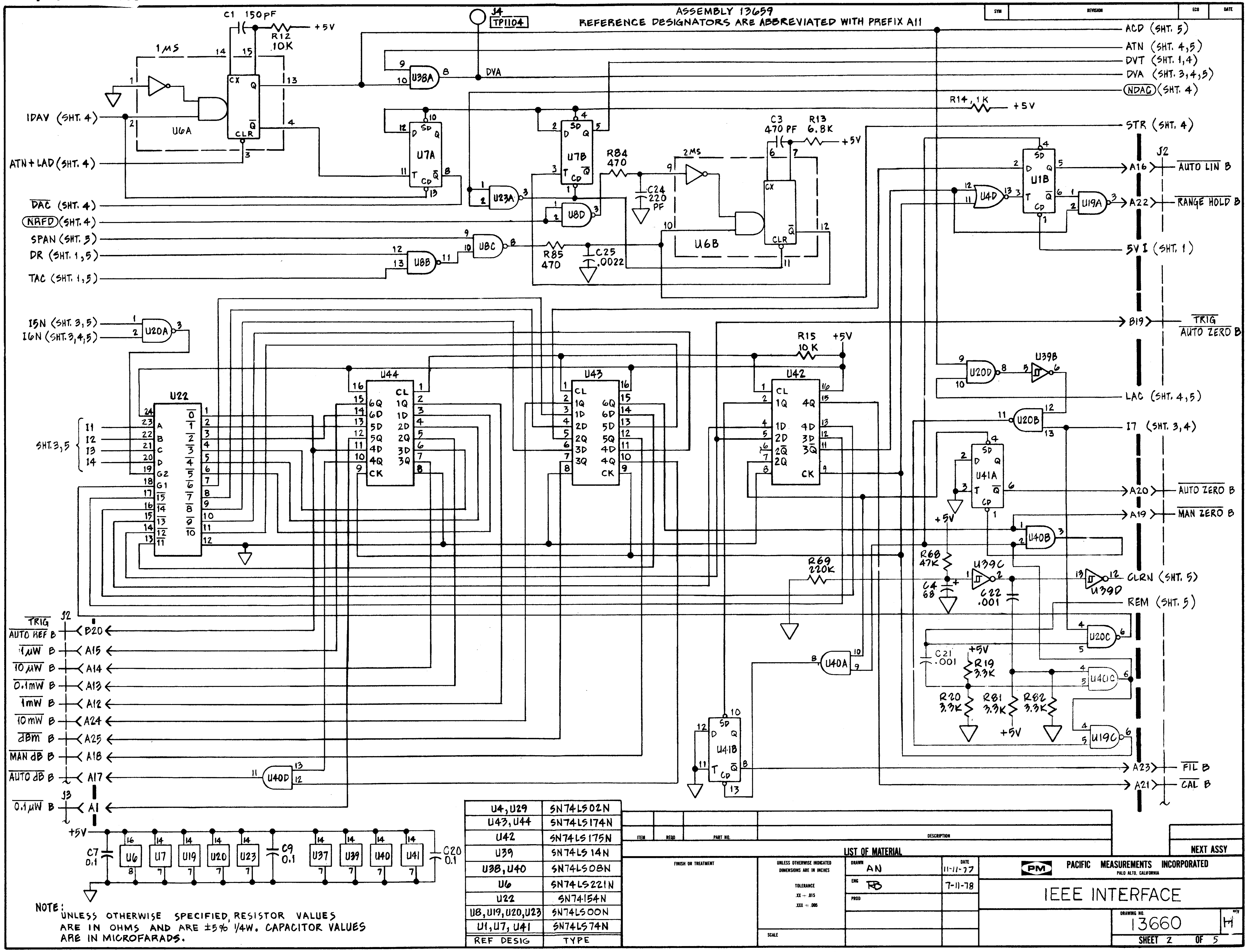
DRAWN AN 11-11-77
ENG RB 7-11-78

PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

IEEE INTERFACE

DRAWING NO. 13660 REV H

SHEET 1 OF 5



REF DESIG	TYPE
U4, U29	SN74LS02N
U43, U44	SN74LS174N
U42	SN74LS175N
U39	SN74LS14N
U38, U40	SN74LS08N
U6	SN74LS221N
U22	SN74154N
U8, U19, U20, U23	SN74LS00N
U1, U7, U41	SN74LS74N

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

LIST OF MATERIAL

ITEM	REQD	PART NO.	DESCRIPTION

NEXT ASSY

FINISH OR TREATMENT

UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES
TOLERANCE .XX ± .015 .XXX ± .005

SCALE

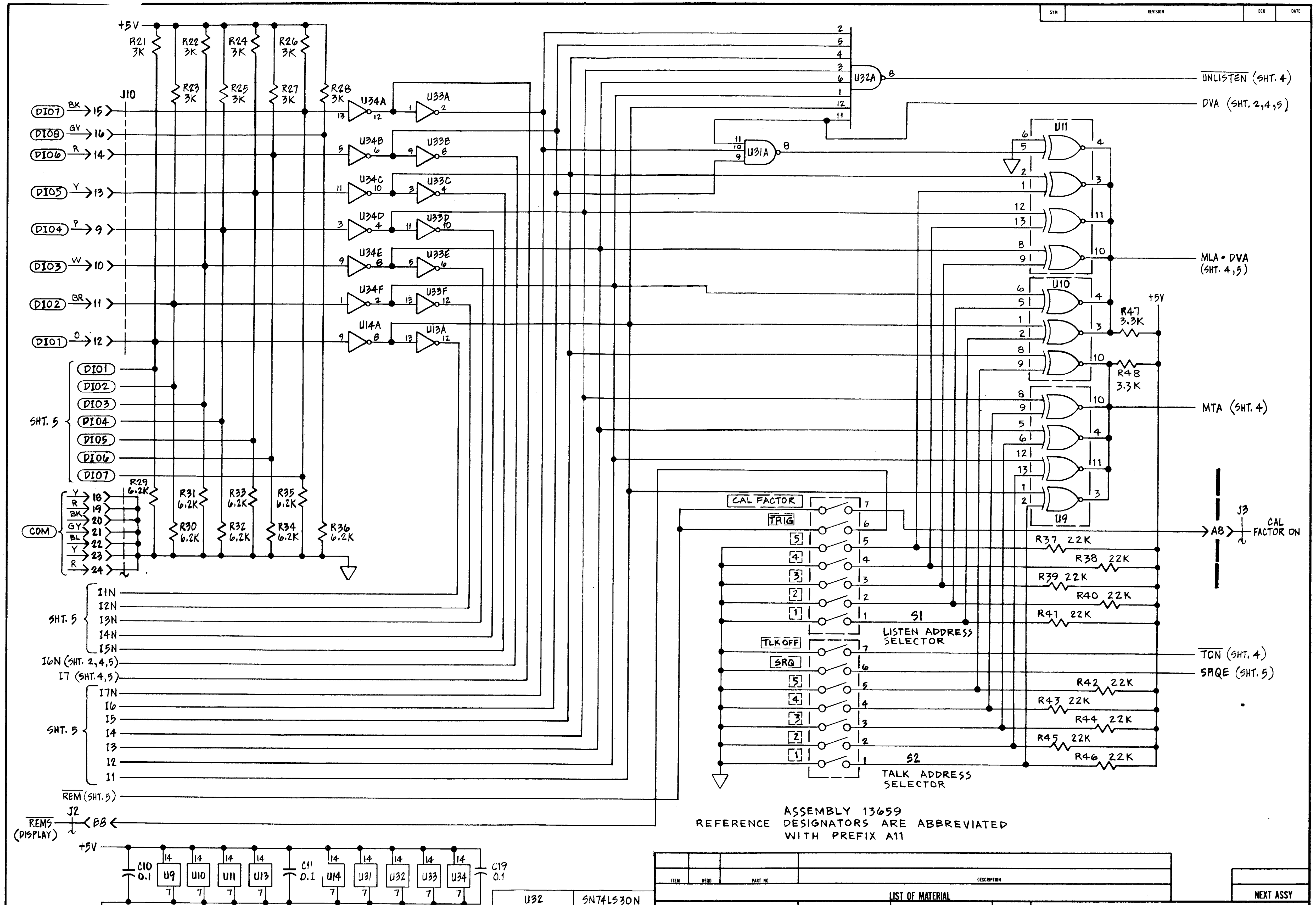
		DATE
DRAWN	AN	11-11-77
ENG	RB	7-11-78
PROD		

