MEGOHMMETER

MODEL R1M-A, R1M-AR

Operation and Maintenance Manual

PN# R1M-A-900-01
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• sales@tegam.com

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SECTION 1

INSTRUMENT DESCRIPTION

INTRODUCTION

1.1 Purpose

The Model RIM-A Megohmmeter is a portable instrument used to measure high values of resistance. It is enclosed in a rugged weather-resistant housing designed for severe industrial and military applications.
The Model RIM-A may be used to measure resistances between 50 kΩ and 10 GΩ with 50 V test voltage, and between 1 MΩ and 200 GΩ with 100 V, 250 V, or 500 V test voltage.

1.2 Performance Characteristics

This is a digital reading instrument with six resistance ranges and four test voltage ranges.

Range	Full Scale (Ω)	Resolution (Ω)	Test Voltage (V)	
1	1 M	1 k	50	
2	10 M	10 k		100, 250, or 500
3	100 M	100 k		
4	1 G	1 M		
5	10 G	10 M		
6	100 G	100 M		

Table 1: Specifications

Accuracy:
Resistance accuracy on all ranges: ± 5%
Test Voltage accuracy on all ranges: ± 3%

1.3 Description of Equipment

Physical: A rugged heavy-duty case is provided to contain and protect the instrument. When closed, a gasket seals the lid to protect the instrument against water and dirt while the instrument is carried through rainstorms or other hazardous conditions. The lid is secured by two latches. A handle is provided for portability. A compartment is provided for storage of test cables and line cord.

Dimensions: 216 mm (8.5") x 228 mm (9") x 152 mm (6"). Weight is 2.3 kg (5 lb). Controls and connectors are of a size and spacing such that the instrument may be operated while wearing safety gloves.

Electrical: Input power is from the AC power line (103.5 V to 129 V at 50 Hz or 60 Hz, at less than 1/8 A).

Environmental: This unit will operate over a temperature range from 0 °C to 50 °C, 75% RH non-condensing, up to 3050 m altitude. Withstand functional shock of 40 G for 11 ms. Vibration: 2 G maximum at 5 Hz to 55 Hz.

Front Panel Controls and Displays (See figure 2)

OHMS RANGE Switch is a rotary six position selector switch used to step through all six ranges.

TEST VOLTAGE RANGE Switch is a rotary four position selector switch used to step through all four voltage ranges.

POWER Switch is used to turn the power on or off to the instrument.

TEST pushbutton is a round sealed switch. This pushbutton switch turns on the power to the unit. A LED is provided to indicate that the test voltage is on.

DISPLAY is a 3 ½ digit LCD, displaying readings from 1.999 to 199.9.

TEST VOLTAGE Jack is recessed to prevent any accidental encounter.

Three Binding Posts for connection of test leads are marked SIG (Signal), GUARD and GND (Ground). Proper connections to the resistor under test are described in Section 2.2 below.

WARNING
DO NOT TOUCH THE BINDING POSTS WHEN THEY ARE CONNECTED TO EXTERNAL CIRCUITS. LETHAL VOLTAGES MAY BE PRESENT AT THESE POSTS.

1.4 List of Items Furnished

1 each Model R1M-A with power cord
2 each test cables, one shielded with two alligator clips and the other with one alligator clip
1 each R1M-A Instruction Manual

1.5 Storage and Shipping Requirements

Standard precautions which apply to electronic test instruments should be followed. A hard mechanical shock, such as from dropping the R1M-A, could damage the liquid crystal display. Care should be taken to prevent damage to associated cables.

The R1M-A should be stored in a relatively dust-free environment.
Temperature: -40 °C to +71 °C.
Relative humidity: 0 to 100%, non-condensing.
Altitude: 4570 m
See Section 5.7 below for shipping requirements.

SECTION 2

PREPARATION FOR USE AND INSTALLATION

2.1 Unpacking and Inspection

Upon receipt, the R1M-A and accessories should be carefully unpacked and removed from the shipping container. Separate the units from the packing material and inspect both the instrument and the accessories for any external damage.

- If any dents, broken, or loose parts are seen, do not use the equipment. Notify the shipping company immediately and follow their instructions as to how to proceed.
- Check that all items are present. If any items are missing, notify the shipper if this is a new instrument. If not new, contact the previous user to locate the missing item(s).

2.2 Preparation for Use

Release the two latches which secure the lid and open the lid. Remove the power cord and the two test cables which are stored in the side compartment. If desired, the lid may then be removed by pushing it to the right.
Set the 'TEST VOLTAGE' rotary switch to the desired value, from 50 V to 500 V and set the 'OHMS RANGE' switch to the anticipated range.
Note that although the 'OHMS RANGE' switch is marked from 1 M to 100 G, a 100% over-range capability is built into this instrument.
Note also, that for resistance values less than 1 MΩ, the only test voltage that should be used is 50 V. No damage will occur if a higher voltage is selected, but the readings may not be accurate. Do not measure resistors less than 50 kΩ with the R1M-A; it may damage the instrument.

WARNING
SHORTING THE 'TEST' and 'SIGNAL' LEADS TOGETHER WILL CAUSE INSTRUMENT DAMAGE.

Power Up

Plug the power cord into a source of AC power (103.5 V to 129 V at 50 Hz or 60 Hz). Check that the other end is plugged securely into the power input receptacle on the front panel and turn on the POWER toggle switch.

Connections to DUT

One test cable has a double banana plug at one end and red and black insulated alligator clips at the other end. This is the shielded test cable. Connect the red alligator clip to one end of the resistor under test. Connect the black clip to the guard circuit, if any. If no guard is available, this clip may be left floating (it is connected to the cable shield and to the R1M-A guard circuit at the other end) however, this clip must not be allowed to make accidental contact with any part of the external circuit. Plug the dual-banana plug on this cable into the SIG and GUARD binding posts. Note that the pin marked GROUND should go into the GUARD binding post. If there is no guard available and the black alligator clip at the other end of the test cable is left floating, the operator may choose to orient the dual banana plug so that the GROUND pin is NOT plugged into the GUARD binding post. This will ensure that any accidental contact of the black alligator clip will cause no problem; however, the cable shield will then be floating and the signal may be excessively noisy.
The other test cable has a shrouded banana plug on one end and an insulated alligator clip on the other end. This cable carries the high voltage output of the R1M-A to the resistor under test. Connect the alligator clip to the other end of the resistor under test; then plug the shrouded banana plug into the recessed (RED) 'TEST' jack. Please refer to the connection diagram (figure 1) below.

The shorting link on the GROUND binding post may be swung around and connected to the GUARD binding post to ground the R1M-A circuitry. This may be done only if there is no external voltage with respect to ground on the measured resistor or guard.

