MEGOHMMETER

MODEL R1M-A

Operation and Maintenance Manual

PN# R1M-A-900-01

Publication Date: April 2016, Rev. F

NOTE: This User's Manual was as current as possible when this product was manufactured. However, products are constantly being updated and improved. To ensure you have the latest documentation, refer to www.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		
2	10 M	10 k		
3	100 M	100 k	50	100, 250, or 500
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 1)

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.

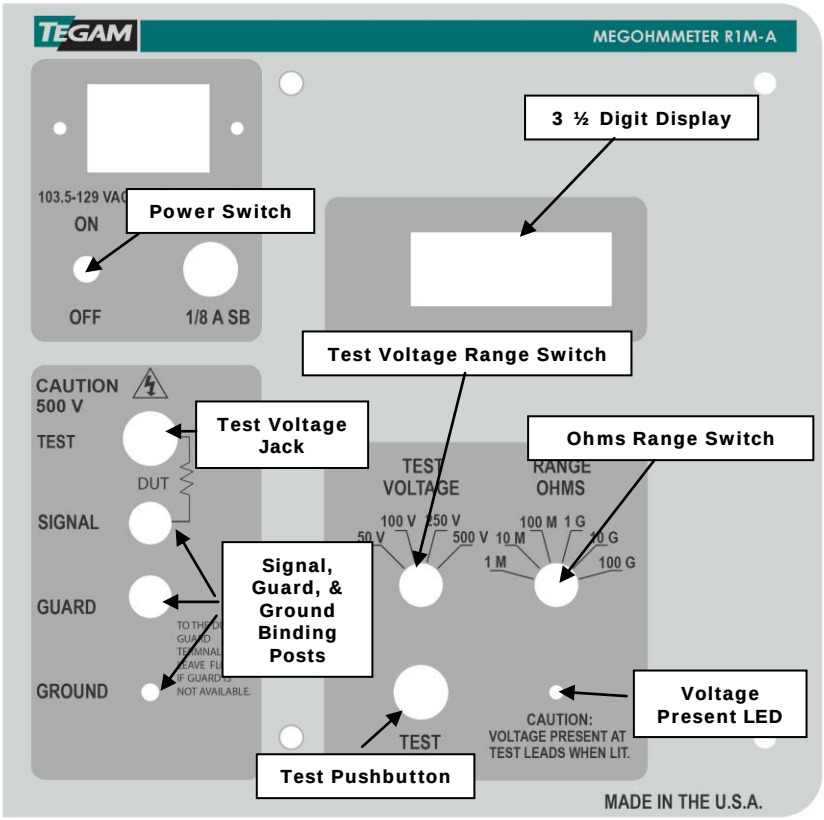

Figure 1: Front Panel Controls

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. Care should be taken to prevent damage to associated cables.

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 TEGAM immediately.
- Check that all items are present. If any items are missing, notify TEGAM immediately.

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.

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 2).

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.

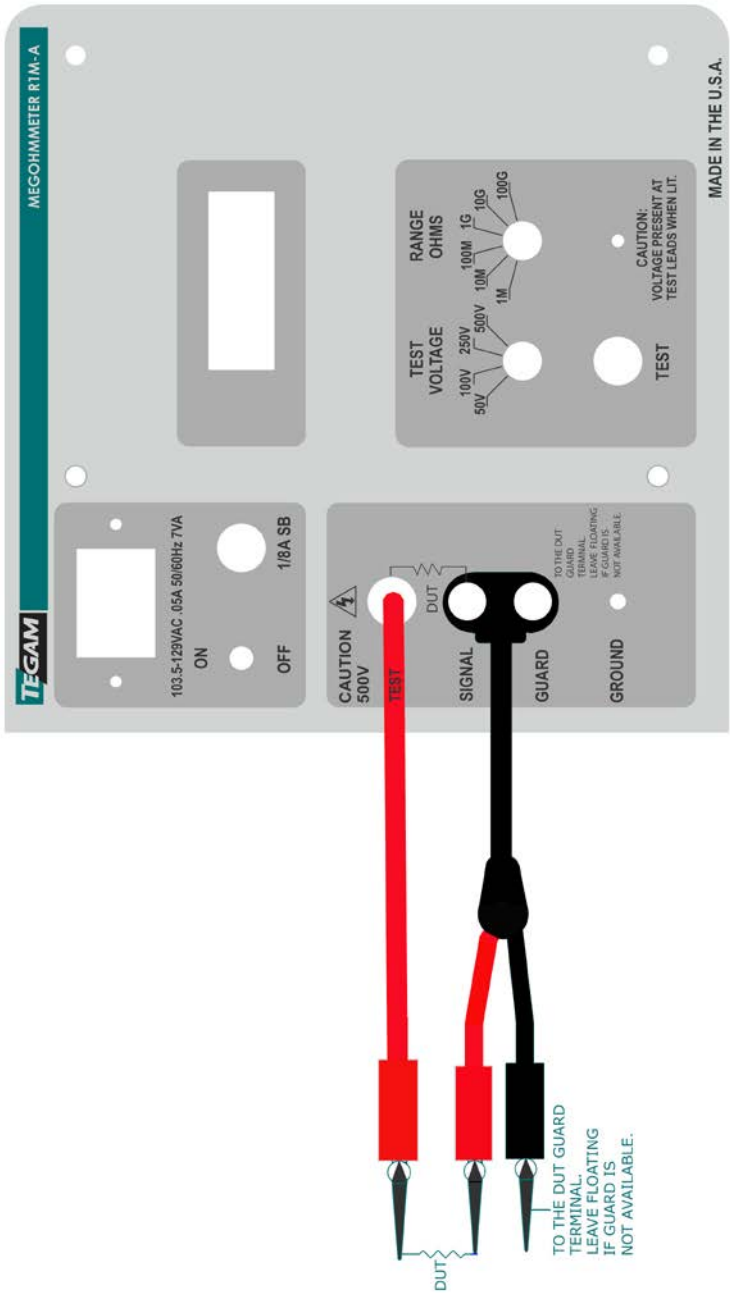

Figure 2: Connection Diagram

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 minutes before making measurements.