PM PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

IEEE INTERFACE

DRAWING NO. 13660 REV H

SHEET 2 OF 5



ASSEMBLY 13659
REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A11

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

REF DESIG	TYPE
U32	SN74LS30N
U31	SN74LS10N
U14, U34	SN74LS14N
U13, U33	SN74LS04N
U9, U10, U11	SN74LS266N

LIST OF MATERIAL

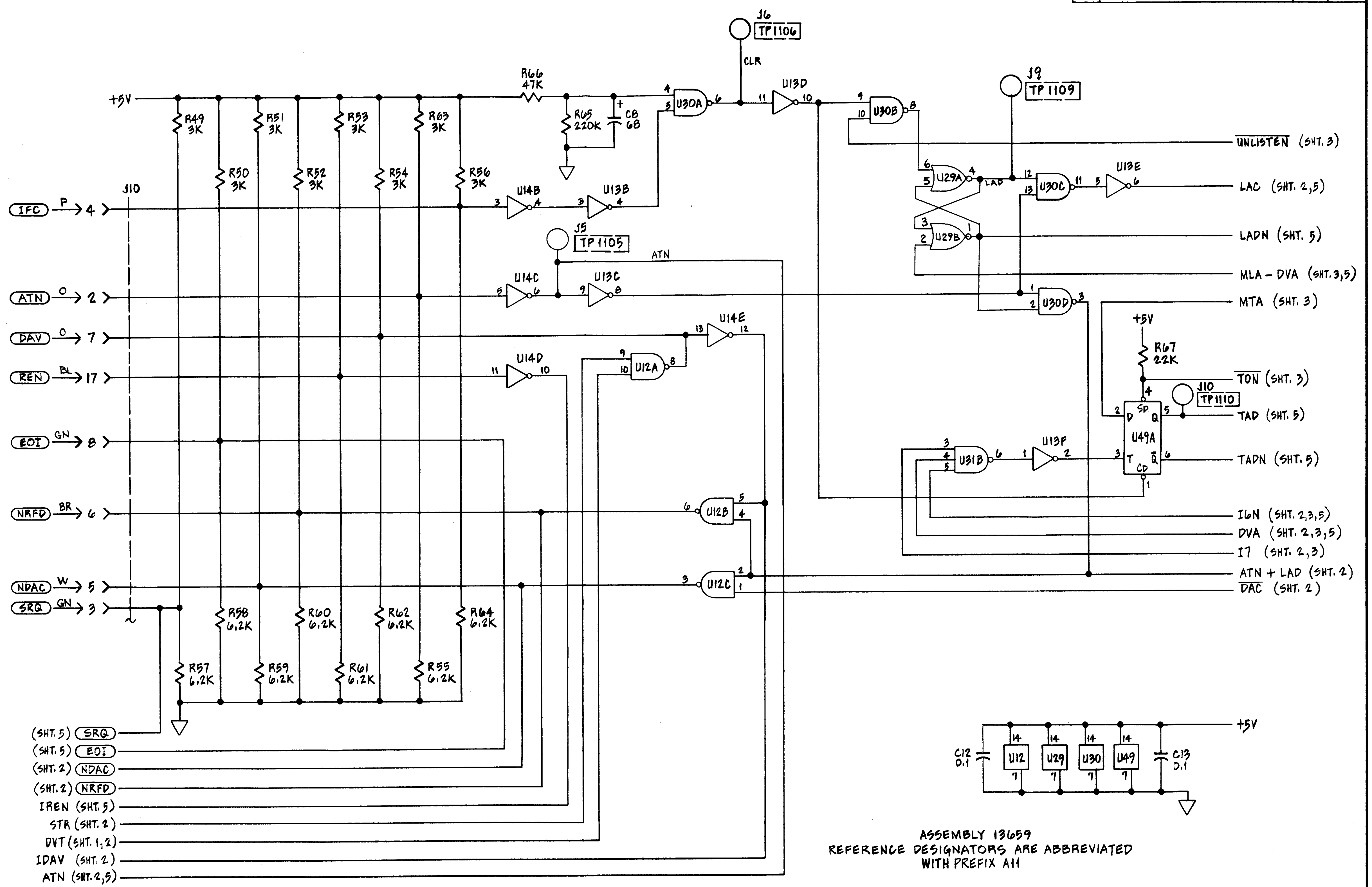
NEXT ASSY

DRAWN AN 11-11-77
ENG 7-11-78

PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

IEEE INTERFACE

DRAWING NO 13660 REV A
SHEET 3 OF 5



ASSEMBLY 13659
REFERENCE DESIGNATORS ARE ABBREVIATED
WITH PREFIX A11

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

REF DESIG	TYPE
U49	SN74LS74N
U31	SN74LS10N
U30	SN74LS00N
U29	SN74LS02N
U14	SN74LS14N
U13	SN74LS04N
U12	SN74LS38N

LIST OF MATERIAL

ITEM	REQD	PART NO.	DESCRIPTION

NEXT ASSY

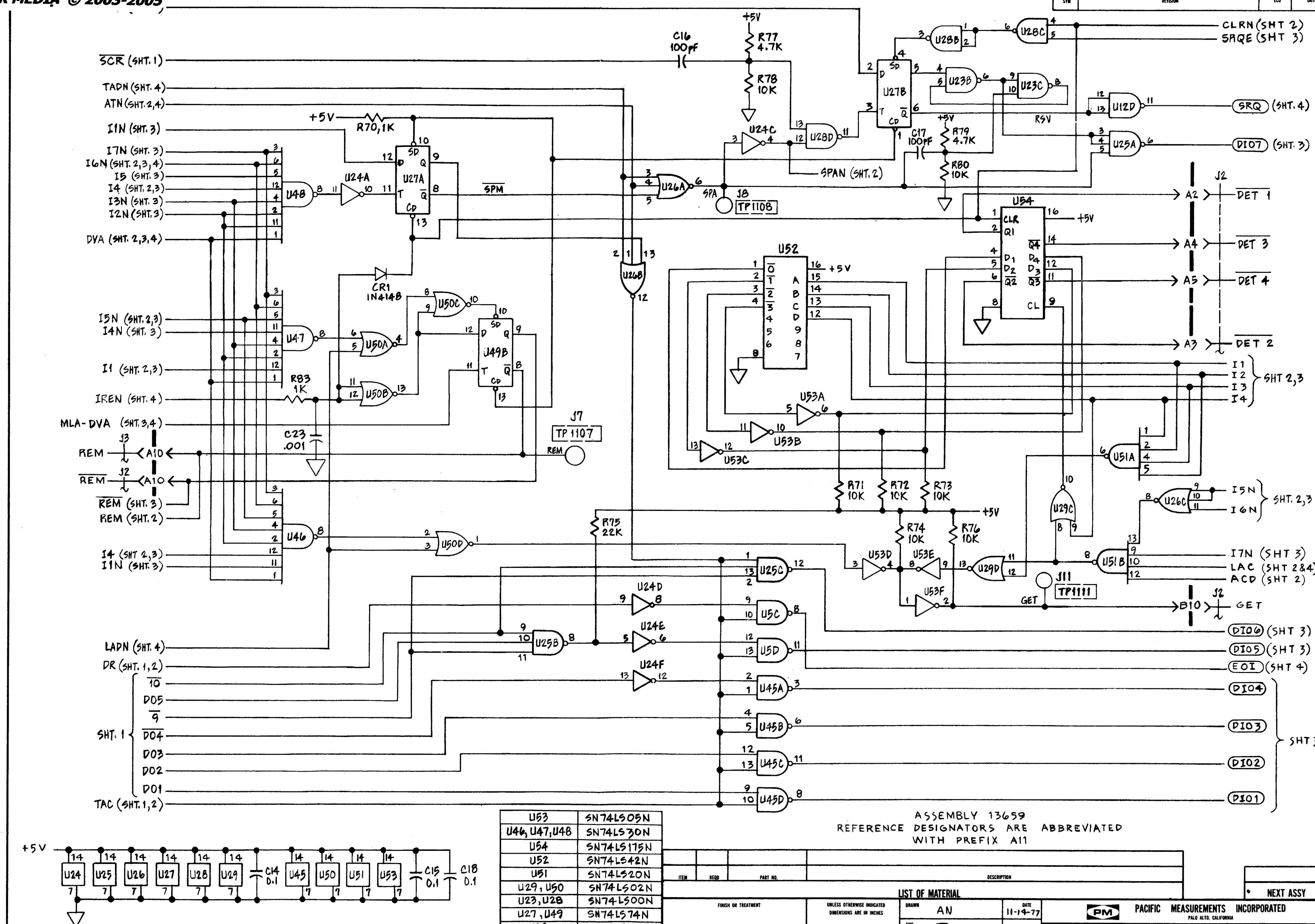
DRAWN AN 11-11-77
ENG RB 7-11-78

PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

IEEE INTERFACE

DRAWING NO. 13660 E

SHEET 4 OF 5



REF DESIG	TYPE
U53	SN74LS05N
U46, U47, U48	SN74LS30N
U54	SN74LS175N
U52	SN74LS42N
U51	SN74LS20N
U29, U50	SN74LS02N
U23, U28	SN74LS00N
U27, U49	SN74LS74N
U26	SN74LS27N
U25	SN74LS12N
U24	SN74LS04N
U5, U12, U45	SN74LS38N

ASSEMBLY 13659
REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A11

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

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

DRAWN	AN	11-14-77
ENG	RB	7-11-78
PROD		

PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

IEEE INTERFACE

DRAWING NO. 13660 REV H

SHEET 5 OF 5

SUPPLEMENTARY DATA

MODEL 1045 SPEC 5260

This instrument is equipped with the standard Model 1047 Adapter without the chassis slides.

REV	A													
ECO	—													
DATE	9/30/82													

	DATE	
ORIG		PACIFIC MEASUREMENTS INCORPORATED SUNNYVALE, CALIFORNIA
ENG Y. Ophuis	9-30-82	1045 SPEC 5260
PROD/TEST Gary S. Hurst	9/30/82	
Marketing	30 Sep 82	DOCUMENT NO. SPEC 5260
QA	9-30-82	SHEET 1 OF 1

SECTION 9

REPLACEABLE PARTS LISTINGS

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
		CHASSIS ASSEMBLY - 13900
C1	10000-11	Ceramic .01 µF ±20% 100V
J1	16364	AC Receptacle
J2	10048	Connector Type BNC UG-1094/U
J3	10048	Connector Type BNC UG-1094/U
J4	10048	Connector Type BNC UG-1094/U
J5	10048	Connector Type BNC UG-1094/U
J6	13257	Connector, 7 Contact
J7	---	(Part of W6 RF Cable Assy 14047)
M1	13894	Meter
R1	14082	Variable 25 KΩ 2W
R2, R3	14198	Variable 20 KΩ/10 KΩ 10 Turns
S1	10057	Toggle, DPDT
S2	10059	Miniature Slide, DPDT
T1	13577	Transformer
W1	13939	Flat Cable Assy
W2	14044-1	Flat Cable 30 Conductor
W3	13938-1	Flat Cable Assy
W4	13938-1	Flat Cable Assy
W5	13938-1	Flat Cable Assy
W6	14047	RF Cable Assy
F1	10064-2	Fuse 0.5A 250V
		CONTROL LOGIC AND AMPLIFIER PC BOARD ASSEMBLY-13455
A1C1	10000-10	Ceramic 0.1 µF +80% -20% 100V
A1C2	10000-10	Ceramic 0.1 µF +80% -20% 100V
A1C3	10000-11	Ceramic .01 µF ±20% 100V
A1C4	10000-11	Ceramic .01 µF ±20% 100V
A1C5	13979-1	Polycarbonate 1.0 µF ±10%
A1C6	10001-3	Ceramic 10 pF ±5% 1000 VDC
A1C7	---	Not Used
A1C8	10787-4	Tantalum 68 µF ±20% 15V
A1C9	10787-9	Tantalum 47 µF ±20% 15V
A1C10	10000-1	Tantalum 100 pF ±20% 1000V
A1C11	10787-8	Tantalum .47 µF ±20% 15V
A1C12	10787-5	Tantalum 1.0 µF ±20% 15V
A1C13	10000-11	Ceramic .01 µF ±20% 100V
A1C14	---	Not Used
A1C15	10787-3	Tantalum 27 µF ±20% 25V

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A1CR1	10043	1N4148
A1CR2	10043	1N4148
A1CR3	---	Not Used
A1CR4	---	Not Used
A1CR5	---	Not Used
A1CR6	---	Not Used
A1CR7	---	Not Used
A1CR8	10043	1N4148
A1CR9	10043	1N4148
A1Q1	11119	2N4250
A1Q2	11119	2N4250
A1Q3	11119	2N4250
A1Q4	11119	2N4250
A1Q5	11119	2N4250
A1Q6	12591	E112
A1Q7	12591	E112
A1Q8	12591	E112
A1Q9	12591	E112
A1Q10	12591	E112
A1Q11	11119	2N4250
A1Q12	11119	2N4250
A1Q13	11119	2N4250
A1Q14	11119	2N4250
A1Q15	11119	2N4250
A1Q16	11119	2N4250
A1Q17	11119	2N4250
A1Q18	12799	E109
A1Q19	12799	E109
A1Q20	12591	E112
A1Q21	12591	E112
A1Q22	10019	2N3565
A1Q23	14132	2N4119
A1Q24	12591	E112
A1Q25	10017	2N3569
A1Q26	12591	E112
A1Q27	12591	E112
A1Q28	10019	2N3565
A1Q29	11119	2N4250
A1Q30	12799	E109
A1Q31	11119	2N4250
A1R1	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A1R2	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A1R3	---	Not Used
A1R4	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R5	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R6	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R7	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R8	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R9	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R10	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R11	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R12	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R13	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R14	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R15	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R16	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R17	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R18	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R19	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A1R20	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A1R21	10013-41	Carbon Film 22 KΩ ±5% 1/4 W

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A1R22	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A1R23	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A1R24	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R25	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A1R26	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R27	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R28	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R29	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R30	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R31	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R32	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R33	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R34	10013-96	Carbon Film 20 KΩ ±5% 1/4 W
A1R35	10013-96	Carbon Film 20 KΩ ±5% 1/4 W
A1R36	10013-96	Carbon Film 20 KΩ ±5% 1/4 W
A1R37	10013-96	Carbon Film 20 KΩ ±5% 1/4 W
A1R38	10013-96	Carbon Film 20 KΩ ±5% 1/4 W
A1R39	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A1R40	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A1R41	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A1R42	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A1R43	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A1R44	---	Not Used
A1R45	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A1R46	10015-118	Metal Film 28.7 KΩ ±1% 1/8 W
A1R47	10015-248	Metal Film 44.2 KΩ ±1% 1/8 W
A1R48	10015-63	Metal Film 402 KΩ ±1% 1/8 W
A1R49	10015-237	Metal Film 165 KΩ ±1% 1/8 W
A1R50	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A1R51	12449-53	Metal Film 50.00 KΩ ±0.1% 1/8 W
A1R52	10015-248	Metal Film 44.2 KΩ ±1% 1/8 W
A1R53	10015-118	Metal Film 28.7 KΩ ±1% 1/8 W
A1R54	12449-64	Metal Film 18.18 KΩ ±0.1% 1/8 W
A1R55	10015-14	Metal Film 316KΩ ±1% 1/4W
A1R56	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R57	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R58	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R59	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R60	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R61	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R62	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R63	10013-96	Carbon Film 20 KΩ ±5% 1/4 W
A1R64	10013-96	Carbon Film 20 KΩ ±5% 1/4 W
A1R65	10013-96	Carbon Film 20 KΩ ±5% 1/4 W
A1R66	10013-96	Carbon Film 20 KΩ ±5% 1/4 W
A1R67	10013-96	Carbon Film 20 KΩ ±5% 1/4 W
A1R68	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A1R69	11695-3	Prec. WW 25.00 KΩ ±.01% 1/8 W
A1R70	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A1R71	11695-4	Prec. WW 50.00 KΩ ±.01% 1/8 W
A1R72	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A1R73	12449-33	Metal Film 100 KΩ ±0.1% 1/8 W
A1R74	10013-57	Carbon Film 470 Ω ±5% 1/4 W
A1R75	12449-33	Metal Film 100 KΩ ±0.1% 1/8 W
A1R76	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A1R77	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A1R78	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A1R79	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A1R80	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A1R81	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A1R82	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A1R83	10046-10	Variable Comp 100KΩ ±20% 1/4W
A1R84	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A1R85	---	Not Used
A1R86	---	Not Used
A1R87	---	Not Used
A1R88	10013-37	Carbon Film 10KΩ ±5% 1/4W
A1R89	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A1R90	10013-51	Carbon Film 150 KΩ ±5% 1/4 W
A1R91	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A1R92	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A1R93	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R94	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R95	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A1R96	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A1R97	10013-21	Carbon Film 470 Ω ±5% 1/4 W
A1R98	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A1R99	10013-47	Carbon Film 68 KΩ ±5% 1/4 W
A1R100	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R101	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R102	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R103	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R104	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R105	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R106	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R107	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R108	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R109	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R110	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R111	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R112	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R113	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R114	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R115	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R116	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R117	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R118	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A1R119	12449-21	Metal Film 10.00 KΩ ±0.1% 1/8 W
A1R120	10015-106	Metal Film 6.81 KΩ ±1% 1/8 W
A1R121	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A1R122	10013-96	Carbon Film 20 KΩ ±5% 1/4 W
A1R123	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R124	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A1R125	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A1R126	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R127	10013-43	Carbon Film 33KΩ ±5% 1/4W
A1R128	10013-43	Carbon Film 33KΩ ±5% 1/4W
A1U1	13470-17	SN74LS123N
A1U2	13470-6	SN74LS10N
A1U3	11270-1	SN7400N
A1U4	13470-28	SN74LS190N
A1U5	13470-12	SN74LS42N
A1U6	13470-6	SN74LS10N
A1U7	13470-6	SN74LS10N
A1U8	13470-1	SN74LS00N
A1U9	13470-3	SN74LS02N
A1U10	13470-4	SN74LS04N
A1U11	11270-34	SN7407N
A1U12	11270-1	SN7400N
A1U13	13470-6	SN74LS10N
A1U14	13470-1	SN74LS00N
A1U15	11270-34	SN7407N
A1U16	13470-1	SN74LS00N
A1U17	13470-4	SN74LS04N
A1U18	13470-3	SN74LS02N
A1U19	13470-4	SN74LS04N
A1U20	13470-3	SN74LS02N
A1U21	13470-3	SN74LS02N
A1U22	13470-9	SN74LS27N
A1U23	13892	CA3140T
A1U24	13470-18	SN74LS221N
A1U25	13470-1	SN74LS00N