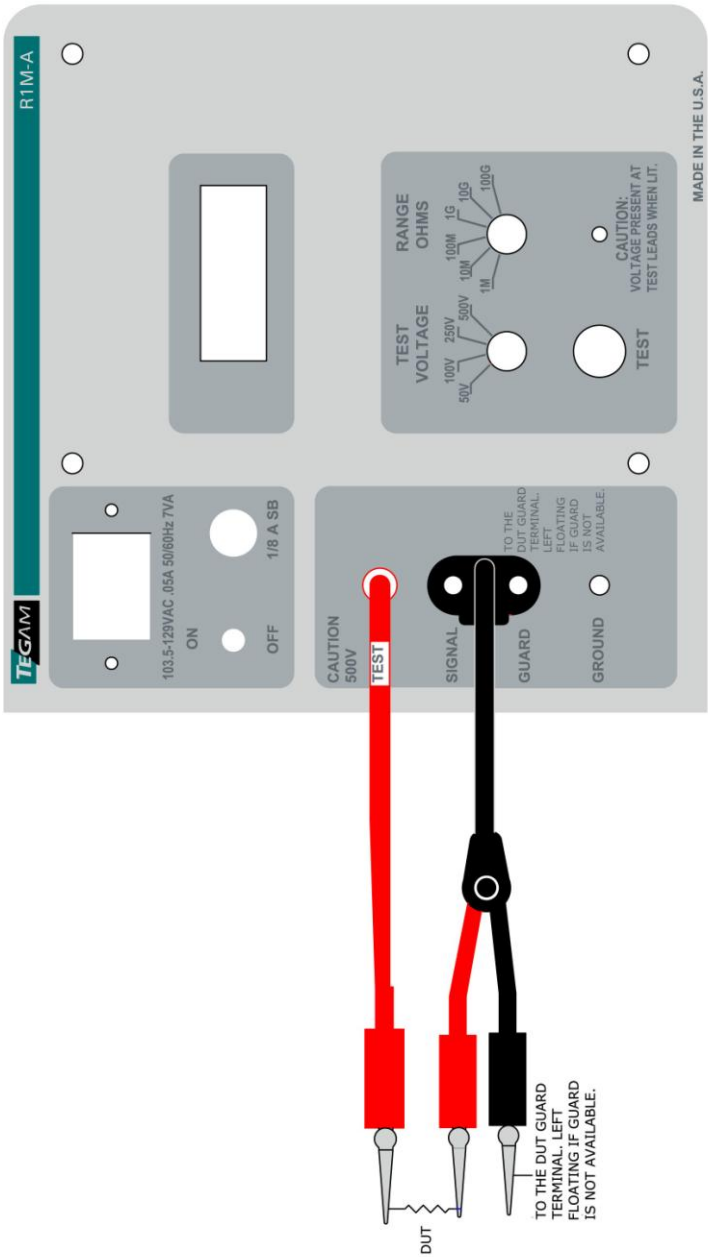

Figure 1: Connection Diagram

SECTION 3

OPERATING INSTRUCTIONS

The R1M-A is designed for bench-top or field operation. Use the cables connecting their banana plug terminations to the appropriate connectors explained in Section 2.2.

WARNING
DO NOT TOUCH ANY ALIGATOR CLIP WHILE DEPRESSING THE TEST PUSHBUTTON. LETHAL VOLTAGES MAY BE PRESENT ON THESE CLIPS.

3.1 Rotary Switch Functions

The two rotary switches manually scroll through the six resistance and four voltage ranges.
Full scale on any range may be described as 2,000 (actually 1,999), since this is a 3 ½ digit meter. If the readings are exceeding 1,999 counts, step to the next higher range. If the readings are less than 2,000 counts, step down a range, so that it will read 1,999 counts, or less. The decimal point is located automatically for the correct reading.
If the selected range is too low for the value of the resistor under test, the display will show over-range by showing "1" on the display. Similarly, the under-range condition is displayed by showing negative readings on the display. "-1" is displayed on the display until the test button is pressed.
The POWER switch turns on the power to operate the unit or turns off the power to the unit. Note that when power is turned off, it may take several seconds to discharge circuit capacity to completely blank the display. The black markings seen have no effect and disappear when power is turned back on.

WARNING
TAKING RESISTANCE MEASUREMENTS ON A POWERED OR ENERGIZED COMPONENT COULD CAUSE SERIOUS HARM TO THE OPERATOR AND/OR DAMAGE THE R1M-A. BE SURE THE ITEM TO BE MEASURED IS DISCONNECTED FROM OTHER COMPONENTS AND APPARATUS.

3.2 General Theory Of Operation

A 2-terminal measurement method is used to determine the resistance of the item under test. The R1M-A calculates the resistance of the item under test utilizing Ohm's law and displays it on a 3 ½ digit display.

To obtain the best accuracy, allow the R1M-A to warm up for 15 to 30 minutes before making measurements. In any case, a minimum warm-up of 30 seconds is advised.

Depress the TEST pushbutton, which switches on the high voltage. Note that the red LED will light, indicating that high voltage is present on the terminal. Allow for a brief settling time and read the resistance on the digital display. Note that the operating range of resistance values which may be read on any given range extends from 5% to 199.9% of the nominal value of the selected range. Note that readings greater than 100% will take more time. Thus, the 1 MΩ range may be used to measure resistors from 50 kΩ to 1.999 MΩ. Note that the test voltage must be 50 V for resistances less than 1 MΩ. If the resistance measured exceeds the maximum value for the selected range, the display will show blanks; in that case, set the range switch to a higher range. If the resistance measured is less than 5% of the nominal value of the selected range, the display will show a minus sign; if so, switch to a lower range, since the readings may be inaccurate.

If readings are noisy, especially at very high values of resistance, it may be caused by 60 Hz coupled to the test resistance from the power line. Note that at 100 GΩ, an extremely small capacitance will couple many volts into the test resistance from a power line. If so, it may be necessary to interpose a grounded shield plate or to put the unknown resistor into a metal box, connected to the GUARD alligator clip.

To close up the R1M-A, first reattach the lid to the main case, if it has been removed. Then store the power cord and test cables in the side compartment.

SECTION 4

PRINCIPLES OF OPERATION

The power supply uses a transformer with two secondary windings. The low-voltage winding is a center-tapped winding. Diodes D9 and D12 provide rectified + power filtered by C26 and regulated at +6 V by D7. Diodes D10 and D11 provide rectified - power, filtered by C25 and regulated at -6 V by D8. The high-voltage winding on T-1 charges C23 through D7 and C24 through D8. Since these two capacitors are connected in series, this circuit functions as a voltage doubler to provide a high voltage nearly equal to twice the peak voltage of the high voltage winding. This high voltage is at least 650 V at low line in order to provide 500 V test voltage with 1 IDA of I x R drop across R37.

R37, a series resistor, is followed by Q1, a high-voltage shunt regulator, to regulate the high voltage supply at the selected value. R38 provides protection for Q1 from excess current caused by external voltages. R6-R9 operate as a four-section voltage divider, dividing the voltage from U2, a 2.5 V precision voltage reference, to 0.25, 0.5; 1.25, and 2.5 V. The voltage selected by S1 A, the 'TEST VOLTAGE' selection switch, is fed into pin 9 of U1, a quad operational amplifier. The high voltage output is divided by R3 and R4 to 1/200 of the high voltage output. This divided voltage is fed to pin 10 of U1, where it is compared with the selected reference voltage. If the divided output is higher than the reference, the output (pin 8) of U1 goes more positive, increasing the base current drive to Q1. Since this is a shunt regulator, the output high voltage decreases, until an equilibrium point is reached. Thus, the high voltage is regulated at the selected value.

When a resistor is not being tested, S3 (the 'TEST' switch) is closed, shorting out the high voltage. This also provides added safety in the event that the external circuit under test contains capacitors. If so, they will be charged during 'TEST', but discharged automatically as soon as S3 is released.

When the 'TEST' switch S3 is pressed, the high voltage is no longer shorted out and it will be outputted at the 'TEST' jack. Current will then flow through the resistor under test to the SIG binding post and then to the wiper of S2A, the OHMS RANGE selector switch. This current then passes through the selected resistor, R16 through R21. The IR drop generated shows up as a negative voltage at the output, pin 6, of U3. U3 is an extremely low bias current amplifier, so that less than 1 pA is diverted into its input. Also, the protection diodes, Q5 and Q6, are low leakage transistors. Thus, even currents as low as 1 nA, generated by a 100 V test voltage and a 100 GΩ resistor, are passed with essentially no loss.

NOTE: D5 and D6 on the display board parts layout (Figure 8) correspond to Q5 and Q6 on the display board schematic (Figure 7a). This is due to the fact that transistors are being used as diodes.
NOTE: The action of D3 is to create a virtual ground at the input (pin 2) and at the 'SIG' binding post. This has the advantage that the full value of the test voltage is developed across the resistor under test, with no error caused by the current monitoring resistor, R16 through R21. A second advantage is that the power common may then be used as a guard voltage because it is essentially at the same potential as the 'SIG' binding post.

The signal current through the resistor under test increases with increasing test voltage. Thus, the IR drop at the output of U3 varies with the test voltage. The signal current with 50 V test voltage and a 1 MΩ test resistor is 50 µA. With S2A set to the 1 MΩ range, this current flows through R21, 499 Ω. Thus, the voltage at the output of U3 is 25 mV. For higher resistance ranges, S2A selects higher values of resistance, R20 (4.99 kΩ), R19 (49.9 kΩ), etc. to compensate for decreasing values of signal current. Thus, the output of U3 remains at 25 mV for full-scale test resistors for all ranges, with 50 V test voltage.

However, if the test voltage is increased, the signal current and the voltage output of U3 will increase. To compensate for this, the amplifier section of U1 having pins 1, 2, and 3

changes gain with the test voltage. With 50 V, its gain is set by S1B and R22 at 4.23x so the output at pin 1 is 106 mV. With 500 V, the gain is decreased to 0.423x so the output remains at 106 mV, even though the increased test voltage increases the signal current by ten times.