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 CR109 and CR112 provide rectified + power filtered by C126 and regulated at +6.2 V by VR109. Diodes CR110 and CR111 provide rectified - power, filtered by C125 and regulated at -6.2 V by VR110. The high-voltage winding on T-100 charges C123 through CR107 and C124 through CR108. 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 mA of current limit through R137 and R140.

R137 and R140, series resistors, are followed by Q1, a high-voltage shunt regulator, to regulate the high voltage supply at the selected value. R138 and R139 provide 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 V, 0.5 V, 1.25 V, 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. Transistors Q2 and Q3 are configured to operate as low leakage protection diodes. 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: The action of Q2 is to create a virtual ground at the non-inverting input of U3 (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 CR4. 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 39, and the test voltage signal connected to the normal reference input, pin 44.

U5 is a 3½ 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, R34, and R35 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. To obtain the best results, allow the R1M-A to warm up for 30 minutes before making any adjustments.
(The calibration procedure and schematics provided in this manual are for the surface mount units manufactured after October 2013. Please contact TEGAM if your instrument is purchased prior to that date.)

Precision decade resistor box or standard resistors with the following values: 50 kΩ, 1 MΩ, 10 MΩ, 100 MΩ, 1 GΩ, 10 GΩ, and 100 GΩ with calibrated 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.

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.

A. Standard Voltage Measurement Points

1. Set the UUT RANGE OHMS switch to 1 MΩ.
   a. Connect the DMM to the 1 MΩ Resistance Standard as follows using the dual banana to dual banana cable:
      a) DMM HI to the 1 MΩ Standard High; and
      b) DMM LO to the 1 MΩ Standard Low.
2. Connect the 1 MΩ Resistance Standard to the UUT as follows:
      a) UUT TEST to the 1 MΩ Standard High;
      b) UUT SIGNAL to the 1 MΩ Standard Low;
      c) UUT GUARD to the 1 MΩ Standard Guard; and
      d) Verify the GUARD of the UUT is connected to the UUT GROUND.
3. Perform the following steps for the values listed in Table A:
      a) Set the UUT TEST VOLTAGE switch to Vx;
      b) Press and hold the UUT TEST button;
      c) Verify the reading displayed by the DMM is within the tolerance given in Table A; and
      d) Release the UUT TEST button.

Vx	Allowable Reading
50 V	±1.5 V
100 V	±3.0 V
250 V	±7.5 V
500 V	±15.0 V

Table A

4. Disconnect the Setup.

B. Standard Resistance Measurement Points

1. Perform the following steps for the values listed in Table B:
   a. Connect the Rx resistance standard to the UUT as followed:
      a) UUT TEST to the Rx Resistance Standard High;
      b) UUT SIGNAL to the Rx Resistance Standard Low;
      c) UUT GUARD to the Rx Resistance Standard Guard; and
      d) Verify the GUARD of the UUT is connected to the UUT GROUND.
   b. Set the UUT RANGE OHMS switch to Sx;
   c. Set the UUT TEST VOLTAGE switch to Vx;
   d. Press and hold the UUT TEST button.
   e. Verify the reading displayed by the UUT is within the tolerance given in Table B of the actual standards value; and
   f. Release the UUT TEST button.

Test	Range Ohms (Sx)	Standard Resistance Value (Rx)	Dial Setting	Test Volltage (Vx)	Allowable % of Reading
1	1 M	1 MΩ	0-0-1	500 V	±5%
2	1M	1 MΩ	0-0-1	250 V	±5%
3	1 M	1 MΩ	0-0-1	100 V	±5%
4	1 M	1 MΩ	0-0-1	50 V	±5%
5	10 M	1 MΩ	0-0-1	50 V	±5%
6	10M	10 MΩ	0-1-0	50 V	±5%
7	100 M	10 MΩ	0-1-0	50 V	±5%

8	100 M	100 MΩ	1-0-0	50 V	±5%
9	1 G	100 MΩ	1-0-0	50 V	±5%
10	1 G	1000 MΩ	10-0-0	50 V	±5%
11	10 G	1000 MΩ	10-0-0	50 V	±5%

Table B

2. Disconnect the setup.

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 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 board on the retaining brackets.

There are three trimpots on the lower edge of the 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!

A. DC Offset Adjust

1. Turn off the UUT.
2. Set the UUT RANGE OHMS switch to 1 GΩ.
3. Set the UUT TEST VOLTAGE switch to 50 V.
4. For the through-hole version PCB, connect the DMM to the UUT using the clip leads as follows:
    a) DMM HI to the output of U3 pin 6 by way of the right side of R21; and
    b) DMM LO to the common by way of the top side of R27, closest to D6.
5. For the surface mount version PCB, connect the DMM to the UUT using the clip leads as follows:
    a) DMM HI to TP3 (U3, PIN6) on the component side of the PCB; and

b) DMM LO to TP2 (GND) on the component side of the PCB.

6. Turn on the UUT.
7. Adjust R29 for 0 V ±0.1 mV as displayed by the DMM.
8. Turn off the UUT.
9. For the through-hole version PCB, move the HI lead of the DMM to the output of U1 pin 1 by way of S1-B pin 1B.
10. For the surface mount version PCB, move and connect the DMM HI test lead to TP1 (REF_HI), U1 pin 1, on the component side of the PCB.
11. Turn on the UUT.
12. Adjust R32 for 0 V ±0.1 mV as displayed by the DMM.
13. Turn off the UUT.
14. Disconnect the Setup.