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
		ANALOG AND PREAMP PC BOARD ASSEMBLY 13509
A2C1	10000-1	Ceramic 100 pF ±20% 1000 VDC
A2C2	10001-6	Ceramic 47 pF ±5% 1000 VDC
A2C3	10001-2	Ceramic 4.7 pF ±5% 1000 VDC
A2C4	10007-6	Mylar .047 µF ±10% 200 VDC
A2C5	10630-1	Variable Ceramic 2-8 pF
A2C6	-------	Factory Selected Value
A2C7	10133-2	Ceramic .5 pF ±.25 pF 500 VDC
A2C8	10007-7	Mylar 0.1 µF ±10% 200 VDC
A2C9-	10001-6	Ceramic 47 pF ±5% 1000 VDC
A2C19	10787-8	Tantalum .47 µF ±20% 15 VDC
A2C20	10011-2	Mylar 1 µF ±10% 200 VDC
A2C21	10787-1	Tantalum 4.7 µF ±20% 15 VDC
A2C22	10011-2	Mylar 1 µF ±10% 200 VDC
A2C23	10787-3	Tantalum 27 µF ±20% 25 VDC
A2C24	10787-3	Tantalum 27 µF ±20% 25 VDC
A2C25	---	Not Used
A2C26	10000-9	Ceramic .05 µF +80% -20% 500 VDC
A2C27	10001-16	Ceramic 120 pF ±5% 1000 VDC
A2C28	10000-5	Ceramic .0022 µF ±20% 500 VDC
A2C29	10787-4	Tantalum 68 µF ±20% 15 VDC
A2C30	10001-14	Ceramic 68 pF ±5% 1000 VDC
A2C31	---	Not Used
A2C32	---	Not Used
A2C33	10000-4	Ceramic .001 µF ±20% 1000 VDC
A2C34	10000-8	Ceramic .02 µF ±20% 500 VDC
A2C35	10000-9	Ceramic .05 µF +80%-20% 1000 VDC
A2C36	10007-7	Mylar 0.1 µF ±10% 200 VDC
A2C37	10007-7	Mylar 0.1 µF ±10% 200 VDC
A2C38	10133-3	Ceramic 1 pF ±.25 pF 500 VDC
A2C39	10007-6	Mylar .047 µF ±10% 200 VDC
A2C40	10000-11	Ceramic .01 µF ±20% 100 VDC
A2C41	10000-4	Ceramic .001 µF ±20% 1000 VDC
A2C42	10000-11	Ceramic .01 µF ±20% 100 VDC
A2C43	10787-2	Tantalum 12 µF ±20% 20 VDC
A2C44	10001-12	Ceramic 3.3 pF ±5% 1000 VDC
A2C45	10787-5	Tantalum 1.0 µF ±20% 15 VDC
A2C46	10011-2	Mylar 1 µF ±10% 200 VDC
A2C47	10787-8	Tantalum .47 µF ±20% 15 VDC
A2C48	10677-4	Mica 330 pF ±5% 500 VDC
A2C49	10787-1	Tantalum 4.7 µF ±20% 15 VDC
A2C50	11501-2	Ceramic 0.1 µF ±80%-20% 100VDC
A2C51	10000-9	Ceramic .05 µF +80% -20% 1000 VDC
A2C52	10585-7	Ceramic 3300 pF ±5% 500 VDC
A2C53	11501-2	Ceramic 0.1 µF +80%-20% 100VDC
A2C54	10000-3	Ceramic 470 pF ±20% 1000 VDC
A2C55	10787-2	Tantalum 12 µF ±20% 20 VDC
A2C56	10787-1	Tantalum 4.7 µF ±20% 15 VDC
A2C57	10000-11	Ceramic .01 µF ±20% 100 VDC
A2C58	10000-11	Ceramic .01 µF ±20% 100 VDC
A2C59	---	Not Used
A2C60	---	Not Used
A2C61	10787-1	Tantalum 4.7 µF ±20% 15 VDC
A2C62	10000-11	Ceramic .01 µF ±20% 100 VDC
A2C63	10000-11	Ceramic .01 µF ±20% 100 VDC
A2C64	10787-1	Tantalum 4.7 µF ±20% 15 VDC
A2C65	10000-11	Ceramic .01 µF ±20% 100 VDC
A2C66	10000-11	Ceramic .01 µF ±20% 100 VDC
A2C67	10011-2	Mylar 1 µF ±10% 200 VDC
A2C68	10001-12	Ceramic 3.3 pF ±5% 1000 VDC
A2C69	10000-11	Ceramic .01 µF ±20% 100 VDC
A2C70	10000-11	Ceramic .01 µF ±20% 100 VDC
A2C71	10011-2	Mylar 1 µF ±10% 200 VDC
A2C72	---	Not Used
A2C73	---	Not Used
A2C74	10001-5	Ceramic 33 pF ±5% 1000 VDC
A2C75	10001-5	Ceramic 33 pF ±5% 1000 VDC
A2C76	11501-2	Ceramic .1 µF +80% -20% 100 VDC
A2C77	10000-11	Ceramic .01 µF ±20% 100 VDC
A2C78	10000-11	Ceramic .01 µF ±20% 100 VDC
A2C79	10000-11	Ceramic .01 µF ±20% 100 VDC
A2C80	10000-11	Ceramic .01 µF ±20% 100 VDC
A2C90	---	Not Used
A2C91	10000-11	Ceramic .01 µF ±20% 100 VDC
A2C92	10007-2	Mylar .0022 µF ±10% 200 V
A2CR1	10043	1N4148
A2CR2	10043	1N4148
A2CR3	10043	1N4148
A2CR4	10043	1N4148
A2CR5	10043	1N4148
A2CR6	---	Not Used
A2CR7	10045	1N823
A2CR8	10043	1N4148
A2CR9	10045	1N823
A2CR10	---	Not Used
A2CR11	---	Not Used
A2CR12	10043	1N4148
A2CR13	10043	1N4148
A2CR14	10043	1N4148
A2CR15	10043	1N4148
A2CR16	10043	1N4148
A2J1	10140-2	Test Jack, Yellow
A2J2	10140-3	Test Jack, Black
A2J3	10140-2	Test Jack, Yellow
A2J4	10140-2	Test Jack, Yellow
A2J5	10140-1	Test Jack, Red
A2J6	---	Not Used
A2J7	10140-4	Test Jack, Blue
A2J8	10140-2	Test Jack, Yellow
A2J9	10140-1	Test Jack, Red
A2J10	10140-4	Test Jack, Blue
A2J11	10140-1	Test Jack, Red
A2J12	10140-4	Test Jack, Blue
A2J13	10140-2	Test Jack, Yellow
A2J14	10140-2	Test Jack, Yellow
A2J15	10140-2	Test Jack, Yellow
A2J16	10140-2	Test Jack, Yellow
A2J17	10140-1	Test Jack, Red
A2J18	10140-3	Test Jack, Black
A2J19	10140-4	Test Jack, Blue
A2J20	10140-2	Test Jack, Yellow
A2J21	10140-2	Test Jack, Yellow
A2J22	10140-2	Test Jack, Yellow

CIRCUIT REFERENCE	PART NO.	DESCRIPTION
A2J23	---	Not Used
A2J24	10140-2	Test Jack, Yellow
A2Q1	10896	MFE 3004 or 3N138*
A2Q2	10896	MFE 3004 or 3N138*
A2Q3	13916	E230
A2Q4	11507	TIS97
A2Q5	10019	2N3565
A2Q6	11507	TIS97
A2Q7	13916	E230
A2Q8	12591	E112
A2Q9	11507	TIS97
A2Q10	10019	2N3565
A2Q11	11119	2N4250
A2Q12	12591	E112
A2Q13	12591	E112
A2Q14	10019	2N3565
A2Q15	---	Not Used
A2Q16	---	Not Used
A2Q17	---	Not Used
A2Q18	11432	2N3955
A2Q19	12591	E112
A2Q20	12591	E112
A2Q21	10019	2N3565
A2Q22	10019	2N3565
A2Q23	12591	E112
A2Q24	13249-1	2N3808
A2Q25	---	Not Used
A2Q26	---	Not Used
A2Q27	---	Not Used
A2Q28	11507	TIS97
A2Q29	12591	E112
A2Q30	12591	E112
A2Q31	12591	E112
A2Q32	10017	2N3569
A2Q33	12439-1	2N5785
A2Q34	---	Not Used
A2Q35	---	Not Used
A2Q36	---	Not Used
A2Q37	10019	2N3565
A2Q38	12591	E112
A2Q39	12591	E112
A2Q40	11119	2N4250
A2Q41	10019	2N3565
A2Q42	10019	2N3565
A2Q43	12591	E112
A2Q44	10019	2N3565
A2Q45	12591	E112
A2Q46	13915	2N2642
A2Q47	11119	2N4250
A2Q48	11119	2N4250
A2Q49	12591	E112
A2Q50	12591	E112
A2Q51	10019	2N3565
A2Q52	---	Not Used
A2Q53	---	Not Used
A2Q54	10019	2N3565
A2Q55	12799	E109
A2R1	10015-65	Metal Film 4.99 KΩ ±1% 1/8 W
A2R2	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R3	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R4	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A2R5	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A2R6	10015-83	Metal Film 261 Ω ±1% 1/8 W
A2R7	10013-73	Carbon Film 10 MΩ ±5% 1/4 W
A2R8	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R9	10015-188	Metal Film 33.2 KΩ ±1% 1/8 W
A2R10	10015-87	Metal Film 15 KΩ ±1% 1/8 W
A2R11	10015-106	Metal Film 6.81 KΩ ±1% 1/8 W
A2R12	10015-87	Metal Film 15 KΩ ±1% 1/8 W
A2R13	10015-96	Metal Film 12.1 KΩ ±1% 1/8 W
A2R14	10015-189	Metal Film 5.90 KΩ ±1% 1/8 W
A2R15	10015-188	Metal Film 33.2 KΩ ±1% 1/8 W
A2R16	10015-13	Metal Film 100 KΩ ±1% 1/8 W
A2R17	10142-4	Carbon Comp 22 MΩ ±5% 1/4 W
A2R18	10015-210	Metal Film 150 KΩ ±1% 1/8 W
A2R19	10015-7	Metal Film 10.0 KΩ ±1% 1/8 W
A2R20	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A2R21	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R22	10015-13	Metal Film 100 KΩ ±1% 1/8 W
A2R23	10013-11	Carbon Film 68 Ω ±5% 1/4 W
A2R24	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R25	10013-64	Carbon Film 1.8 MΩ ±5% 1/4 W
A2R26	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A2R27	10013-64	Carbon Film 1.8 MΩ ±5% 1/4 W
A2R28	10013-11	Carbon Film 68 Ω ±5% 1/4 W
A2R29	10013-11	Carbon Film 68 Ω ±5% 1/4 W
A2R30	10015-89	Metal Film 3.09 KΩ ±1% 1/8 W
A2R31	10013-7	Carbon Film 33Ω ±5% 1/4 W
A2R32	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R33	---	Not Used
A2R34	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R35	10015-117	Metal Film 54.9 KΩ ±1% 1/8 W
A2R36	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R37	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R38	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R39	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R40	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R41	10013-11	Carbon Film 68 Ω ±5% 1/4 W
A2R42	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R43	10013-73	Carbon Film 10 MΩ ±5% 1/4 W
A2R44	10013-73	Carbon Film 10 MΩ ±5% 1/4 W
A2R45	10015-13	Metal Film 100 KΩ ±1% 1/8 W
A2R46	10015-248	Metal Film 44.2 KΩ ±1% 1/8 W
A2R47	10015-250	Metal Film 60.4 KΩ ±1% 1/8 W
A2R48	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R49	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R50	10015-248	Metal Film 44.2 KΩ ±1% 1/8 W
A2R51	10015-68	Metal Film 100 Ω ±1% 1/8 W
A2R52	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R53	10015-102	Metal Film 249 KΩ ±1% 1/8 W
A2R54	10013-1	Carbon Film 10 Ω ±5% 1/4 W
A2R55	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R56	10013-7	Carbon Film 33 Ω ±5% 1/4 W
A2R57	10015-230	Metal Film 11 KΩ ±1% 1/8 W
A2R58	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R59	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R60	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R61	10046-11	Variable Comp 250 KΩ ±20% 1/4 W
A2R62	10013-5	Carbon Film 22 Ω ±5% 1/4 W
A2R63	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R64	10015-13	Metal Film 100 KΩ ±1% 1/8 W
A2R65	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R66	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R67	10015-15	Metal Film 21.5 KΩ ±1% 1/8 W
A2R68	10046-7	Variable Comp 1 KΩ ±20% 1/5 W
A2R69	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A2R70	10015-102	Metal Film 249 KΩ ±1% 1/8 W
A2R71	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R72	10015-40	Metal Film 43.2 KΩ ±1% 1/8 W
A2R73	10046-10	Variable Comp 100 KΩ ±20% 1/4 W

*A2Q1 and A2Q2 must come from same mfr.