As indicated above, the output at pin 1 of U1 is 106 mV for full-scale resistor values of any range and with any test voltage. For smaller resistors, this voltage increases. At 5% of full scale, this voltage is approximately 2.12 V, approaching its upper limit. If the value of resistance under test is less than 5% of the selected range, the voltage at pin 1 of U1 will exceed 2.12 V. This voltage is connected to pin 5 of U1, where it is compared with the 2.5 V reference from U2. If the voltage exceeds 2.5 V, the output at pin 7 of U1 goes positive, increasing the base current to the shunt regulator Q1 and reducing the output high voltage. When this happens, the normal regulating section of U1, with output pin 8 (which is normally somewhat positive to control Q1) turns off and pin 8 goes full negative, trying to increase the value of the high voltage. This negative voltage is coupled to the input pin of the A/D IC, U4, via diode D4. Thus, the display will show a minus sign to indicate that the resistor is too small for the selected range and a smaller range should be selected.

U4 is a 3 ½ digit A/D converter and LCD driver, functioning as a digital voltmeter. However, since the test current and voltage are inversely proportional to the test resistance, the digital voltmeter is operated as a ratio meter, with a fixed DC voltage as the normal input to pin 31, and the test voltage signal connected to the normal reference input, pin 36.

U5 is a 3 ½ digit liquid crystal display, driven segment by segment by U4. S2B provides the proper logic levels to the quad exclusive-or gate U6 to locate the decimal point on the display. R33, 34 and 35 are pull-down resistors.

SECTION 5

MAINTENANCE

5.1 Inspection

These units should be inspected semi-annually. Cables should be periodically inspected to make sure they are in good condition. Check that the pushbutton and rotary switches operate smoothly. Check all four binding posts to ensure that they operate smoothly. Check that the case opens and closes with no binding.

5.2 Cleaning

The instrument should be cleaned periodically, as is necessary, using mild soap and a damp cloth both followed by second damp rinsing cloth.
Clean the LCD window using a soft cloth moistened with water or "Windex" type window cleaner. **DO NOT** use common paper towel products as some brands may contain fibers which could scratch the display window. **DO NOT** apply significant pressure to the LCD window as it could separate from the front panel. **DO NOT** use alcohol, solvents, or harsh chemicals to clean the LCD window.

5.3 Test Equipment Required for Calibration and Repair

Calibration of the R1M-A is recommended on a yearly basis, and is done at a temperature of 23 °C ± 1 °C.

Precision decade resistor boxes settable to 50 kΩ, 1 MΩ, 10 MΩ, 100 MΩ, 1 GΩ, 10 GΩ, and 100 GΩ with accuracy of 0.1% or better.

A standard digital voltmeter: 3 ½ digits minimum, with 19.99 and 999 V ranges, accuracy of 0.02% of reading or better. HP/Agilent 34401A or equivalent.

Oscilloscope: 20 MHz minimum bandwidth, 5 mV/div. sensitivity. Tektronix Model 2205 or equivalent

Screwdrivers: Phillips No.2 and small flat-bladed

5.4 Performance Verification

WARNING
DO NOT TOUCH ANY ALLIGATOR CLIP WHILE THE TEST PUSHBOTTUN IS PRESSED. LETHAL VOLTAGES MAY BE PRESENT ON THESE CLIPS.

1. Check the test voltages. Connect a DVM with at least 1 MΩ resistance between the 'TEST' (high) jack and the 'SIG' (low) binding post. Note that the OHMS RANGE switch must be on the 1 MΩ range, or the short circuit protection circuit may start to shut down the high voltage power supply. Check that the voltages are as selected by the 'TEST VOLTAGE' selector switch within ± 3%. If not, there is no adjustment other than to check the various components in the high voltage regulator circuit and to replace any found to be defective.

2. Check that the light-emitting diode circuit is operating correctly. It should light when the 'TEST' pushbutton is depressed (provided that the resistor under test is within the selected resistance range) (Power must be ON).

3. Check the accuracy of the resistance indication by measuring resistors of known accuracy. Resistors required are 50 kΩ, 1 MΩ, 10 MΩ, 100 MΩ, 1 GΩ, 10 GΩ, and 100 GΩ. Check each range with a resistor of the indicated value of that range and also with a resistor of 10% of that value, with the exception of the 1 MΩ range, which should be checked with a 50 kΩ resistor. Check first with 50 V and then with 500 V (but DO NOT CHECK THE 50 kΩ AT 500 V). All readings must be within 5% of the actual value. If not, adjust the trimpots as described below.

5.5 Calibration

WARNING
DISCONNECT THE AC POWER CABLE BEFORE REMOVING THE INSTRUMENT FROM ITS CASE. LETHAL VOLATEGS ARE PRESENT WITH AC POWER CONNECTED.

Remove the four large mounting screws from the front panel and remove the instrument from the case. The binding posts and switch knobs may be held to assist in removal. Note that the unit must be extracted carefully to avoid catching the internal boards on the retaining brackets.

For calibration, only, it is not necessary to separate the printed circuit boards. There are three trimpots on the lower edge of the display board which may be adjusted for calibration.

WARNING
USE EXTREME CARE IN HANDLING THIS UNIT! EVEN WITHOUT OPERATING THE TEST PUSHBUTTON, THERE ARE VERY HIGH VOLTAGES PRESENT! THEY COULD BE LETHAL!

1. Connect the power cord and remove the test cables. Set the test voltage to 50 V and the Ohms range to 1 GΩ.

2. To adjust R29 (see Figures 7a and 8), connect the voltmeter Low lead to R27, the side closest to D6. Connect the High lead to R26, the side between R26 and R20. Turn the power on. DO NOT TOUCH ANYTHING EXCEPT THE SCREW ADJUSTMENT OF R29! Adjust R29 for 0 ± 0.1 V on the voltmeter. Turn the power off.

3. To adjust R32, connect the voltmeter High lead to R22, the side closest to S1. Turn the power on. DO NOT TOUCH ANYTHING EXCEPT THE SCREW ADJUSTMENT OF R32! Adjust R32 for 0 ± 0.1 V on the voltmeter. Turn the power off and remove the voltmeter leads.

4. To adjust R14, connect the test leads to a 1 GΩ resistor and set the voltage switch to 100 V. Turn the power on. Very carefully operate the Test pushbutton and adjust R14 so that the display reads between 0.990 and 1.010 GΩ (for 1% accuracy). Turn the power off.

5.6 Troubleshooting

Disassembly
After removing the unit from the cabinet, it may be disassembled as follows:

- Remove the two knobs on the rotary switches.
- Remove the four small screws holding the power supply board to the threaded spacers.
- Remove the four front panel screws that pass through the front panel, metal tubular spacers, nylon washers, the display board, into the threaded spacers.
- The two boards may now be separated for service.

Re-assembly
After trouble-shooting and repair, re-assemble in reverse order from above.

Following are possible symptoms, diagnosis, and repair suggestions for use in trouble-shooting (the most likely causes are listed first). Note that the TEST button must be held in for most of these tests; do not try to bypass it because it is a safety feature, shorting the high voltage supply.

Note that even with the TEST button released; high voltage still exists between the transformer secondary and R37.

SYMPTOM	FAULTY COMPONENT	REPAIR
No Display	Line Power Line Fuse TEST pushbutton U5/U6 T1, D9 & 12, or U7 T1, D10 & 11, or U8 U4 or U5	Check power cord & power. Check fuse. Depress the TEST pushbutton and see if the LED comes on. If so, check for a square wave at pin 40 of U4 and/or replace U5/U6. If not, check for proper power supply voltages and check or replace fuse. Check for +6 V. If not, trace & replace bad part. Check for -6 V. If not trace & replace bad part. Replace U4 or U5.
No Test Voltage	T1 D7, 8 C23, 24 R37	Check for 360 VAC pins 7-8. Replace D7, 8. Replace C23, 24. Replace R37.
1 MΩ Range not Accurate	R21	Replace R21.
10 MΩ Range not Accurate	R20	Replace R20.
100 MΩ Range not Accurate	R19	Replace R19.
1 GΩ Range not Accurate	R18	Replace R18.
10 GΩ Range not Accurate	R17	Replace R17.
100 GΩ Range not Accurate	R16	Replace R16.
Error with some test voltages	U1, S1, R22-25	Replace bad part.
All Ohm readings too high or too low	R14 Adjustment	Adjust R14.

Table 2: Fault Symptoms and Repair Actions

After trouble-shooting and repair, the instrument must be recalibrated in accordance with 5.5 above.

5.7 Preparation for Shipment

The original shipping carton is not reusable.

The two test cables and line cord should be stored in the side compartment and the lid closed and latched.