B. Gain Adjust

1. Turn on the UUT.
2. Set the UUT TEST VOLTAGE switch to 100 V.
3. Connect the 1 GΩ Resistance Standard to the UUT as follows:
   a) UUT TEST to the 1 GΩ Standard High;
   b) UUT SIGNAL to the 1 GΩ Standard Low;
   c) UUT GUARD to the 1 GΩ Standard Guard; and
   d) Verify the UUT GUARD is connected to the UUT GROUND.
4. Press and hold the UUT TEST button.
5. Adjust R14 to the actual recorded value of the standard as displayed by the UUT.
6. Release the UUT TEST button.

5.6 Troubleshooting

Disassembly

- Remove the four screws from the front panel.
- The circuit board is accessible once it is removed from the case.

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 R137 and R140.

SYMPTOM	FAULTY COMPONENT	REPAIR
No Display	Line Power	Check power cord & power. Check fuse.
	Line Fuse	Depress the TEST pushbutton and see if the LED comes on.
	TEST pushbutton	
	U5/U6	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.
	T100, CR109 & CR112, or VR109	Check for +6.2 V. If not, trace & replace bad part.
	T100, CR110 & CR111, or VR110	Check for -6.2 V. If not trace & replace bad part.
	U4 or U5	Replace U4 or U5.
No Test Voltage	T100	Check for 360 VAC pins 7-8.
	CR107, CR108	Replace CR107, CR108.
	C123, C124	Replace C123, C124.
	R137, R140	Replace R137, R140.

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 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.

