AVM-2000
HIGH SENSITIVITY ANALOG DC VOLTMETER / NULLMETER

Instruction and Service Manual

PN# AVM2000-900

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REV. D

Applies to Firmware Version: 2.1.14 or Later

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TEGAM is a manufacturer of electronic test and measurement equipment for metrology, calibration, and production test. We also provide repair, calibration, and other support services for a wide variety of test and measurement equipment including RF power sensor calibration systems, RF attenuation measurement systems, ratio transformers, arbitrary waveform generators, micro-ohmmeters, LCR meters, handheld temperature calibrators, thermometers, humidity and temperature control devices, and more.

TEGAM also repairs and calibrates test and measurement equipment formerly manufactured by Electro-Scientific Industries (ESI), Gertsch, Keithley Instruments, Lucas Weinschel, and Pragmatic Instruments. A complete list can be viewed on our Product Service Directory at www.tegam.com

For more information about TEGAM and our products, please visit our website at www.tegam.com: or contact one of our customer service representatives at sales@tegam.com or 800-666-1010.

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Safety Information & Precautions:
The following safety information applies to both operation and service personnel. Safety precautions and warnings may be found throughout this instruction manual and the equipment. These warnings may be in the form of a symbol or a written statement. Below is a summary of these precautions.

Terms in This Manual:
CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

Terms as Marked on Equipment:
CAUTION indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

Symbols:
As Marked in This Manual:

	This symbol denotes where precautionary information may be found.

As Marked on Equipment:

	CAUTION – Risk of Danger
	DANGER – Risk of Electric Shock
	Earth Ground Terminal
I	On
O	Off
	Frame or Chassis Terminal
	Earth Ground Terminal
	Alternating Current

Purpose and Function

The AVM-2000 is a multi-range analog DC Voltmeter/Nullmeter. It has 21 bipolar ranges from ± 100 nanovolts full scale to ± 1000 volts full scale in a 1-3-10 sequence. The AVM-2000 functions either as an isolated null detector or as an isolated analog voltmeter.

Key functions of the AVM-2000:

- The AVM-2000 is a freestanding bench instrument housed in a protective metal enclosure. A single unit may be mounted in a standard 19 inch rack using a conventional rack shelf.
- Bail front feet allow the user to tilt the instrument for optimal viewing.
- Voltage readings are displayed on a taut-band, zero-center, 4½ inch, mirror-backed, dual-scale analog meter.
- A rotary control provides selection of the instrument's 21 ranges.
- Instrument status (range, offset voltage, filter settings, battery condition, input impedance selection, etc.) are displayed on a front panel LCD.
- The AVM-2000 may be operated from the AC power line, an internal rechargeable battery or an external DC source of 12 – 30 V. The instrument's internal battery charger operates any time the AVM-2000 is connected to a power source and the instrument is in a standby mode.
- Voltages to be measured are applied to the AVM-2000 via low-thermal EMF front panel input terminals—HI and LO. A GUARD terminal is provided to connect input wiring shields.
- A FILTER selection feature allows the operator to choose signal filtering from 0.1 to 100 seconds to improve measurements.
- An OFFSET feature allows the user to offset a wide range of input voltages.
- An OPERATE/ZERO switch allows the user to disconnect the HI input terminal from the amplifier input and short the amplifier input to input common (LO). The user may select any one of 4 different input impedances for ranges below 3 mV and either 10 or 100 MΩ for ranges of 3 mV to 300 V. The 1 kV range input impedance is fixed at 100 MΩ.
- A multi-mode INPUT OFFSET control allows the user to adjust the instrument's zero (voltage) for the current range, to inject an input offset current of up to ± 2.5 nA to offset the effects of input bias currents on high impedance voltage sources or to select the digit of offset voltage to be changed.
- A two-terminal rear panel output is provided for use with external devices such as chart recorders, remote data acquisition systems, digital readouts, etc. This output allows the AVM-2000 to function as a high sensitivity instrumentation amplifier with gains that are the inverse of the input attenuator settings. These two terminals are an ISOLATED OUTPUT. A third rear panel terminal is connected to the case. A front panel control allows adjustment of the full scale output level from ± 0.5 volts to ± 1.5 volts.