The Model R1M-AR is a rugged instrument and requires no special covering, preservation or special cradles. Packaging must provide sufficient resilient material, in accordance with standard packaging practices, to prevent excessive shock to the power supply and display during shipment.

5.8 Overhaul Instructions

The R1M-A is an all solid-state unit and requires no periodic overhaul, other than routine cleaning, inspection of cables per section 5, and calibration per section 5.5.

Tools and test equipment used for disassembly, calibration and troubleshooting of the R1M-A are listed in section 5.3.

Troubleshooting suggestions are given in section 5.6.

Figure 2: Front Panel Controls

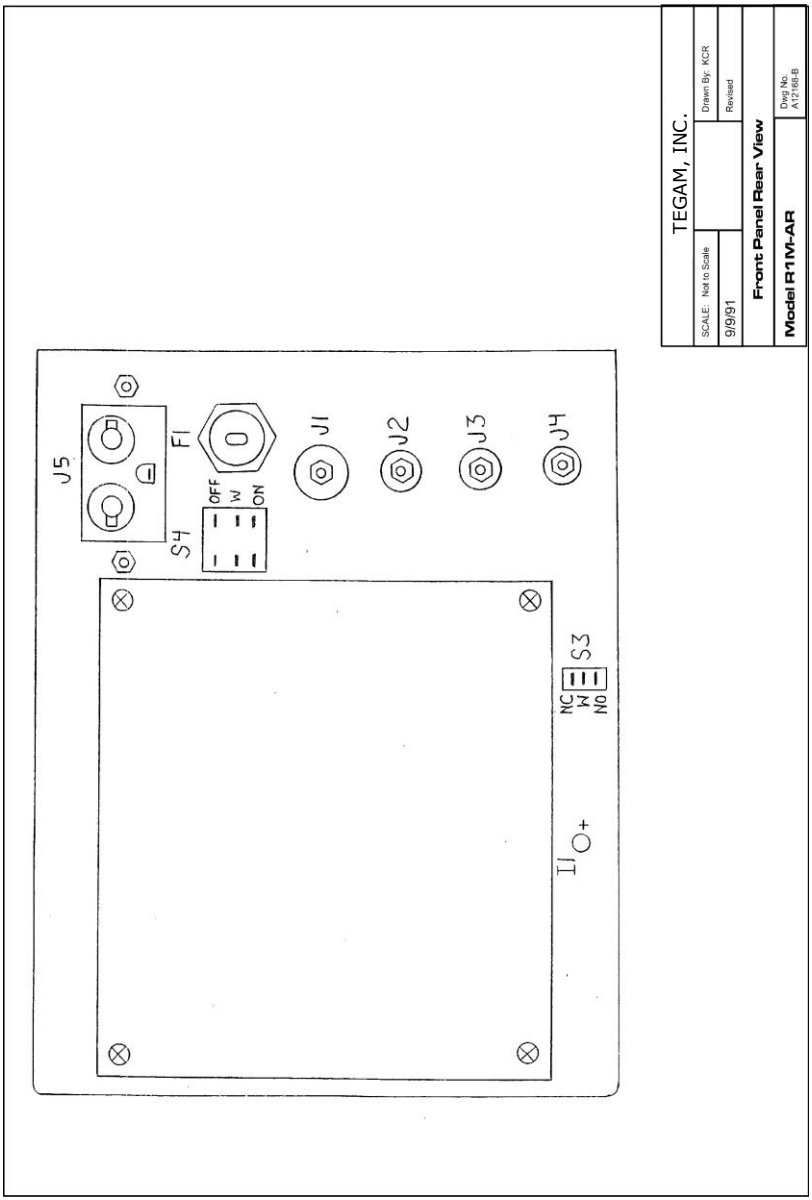

Figure 3: Front Panel - Rear View

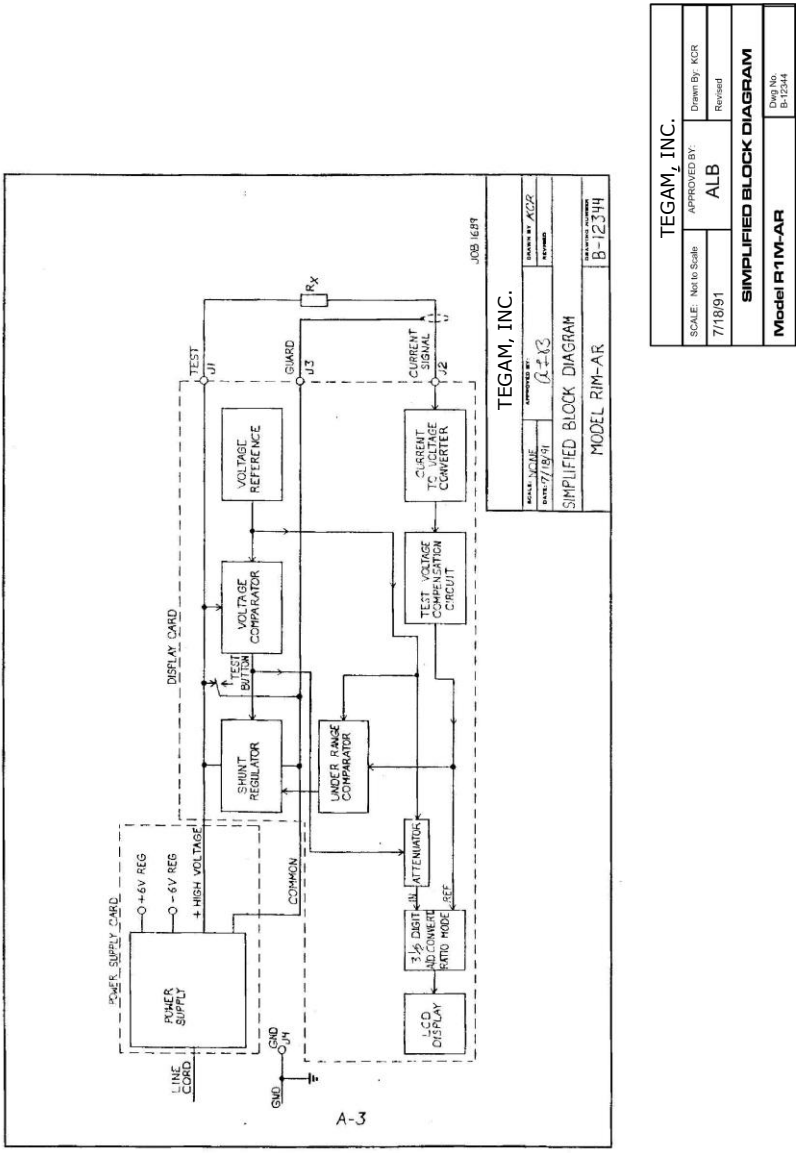

Figure 4: Simplified Block Diagram

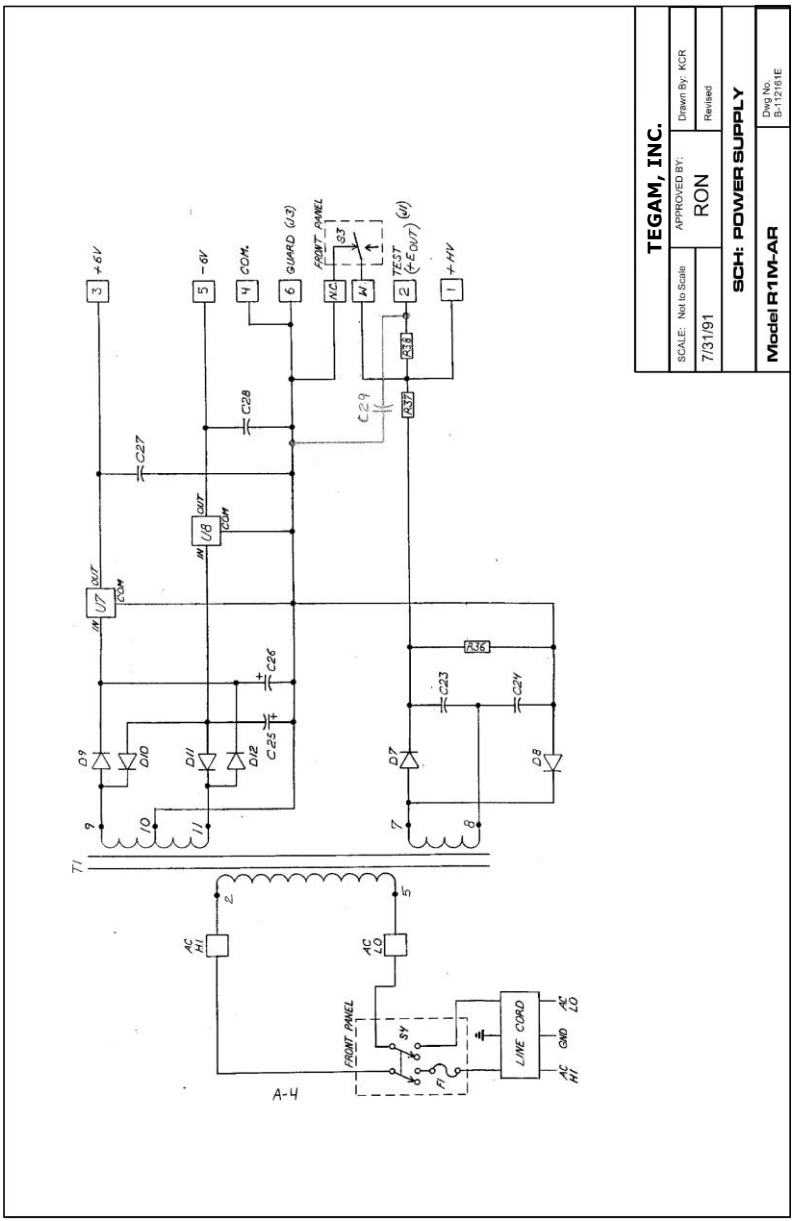

Figure 5: Power Supply Schematics

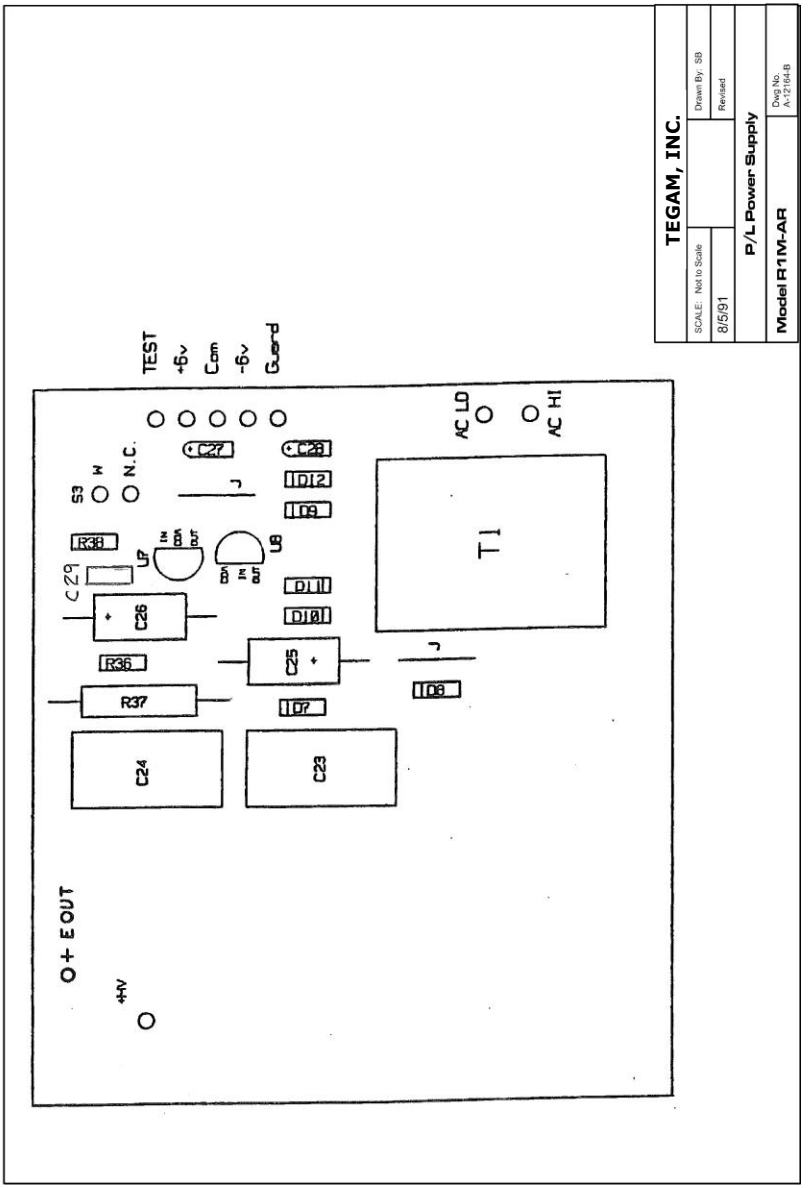