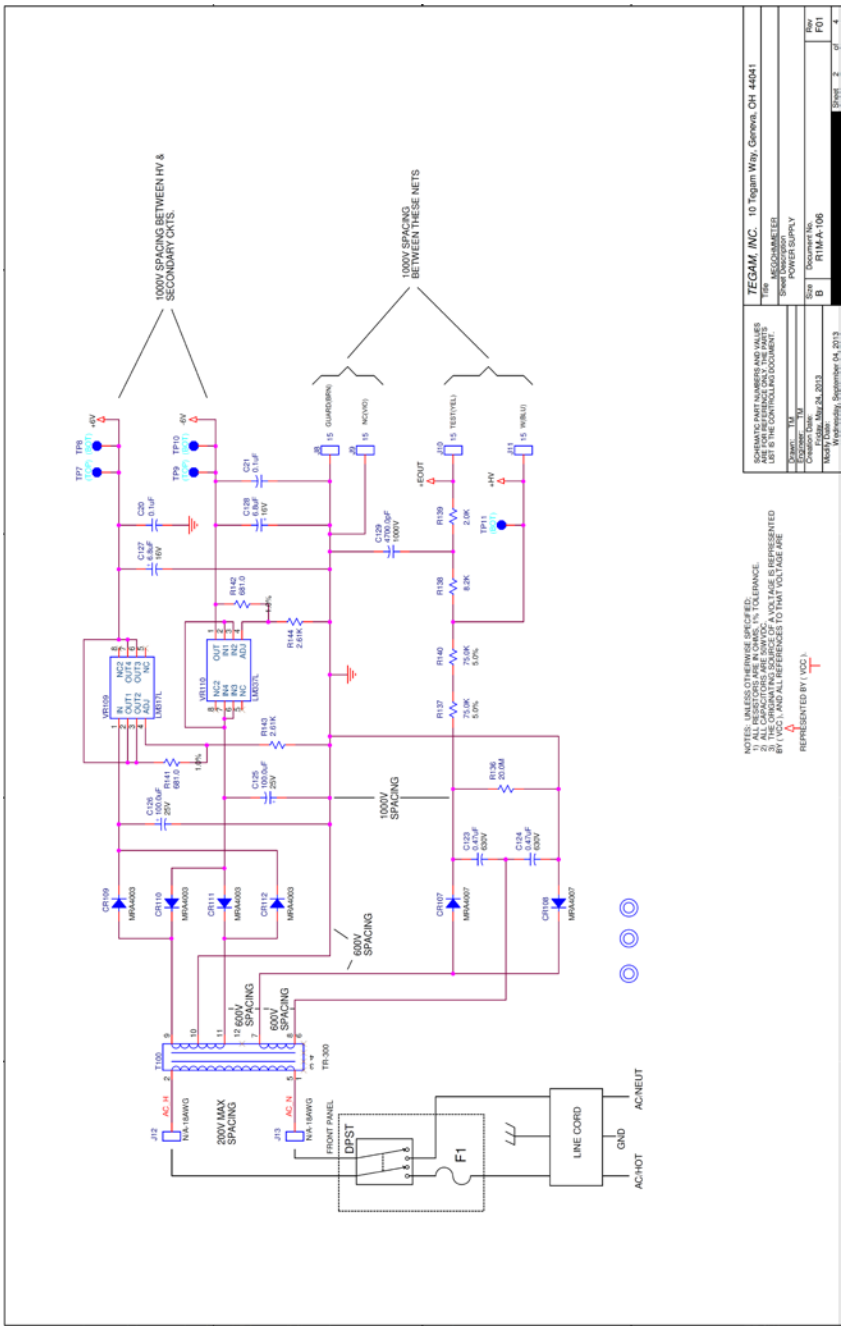

Figure 3: Power Supply

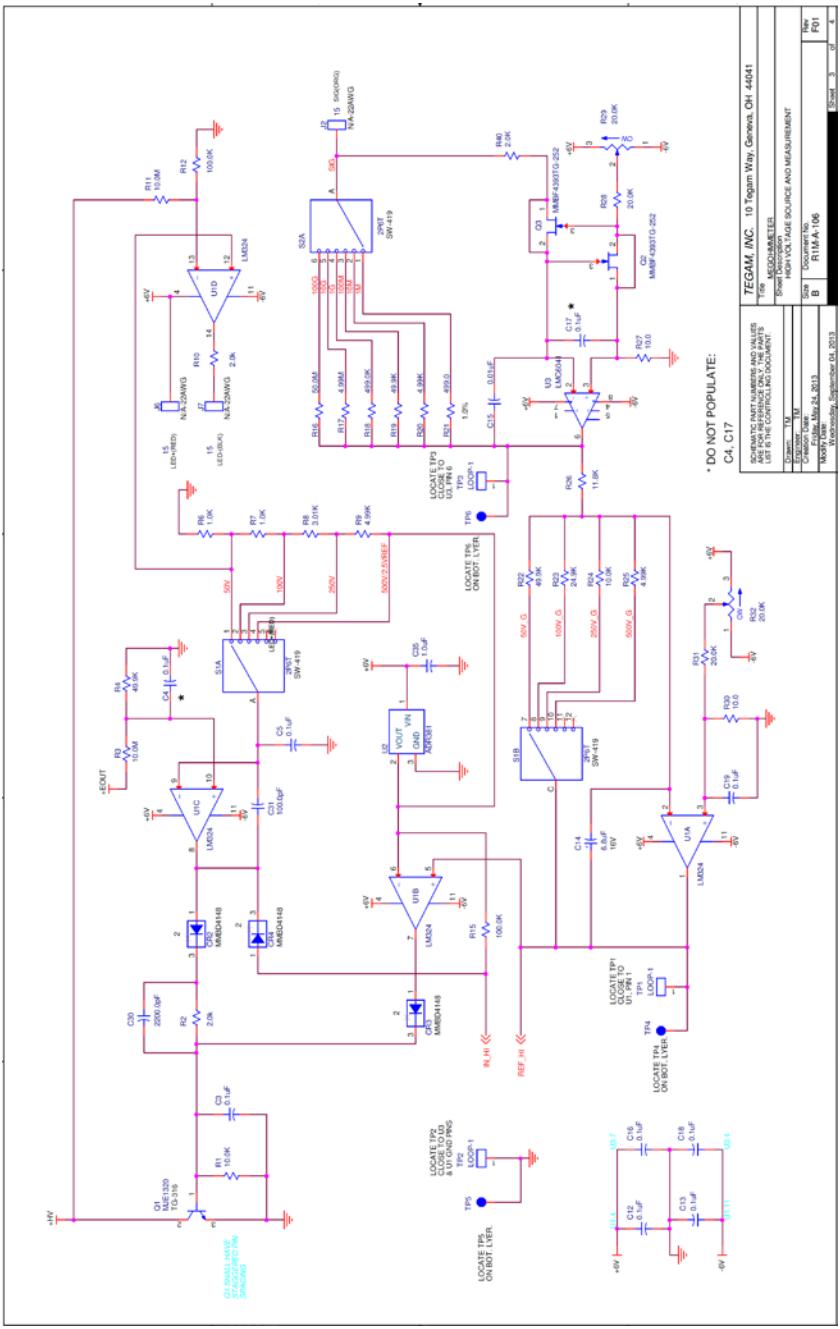

Figure 4: High Voltage Source and Measurement

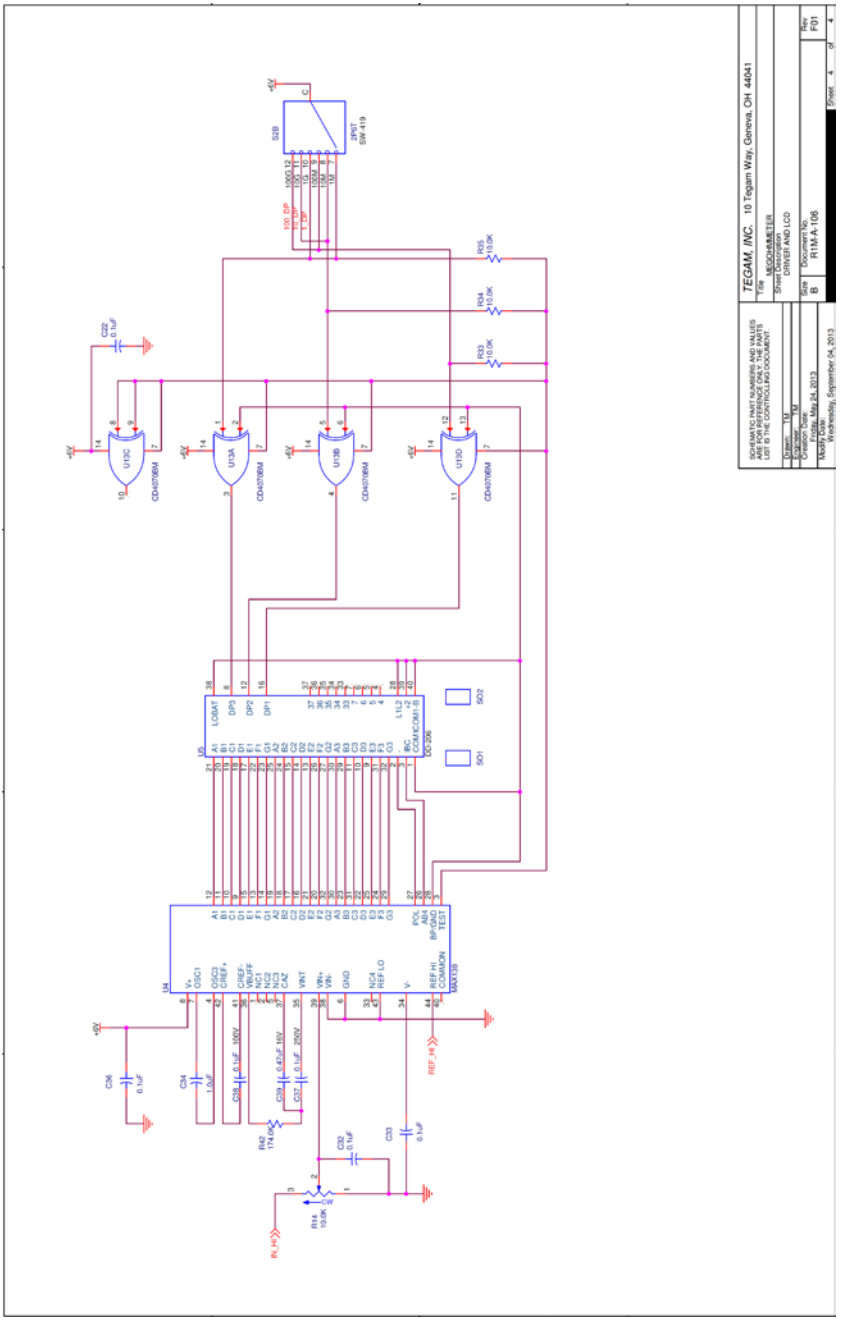

Figure 5: Driver and LCD

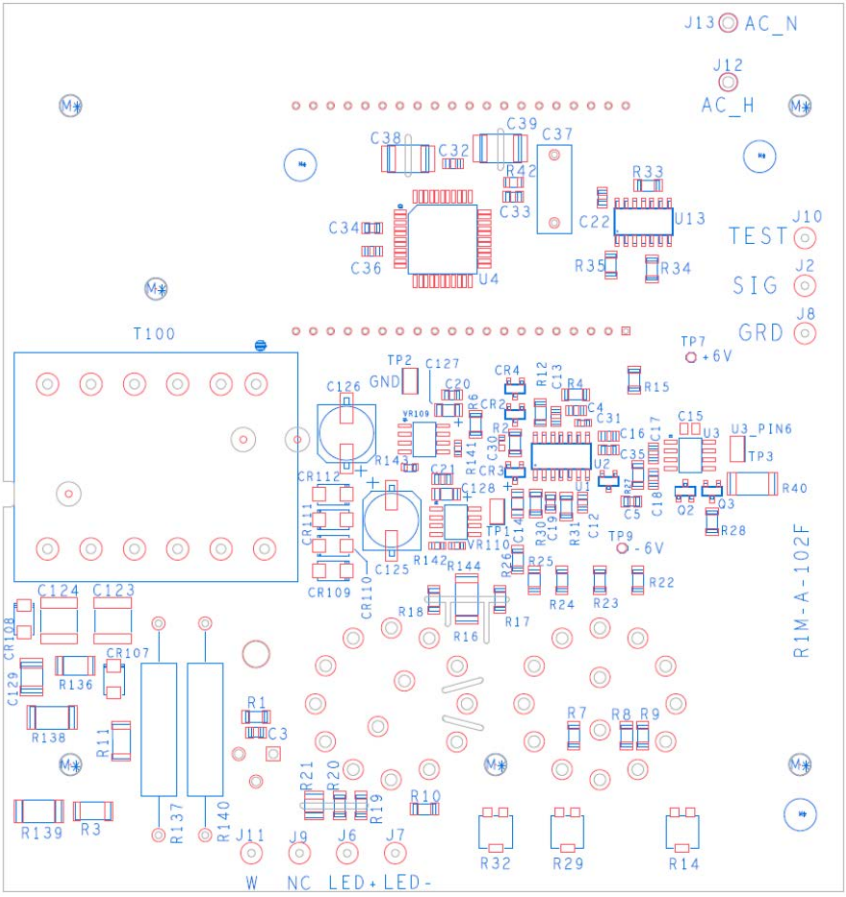

Figure 6: Parts (Top) Layout

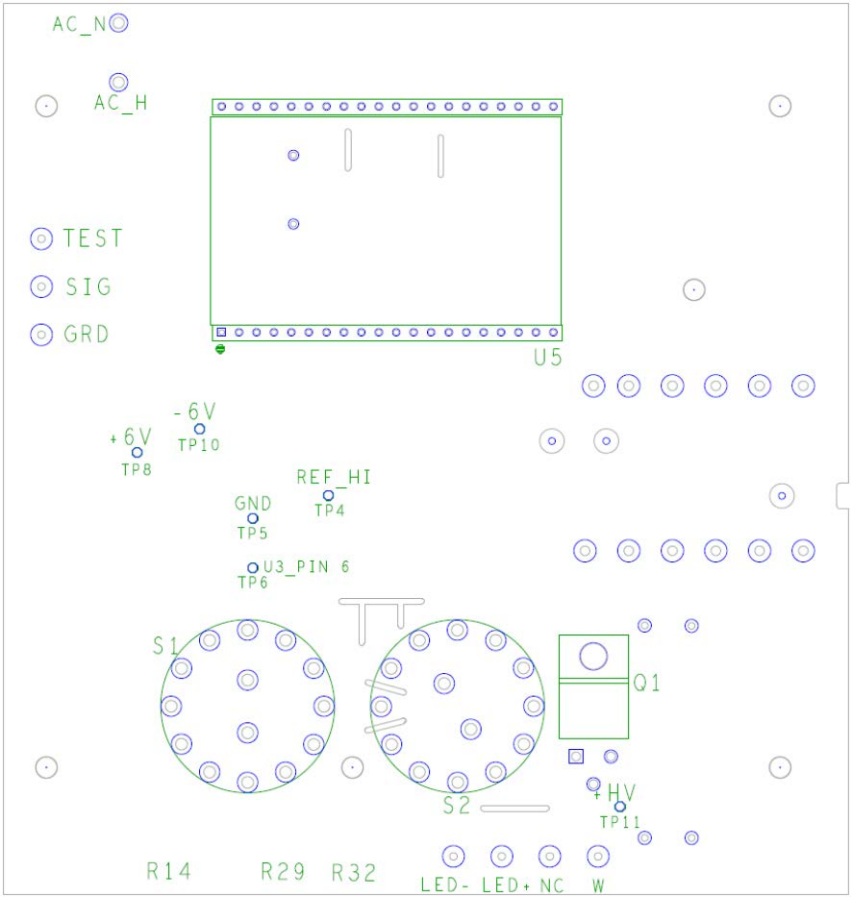

Figure 7: Parts (Bottom) Layout

Assembly	TEGAM Part Number	Part Description	Qty	Manufacturer	Cage Code	Mfg Part Number
R1M-A	5010	CASE,R1M-A/AR	1	AMERIPACK	0TJ49	5000
R1M-A	CO-103	POWER CORD STANDARD	1	VOLEX	U7112	17757-10-B1
R1M-A	13770	STNDOFF,BATRY,8-32x2x3/8	4	MCMASTER-CARR	0KVE6	91780A342
R1M-A	ST-332	STNDOF,8-32X3/8X3/8 HEX	4	MCMASTER-CARR	0KVE6	91780A279
R1M-A	WELD-ON	IPS WELD-ON #3 SOLVENT CE	AR			
R1M-A	SH-4	PNL,BLK ABS 6.62"X6.68"	1	AMERICAN METAL SPECIALTIE	5JH28	PER PRINT
R1M-A	MC-1206	LBL,CASE R1M-A	1	NUTRON NAMEPLATE	30236	MC-1206 PRINT
R1M-A	8-32X1PFH	SCW,8-32X1PFH MS STEEL	4	MCMASTER-CARR	0KVE6	90273A199
R1M-A	8-32X3/8PPH	SCR,BLK,8-32X3/8PPH S	4	MCMASTER-CARR	0KVE6	91249A192
R1M-A	CA-109	TEST CABLE RED R1M-A/AR	1	OLDAKER MFG CORP		510-1(4'RED)
				MUELLER ELECTRIC		BU-3061-M-48-2