Capabilities

The AVM-2000 is designed for the calibration laboratory. By utilizing a unipolar, high gain, low drift amplifier coupled with the ability to attenuate or amplify the input voltage makes the AVM-2000 ideal for nulling applications/calibrations. This is ideal for comparing an unknown to a known (comparing a 10 V source to a voltage standard).

Specifications

(Includes performance characteristics, description, power and utility information and environmental information)

Table 1.1 Physical and Electrical Specifications

Inputs and Ranges	• One set of input terminations for all ranges • HI LO & Guard • Low end 100nV full scale deflection with 2nV resolution • High-end range ≥1000V full scale deflection. with 5V or better resolution • 21 selectable ranges, (1-3-10 sequence)
Outputs and Indicators	2 output indications • Analog meter • Isolated analog rear panel output
Analog Output Accuracy • **Resolution** • **Linearity**	± 0.5% of full scale of range selected (typically 0.1%) Within 0.1% of full scale of selected range (after floor noise compensation) Within 0.5% of full scale of selected range
Analog Meter Accuracy[1] • **Scaling** • **Resolution** • **Linearity**	± 2% of selected range (1 µV-1000 V), ± 5% of 300 nV range, ± 15% of 100 nV range Mirrored zero center 10-0-10 and 3-0-3 ≤ 2% of full scale of selected range (typically, 0.5% of full scale of selected range) ≤ ± 1% of full scale of selected range
Meter Response Time[2]	(To 90% of final reading) **100 nV - 1 µV full scale:** 5 seconds **3 µV full scale:** 3 seconds **All other ranges**: 1.5 seconds
Input Impedance **100 nV to 1 mV FS** **3 mV to 300 V FS** **1 KV FS**	1 MΩ, 10 MΩ, 100 MΩ, or 1 GΩ Selectable +/- 10% 10 MΩ or 100 MΩ +/- 5% 100 MΩ +/- 5%
Offset Current	Adjustable (± 2.5 nA) to zero at front panel
Filter	10-position digital low pass filter selectable from front panel 100, 200, 500 mSec, 1, 2, 5, 10, 20, 50, 100 Sec
Offset Voltage • **Resolution** • **Accuracy**	Continuously variable offset for all ranges (minimum ± 100.0% of range); See Table 4-2 for limitations. 0.01 µV ≤ ± 0.5% of offset full scale (1 mV – 1000 V ranges), ± 2.0% (30 µV – 300 µV ranges), ± 7.5% (100 nV – 10 µV ranges)

[1] Meter specification measurements and terms per ANSI C39.1

[2] With filter response time set to 100 ms. Otherwise, filter response times add to meter response time.

Series Mode Rejection	> 80dB at 50Hz-60 Hz
Outputs	Isolated yielding ±0.5 to ±1.5V (user adjustable) for full scale deflection
Isolation	Input to case or output > 100 GΩ (typically > 500 GΩ)
Overload Protection	1100 VDC or peak on any range
Indicators	**Meter:** 4 ½" Mirror Backed with – 3 –- 0 –- +3 and -10 –- 0 –- +10 Scales **Status Backlit LCD:** Range, Offset, Filter Response Time, Input Impedance, ZERO/OPERATE Mode, Input Offset Mode and Isolated Output Mode
Dimensions	6.5" H X 11.5"W X 13.5" D
Weight	22.5 lbs
Connectors	• Low thermal EMF input terminals plus guard • Two output Binding Posts, plus a third for case common • Input terminal cover
Power Supply	• Internal rechargeable battery • External 12 to 30 V DC @1.25 Ampere • External "Power Cube" included
Environmental	**Operating Temperature Range:** 15 - 30 °C Full Specifications **Operating Humidity Range**: 0 - 50% RH Full Specifications **Storage Temp / Humidity:** -20 to + 60 °C / 0 - 80% non- condensing

Line Voltage Selection:
The AVM-2000 is delivered with an AC Power Module for operation from 120 ±10% VAC, 60 Hz. If the AVM-2000 is to be operated from a 240 ±10% VAC, 50-400 Hz power source, or the input power range needs to be changed from a previous selection, an alternative AC Power Module is required. Contact TEGAM for a selection of input Power Modules.