CIRCUIT REFERENCE	PART NO.	DESCRIPTION
A2R74	10015-247	Metal Film 22.1 KΩ ±1% 1/8 W
A2R75	10015-40	Metal Film 43.2 KΩ ±1% 1/8 W
A2R76	10015-251	Metal Film 118 KΩ ±1% 1/8 W
A2R77	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R78	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R79	10142-8	Carbon Comp 47Ω ±5% 1/4 W
A2R80	10142-8	Carbon Comp 47Ω ±5% 1/4 W
A2R81	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R82	10015-235	Metal Film 147 KΩ ±1% 1/8 W
A2R83	10013-5	Carbon Film 22 Ω ±5% 1/4 W
A2R84	10015-78	Metal Film 2.26 KΩ ±1% 1/8 W
A2R85	10015-39	Metal Film 464 Ω ±1% 1/8 W
A2R86	10015-31	Metal Film 3.16 KΩ ±1% 1/8 W
A2R87	10015-7	Metal Film 10 KΩ ±1% 1/8 W
A2R88	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R89	10046-4	Variable Comp 5 KΩ ±20% 1/4 W
A2R90	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A2R91	10015-72	Metal Film 1.96 KΩ ±1% 1/8 W
A2R92	10046-6	Variable Comp 200 Ω ±20% 1/5 W
A2R93	10015-109	Metal Film 348 KΩ ±1% 1/8 W
A2R94	10015-253	Metal Film 30.9 KΩ ±1% 1/8W
A2R95	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A2R96	10015-109	Metal Film 348 KΩ ±1% 1/8W
A2R97	10015-252	Metal Film 453 KΩ ±1% 1/8 W
A2R98	10015-13	Metal Film 100 KΩ ±1% 1/8 W
A2R99	10015-13	Metal Film 100 KΩ ±1% 1/8 W
A2R100	10015-237	Metal Film 165 KΩ ±1% 1/8 W
A2R101	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A2R102	10015-6	Metal Film 464KΩ ±1% 1/8W
A2R103	10013-11	Carbon Film 68 Ω ±5% 1/4 W
A2R104	10015-13	Metal Film 100 KΩ ±1% 1/8 W
A2R105	10015-188	Metal Film 33.2 KΩ ±1% 1/8 W
A2R106	10015-209	Metal Film 130 KΩ ±1% 1/8 W
A2R107	10015-20	Metal Film 1.1 KΩ ±1% 1/8 W
A2R108	10015-183	Metal Film 80.6 KΩ ±1% 1/8W
A2R109	10015-184	Metal Film 243 KΩ ±1% 1/8W
A2R110	10015-34	Metal Film 162 KΩ ±1% 1/8 W
A2R111	10015-74	Metal Film 2.0 KΩ ±1% 1/8 W
A2R112	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R113	10015-102	Metal Film 249 KΩ ±1% 1/8 W
A2R114	10015-81	Metal Film 11.3 KΩ ±1% 1/8 W
A2R115	10015-85	Metal Film 287 KΩ ±1% 1/8 W
A2R116	10013-58	Carbon Film 560 KΩ ±5% 1/8 W
A2R117	10046-12	Variable Comp 500 KΩ ±20% 1/4 W
A2R118	10015-85	Metal Film 287 KΩ ±1% 1/8 W
A2R119	10015-60	Metal Film 19.6 KΩ ±1% 1/8 W
A2R120	10015-71	Metal Film 909 Ω ±1% 1/8 W
A2R121	10015-254	Metal Film 8.45 KΩ ±1% 1/8 W
A2R122	---	Not Used
A2R123	10015-7	Metal Film 10 KΩ ±1% 1/8 W
A2R124	10013-78	Carbon Film 2.0 KΩ ±5% 1/4 W
A2R125	11711-4	Variable Cermet 1 KΩ ±20% 1/2 W
A2R126	10015-189	Metal Film 5.90 KΩ ±1% 1/8 W
A2R127	10046-9	Variable Comp 100 Ω ±20% 1/5 W
A2R128	12449-21	Metal Film 10 KΩ ±0.1% 1/8 W
A2R129	12449-21	Metal Film 10 KΩ ±0.1% 1/8 W
A2R130	10015-65	Metal Film 4.99 KΩ ±1% 1/8 W
A2R131	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A2R132	10015-47	Metal Film 2.49 KΩ ±1% 1/8 W
A2R133	10015-180	Metal Film 280 KΩ ±1% 1/8 W
A2R134	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R135	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R136	10013-49	Metal Film 100 KΩ ±5% 1/8 W
A2R137	10013-27	Carbon Film 1.5 KΩ ±5% 1/4 W
A2R138	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A2R139	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R140	10015-232	Metal Film 432 KΩ ±1% 1/8 W
A2R141	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R142	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A2R143	10015-82	Metal Film 61.9 Ω ±1% 1/8 W
A2R144	10013-25	Carbon Film 1 KΩ ±5% 1/4 W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION
A2R145	11711-4	Variable Cermet 1 KΩ ±20% 1/2 W
A2R146	10015-7	Metal Film 10 KΩ ±1% 1/8 W
A2R147	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A2R148	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A2R149	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R150	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R151	10015-227	Metal Film 9.31 KΩ ±1% 1/8 W
A2R152	10013-78	Carbon Film 2.0 KΩ ±5% 1/4 W
A2R153	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R154	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A2R155	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A2R156	10015-65	Metal Film 4.99 KΩ ±1% 1/8 W
A2R157	10015-7	Metal Film 10 KΩ ±1% 1/8 W
A2R158	10015-34	Metal Film 162 KΩ ±1% 1/8 W
A2R159	10046-9	Variable Comp 100 Ω ±20% 1/5 W
A2R160	12449-21	Metal Film 10.00 KΩ ±0.1% 1/8 W
A2R161	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A2R162	10013-83	Carbon Film 62 KΩ ±5% 1/4 W
A2R163	12449-21	Metal Film 10.00 KΩ ±0.1% 1/8 W
A2R164	10015-65	Metal Film 4.99 KΩ ±1% 1/8 W
A2R165	10015-19	Metal Film 1.00 KΩ ±1% 1/8 W
A2R166	10015-174	Metal Film 1.62 KΩ ±1% 1/8 W
A2R167	10046-6	Variable Comp 200 Ω ±20% 1/5 W
A2R168	10015-211	Metal Film 2.74 KΩ ±1% 1/8 W
A2R169	10015-7	Metal Film 10 KΩ ±1% 1/8 W
A2R170	10015-47	Metal Film 2.49 KΩ ±1% 1/8 W
A2R171	10015-7	Metal Film 10 KΩ ±1% 1/8 W
A2R172	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R173	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R174	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R175	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R176	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R177	10241-9	Carbon Comp 2 Ω ±5% 1/2 W
A2R178	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A2R179	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A2R180	---	Not Used
A2R181	---	Not Used
A2R182	---	Not Used
A2R183	10013-28	Carbon Film 1.8 KΩ ±5% 1/4 W
A2R184	10015-57	Metal Film 8.66 KΩ ±1% 1/8 W
A2R185	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A2R186	11695-2	Metal Film 10.000 KΩ ±.01% 1/8 W
A2R187	10015-57	Metal Film 8.66 KΩ ±1% 1/8 W
A2R188	10015-85	Metal Film 287 KΩ ±1% 1/8 W
A2R189	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A2R190	10015-207	Metal Film 20 KΩ ±1% 1/8 W
A2R191	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A2R192	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A2R193	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A2R194	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R195	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R196	10015-78	Metal Film 2.26 KΩ ±1% 1/8 W
A2R197	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A2R198	10015-7	Metal Film 10 KΩ ±1% 1/8 W
A2R199	10015-67	Metal Film 143 KΩ ±1% 1/8 W
A2R200	10013-38	Carbon Film 12 KΩ ±5% 1/4 W
A2R201	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A2R202	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A2R203	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A2R204	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A2R205	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A2R206	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A2R207	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R208	10015-13	Metal Film 100 KΩ ±1% 1/8 W
A2R209	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A2R210	11695-2	Prec. WW 10.000 KΩ ±.01% 1/8 W
A2R211	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A2R212	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A2R213	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R214	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R215	10015-13	Metal Film 100 KΩ ±1% 1/8 W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION
A2R216	11711-5	Variable Comp 250 KΩ ±20% 1/4 W
A2R217	10015-255	Metal Film 115 KΩ ±1% 1/8 W
A2R218	10015-11	Metal Film 16.2 KΩ ±1% 1/8 W
A2R219	10046-9	Variable Comp 100 Ω ±20% 1/5 W
A2R220	10015-20	Metal Film 1.1 KΩ ±1% 1/8 W
A2R221	11695-2	Prec. WW 10.000 KΩ ±.01% 1/8 W
A2R222	---	Not Used
A2R223	11695-2	Prec. WW 10.000 KΩ ±.01% 1/8 W
A2R224	10015-225	Metal Film 3.32 KΩ ±1% 1/8 W
A2R225	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R226	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R227	---	Not Used
A2R228	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A2R229	10013-92	Carbon Film 160 KΩ ±5% 1/4 W
A2R230	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R231	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R232	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A2R233	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R234	12449-21	Metal Film 10 KΩ ±0.1% 1/8 W
A2R235	---	Not Used
A2R236	10015-28	Metal Film 23.7 KΩ ±1% 1/8 W
A2R237	10015-28	Metal Film 23.7 KΩ ±1% 1/8 W
A2R238	10013-15	Carbon Film 150 Ω ±5% 1/4 W
A2R239	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R240	10013-59	Carbon Film 680 KΩ ±5% 1/4 W
A2R241	10013-67	Carbon Film 3.3 MΩ ±5% 1/4 W
A2R242	10013-57	Carbon Film 470 KΩ ±5% 1/8 W
A2R243	10013-57	Carbon Film 470 KΩ ±5% 1/8 W
A2R244	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A2R245	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R246	---	Not Used
A2R247	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R248	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A2R249	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A2R250	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R251	10013-23	Carbon Film 680 Ω ±5% 1/4 W
A2R252	---	Not Used
A2R253	---	Not Used
A2R254	---	Not Used
A2R255	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A2R256	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R257	10013-65	Carbon Film 2.2 MΩ ±5% 1/4 W
A2R258	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R259	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A2R260	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R261	10013-35	Carbon Film 6.8 KΩ ±5% 1/4 W
A2R262	10013-13	Carbon Film 100Ω ±5% 1/4 W
A2RT1	13914	Thermistor 10 KΩ ±10%
A2U1	13253-2	CD4060AE
A2U2	13253-1	CD4001AE
A2U3	12445	LM725C
A2U4	---	Not Used
A2U5	12445	LM725C
A2U6	11118	CA3039
A2U7	11627	LM301A
A2U8	12445	LM725C
A2U9	13587	TL084C
A2U10	13471	LM324N
A2U11	13476	MCT-6
A2U12	13476	MCT-6
A2U13	13892	CA3140T

CIRCUIT REFERENCE	PART NO.	DESCRIPTION
A2U14	11627	LM301A
A2U15	13471	LM324
A2U16	13587	TL084C
A2U17	14226	TL074CN
A2U18	11539	741C
A2U19	13476	MCT-6

DISPLAY LOGIC AND D/A CONVERTER P.C. BOARD ASSEMBLY-13421

CIRCUIT REFERENCE	PART NO.	DESCRIPTION
A3C1	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A3C2	10000-4	Ceramic .001 µF ±5% 1000 V
A3C3	10585-5	Ceramic .001 µF ±20% 1000 V
A3C4	---	Not Used
A3C5	---	Not Used
A3C6	---	Not Used
A3C7	10000-11	Ceramic .01 µF ±20% 100 V
A3C8	10000-4	Ceramic .001 µF ±20% 1000 V
A3C9	10001-4	Ceramic 22 pF ±5% 1000 V
A3C10	10000-11	Ceramic .01 µF ±20% 100 V
A3C11	10007-7	Mylar 0.1 µF ±10% 200 V
A3C12	10007-7	Mylar 0.1 µF ±10% 200 V
A3C13	10909-2	Mica 470 pF ±1% 500 V
A3C14	10000-11	Ceramic .01 µF ±20% 100 V
A3C15	---	Not Used
A3C16	10000-3	Ceramic 470 pF ±20% 1000 V
A3C17	10000-11	Ceramic .01 µF ±20% 100 V
A3C18	10000-3	Ceramic 470 pF ±20% 1000 V
A3C19	10000-8	Ceramic .022 µF ±20% 500 V
A3C20	10000-11	Ceramic .01 µF ±20% 100 V
A3C21	10000-11	Ceramic .01 µF ±20% 100 V
A3C22	14119-1	Polystyrene .01 µF ±2.5% 160 V
A3C23	10000-11	Ceramic .01 µF ±20% 100 V
A3C24	10000-11	Ceramic .01 µF ±20% 100 V
A3C25	10787-4	Tantalum 68 µF ±20% 20 V
A3C26	10000-11	Ceramic .01 µF ±20% 100 V
A3C27	10000-8	Ceramic .022 µF ±20% 500 V
A3C28	10000-11	Ceramic .01 µF ±20% 100 V
A3C29	---	Not Used
A3C30	10000-11	Ceramic .01 µF ±20% 100 V
A3C31	10000-11	Ceramic .01 µF ±20% 100 V
A3C32	10001-6	Ceramic 47 pF ±5% 1000 V
A3C33	10000-11	Ceramic .01 µF ±20% 100 V
A3C34	10000-11	Ceramic .01 µF ±20% 100 V
A3C35	10585-5	Ceramic .001 µF ±5% 1000 V
A3C36	10000-11	Ceramic .01 µF ±20% 100 V
A3C37	10585-5	Ceramic .001 µF ±5% 1000 V
A3C38	10677-17	Mica 680 pF ±5% 300 V
A3C39	10677-2	Mica 220 pF ±5% 500 V
A3C40	10000-1	Ceramic 100 pF ±20% 1000 V
A3C41	10677-8	Mica 82 pF ±5% 500 V
A3C42	---	Not Used
A3C43	10677-9	Mica 120 pF ±5% 500 V
A3C44	10677-16	Mica 43 pF ±5% 500 V
A3C45	10677-8	Mica 82 pF ±5% 500 V
A3C46	---	Not Used
A3C47	10000-11	Ceramic .01 µF ±20% 100 V
A3C48	10000-4	Ceramic .001 µF ±20% 1000 V
A3C49	10001-1	Ceramic 2.2 pF ±5% 1000 V
A3C50	10000-4	Ceramic .001µF ±20% 1000V
A3C51	10000-2	Ceramic 220pF ±10% 100V
A3C52	10000-2	Ceramic 220pF ±10% 100V
A3C53	10000-2	Ceramic 220pF ±10% 100V
A3C54	10000-2	Ceramic 220pF ±10% 100V

CIRCUIT REFERENCE	PART NO.	DESCRIPTION
A3CR1	10043	IN4148
A3CR2	10043	IN4148
A3CR3	---	Not Used
A3CR4	10043	IN4148
A3CR5	10043	IN4148
A3CR6	10043	IN4148
A3CR7	10043	IN4148
A3CR8	10045	IN823A
A3CR9	---	Not Used
A3CR10	10043	IN4148
A3CR11	10043	IN4148
A3CR12	10043	IN4148
A3CR13	10043	IN4148
A3CR14	10043	IN4148
A3CR15	10043	IN4148
A3CR16	10043	IN4148
A3CR17	10043	IN4148
A3CR18	10043	IN4148
A3CR19	10043	IN4148
A3CR20	10043	IN4148
A3CR21	10043	IN4148
A3CR22	10043	IN4148
A3CR23	10043	IN4148
A3CR24	10043	IN4148
A3CR25	10043	IN4148
A3CR26	---	Not Used
A3CR27	---	Not Used
A3CR28	---	Not Used
A3CR29	---	Not Used
A3CR30	10043	IN4148
A3CR31	10045	IN823A
A3CR32	10043	IN4148
A3CR33	10043	IN4148
A3J1	10140-1	Test Jack, Red
A3J2	10140-2	Test Jack, Yellow
A3J3	10140-2	Test Jack, Yellow
A3J4	10140-3	Test Jack, Black
A3J5	10140-2	Test Jack, Yellow
A3J6	10140-2	Test Jack, Yellow
A3J7	10140-2	Test Jack, Yellow
A3J8	10140-2	Test Jack, Yellow
A3J9	10140-2	Test Jack, Yellow
A3J10	13271	Connector, SMB
A3J11	10140-2	Test Jack, Yellow
A3L1	16642	Coil, RF 4 Turns
A3L2	10631-11	Coil, RF .33 µH ±10%
A3L3	10631-11	Coil, RF .33 µH ±10%
A3Q1	10018	2N3646
A3Q2	---	Not Used
A3Q3	---	Not Used
A3Q4	11507	TIS97
A3Q5	11507	TIS97
A3Q6	---	Not Used
A3Q7	---	Not Used
A3Q8	---	Not Used
A3Q9	10018	2N3646
A3Q10	---	Not Used