Figure 6: Power Supply Board Layout

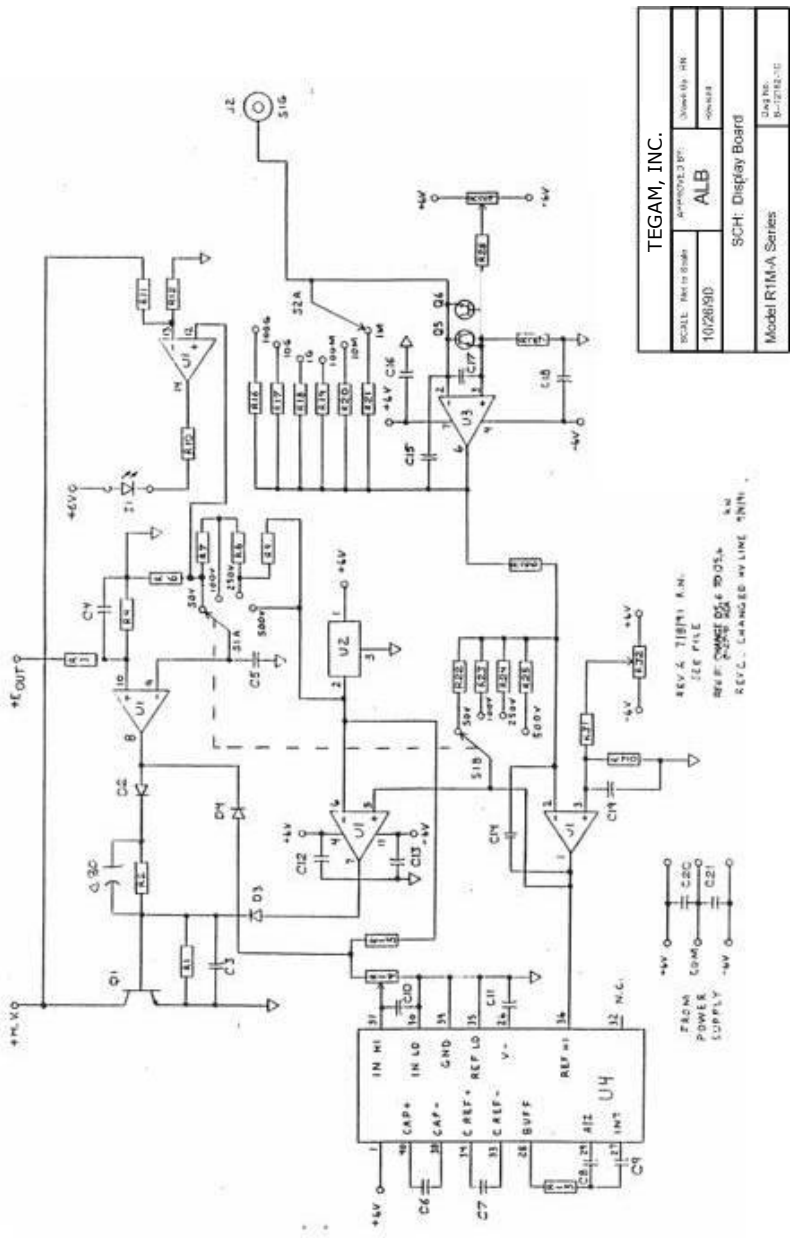

Figure 7a: Display Board Schematic

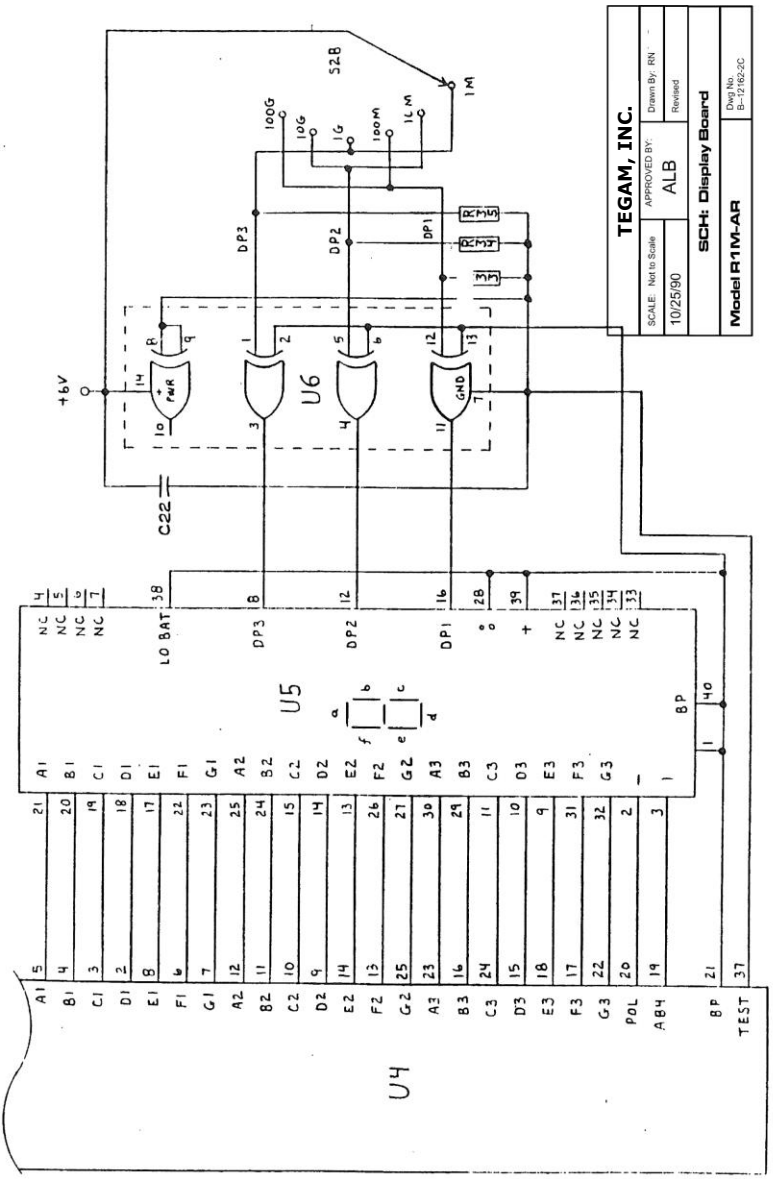

Figure 7b: Display Board Schematic

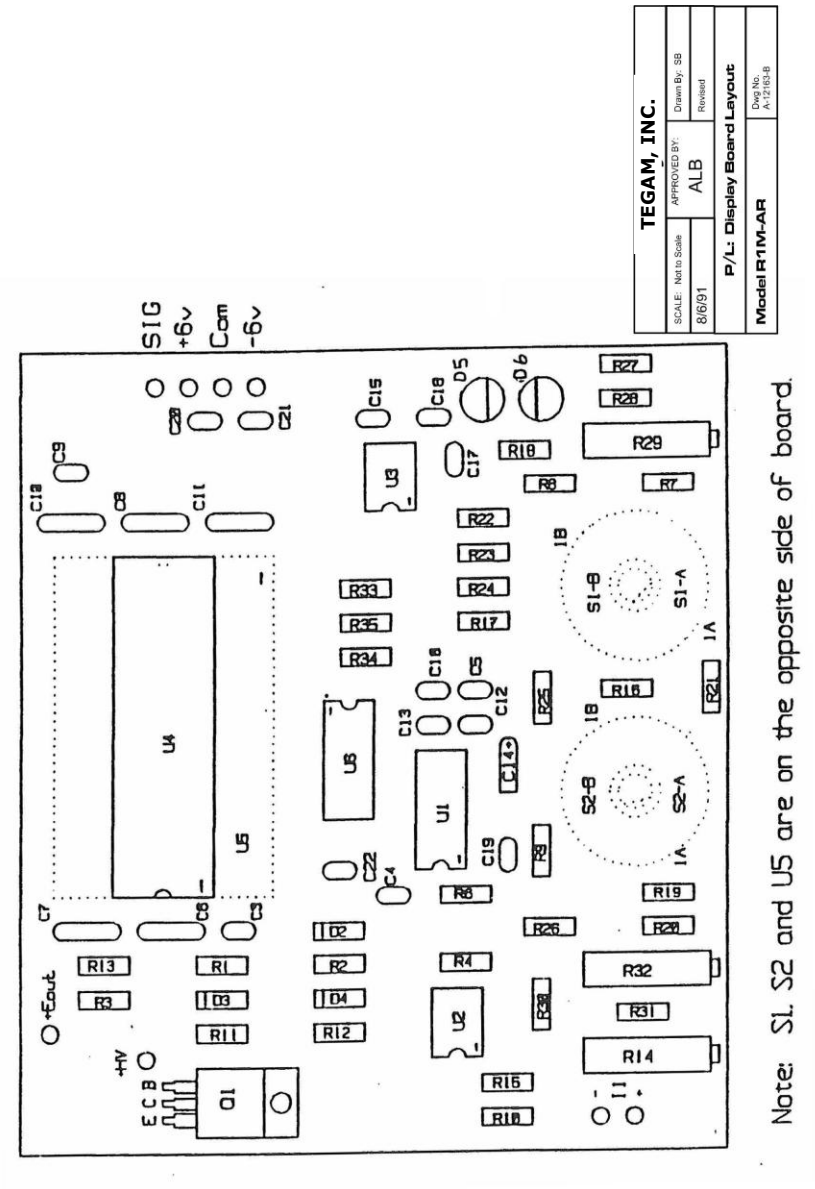

Figure 8: Display Board Parts Layout

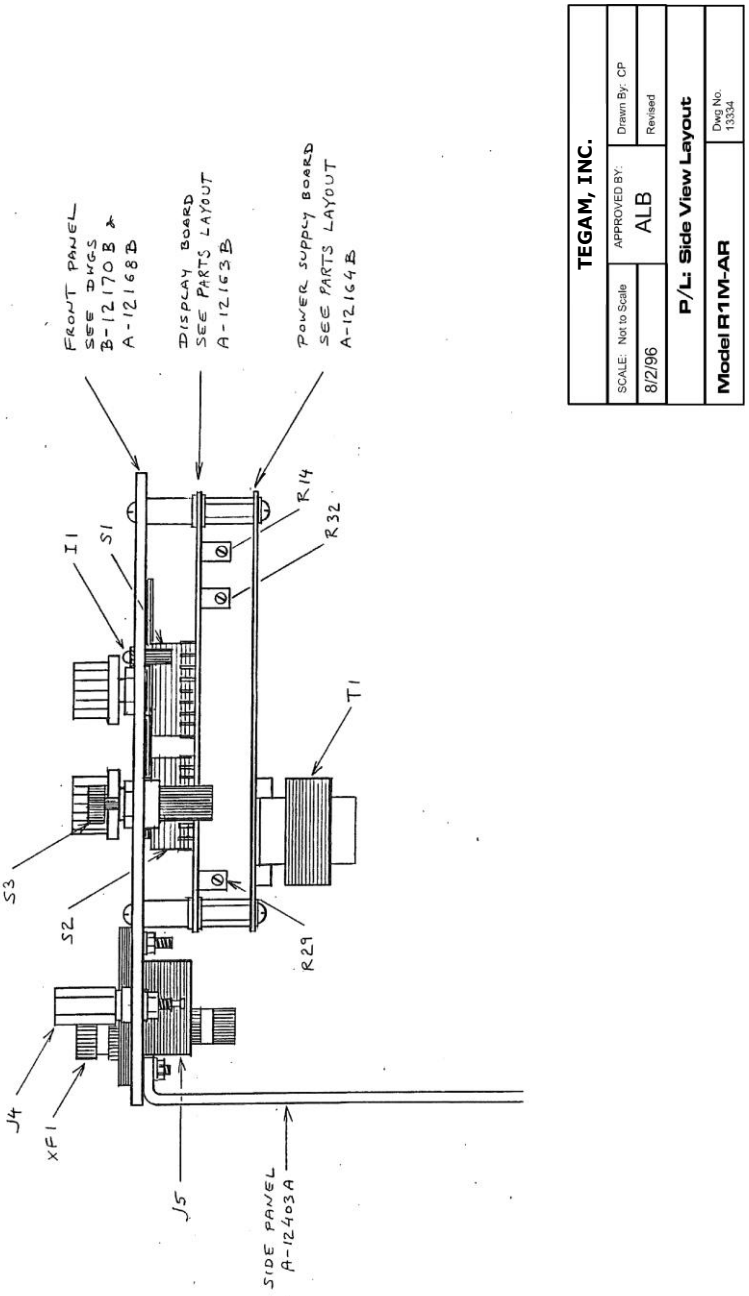

Figure 9: System (Side View) Layout

TEGAM Inc., Geneva, OH BOM Part Number: M601 (Formerly M100371)
Bill Of Material for: System Model Number:
By: CMG Date: 9/1/09 Job No. R1M-AR+850