R1M-A	CA-105	TEST CABLE BLACK R1M-A/AR	1	OLDAKER MFG CORP		506-2(4'BLACK)
				MUELLER ELECTRIC		BU-7030-M-48-0
R1M-A	R1M-A-900-01	OPERATION & MAINTENANCE MANUAL	1	TEGAM, INC	49374	R1M-A-900-01
R1M-A	R1M-A-841	CD MANUAL MILITARY	AR			
R1M-A	R1MAR-040	FRONT PNL ASSY R1M-AR	1			

Table 3: Parts List – Final Assembly

Assembly	TEGAM Part Number	Part Description	Qty	Manufacturer	Cage Code	Mfg Part Number
R1MAR-040	BP-50-0	BIND POST CON GLD-PLT BLK	1	POMONA ELECTRONICS		3750-0
R1MAR-040	BP-50-2	BIND POST CON GLD-PLT RED	1	POMONA ELECTRONICS		3750-2
R1MAR-040	FH-20	FUSE HLD PNL MNT 6.3X32MM	1	LITTELFUSE	7E222	03453LF1H
R1MAR-040	LD-5	LED,PNL MNT INDITOR,RED	1	DIALIGHT		558-0101-003F
R1MAR-040	BJ-1	BANANA JACK RECESSED RED	1	MULTI-CONTACT		23.3000-22
R1MAR-040	IN-2	DUBLE MOUNT BASE STD BIND	1	POMONA ELECTRONICS		3862-0
R1MAR-040	250092	BNC,UNINSULATED,GROUNDING	1	HH SMITH	91967	137
R1MAR-040	J-6	SHORTING BAR	1	HH SMITH	91967	1828
				ABBATRON		1828
R1MAR-040	PE-3	POWER ENTRY CONNECTOR	1	CORCOM	38AS8	6ESRM-3
R1MAR-040	MS35338-135	WSH LOCK #4	2	MPT FASTENER	45T10	NON MIL EQUAL BY DESC
R1MAR-040	3538	NUT,HEX,4-40	2	BEAVER BOLT	OB6M9	3538
				MPT FASTENER	45T10	4-40 HEX NUT 18-8