CIRCUIT REFERENCE	PART NO.	DESCRIPTION
A3Q11	---	Not Used
A3Q12	---	Not Used
A3Q13	---	Not Used
A3Q14	---	Not Used
A3Q15	10018	2N3646
A3Q16	10017	2N3569
A3Q17	11119	2N4250
A3R1	10015-98	Metal Film 13.3 KΩ ±1% 1/8 W
A3R2	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R3	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A3R4	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A3R5	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R6	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R7	---	Not Used
A3R8	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R9	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A3R10	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A3R11	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R12	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R13	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R14	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R15	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R16	10013-67	Carbon Film 3.3 MΩ ±5% 1/4W
A3R17	10013-15	Carbon Film 150Ω ±5% 1/4W
A3R18	10013-39	Carbon Film 15 KΩ ±5% 1/4 W
A3R19	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R20	10015-09	Metal Film 17.8 KΩ ±1% 1/8 W
A3R21	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R22	10015-85	Metal Film 287 KΩ ±1% 1/8 W
A3R23	10013-51	Carbon Film 47 KΩ ±5% 1/4 W
A3R24	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R25	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R26	---	Not Used
A3R27	---	Not Used
A3R28	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A3R29	10046-7	Variable Comp 1 KΩ ±20% 1/4 W
A3R30	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A3R31	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R32	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A3R33	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A3R34	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R35	12449-21	Metal Film 10.00 KΩ ±0.1% 1/8 W
A3R36	10046-9	Variable Comp 100 Ω ±20% 1/4 W
A3R37	10013-71	Carbon Film 6.8 MΩ ±5% 1/4 W
A3R38	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R39	10013-7	Carbon Film 33 Ω ±5% 1/4 W
A3R40	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R41	12449-21	Metal Film 10.00 KΩ ±0.1% 1/8 W
A3R42	12449-21	Metal Film 10.00 KΩ ±0.1% 1/8 W
A3R43	10013-38	Carbon Film 12 KΩ ±5% 1/4 W
A3R44	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A3R45	10013-21	Carbon Film 470 Ω ±5% 1/4 W
A3R46	12449-21	Metal Film 10.00 KΩ ±0.1% 1/8 W
A3R47	10013-38	Carbon Film 12 KΩ ±5% 1/4 W
A3R48	12449-19	Metal Film 1.00 KΩ ±0.1% 1/8 W
A3R49	10015-7	Metal Film 10.0 KΩ ±1% 1/8 W
A3R50	10015-42	Metal Film 1.27 KΩ ±1% 1/8 W
A3R51	10013-71	Carbon Film 6.8 MΩ ±5% 1/4 W
A3R52	10013-26	Carbon Film 1.2 KΩ ±5% 1/4 W
A3R53	10015-7	Metal Film 10.0 KΩ ±1% 1/8 W
A3R54	12449-58	Metal Film 1.620 KΩ ±0.1% 1/8 W
A3R55	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A3R56	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A3R57	10013-13	Carbon Film 100 Ω ±5% 1/4 W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION
A3R58	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A3R59	10013-71	Carbon Film 6.8 MΩ ±5% 1/4 W
A3R60	10015-19	Metal Film 1.00 KΩ ±1% 1/8 W
A3R61	11711-1	Variable Cermet 500 Ω ±20% 1/2 W
A3R62	10015-211	Metal Film 2.74 KΩ ±1% 1/8 W
A3R63	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A3R64	10015-176	Metal Film 3.48 KΩ ±1% 1/8 W
A3R65	10015-109	Metal Film 348 KΩ ±1% 1/8 W
A3R66	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A3R67	11695-19	Prec. WW 1.985 KΩ ±.01% 1/8 W
A3R68	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A3R69	10046-11	Variable Comp 250 KΩ ±20% 1/4 W
A3R70	11695-20	Prec. WW 3.988 KΩ ±.01% 1/8 W
A3R71	11695-21	Prec. WW 7.949 KΩ ±.01% 1/8 W
A3R72	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A3R73	---	Not Used
A3R74	11695-17	Prec. WW 9.945 KΩ ±.01% 1/8 W
A3R75	11695-18	Prec. WW 19.935 KΩ ±.01% 1/8 W
A3R76	12449-52	Metal Film 39.96 KΩ ± 0.1% 1/8 W
A3R77	12449-59	Metal Film 80.1 KΩ ±0.1% 1/8 W
A3R78	12449-33	Metal Film 100 KΩ ±0.1% 1/8 W
A3R79	12449-60	Metal Film 201 KΩ ±0.1% 1/8 W
A3R80	10015-63	Metal Film 402 KΩ ±1% 1/8 W
A3R81	10015-214	Metal Film 374 KΩ ±1% 1/8 W
A3R82	10015-232	Metal Film 432 KΩ ±1% 1/8 W
A3R83	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A3R84	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A3R85	10013-74	Carbon Film 2.0 MΩ ±5% 1/4 W
A3R86	10013-68	Carbon Film 3.9 MΩ ±5% 1/4 W
A3R87	10013-72	Carbon Film 8.2 MΩ ±5% 1/4 W
A3R88	---	Not Used
A3R89	---	Not Used
A3R90	10015-114	Metal Film 75.0 KΩ ±1% 1/8 W
A3R91	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A3R92	---	Not Used
A3R93	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A3R94	10015-116	Metal Film 30.1 KΩ ±1% 1/8 W
A3R95	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R96	10015-217	Metal Film 1.21 KΩ ±1% 1/8 W
A3R97	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A3R98	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A3R99	10142-8	Carbon Comp 47 Ω ±5% 1/4 W
A3R100	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A3R101	10013-21	Carbon Film 470 Ω ±5% 1/4 W
A3R102	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A3R103	10015-188	Metal Film 33.2 KΩ ±1% 1/8 W
A3R104	10015-3	Metal Film 49.9 Ω ±1% 1/8 W
A3R105	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R106	10013-39	Carbon Film 15 KΩ ±5% 1/4 W
A3R107	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R108	10015-197	Metal Film 221 Ω ±1% 1/8 W
A3R109	10015-231	Metal Film 23.7 Ω ±1% 1/8 W
A3R110	10015-197	Metal Film 221 Ω ±1% 1/8 W
A3R111	10013-7	Carbon Film 220Ω ±5% 1/4W
A3R112	10013-7	Carbon Film 220Ω ±5% 1/4W
A3R113	10013-7	Carbon Film 220Ω ±5% 1/4W
A3R114	10013-7	Carbon Film 220Ω ±5% 1/4W
A3S1	12430	DPDT
A3U1	13470-12	SN74LS42N
A3U2	13470-4	SN74LS04N
A3U3	13470-15	SN74LS90N
A3U4	13470-6	SN74LS10N
A3U5	13470-16	SN74LS107N
A3U6	13470-9	SN74LS27N
A3U7	13470-3	SN74LS02N
A3U8	13470-17	SN74LS123N

CIRCUIT REFERENCE	PART NO.	DESCRIPTION
A3U9	13470-15	SN74LS90N
A3U10	13470-15	SN74LS90N
A3U11	13470-9	SN74LS27N
A3U12	13470-1	SN74LS00N
A3U13	13470-1	SN74LS00N
A3U14	13470-15	SN74LS90N
A3U15	13470-1	SN74LS00N
A3U16	13470-4	SN74LS04N
A3U17	13470-13	SN74LS74N
A3U18	13470-15	SN74LS90N
A3U19	13470-13	SN74LS74N
A3U20	13871	NE555V
A3U21	12474	FCD810
A3U22	13872	LF398H
A3U23	13471	LM324C
A3U24	11691	LM311H
A3U25	11118-3	CA3039 (Matched Pair)
A3U26	11118-3	CA3039 (Matched Pair)
A3U27	11118	CA3039
A3U28	11539	741C
		POWER SUPPLY P.C. BOARD ASSEMBLY-13795
A4C1	10005-4	Elect. 330 µF 35 VDC
A4C2	10787-8	Tantalum .47 µF ±20% 15 VDC
A4C3	10003-7	Elect. 1000 µF ±50% -10% 35 VDC
A4C4	10787-12	Tantalum 2.2 µF ±20% 35 VDC
A4C5	10000-10	Ceramic 0.1 µF +80% -20% 100 VDC
A4C6	10787-11	Tantalum 1.0 µF ±20% 35 VDC
A4C7	10787-2	Tantalum 12 µF ±20% 20 VDC
A4C8	10787-2	Tantalum 12 µF ±20% 20 VDC
A4C9	10003-9	Elect. 7500 µF +100% -10% 16 VDC
A4C10	10787-8	Tantalum .47 µF ±20% 15 VDC
A4C11	10787-4	Tantalum 68 µF ±20% 15 VDC
A4C12	10005-4	Elect. 330 µF 35 VDC
A4C13	10005-4	Elect. 330 µF 35 VDC
A4C14	10000-10	Ceramic 0.1 µF +80% -20% 100 VDC
A4C15	10000-1	Ceramic 100 pF ±20% 1000 VDC
A4C16	10787-2	Tantalum 12 µF ±20% 20 VDC
A4C17	10000-1	Ceramic 100 pF ±20% 1000 VDC
A4C18	10787-2	Tantalum 12 µF ±20% 20 VDC
A4C19	10000-5	Ceramic .0022 µF ±20% 500VDC
A4CR1	12409	PE10
A4CR2	12409	PE10
A4CR3	12409	PE10
A4J2	10054-2	Test Jack, Red
A4J3	10054-1	Test Jack, Black
A4J4	10054-3	Test Jack, Blue
A4J5	10054-2	Test Jack, Red
A4J6	10054-2	Test Jack, Red
A4J7	10054-1	Test Jack, Black
A4J8	10054-3	Test Jack, Blue

A4R1	10046-5	Variable 2 KΩ ±20% 1/5 W
A4R2	10015-227	Metal Film 9.31 KΩ ±1% 1/8 W
A4R3	10015-65	Metal Film 4.99 KΩ ±1% 1/8 W
A4R4	10015-78	Metal Film 2.26 KΩ ±1% 1/8 W
A4R5	10015-96	Metal Film 12.1 KΩ ±1% 1/8 W
A4R6	10046-5	Variable 2 KΩ ±20% 1/5 W
A4R7	10015-47	Metal Film 2.49 KΩ ±1% 1/8 W
A4R8	10241-1	Carbon Film 3.3 Ω ±5% 1/2 W
A4R9	10015-21	Metal Film 4.64 KΩ ±1% 1/8 W
A4R10	10046-7	Variable Comp 1 KΩ ±20% 1/5 W
A4R11	10015-221	Metal Film 4.22 KΩ ±1% 1/8 W
A4R12	10015-206	Metal Film 7.50 KΩ ±1% 1/8 W
A4R13	10015-110	Metal Film 3.01 KΩ ±1% 1/8 W
A4R14	10046-1	Variable Comp 500 Ω ±20% 1/5 W
A4R15	10015-110	Metal Film 3.01 KΩ ±1% 1/8 W
A4R16	10015-226	Metal Film 2.21 KΩ ±1% 1/8 W
A4R17	10013-78	Carbon Film 2 KΩ ±5% 1/4 W
A4R18	10046-10	Variable Comp 100 KΩ ±20% 1/4W
A4U1	13902	µA78MGC
A4U2	13586	µA79MGC
A4U3	13479-1	LM340T-5
A4U4	13893	µA723C
A4U5	13893	µA723C
		FRONT PANEL CONTROL AND DISPLAY P.C. BOARD ASSEMBLY - 13805
A5C1	10003-12	Elect. 2200 µF +50% -10% 10 VDC
A5CR1	13550	Led, Yellow
A5CR2	13550	Led, Yellow
A5CR3	13550	Led, Yellow
A5CR4	14006	Led, Red
A5CR5	14006	Led, Red
A5CR6	14006	Led, Red
A5CR7	14006	Led, Red
A5CR8	14006	Led, Red
A5CR9	14006	Led, Red
A5CR10	12389	Led, Red
A5CR11	13550	Led, Yellow
A5CR12	13550	Led, Yellow
A5R1	14162-1	Variable 100KΩ ±10% 1/4W
A5R2	13947-1	Variable Cermet 100KΩ ±20% 1/2W
A5R3	---	Not Used
A5R4	13908-1	Prec. WW 2 Ω ±5% 1/2 W
A5R5	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A5R6	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R7	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R8	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R11	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R12	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R13	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R14	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R15	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R16	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R17	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R18	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R19	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R20	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R21	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R22	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R23	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R24	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R25	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R26	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R27	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R28	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R29	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R30	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R31	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R32	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R33	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R34	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R35	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R36	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R37	10013-20	Carbon Film 390 Ω ±5% 1/4 W
A5R38	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A5R39	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A5R40	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A5S1	13897	Slide 1P6T
A5S2	13897	Slide 1P6T
A5S3	13897	Slide 1P6T
A5S4	---	Not Used
A5S5	12483	Pushbutton SPST
A5S6	13899	Slide DPDT
A5S7	12483	Pushbutton SPST
A5U1	13418	HP5082-7652
A5U2	13417	HP5082-7650
A5U3	13417	HP5082-7650
A5U4	13417	HP5082-7650
A5U5	13417	HP5082-7650
A5U6	11270-1	SN7400N
A5U7	13470-19	SN74LS247N
A5U8	13470-19	SN74LS247N
A5U9	13470-19	SN74LS247N
A5U10	13470-19	SN74LS247N
A6	--	Not Used
		MOTHER BOARD #1 P.C. BOARD ASSEMBLY - 13811
A7J1	12440-3	PC Edge 25 Contact 2 Rows
A7J2	12440-3	PC Edge 25 Contact 2 Rows
A7J3	12440-3	PC Edge 25 Contact 2 Rows