ITEM	REFERENCE	QTY.	DESCRIPTION	MFGR.	MFGR. PART NO.
1		1	Case	Ameripack	5000
1B		4	#4 x 0.01 Nylon Washer	McMaster	
2		1	Test Cable	Oldaker	506-2 (4' Black)
3		1	Test Cable	Oldaker	510-1 (4' Red)
4		1	Linecord	Volex	17757-B1-10
5		4	4-40 Lockwasher	McMaster	
6		2	4-40 x ½" PFH MS SS	McMaster	
7		4	4-40 x 1" PPH MS SS	McMaster	
8		4	4-40 x 1/4" PPH MS SS	McMaster	
9		4	#4 x ½" Rnd Spacer, Alm	McMaster	1128-4-B-12
10		4	4-40 x ½" Threaded Hex Standoff, Aluminum	McMaster	2104-440-B-12
12					
13		1	Power Supply Board	TEGAM	M603
14		1	Display board	TEGAM	M602
15		1	Front Panel Assy	TEGAM	M604
16		4	8-32 x 1" PFH MS SS	McMaster	
17		4	8-32 x 3/8" x 3/8" Hex Aluminium Standoff	McMaster	
18		4	8-32 x 2" x 3/8" Hex Aluminium Standoff		
19		4	8-32 x 3/8" Philips Truss Head Screw SS	McMaster	
20		1	Black ABS Panel 6.62" X 6.68" Horcell Finsh	TEGAM	
21		1	1/16th Oz. IPS Weld-On #3 Solvent Cement	McMaster	
22		1	User's Manual	TEGAM	
23		1	Serial Number	TEGAM	
24		1	Warranty Sticker	TEGAM	
25		1	Calibration Sticker	TEGAM	
26		2	Model 850 Surface Resistance Probes	Electro-Tech Systems, Inc.	
27		1	Packaging		

Table 3: Parts List – Board Assembly

TEGAM Inc., Geneva, OH BOM Part Number: M602 (Formerly M100332)
Bill Of Material for: Display Board Model Number:
By: CMG Date: 9/1/09 R1M-AR

ITEM	REFERENCE	QTY.	DESCRIPTION	MFGR.	MFGR. PART NO.
1		1	PC Board (4.2 x 4.7")	Cleveland Circuits	12156-B
2	C5, 7, 9-13, 16, 18-22	13	0.1 MFD, 50 WVDC	Kemet	C315C104M5U5CA
3	C6	1	1 MFD, 50 WVDC	AVX	SR305E105MAA
4	C8	1	0.47 MFD	Kemet	C330C474M5U5TA
5	C14	1	6.8 MFD, 15V Tantalum	Sprague	173D685X9015V
6	C15	1	0.01 MFD, 50 WVDC	AVX	SR151E103MAA
6A	C30	1	2200 pF 100V X7R Cer.	AVX	SR151C222KAR
6B	CC (C31)	1	100 pF, 100V NPO Ceramic	Multicomp	2222 680 34101
	C3,4, 17	0	Not Used		
7	D2, 3, 4	3	Diode, Signal	Fairchild	1N4148
8	Q1	1	Hi-Voltage NPN	ST Micro	BUL216
9	D5, 6	2	NPN (used as diode)	Fairchild	2N5172
10	R1, 2	2	2K	Dale	RN55D2001F
11	R3	1	10M, 500V	Dale	RNX03810M0FNLB
11A	R11	1	10M, 1%	Dale	RN55D1005F
12	R4, 19, 22	3	49.9K	Dale	RN55D4992F
13	R6, 7, 10	3	1K	Dale	RN55D1001F
14	R8	1	3.01K	Dale	RN55D3011F
15	R9, 20, 25	3	4.99K	Dale	RN55D4991F
16	R12, 15	2	100K	Dale	RN55D1003F
17	R13	1	174K	Dale	RN55D1743F
18	R14	1	Trimpot, 10K	Bourns	3006P-1-103
19	R16	1	49.9M	Phillips	RNX1/4 50M 1%K
20	R17	1	4.99M	Dale	CMF554M9900FKEK
21	R18	1	499K	Dale	RN55D4993F
22	R21	1	499 OHMS	Dale	RN55D4990F
23	R23	1	24.9K	Dale	RN55D2492F
24	R24, 33-35	4	10K	Dale	RN55D1002F
25	R26	1	11.8K	Dale	RN55D1182F
26	R27, 30	2	10 OHMS	Dale	RN55D10R0F
27	R28, 31	2	20K	Dale	RN55D2002F
28	R29, 32	2	Trimpot, 20K	Bourns	3006P-1-203
29	S1*	1	Rotary, 2 Pole, 4 Pos*	Electrosw	C5P0206N-4006*
30	S2*	1	Rotary, 2 Pole, 6 Pos*	Electrosw	C5P0206N-4006*
31	U1	1	Quad OPAMP	National	LM324AN
32	U2	1	2.5V Reference	Motorola	MC1403P1G
33	U3	1	Low Bias Current OPAMP	National	LMC6041AIN
34	U4	1	3.5 Digit D-A LCD Out	Maxim	MAX138CPL
35	U5	1	LCD Display	FEMA	35D050-R3PB-Z
36	U6	1	Quad Exc or Gate	National	CD4030BE
37	XU1, 6	0	14 Pin IC Socket	MillMax	110-93-314-41-001000
38	XU2, 3	0	8 Pin IC Socket	MillMax	110-99-308-41-001
39	XU4	1	40 Pin IC Socket	Millmax	110-99-640-41-001
40	XU5	4	20 Pin Row Socket	MillMax	316-93-120-41-001
41	For Mtg. Q1	1	4-40 x 1/4" PPH MS SS	Commercial	
42	For Mtg. Q1	1	4-40 Hex Nut	Commercial	
43	For Mtg. Q1	1	#4 Internal Tooth LW	Commercial	
44	For +6V	4	24 AWG Red Wire 4"		
45	For -6V	4	24 AWG Brown Wire 4"		
46	For COM	4	24 AWG Gray Wire 4"		
47	For +HV	4	24 AWG Yellow Wire 4"		
48	For +Eout	4	24 AWG Violet Wire 4"		

Table 4: Parts List – Display Board

TEGAM Inc., Geneva, OH BOM Part Number M604 (Formerly M100580)
Bill Of Material for: Front Panel Assembly Model Number:
By: CMG Date: 9/1/09 Job No. R1M-AR

ITEM	REFERENCE	QTY.	DESCRIPTION	MFGR.	MFGR. PART NO.
1	I1	1	LED	Dialco	558-0101-003
2	J1	1	Banana Jack, Recessed, Red Type SLB4-F	MultiContact	23.3000-22
3	J2	1	Binding Post, Black	Pomona	3750-0
4	J3	1	Binding Post, Red	Pomona	3750-2
5	J2, 3	1	Double Binding Post Base, Black	Pomona	3862-0
6	J4	1	Binding Post, Metal	H.H. Smith	137
7	For J4	1	Spacer	TEGAM	
8	Make From	0.15	3/8" Dia Alum Rod		
9		1	Shorting Link	Concord	25-1111
10			ALT	H.H. Smith	1828
11		4	#4 x 0.01 Nylon Washer	Commercial	
12	J5	1	Appliance Connector	Corcom	6ESRM-3
13	For S1, 2	2	Knob	Eagle	45KN018
14		1	Plexiglass Window, Cl	TEGAM	A-12400
15	Make From		3" x 1 1/4" x 1/16"	Commercial	
16		0.02	Tube, Clear RTV	Commercial	
17		1	Front Panel (5.45 x 8.45)	Etched Metal	C-12372
18		1	4-40 x ½" PPH MS SS	Commercial	
19		2	4-40 Lockwasher	Commercial	
20		3	4-40 Hex Nut	Commercial	
21		2	4-40 x ½" PFH MS SS	Commercial	
22		4	4-40 x 1" PPH MS SS	Commercial	
23		1	Display Gasket	Disch	A-12373
24	Make From	4	5.3 x 4.88 x 1/8" Alum		
25		4	6 pieces 3/32" Heatshrink, 0.75" Ea.	Alpha	RNF-100-3/32-BK-STK
26		4	6 pieces 3/16" Heatshrink, 0.75" Ea.	Alpha	RNF-100-3/16-BK-STK
27		1	S/N Label	Bus. Book	9997
28	F1	1	Fuseholder	Littlefuse	03453LF1
29		1	Fuse, 1/8 AMP 3AG	Littlefuse	313.125
30			ALT	Bussman	AGC 1/8
31	S3	1	Push Button, N.O.	Grayhill	46-102
32	S4	1	DPDT Toggle, ON-NONE-ON	Tyco	A201SYZQ04
33		0	ALT	C&K	7201 SYZQE
34		4	24 AWG Brown Wire 4"		
35		4	24 AWG Orange Wire 4"		
36		4	24 AWG Yellow Wire 4"		
37		8	24 AWG Blue Wire 8"		
38		8	24 AWG Violet Wire 8"		
39		10	18 AWG Black Wire 10"		
40		7	18 AWG Green Wire 7"		
41		7	18 AWG White Wire 7"		
42		1	4" Cable Ties	Tyton	T18R