R1MAR-040	12373	DISPLAY GASKET R1L-B	1	GASKO		12373
R1MAR-040	TX-101-3/32	HEAT SHRINK 3/32"	AR			
R1MAR-040	TX-101-3/16	TUBING,SHRINK,3/16	AR	ALPHA WIRE & CABLE	92194	FIT-300-3/16-6-BLK
				COLEFLEX		ST-300-3/16
R1MAR-040	FU-20	FUSE,1/8 AMP,3AG	1	LITTELFUSE	7E222	0313.125
			1	Cooper Bussmann	1UW16	MDL-1/8-R
R1MAR-040	SW-313	SWITCH TOGGLE DPDT 5A	1	TYCO\TE CONNECTIVITY		A201SYZQ04
				C&K COMPONENTS		7201 SYZQE
R1MAR-040	999924-001	WIRE,24 AWG,TFE,BRN	AR	BELDEN WIRE AND CABLE	3HXC8	83003-1(BRN)
R1MAR-040	999924-004	WIRE,24 AWG,YEL,TEFLON	AR	STANDARD WIRE	4946	1100-54A(YEL)
R1MAR-040	999924-006	WIR,24 AWG, TEFLON,BLUE	AR	BELDEN WIRE AND CABLE	3HXC8	83003-13(DRK BLUE)
R1MAR-040	999924-007	WIRE,24 AWG,TEFL,VIOLET	AR	BIRNBACH	71002	8524/19(VIOLET)
				BELDEN WIRE AND CABLE	3HXC8	83003-7(VIOLET)
R1MAR-040	12400	PLEXIGLASS WINDOW,CLEAR	1	HP MANUFACTURING		PER PRINT
R1MAR-040	4-40X1/2PFHBK	SCR,4-40X1/2,PFH,MS,BLK	2	MCMASTER-CARR	0KVE6	96640A058
R1MAR-040	6166	WIRE,#18 STR BLK TEFL	AR	BIRNBACH	71002	8518/19 BLK
				BELDEN WIRE AND CABLE	3HXC8	83009-10
				TEGAM, INC	49374	079-145-10
				TEGAM, INC	49374	600010
R1MAR-040	6172	WIR,N18 STR,GRY,TFLN	AR	BELDEN WIRE AND CABLE	3HXC8	83029 008100