CIRCUIT REFERENCE	PART NO.	DESCRIPTION
		MOTHER BOARD #2 P.C. BOARD ASSEMBLY - 13813
A8C1	10000-11	Ceramic .01 μF ±20% 100 V
A8J4	12440-3	PC Edge 25 Contact 2 Rows
A8J5	12440-3	PC Edge 25 Contact 2 Rows
A8J6	12440-3	PC Edge 25 Contact 2 Rows
A8J7	12440-3	PC Edge 25 Contact 2 Rows
		IEEE INTERFACE, OPTION 05 P.C. BOARD ASSEMBLY - 13659
A11C1	10000-12	Ceramic 150 pF ±20% 1000 V
A11C2	10000-10	Ceramic 0.1 μF +80% -20% 100 V
A11C3	10000-3	Ceramic 470 pF ±20% 1000 V
A11C4	10787-4	Tantalum 68 μF ±20% 15 V
A11C5	10000-10	Ceramic 0.1 μF +80% -20% 100 V
A11C6	10000-10	Ceramic 0.1 μF +80% -20% 100 V
A11C7	10000-10	Ceramic 0.1 μF +80% -20% 100 V
A11C8	10787-4	Tantalum 68 μF ±20% 15 V
A11C9	10000-10	Ceramic 0.1 μF +80% -20% 100 V
A11C10	10000-10	Ceramic 0.1 μF +80% -20% 100 V
A11C11	10000-10	Ceramic 0.1 μF +80% -20% 100 V
A11C12	10000-10	Ceramic 0.1 μF +80% -20% 100 V
A11C13	10000-10	Ceramic 0.1 μF +80% -20% 100 V
A11C14	10000-10	Ceramic 0.1 μF +80% -20% 100 V
A11C15	10000-10	Ceramic 0.1 μF +80% -20% 100 V
A11C16	10000-1	Ceramic 100 pF ±20% 1000 V
A11C17	10000-1	Ceramic 100 pF ±20% 1000 V
A11C18	10000-10	Ceramic 0.1 μF +80% -20% 100 V
A11C19	10000-10	Ceramic 0.1 μF +80% -20% 100 V
A11C20	10000-10	Ceramic 0.1 μF +80% -20% 100 V
A11C21	10000-4	Ceramic .001 μF ±20% 1000 V
A11C22	10000-4	Ceramic .001μF ±20% 1000 V
A11C23	10000-4	Ceramic .001μF ±20% 1000 V
A11C24	10000-2	Ceramic 220pF ±20% 1000 V
A11C25	10000-5	Ceramic .0022 μF ±20% 500 V
A11CR1	10043	1N4148
A11J1	10140-2	Test Jack, Yellow
A11J2	10140-1	Test Jack, Red
A11J3	10140-3	Test Jack, Black
A11J4	10140-2	Test Jack, Yellow
A11J5	10140-2	Test Jack, Yellow
A11J6	10140-2	Test Jack, Yellow
A11J7	10140-2	Test Jack, Yellow
A11J8	10140-2	Test Jack, Yellow
A11J9	10140-2	Test Jack, Yellow
A11J10	10140-2	Test Jack, Yellow
A11J11	10140-2	Test Jack, Yellow
A11R1	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A11R2	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A11R3	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A11R4	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A11R5	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A11R6	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A11R7	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A11R8	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A11R9	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A11R10	---	Not Used
A11R11	---	Not Used
A11R12	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A11R13	10013-35	Carbon Film 6.8 KΩ ±5% 1/4 W
A11R14	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A11R15	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A11R16	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A11R17	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A11R18	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A11R19	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A11R20	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A11R21	10013-75	Carbon Film 3 KΩ ±5% 1/4 W
A11R22	10013-75	Carbon Film 3 KΩ ±5% 1/4 W
A11R23	10013-75	Carbon Film 3 KΩ ±5% 1/4 W
A11R24	10013-75	Carbon Film 3 KΩ ±5% 1/4 W
A11R25	10013-75	Carbon Film 3 KΩ ±5% 1/4 W
A11R26	10013-75	Carbon Film 3 KΩ ±5% 1/4 W
A11R27	10013-75	Carbon Film 3 KΩ ±5% 1/4 W
A11R28	10013-75	Carbon Film 3 KΩ ±5% 1/4 W
A11R29	10013-76	Carbon Film 6.2 KΩ ±5% 1/4 W
A11R30	10013-76	Carbon Film 6.2 KΩ ±5% 1/4 W
A11R31	10013-76	Carbon Film 6.2 KΩ ±5% 1/4 W
A11R32	10013-76	Carbon Film 6.2 KΩ ±5% 1/4 W
A11R33	10013-76	Carbon Film 6.2 KΩ ±5% 1/4 W
A11R34	10013-76	Carbon Film 6.2 KΩ ±5% 1/4 W
A11R35	10013-76	Carbon Film 6.2 KΩ ±5% 1/4 W
A11R36	10013-76	Carbon Film 6.2 KΩ ±5% 1/4 W
A11R37	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A11R38	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A11R39	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A11R40	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A11R41	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A11R42	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A11R43	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A11R44	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A11R45	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A11R46	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A11R47	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A11R48	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A11R49	10013-75	Carbon Film 3 KΩ ±5% 1/4 W
A11R50	10013-75	Carbon Film 3 KΩ ±5% 1/4 W
A11R51	10013-75	Carbon Film 3 KΩ ±5% 1/4 W
A11R52	10013-75	Carbon Film 3 KΩ ±5% 1/4 W
A11R53	10013-75	Carbon Film 3 KΩ ±5% 1/4 W
A11R54	10013-75	Carbon Film 3 KΩ ±5% 1/4 W
A11R55	10013-76	Carbon Film 6.2 KΩ ±5% 1/4 W
A11R56	10013-75	Carbon Film 3 KΩ ±5% 1/4 W
A11R57	10013-76	Carbon Film 6.2 KΩ ±5% 1/4 W
A11R58	10013-76	Carbon Film 6.2 KΩ ±5% 1/4 W
A11R59	10013-76	Carbon Film 6.2 KΩ ±5% 1/4 W
A11R60	10013-76	Carbon Film 6.2 KΩ ±5% 1/4 W
A11R61	10013-76	Carbon Film 6.2 KΩ ±5% 1/4 W
A11R62	10013-76	Carbon Film 6.2 KΩ ±5% 1/4 W
A11R63	10013-75	Carbon Film 3 KΩ ±5% 1/4 W
A11R64	10013-76	Carbon Film 6.2 KΩ ±5% 1/4 W
A11R65	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A11R66	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A11R67	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A11R68	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A11R69	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A11R70	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A11R71	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A11R72	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A11R73	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A11R74	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A11R75	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A11R76	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A11R77	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A11R78	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A11R79	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A11R80	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A11R81	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A11R82	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W

CIRCUIT REFERENCE	PART NO.	DESCRIPTION
A11R83	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A11R84	10013-21	Carbon Film 470Ω ±5% 1/4 W
A11R85	10013-21	Carbin Film, 470Ω ±5% 1/4W
A11S1	13475	Switch, 7 Contact Dip
A11S2	13475	Switch, 7 Contact Dip
A11U1	13470-13	SN74LS74N
A11U2	11270-11	SN7493N
A11U3	13470-2	SN74LS01N
A11U4	13470-3	SN74LS02N
A11U5	13470-11	SN74LS38N
A11U6	13470-18	SN74LS221N
A11U7	13470-13	SN74LS74N
A11U8	13470-1	SN74LS00N
A11U9	13470-22	SN74LS266N
A11U10	13470-22	SN74LS266N
A11U11	13470-22	SN74LS266N
A11U12	13470-11	SN74LS38N
A11U13	13470-4	SN74LS04N
A11U14	13470-7	SN74LS14N
A11U15	11270-34	SN7407N
A11U16	13470-5	SN74LS08N
A11U17	11270-32	SN74154N
A11U18	13470-4	SN74LS04N
A11U19	13470-1	SN74LS00N
A11U20	13470-1	SN74LS00N
A11U21	13470-20	SN74LS257N
A11U22	11270-32	SN74154N
A11U23	13470-1	SN74LS00N
A11U24	13470-4	SN74LS04N
A11U25	13470-26	SN74LS12N
A11U26	13470-9	SN74LS27N
A11U27	13470-13	SN74LS74N
A11U28	13470-1	SN74LS00N
A11U29	13470-3	SN74LS02N
A11U30	13470-1	SN74LS00N
A11U31	13470-6	SN74LS10N
A11U32	13470-10	SN74LS30N
A11U33	13470-4	SN74LS04N
A11U34	13470-7	SN74LS14N
A11U35	13470-21	SN74LS258N
A11U36	13470-21	SN74LS258N
A11U37	13470-20	SN74LS257N
A11U38	13470-5	SN74LS08N
A11U39	13470-4	SN74LS14N
A11U40	13470-5	SN74LS08N
A11U41	13470-13	SN74LS74N
A11U42	13470-34	SN74LS175N
A11U43	13470-33	SN74LS174N
A11U44	13470-33	SN74LS174N
A11U45	13470-11	SN74LS38N
A11U46	13470-10	SN74LS30N
A11U47	13470-10	SN74LS30N
A11U48	13470-10	SN74LS30N
A11U49	13470-13	SN74LS74N
A11U50	13470-3	SN74LS02N
A11U51	13470-32	SN74LS20N
A11U52	13470-12	SN74LS42N
A11U53	13470-36	SN74LS05N
A11U54	13470-34	SN74LS175N
A11W1	14097	Cable Assy

CIRCUIT REFERENCE	PART NO.	DESCRIPTION
		MULTI-DETECTOR MULTIPLEXER ASSEMBLY - 14108
S3	14335	Switch Assembly
---	14372	Calibraté Fixture P.C. Board
		MULTI-DETECTOR P.C. BOARD ASSEMBLY - 13864
A12C1	10000-11	Ceramic .01 μf ±20% 100 VDC
A12CR1	10043	IN4148
A12CR2	10043	IN4148
A12CR3	10043	IN4148
A12CR4	10043	IN4148
A12CR5	10043	IN4148
A12CR6	10043	IN4148
A12CR7	10043	IN4148
A12CR8	10043	IN4148
A12CR9	10043	IN4148
A12CR10	10043	IN4148
A12CR11	10043	IN4148
A12CR12	10043	IN4148
A12K1	14136	DPDT 5V 450 Ω
A12K2	14136	DPDT 5V 450 Ω
A12K3	14136	DPDT 5V 450 Ω
A12K4	14136	DPDT 5V 450 Ω
A12Q1	11119	2N4250
A12Q2	12591	E112
A12Q3	11119	2N4250
A12Q4	12591	E112
A12Q5	11119	2N4250
A12Q6	12591	E112
A12Q7	10019	2N3565
A12Q8	12591	E112
A12Q9	10019	2N3565
A12Q10	12591	E112
A12Q11	10019	2N3565
A12Q12	12591	E112
A12Q13	10019	2N3565
A12Q14	12591	E112
A12Q15	10019	2N3565
A12Q16	12591	E112
A12Q17	10019	2N3565
A12Q18	12591	E112
A12Q19	10019	2N3565
A12Q20	12591	E112
A12Q21	10019	2N3565
A12Q22	12591	E112

CIRCUIT REFERENCE	PART NO.	DESCRIPTION
A12R1	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A12R2	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A12R3	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A12R4	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A12R5	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A12R6	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A12R7	10013-96	Carbon Film 20 KΩ ±5% 1/4 W
A12R8	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A12R9	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A12R10	10013-96	Carbon Film 20 KΩ ±5% 1/4 W
A12R11	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A12R12	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A12R13	10013-96	Carbon Film 20 KΩ ±5% 1/4 W
A12R14	10013-51	Carbon Film 150 KΩ ±5% 1/4W
A12R15	10013-51	Carbon Film 150 KΩ ±5% 1/4W
A12R16	10013-51	Carbon Film 150 KΩ ±5% 1/4W
A12R17	10013-51	Carbon Film 150 KΩ ±5% 1/4W
A12R18	10013-39	Carbon Film 15 KΩ ±5% 1/4 W
A12R19	10013-63	Carbon Film 1.5 MΩ ±5% 1/4 W
A12R20	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A12R21	10013-63	Carbon Film 1.5 MΩ ±5% 1/4 W
A12R22	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A12R23	10013-63	Carbon Film 1.5 MΩ ±5% 1/4 W
A12R24	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A12R25	10013-63	Carbon Film 1.5 MΩ ±5% 1/4 W
A12R26	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A12R27	10013-63	Carbon Film 1.5 MΩ ±5% 1/4 W
A12R28	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A12R29	10013-63	Carbon Film 1.5 MΩ ±5% 1/4 W
A12R30	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A12R31	10013-63	Carbon Film 1.5 MΩ ±5% 1/4 W
A12R32	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A12R33	10013-63	Carbon Film 1.5 MΩ ±5% 1/4 W
A12R34	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A12R35	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A12R36	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A12R37	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A12R38	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A12R39	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A12R40	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A12R41	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A12R42	10013-28	Carbon Film 1.8KΩ ±5% 1/4W
A12R43	10013-28	Carbon Film 1.8KΩ ±5% 1/4W
A12R44	10013-28	Carbon Film 1.8KΩ ±5% 1/4W
A12R45	10013-28	Carbon Film 1.8KΩ ±5% 1/4W
A12R46	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A12R47	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A12R48	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A12R49	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A12R50	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A12R51	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A12R52	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A12U1	13470-21	SN74LS258
A12U2	13470-2	SN74LS01
A12U3	13470-36	SN74LS05
A12U4	13476	MCT-6
A12U5	13476	MCT-6

CIRCUIT REFERENCE	PART NO.	DESCRIPTION
		MULTI-DETECTOR POT-CONNECTOR P.C. BOARD ASSEMBLY-14290
A13C1	10000-11	Ceramic .01 μF ±20% 100V
A13C2	10000-11	Ceramic .01 μF ±20% 100V
A13C3	10000-11	Ceramic .01 μF ±20% 100V
A13C4	10000-11	Ceramic .01 μF ±20% 100V
A13J6	13257	Connector, 7 contact
A13J7	13257	Connector, 7 contact
A13J8	13257	Connector, 7 contact
A13J9	13257	Connector, 7 contact
A13R3	11676-1	Variable 100KΩ ±20% 1/2W
A13R4	11676-1	Variable 100KΩ ±20% 1/2W
A13R5	11676-1	Variable 100KΩ ±20% 1/2W
A13W1	14291-1	Cable, 24 Pin DIP