Table 5: Parts List – Front Panel Assembly

TEGAM Inc., Geneva, OH BOM Part Number: M603 (Formerly M100370) Date: 9/1/09
Bill Of Material for: Power Supply Board Assembly Model Number: R1M-AR By: CMG

ITEM	REFERENCE	QTY.	DESCRIPTION	MFGR.	MFGR. PART NO.
1		1	PC Board (4.2 x 4.7")	Cleveland Circuits	12157-C
2	C23, 24	2	0.22 MFD, 630 WVDC	IC	224MSR630K
3	C25, 26	2	100 MFD, 50 WVDC	IC	107TTA050M
4	C27, 28	2	6.8 MFD, 15V Tantalum	Sprague	173D685X9015V
4A	C29	1	0.0047 MFD, 1250V	Panasonic	ECW-H12472JV
5	D7, 8	2	Hi Voltage Diode, 1000V	Motorola	1N4007
6	D9, 10, 11, 12	4	Rectfier Diode	Motorola	1N4003
9	R36	1	20M	KOA	CF 1/4 20M 5%
10	R37	1	150K, 3W, 5%	Vishey	5093NW150K0J
11	R38	1	10K	Dale	RN55D1002F
15	T1	1	Transformer	Custom Coil	A-12314-B
16	U7	1	+6V Reg	Micro Commercial	MC78L06BP-APMSCT-ND
17	U8	1	-6V Reg	Micro Commercial	MC79L06BP-APMSCT-ND
18	For 2 Jumpers	2	22 AWG Bus Wire	Belden	8021
19	For C23, 24	1	RTV	GE	RTV 102

Table 6: Parts List – Power Supply

Manufacturer	Cage Code
ABBATRON HH SMITH	91967
ALPHA	92194
AMERIPACK	OTJ49
AVX	16299
BELDEN	3HXC8
BOURNS	F0978
C&K	63HW9
CLEVELAND CIRCUITS-SEE TEGAM	
COMMERCIAL-SEE MCMASTER CARR	
CONCORD	18310
COOPER BUSSMAN	1UW16
CORCOM	38AS8
CUSTOM COIL	0VYL0
DIALIGHT (DIALCO)	96312
DISCH-SEE TEGAM	
EAGLE	0MPC5
ELECTROSWITCH	8T045
ELECTRO-TECH SYSTEMS	56541
ETCHED METAL-SEE TEGAM	
FAIRCHILD SEMICONDUCTOR	4E8P4
FEMA	OP7Z6
GE (MG CHEMICALS)	L3160
GRAYHILL	81073
ILLINOIS CAPACITOR	74840

Manufacturer	Cage Code
KEMET ELECTRONICS	31433
KOA	59124
LITTLEFUSE	7E222
MAXIM	1ES66
MCMASTER CARR	OKVE6
MICRO COMMERCIAL	374W0
MILL MAX	3N087
MOTOROLA	0G546
MULTICOMP	75498
MULTI-CONTACT	0WCJ0
NATIONAL SEMICONDUCTOR	0G557
OLDAKER	64882
PANASONIC	0HF77
PHILIPS	0TBA7
POMONA	5D6S9
PPM-SEE TEGAM	
SPRAGUE	5079
ST MICROELECTRONICS	SCE76
TEGAM	49374
TYCO	Z9V34
TYTON	3E655
VISHAY SILICONIX	CE463
VOLEX POWER CORDS	U7112

Table 7: Vendor Cage Code Directory

SECTION 6

SERVICE INFORMATION

Preparation for Calibration or Repair Service

Once you have verified that the cause for R1M-A malfunction cannot be solved in the field and the need for repair and calibration service arises, contact TEGAM customer service to obtain an RMA, (Returned Material Authorization), number. You can contact TEGAM customer service via the TEGAM website, www.tegam.com or by calling 440.466.6100 (*All Locations*) OR 800.666.1010 (*United States Only*).

The RMA number is unique to your instrument and will help us identify you instrument and to address the particular service request by you which is assigned to that RMA number.

Of even importance, a detailed written description of the problem should be attached to the instrument. Many times repair turnaround is unnecessarily delayed due to a lack of repair instructions or of a detailed description of the problem.

This description should include information such as measurement range, and other instrument settings, type of components being tested, are the symptoms intermittent?, conditions that may cause the symptoms, has anything changed since the last time the instrument was used?, etc. Any detailed information provided to our technicians will assist them in identifying and correcting the problem in the quickest possible manner. Use a copy of the Repair and Calibration Service form provided on the next page.

Once this information is prepared and sent with the instrument to our service department, we will do our part in making sure that you receive the best possible customer service and turnaround time possible.

Expedite Repair & Calibration Form

Use this form to provide additional repair information and service instructions. The Completion of this form and including it with your instrument will expedite the processing and repair process.

RMA#:		Instrument Model #:	
Serial Number:		Company:	
Technical Contact:		Phone Number:	
Additional Contact Info:			

Repair Instructions:

☐ Evaluation ☐ Calibration Only ☐ Repair Only
☐ Repair & Calibration ☐ Z540

Detailed Symptoms:

Include information such as measurement range, instrument settings, type of components being tested, is the problem intermittent? When is the problem most frequent?, has anything changed with the application since the last time the instrument was used?, etc.

Warranty

TEGAM, Inc. warrants this product to be free from defects in material and workmanship for a period of one year from the date of shipment. During this warranty period, if a product proves to be defective, TEGAM Inc., at its option, will either repair the defective product without charge for parts and labor, or exchange any product that proves to be defective.

TEGAM, Inc. warrants the calibration of this product for a period of one year from date of shipment. During this period, TEGAM, Inc. will recalibrate any product, which does not conform to the published accuracy specifications.

In order to exercise this warranty, TEGAM, Inc., must be notified of the defective product before the expiration of the warranty period. The customer shall be responsible for packaging and shipping the product to the designated TEGAM service center with shipping charges prepaid. TEGAM Inc. shall pay for the return of the product to the customer if the shipment is to a location within the country in which the TEGAM service center is located. The customer shall be responsible for paying all shipping, duties, taxes, and additional costs if the product is transported to any other locations. Repaired products are warranted for the remaining balance of the original warranty, or 90 days, whichever period is longer.

Warranty Limitations

The TEGAM, Inc. warranty does not apply to defects resulting from unauthorized modification or misuse of the product or any part. This warranty does not apply to fuses, batteries, or damage to the instrument caused by battery leakage.
The foregoing warranty of TEGAM is in lieu of all other warranties, expressed or implied. TEGAM specifically disclaims any implied warranties of merchantability or fitness for a particular purpose. In no event will TEGAM be liable for special or consequential damages. Purchaser's sole and exclusive remedy in the event any item fails to comply with the foregoing express warranty of TEGAM shall be to return the item to TEGAM; shipping charges prepaid and at the option of TEGAM obtain a replacement item or a refund of the purchase price.

Statement of Calibration

This instrument has been inspected and tested in accordance with specifications published by TEGAM Inc. The accuracy and calibration of this instrument are traceable to the National Institute of Standards and Technology through equipment, which is calibrated at planned intervals by comparison to certified standards maintained in the laboratories of TEGAM Inc.

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