				TEGAM, INC	49374	079-148-8
				TEGAM, INC	49374	600008
R1MAR-040	6168	WIRE,N18 STR GRN TFLN	AR	BIRNBACH	71002	8518/19 GRN
				BELDEN WIRE AND CABLE	3HXC8	83029 005100
				TEGAM, INC	49374	079-145-5
				TEGAM, INC	49374	600005
R1MAR-040	RTV102	SILICONE RUBBER SEALANT	AR	GE SILICONES	L3160	RTV102
R1MAR-040	ST-339	SPC,.166ID,3/8OD X1/8 ALU	1	MCMASTER-CARR	0KVE6	92510A620
R1MAR-040	SW-310	SWITCH,PUSH BUTTON	1	ITW SWITCHES		49-612 RED
				APEM COMPONENTS LLC		IPR5SAD6
				EXCEL CELL ELECTRONICS		PA-S7-B2-M1AES3
R1MAR-040	WA-25	WSH,ID.375XOD.625X.020SS	4	MCMASTER-CARR	0KVE6	97022A448
R1MAR-040	KN-104	KNOB,BLK,.75DX.46H	2	EAGLE PLASTICS		45KN018
				EAGLE PLASTICS		45KN018-GRX
R1MAR-040	R1M-A-319	FRONT PANEL R1M-A/AR	1	AMERICAN METAL SPECIALTIE	5JH28	R1M-A-319 PRINT
R1MAR-040	MS51957-15	SCR PH 4-40 X 3/8 LG	4	MPT FASTENER	45T10	NON MIL CERT MS51957-15
R1MAR-040	R1M-A-100	MAIN BOARD ASSY,R1M-A	1			

Table 4: Parts List – Front Panel Assembly

Part Reference	Qty	Value	Description	TEGAM Part Number	Manufacturer	Mfg Part Number
C3 C5 C12 C13 C16 C18 C19 C20 C21 C22 C32 C33 C36	13	0.1uF	CAP CERAMIC 50V 10% X7R 0805	C-610-0.1UF	KEMET	C0805C104K5RACTU
C14 C127 C128	3	6.8uF	CAP TANTALUM 16V 10% EIAA	C-606-6.8UF	VISHAY	TR3A685K016C3000
C15	1	0.01uF	CAP CERAMIC 200V 10% X7R 0805	C-236-0.01uF	AVX CORP	08052C103KAT2A
C30	1	2200pF	CAP CERAMIC 100V 10% X7R 0603	C-649-2200PF	TDK CORP	C1608X7R222K080AA
C31	1	100pF	CAP CERAMIC 100V 2% C0G 0603	C-655-100PF	TDK CORP	C1608C0G2A101G080AA
C34 C35	2	1.0uF	CAP CERAMIC 50V 10% X7R 0805	C-610-1.0UF	KEMET	C0805C105K5RACTU
C37	1	0.1uF	CAP FILM(PP) 250V 5% RAD_10	C-514-0.1UF	PANASONIC	ECWF2104JAQ
C38	1	0.1uF	CAP FILM(PEN) 100V 5% 2416	C-630-0.1uF	PANASONIC	ECWU1104JC9
C39	1	0.47uF	CAP FILM(PEN) 16V 5% 2416	C-632-0.47uF	PANASONIC	ECWU1C474JC9
C123 C124	2	0.47uF	CAP CERAMIC 630V 20% X7R 2220	C-659-0.47UF	TDK CORP	CKG57NX7R2J474M500JH
C125 C126	2	100uF	CAP ALUMINUM 25V 20% F	C-248-100UF	PANASONIC	EEE-TK1E101P
C129	1	4700pF	CAP CERAMIC 1000V 10% X7R 1812	C-332-4700PF	TDK CORP	C4532X7R3A472K160KA
CR2 CR3 CR4	3	MMBD4148	DIODE 100V 200mA SOT-23-3	DZ-15	FAIRCHILD SEMICONDUCTOR	MMBD4148
CR107 CR108	2	MRA4007	DIODE 1000V 1A SMA	DZ-118	ON SEMICONDUCTOR	MRA4007T3G
CR109 CR110 CR111 CR112	4	MRA4003	DIODE 300V 1A SMA	DZ-125	ON SEMICONDUCTOR	MRA4003T3G
Q1	1	MJE1320	TRANSISTOR NPN 900V 2A TO-220	TG-316	SEMICONDUCTOR TECH.	MJE1320
Q2 Q3	2	MMBF4393	TRANSISTOR JFET(N-CH) 30V SOT-23-3	TG-318	FAIRCHILD SEMICONDUCTOR	MMBF4393
R1 R24 R33 R34 R35	5	10.0K	RES THICKFILM 1/4W 1%1206	R-515-10K	PANASONIC	ERJ-8ENF1002V
R2 R10	2	2.00K	RES THICKFILM 1/4W 1% 1206	R-170-2000	VISHAY	CRCW12062K00FKEA
R3 R11	2	10.0M	RES THICKFILM 1/2W 1% 2010	R-343-10M	VISHAY	CRHV2010AF10M0FKE5
R4 R19 R22	3	49.9K	RES THICKFILM 1/4W 1% 1206	R-515-49.9K	PANASONIC	ERJ-8ENF4992V
R6 R7	2	1.00K	RES THICKFILM 1/4W 1% 1206	R-515-1K	PANASONIC	ERJ-8ENF1001V
R8	1	3.01K	RES THICKFILM 1/4W 1% 1206	R-515-3.01K	PANASONIC	ERJ-8ENF3011V
R9 R20 R25	3	4.99K	RES THICKFILM 1/4W 1% 1206	R-515-4.99K	PANASONIC	ERJ-8ENF4991V
R12 R15	2	100K	RES THICKFILM 1/4W 1% 1206	R-515-100K	PANASONIC	ERJ-8ENF1003V