PART NO. CROSS REFERENCE

PM PART NO.	MFGR. CODE	MFGR. PART NO.
10000-1	56289	5GA-T10
10000-2	56289	5GA-T22
10000-3	56289	5GA-T47
10000-4	56289	5GA-D10
10000-5	56289	5GA-D22
10000-8	56289	5GAS-S20
10000-9	56289	5GA-S50
10000-10	91418	Type TA 0.1 μF
10000-11	72989	805-000-X5VD-103Z
10001-2	56289	10TCC-V22
10001-5	56289	10TCC-Q33
10001-6	56289	10TCC-Q47
10001-12	56289	10TCC-V33
10001-14	56289	10TCC-068
10001-16	56289	10TCC-T12
10003-7	25088	B41010-1000-40-8212
10003-9	05035	EMC-7500-16VDC
10003-12	25088	2200-10-8218
10005-4	56289	503D337G035EK
10007-2	01002	75FIR2A 222
10007-3	01002	75FIR2A 472
10007-6	01002	75FIR2A 473
10007-7	01002	75F3R2A 104
10011-2	27556	ZA1652K
10013-1	80031	B803104NB 100
10013-3	80031	B803104NB 150
10013-5	80031	B803104NB 220
10013-7	80031	B803104NB 330
10013-9	80031	B803104NB 470
10013-11	80031	B803104NB 680
10013-13	80031	B803104NB 101
10013-15	80031	B803104NB 151
10013-17	80031	B803104NB 221
10013-20	80031	B803104NB 391
10013-21	80031	B803104NB 471
10013-23	80031	B803104NB 681
10013-25	80031	B803104NB 102
10013-26	80031	B803104NB 122
10013-27	80031	B803104NB 152
10013-28	80031	B803104NB 182
10013-29	80031	B803104NB 222

PART NO. CROSS REFERENCE

PM PART NO.	MFGR. CODE	MFGR. PART NO.
10013-31	80031	B803104NB 332
10013-33	80031	B803104NB 472
10013-37	80031	B803104NB 103
10013-38	80031	B803104NB 123
10013-39	80031	B803104NB 153
10013-41	80031	B803104NB 223
10013-43	80031	B803104NB 333
10013-45	80031	B803104NB 473
10013-49	80031	B803104NB 104
10013-51	80031	B803104NB 154
10013-53	80031	B803104NB 224
10013-57	80031	B803104NB 474
10013-58	01121	RC07GF564J
10013-61	80031	B803104NB 105
10013-63	80031	B803104NB 155
10013-64	80031	B803104NB 185
10013-65	80031	B803104NB 225
10013-67	80031	B803104NB 335
10013-68	80031	B803104NB 395
10013-71	80031	B803104NB 685
10013-73	80031	B803104NB 106
10013-78	01121	RC07GF202J
10013-83	80031	B803104NB 623
10013-85	80031	B803104NB 430
10013-86	80031	B803104NB 510
10013-87	80031	B803104NB 620
10013-89	80031	B803104NB 201
10013-92	80031	B803104NB 164
10013-96	80031	B803104NB 203
10015-3	24546	RN55D 49.9 Ω 1%
10015-6	24546	RN55D 464 KΩ 1%
10015-7	24546	RN55D 10.0 KΩ 1%
10015-9	24546	RN55D 17.8 KΩ 1%
10015-11	24546	RN55D 16.2 KΩ 1%
10015-13	24546	RN55D 100 KΩ 1%
10015-14	24546	RN55D 31.6 KΩ 1%
10015-19	24546	RN55D 1.0 KΩ 1%
10015-20	24546	RN55D 1.10 KΩ 1%
10015-21	24546	RN55D 4.64 KΩ 1%
10015-28	24546	RN55D 23.7 KΩ 1%
10015-31	24546	RN55D 3.16 KΩ 1%
10015-34	24546	RN55D 162 KΩ 1%
10015-39	24546	RN55D 464 Ω 1%
10015-42	24546	RN55D 1.27 KΩ 1%
10015-45	24546	RN55D 499 KΩ 1%
10015-47	24546	RN55D 2.49 KΩ 1%

PART NO. CROSS REFERENCE

PM PART NO.	MFGR. CODE	MFGR. PART NO.
10015-57	24546	RN55D 8.66 KΩ 1%
10015-59	24546	RN55D 10.5 KΩ 1%
10015-60	24546	RN55D 19.6 KΩ 1%
10015-63	24546	RN55D 402 KΩ 1%
10015-65	24546	RN55D 4.99 KΩ 1%
10015-67	24546	RN55D 143 KΩ 1%
10015-68	24546	RN55D 100 Ω 1%
10015-71	24546	RN55D 909 Ω 1%
10015-72	24546	RN55D 1.96 KΩ 1%
10015-74	24546	RN55D 2.0 KΩ 1%
10015-78	24546	RN55D 2.26 KΩ 1%
10015-81	24546	RN55D 11.3 KΩ 1%
10015-83	24546	RN55D 261 Ω 1%
10015-96	24546	RN55D 12.1 KΩ 1%
10015-102	24546	RN55D 249KΩ 1%
10015-109	24546	RN55D 348 KΩ 1%
10015-110	24546	RN55D 3.01 KΩ 1%
10015-114	24546	RN55D 75 KΩ 1%
10015-116	24546	RN55D 30.1 KΩ 1%
10015-174	24546	RN55D 1.62 KΩ 1%
10015-176	24546	RN55D 3.48 KΩ 1%
10015-180	24546	RN55D 280 KΩ 1%
10015-184	24546	RN55D 243 KΩ 1%
10015-188	24546	RN55D 33.2 KΩ 1%
10015-197	24546	RN55D 221 Ω 1%
10015-206	24546	RN55D 7.50 KΩ 1%
10015-207	24546	RN55D 20.0 KΩ 1%
10015-209	24546	RN55D 130 KΩ 1%
10015-210	24546	RN55D 150 KΩ 1%
10015-211	24546	RN55D 2.74 KΩ 1%
10015-214	24546	RN55D 374 KΩ 1%
10015-217	24546	RN55D 1.21 KΩ 1%
10015-221	24546	RN55D 4.22 KΩ 1%
10015-225	24546	RN55D 3.32 KΩ 1%
10015-226	24546	RN55D 2.21 KΩ 1%
10015-227	24546	RN55D 9.31 KΩ 1%
10015-230	24546	RN55D 11.0 KΩ 1%
10015-231	24546	RN55D 23.7 Ω 1%
10015-232	91637	RN60D 432 KΩ 1%
10015-235	24546	RN55D 147 KΩ 1%
10015-237	24546	RN55D 165 KΩ 1%
10015-245	24546	RN55D 41.2 KΩ 1%
10015-247	24546	RN55D 22.1 KΩ 1%
10015-248	24546	RN55D 44.2 KΩ 1%
10015-250	24546	RN55D 60.4 KΩ 1%
10015-251	24546	RN55D 118 KΩ 1%
10015-252	24546	RN55D 453 KΩ 1%
10015-253	24546	RN55D 30.9 KΩ 1%
10015-254	25546	RN55D 8.45 KΩ 1%
10015-255	25546	RN55D 115 KΩ 1%
10017	07263	2N3569
10018	07263	2N3646
10019	07263	2N3565

PART NO. CROSS REFERENCE

PM PART NO.	MFGR. CODE	MFGR. PART NO.
10043	01002	IN4148
10045	12954	IN823
10046-1	71450	X201R501B
10046-4	71450	X201R502B
10046-5	71450	X201R202B
10046-6	71450	X201R201B
10046-7	71450	X201R102B
10046-9	71450	X201R101B
10046-10	71450	X201R104B
10046-11	71450	X201R254B
10046-12	71450	X201R504B
10048	02660	31-221-1050
10054-1	74970	105-0753-001
10054-2	74970	105-0753-001
10054-3	74970	105-0760-001
10057	09353	7201-SYP
10059	79727	GF-126
10064-2	75192	312-500
10133-2	00656	CC20CKOR5C
10140-1	74970	105-0852-001
10140-2	74970	105-0857-001
10140-3	74970	105-0853-001
10140-4	74970	105-0860-001
10241-1	01121	3.3 Ω 5%
10241-9	80031	2 Ω 5%
10585-2	56289	CO28B102 F331J
10585-5	56289	CO28A102 J102J
10585-7	56289	CO28A102 P332J
10630-1	72982	538-011A-Z-8
10631-11	99800	1025-08
10677-2	84171	DM15F221 J500V
10677-4	84171	DM15F331 J500V
10677-8	84171	DM15E820 J500V
10677-9	84171	DM15F121 J500V
10677-16	84171	DM15F430 J500V
10677-17	04062	DM15F681 J300WV
10787-1	56289	196D475X0035 JA1
10787-2	56289	196D126X9020 JA1
10787-3	56289	196D276X9025 LA3
10787-4	56289	196D686X0025 MA3
10787-5	56289	196D105X0035 HA1
10787-8	56289	196D474X0035 HA1
10787-9	56289	196D476X0020 LA3
10787-11	56289	196D105X9035 HA1
10787-12	56289	196D225X9035 JA1

PART NO. CROSS REFERENCE		
PM PART NO.	MFGR. CODE	MFGR. PART NO.
10896	02735	3N138
11118	02735	CA3039
11119	07263	2N4250
11270-1	01295	SN7400N
11270-34	01295	SN7407N
11432	27014	2N3955
11501-2	72982	8131-050-651-104M
11507	01295	TIS 97
11539	07263	741HC
11627	07263	LM301AH
11676-1	01121	WA1N024S104MZ
11691	07263	LM311H
11695-2	18235	538 10.0 KΩ .01%
11695-3	18235	538 25.0 KΩ .01%
11695-4	18235	538 50.0 KΩ .01%
11695-17	18235	538 9.945 KΩ .01%
11695-18	18235	538 19.935 KΩ .01%
11695-19	18235	538 1.985 KΩ .01%
11695-20	18235	538 3.988 KΩ .01%
11695-21	18235	538 7.949 KΩ .01%
11711-1	73138	66WR 500 Ω
11711-2	73138	66WR 100 Ω
11711-4	73138	66WR 1 KΩ
12389	76541	MV5025
12409	83701	PE10
12430	95146	MSS-2220
12439	02735	2N5785
12440-3	02660	225-22523-110
12445	07263	725HC
12449-19	14298	EE 1/8 C2 1.00 KΩ 0.1%
12449-21	14298	EE 1/8 C2 10.00 KΩ 0.1%
12449-33	14298	EE 1/8 C2 100 KΩ 0.1%
12449-52	91637	MFF-1/8 T-2
12449-58	14298	EE 1/8 C2 1.620 KΩ 0.1%
12449-59	14298	EE 1/8 C2 80.10 KΩ .1%
12449-60	14298	EE 1/8 C2 201.0 KΩ 0.1%
12449-64	14298	EE 1/8 C2 18.18 KΩ 0.1%
12483	81073	39-24
12591	17856	E112
12799	17856	E109
13249	07263	2N3808

PART NO. CROSS REFERENCE		
PM PART NO.	MFGR. CODE	MFGR. PART NO.
13253-1	02735	CD4001AE
13253-2	02735	CD4060AE
13257	02660	91-T-3478-9
13271	16733	700209
13417	28480	5082-7650
13418	28480	5082-7652
13470-1	01295	SN74LS00N
13470-3	01295	SN74LS02N
13470-4	01295	SN74LS04N
13470-6	01295	SN74LS10N
13470-9	01295	SN74LS27N
13470-12	01295	SN74LS42N
13470-13	01295	SN74LS74N
13470-15	01295	SN74LS90N
13470-16	01295	SN74LS107N
13470-17	01295	SN74LS123N
13470-18	01295	SN74LS221N
13470-19	01295	SN74LS247N
13470-28	01295	SN74LS190N
13471	27014	LM324N
13476	76541	MCT6
13479-1	27014	LM340T-5
13492	05245	#6J1
13539	28821	13539
13550	04713	MV5353
13577	28821	13577
13586	07263	UA79GC
13587	01295	TL084CN
13871	27014	LM555CN
13872	27014	LF398H
13874	94222	57-30-201-10
13892	02735	CA3140T
13893	07263	MA723PC
13894	28821	13894
13897	31918	CL6PV1X6BBM SP
13902	07263	MA78MGU1C
13903	01295	TIP 29
13904	01295	TIP 30
13908-1	81483	BWH
13915	04713	2N2642
13916	17856	E230
13938-1	28821	13938-1
13939	28821	13939
13947-1	01121	YR503U
13979-1	80031	C281CH/AIM
14006	76541	MV57124
14044-1	50625	FST-22A-30
14047	28821	14047
14082	28821	14082
14119-1	90303	SXM110
14132	17856	2N4119
14198	80294	84A2A-G24/40-J16/J15
14226	01295	TL074CN
14291-1	28821	14291-1
16642	28821	16642

FEDERAL SUPPLY CODE FOR MANUFACTURERS

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

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

00303	Shelly Associates Inc. El Segundo, California
00656	Aerovox Corp. New Bedford, Massachusetts
00779	AMP Inc. Harrisburg, Pennsylvania
01002	General Electric Co. Capacitor Dept. Hudson Falls, New York
01121	Allen-Bradley Co. Milwaukee, Wisconsin
01295	Texas Instruments, Inc. Semiconductor Components Div. Dallas, Texas
01961	Pulse Engineering Inc. Santa Clara, California
02114	Ferroxcube Corp. of America Saugerties, New York
02660	Amphenol-Borg Elect. Corp. Broadview, Illinois
02735	Radio Corp. of America Semiconductor and Materials Div. Somerville, New Jersey
04062	Elmenco Products Co. New York, New York
04713	Motorola, Inc. Semiconductor Products Div. Phoenix, Arizona
05035	Ayer Manufacturing Co. Chicago Heights, Illinois
05245	Corcom Inc. Chicago, Illinois
07126	Digitran Co. Pasadena, California
07263	Fairchild Camera and Inst. Corp. Semiconductor Div. Mountain View, California
07910	Continental Device Corp. Hawthorne, California
09214	General Electric Co. Semiconductor Products Dept. Auburn, New York
09353	C and K Components Inc. Newton, Massachusetts
11332	General Microwave Corp. Farmingdale, New York
11711	General Instruments Inc. Semiconductor Div. Newark, New Jersey
12674	Syncro Corp. Hicksville, Ohio
12954	Dickson Electronics Corp. Scottsdale, Arizona
14298	American Components, Inc. Conshohocken, Pennsylvania
16733	Cablewave Systems North Haven, Connecticut
17540	Alpha Industries Woburn, Massachusetts
17856	Siliconix Inc. Santa Clara, California
18235	KRL Electronics, Inc. Manchester, New Hampshire
18324	Signetics Corp. Sunnyvale, California
19447	Electro-Technique Inc. Oceanside, California
21847	Aertech Industries Sunnyvale, California
22045	Jordan Electric Co. Van Nuys, California
22526	Berg Electronics Corp. York Expressway New Cumberland, Pennsylvania
24546	Corning Glass Works Electronic Components Div. Raleigh, North Carolina
24931	Speciality Connector Co. Inc. Indianapolis, Indiana
25088	Siemens America Corp. Iselin, New Jersey
27014	National Semiconductor Corp. Santa Clara, California