R14	1	10K	RES POT 12-TURN 1/4W SQUARE 4mm	RP-103-10.0K	BOURNS	3224G-1-103E
R16	1	50.0M	RES THICKFILM 1W 1% 2512	R-352-50M	VISHAY DALE	CRHV2512AF50M0FKE5
R17	1	4.99M	RES THICKFILM 1/4W 1% 1206	R-515-4.99M	VISHAY DALE	CRCW12064M99FKEA
R18	1	499K	RES THICKFILM 1/4W 1% 1206	R-515-499K	PANASONIC	ERJ-8ENF4993V
R21	1	499	RES THICKFILM 1/2W 1% 1210	R-490-499	PANASONIC	ERJ-14NF4990U
R23	1	24.9K	RES THICKFILM 1/4W 1% 1206	R-515-24.9K	PANASONIC	ERJ-8ENF2492V
R26	1	11.8K	RES THICKFILM 1/4W 1% 1206	R-515-11.8K	PANASONIC	ERJ-8ENF1182V
R27 R30	2	10.0	RES THICKFILM 1/4W 1% 1206	R-515-10	PANASONIC	ERJ-8ENF10R0V
R28 R31	2	20.0K	RES THICKFILM 1/4W 1% 1206	R-515-20K	PANASONIC	ERJ-8ENF2002V
R29 R32	2	20K	RES POT 12-TURN 1/4W SQUARE 4mm	RP-103-20K	BOURNS	3224G-1-203E
R40 R139	2	2.00K	RES THICKFILM 1.5W 1% 2512	R-523-2K	MULTICOMP VISHAY	MCPWR12FTEA2001 CRCW25122K00FKEGHP
R42	1	174K	RES THICKFILM 1/8W 1% 0805	R-618-174K	YAGEO	RC0805FR-07174KL
R136	1	20.0M	RES THICKFILM 1/2W 1% 2010	R-343-20M	VISHAY	CRHV2010AF20M0FKE5
R137 R140	2	75K	RES MF 3W 5% AXIAL	R-247-75K	VISHAY BC COMPONENTS	PR030002075 02JAC00
R138	1	8.20K	RES THICKFILM 1.5W 1% 2512	R-523-8.2K	MULTICOMP VISHAY	MCPWR12FTEA8201 CRCW25128K20FKEGHP
R141 R142	2	681	RES THICKFILM 1/10W 1% 0603	R-616-681	PANASONIC	ERJ-3EKF6810V
R143 R144	2	2.61K	RES THICKFILM 1/10W 1% 0603	R-616-2.61K	PANASONIC	ERJ-3EKF2611V
S1 S2	2	2P6T	ROTARY 2 POLE, 6 POSITION SWITCH	SW-419	ELECTROSWITCH	C5P0206N-R
SO1 SO2	2	SIP-20	SINGLE IN LINE SOCKET,ELEVATED, 20 PIN	SO-316-20	MILL-MAX	316-93-120-41-003000
T100	1	5675	STEP UP TRANSFORMER	TR-300	CUSTOM COILS	5675
TP1 TP2 TP3	3	LOOP-1	SINGLE LOOP SOCKET, 1 PIN	CS-122	HARWIN INC.	S1751-46R
U13	1	4070B	QUAD 2-INPUT EXCLUSIVE-OR GATE	IC-863	FAIRCHILD SEMICONDUCTOR	CD4070BCM
U1	1	LM324	QUADRUPLE HIGH-GAIN FREQUENCY COMPENSATED OP AMPS.	IC-205	TEXAS INSTRUMENTS	LM324D
U2	1	ADR381	PRECISION LOW DRIFT, VOLTAGE REFERENCE, 2.5V, SOT-23	IC-381	ANALOG DEVICES	ADR381ARTZ
U3	1	LMC6041	JFET INPUT OP AMP	IC-745	TI	LMC6041IMX/NOPB
U4	1	MAX138	3 1/2 DIGIT ANALOG TO DIGITAL	IC-241	MAXIM	MAX138CMH

			CONVERTERS WITH BANDGAP REFERENCE			
U5	1	3.5 DIGITS	3.5 DIGIT W/ + - AND LOBAT IND., NO BACKLIGHT	DD-206	FEMA ELEC.	35D050-R3PBZ
VR109	1	LM317	100mA, ADJ POSITIVE VOLTAGE REGULATOR, SOIC-8	IC-730	TEXAS INSTRUMENTS	LM317LM/ NOPB
VR110	1	LM337	100mA, ADJ NEGATIVE VOLTAGE REGULATOR, SOIC-8	IC-755	TEXAS INSTRUMENTS	LM337LM/ NOPB

Table 5: Parts List – Circuit Board Assembly

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 BUSSMANN	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, INC	49374
TYCO	Z9V34
TYTON	3E655
VISHAY SILICONIX	CE463
VOLEX POWER CORDS	U7112

Table 6: 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 three years 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

The calibration of this instrument is traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or other recognized national metrology institutes, by comparison to equipment and standards maintained in the laboratories of TEGAM Inc.

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