27556 IMB Electronic Products
Santa Fe Springs, California

28480 Hewlett-Packard Co.
Palo Alto, California

28821 Pacific Measurements Inc.
Sunnyvale, California

31918 International Electro Exchange
Eden Prairie, Minnesota

32284 Rotron Manufacturing Co. Inc.
Woodstock, New York

33025 Omni Spectra
Tempe, Arizona

34078 Midwest Microwave Inc.
Ann Arbor, Michigan

44655 Ohmite Mfg. Co.
Skokie, Illinois

50625 Revere Corp. of America
Wallingford, Connecticut

56289 Sprague Electric Co.
North Adams, Massachusetts

70903 Belden Mfg. Co.
Chicago, Illinois

71034 Bliley Electric Co.
Erie, Pennsylvania

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

71450 CTS Corp.
Elkhart, Indiana

71590 Centralab Electronics
Milwaukee, Wisconsin

72982 Erie Tech. Products Inc.
Erie, Pennsylvania

73138 Beckman Instruments Inc.
Helipot Division
Fullerton, California

73445 Amperex Electronic Corp.
Hicksville, New York

74970 E.F. Johnson Co.
Waseca, Minnesota

75915 Littlefuse Inc.
Des Plaines, Illinois

76493 J.W. Miller Co.
Compton, California

76541 Monsanto Commercial Products Co.
Cupertino, California

76854 Oak Mfg. Co.
Crystal Lake, Illinois

79727 Continental-Wirt Electronics Corp.
Philadelphia, Pennsylvania

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

80294 Bourns Inc.
Trimpot Div.
Riverside, California

81073 Grayhill Inc.
La Grange, Illinois

81095 Traid Transformer Corp.
Venice, California

81483 International Rectifier Corp.
El Segundo, California

82389 Switchcraft Inc.
Chicago, Illinois

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

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

83701 Electronic Devices Inc.
Yonkers, New York

84171 Arco Electronics Inc.
Great Neck, New York

90303 Mallory Battery Co.
Tarrytown, New York

90634 Saft America Inc.
Metuchen, New Jersey

91418 Radio Materials Co.
Chicago, Illinois

91637 Dale Electronics Inc.
Columbus, Nebraska

91929 Honeywell Inc.
Microswitch Div.
Freeport, Illinois

94144 Raytheon Co.
Components Div.
Quincy, Massachusetts

94222 Southco Inc.
Lester, Pennsylvania

95146 Alco Electronics
Lawrence, Massachusetts

99392 STM Corp.
Oakland, California

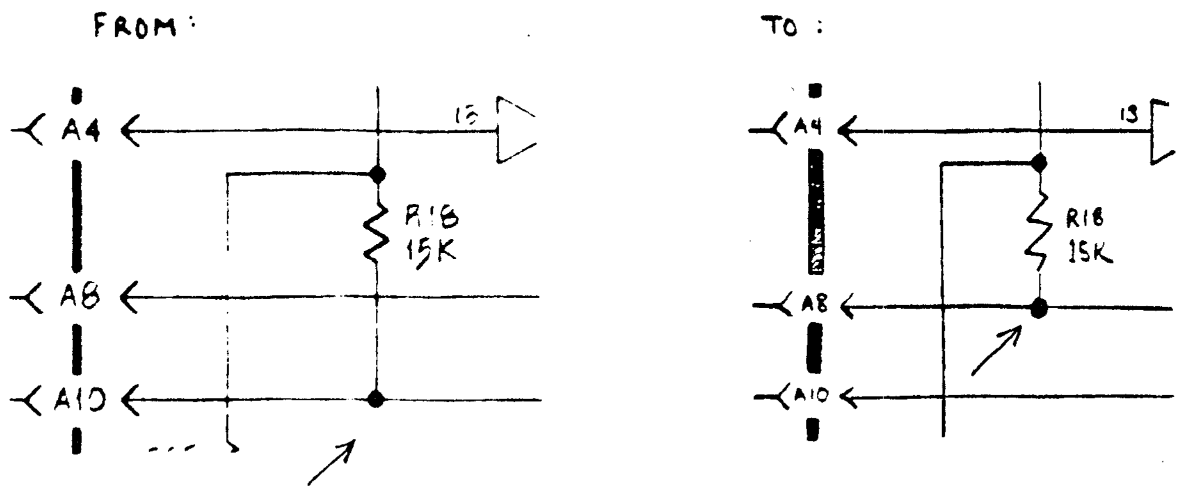
99800 Delavan Electronics Corp.
East Aurora, New York

SECTION 10

MANUAL CORRECTIONS

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

CODE NO.	CORRECTIONS	PM PART NO.	SECTION OF MANUAL AFFECTED
ALL	On page 8-18, SD 13422 Sheet 2, change the circuit configuration on the left side of the SD as follows:		8



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CODE NO.	CORRECTIONS	PM PART NO.	SECTION OF MANUAL AFFECTED
18 and ALL	On page 3-3, Section 3.4f, change the second sentence to read as follows: "Connect the RF detector, or detectors, to the RF power source, or sources." (delete "if Option 01")		3
	On page 7-1, Section 7.2, change the second paragraph to read as follows: "If the TRIG DISABLE switch (#6 on the LISTENER ADDRESS switch) is CLOSED and the 1045 is addressed as a LISTENER, then the rear panel TRIGGER function and internal trigger are disabled and the triggering must be initiated by one of the following methods:".		7
	On page 7-2, Section 7.3, change the NOTE at the bottom of the section to read as follows: "NOTE: EOI made true when $(DAB)_{10}$ is sent."		

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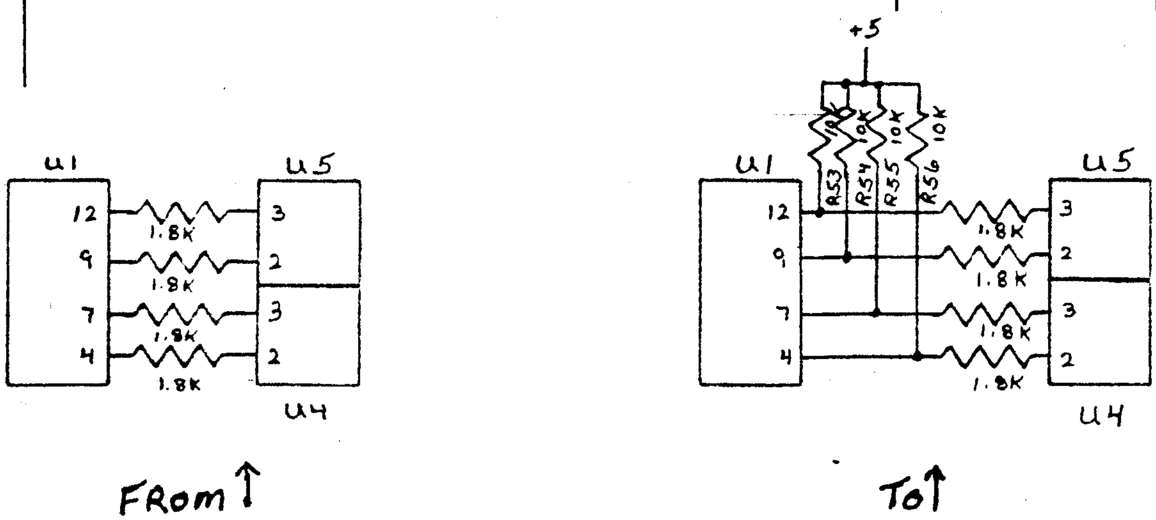
CODE NO.	CORRECTIONS	PM PART NO.	SECTION OF MANUAL AFFECTED
19	On page 9-13, add the following below A12R52:		9
	A12R53 Carbon Film 10KΩ ±5% 1/4W	10013-37	
	A12R54 Carbon Film 10KΩ ±5% 1/4W	10013-37	
	A12R55 Carbon Film 10KΩ ±5% 1/4W	10013-37	
	A12R56 Carbon Film 10KΩ ±5% 1/4W	10013-37	
	On page 8-22, SD 13865, change the circuit as follows;		8



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MANUAL CORRECTIONS

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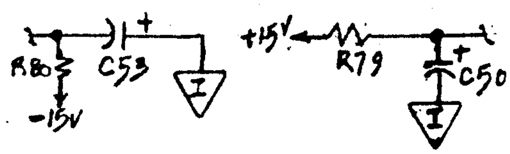
CODE NO.	CORRECTIONS	PM PART NO.	SECTION OF MANUAL AFFECTED
20	On page 9-4, change A2C50 & A2C53 from current listing to the following: (value and P/N only)		9
	27µF	10787-3	
	On page 8-14, SD 13510 Sheet 2, change values for C50 and C53 to 27µF and add + sign as shown below: 		
21	None		

SECTION 10

MANUAL CORRECTIONS

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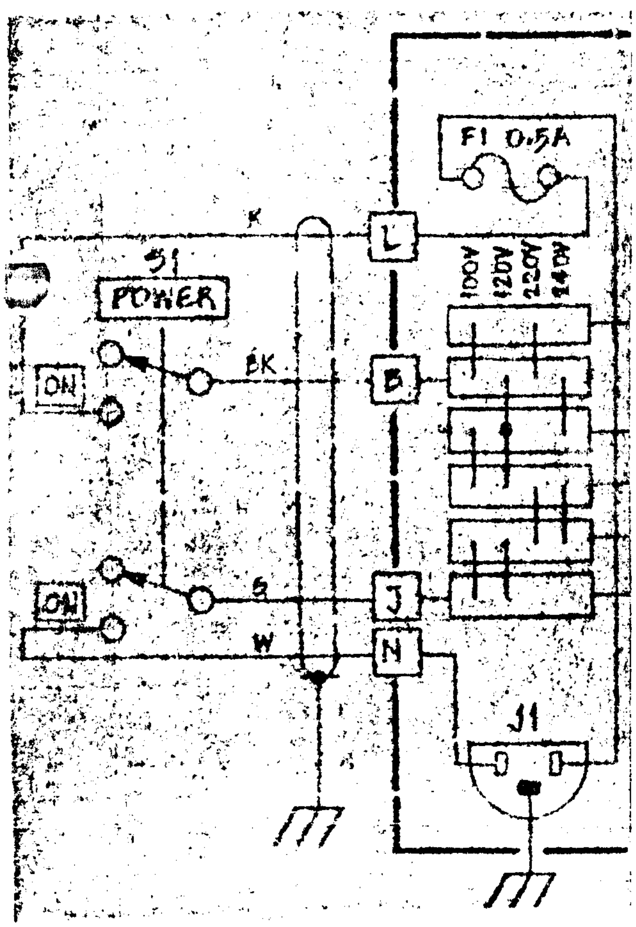
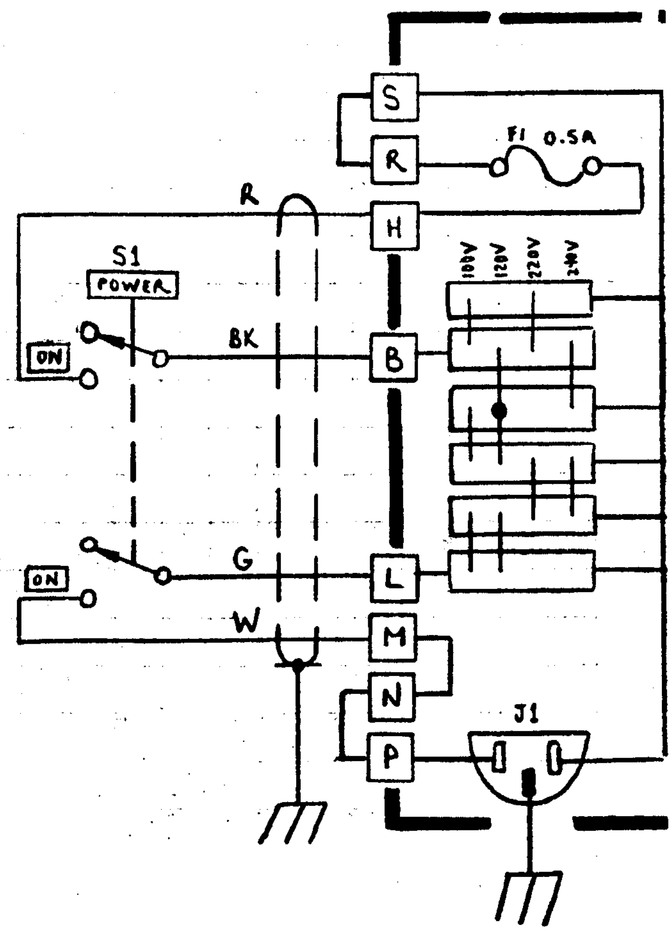
CODE NO.	CORRECTIONS	PM PART NO.	SECTION OF MANUAL AFFECTED
22	On page 9-2, change part number (only) of J1 from present listing to the following:	13492	9
	On page 8-3, SD 13901, revise the circuitry as shown below:		8

FROM:



TO:



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MANUAL CORRECTIONS

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CODE NO.	CORRECTIONS	PM PART NO.	SECTION OF MANUAL AFFECTED
23	On page 9-4, change A2C26, A2C35, and A2C51 from present listing to the following:		9
	Ceramic .047uF 20% 50V	10000-14	
	On pages 8-13 and 8-14, SD 13510 Sheets 1 & 2, change C26, C35, and C51 to reflect above change in value.		8 8