CAUTION: DO NOT APPLY POWER TO THE INSTRUMENT BEFORE READING THIS SECTION.

Check the Power Cord
Make sure the power cord supplied with the Model AVM-2000 is not frayed, broken, or cracked. A damaged power cord is a fire and electrical hazard. If the power cord is damaged, it should be replaced.

Use the Proper Fuse
To avoid fire hazard, use only the correct fuse type as specified for the AC power supply in the unit. The correct fuse for the AVM-2000 is a 1 1/4A, 3AG Slow Blow Fuse.

The fuse is located just below the power cord socket. Before replacing the fuse, place the Model AVM-2000 front panel power switch to the OFF position and remove power cord on the back of the Model AVM-2000. To replace the fuse, gently slide out the fuse drawer. Remove the old fuse and snap a new one into the fuse holder. Reinstall the fuse by simply pushing the fuse drawer back into its original position. The fuse drawer should snap into place.

Grounding the Equipment
ISOLATED OUTPUT
Two (Red and Black) binding posts with banana sockets (4mm) are provided to connect the AVM-2000's ISOLATED OUTPUT to an external device. A third (Yellow) binding post connected to the AVM-2000 case which may be connected to earth ground via other connections to the instrument. The ISOLATED OUTPUT red and black binding posts are electrically isolated from the HI and LO input terminals. The signal level present at the ISOLATED OUTPUT is adjustable, via the OUTPUT LEVEL control, from ± 0.5 V to ±1.5 V full scale for the RANGE selected. The ISOLATED OUTPUT zero reference is adjusted during the Setup mode using the OUTPUT LEVEL control.

WARNING: To avoid electrical shock or other potential safety hazards, plug the power cord into a properly wired receptacle before using this instrument. The proper grounding of this instrument is essential for safety and optimizing instrument operation.

WARNING: Applying more than 1100 Volts across the input terminals or from either input terminal to common or ground results in instrument damage not covered by the warranty.

NOTE: Rapid changes in input voltage potentially can result in voltages well in excess of 1100 Volts due to reactive effects in the supply circuit—such induced voltage may damage the instrument.

Items Included with the AVM-2000

Item	Part Number
AC Power Module	PS-107
Rechargeable Battery	BA-105
Input Terminal Shield	0600-081
GUARD to LO Nickel Plated Shorting Link	J-5
2 µF Filter Block Mounted on Dual Banana Jack	0600-090
Technical (Instruction and Service) Manual	AVM2000-900

Table 1.2– AVM-2000 Packing List

Additional items required for operation and maintenance

- Precision voltage and current source 0 to 1000 Volts DC & AC RMS and 10 µA – 1 A DC, such as Fluke model 5100 or 5720 Multi Product Calibrator
- Precision DMM with range of 0 to ±1000 V DC and AC RMS such as Fluke model 8508A, Keithley 2002 or Agilent 3458A.
- Oscilloscope such as Tektronix model TDS-1000
- Environmental chamber capable of housing the AVM-2000 with ability to regulate temperature from 10°C to 35°C ±0.1°C such as Thermotron model S-5.5 3800
- Megohmmeter such as TEGAM model R1M-A
- Low-thermal EMF shielded test leads (solid copper wire or solid copper wire with gold plated spade terminals)
- Pure copper shorting strap
- 10 mΩ 10 A shunt, 0.1%
- 25 Ω resistor, ¼ Watt, 1%
- 30 Ω resistor, ¼ Watt, 1%
- 10 kΩ resistor. ¼ Watt, 1%
- 1 MΩ resistor, ¼ Watt, 1%
- 10 MΩ resistor, ¼ Watt, 2%
- 100 MΩ resistor, ¼ Watt, 2%

Preparation For Calibration Or Repair Service

Once you have verified that the cause for the AVM-2000 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 (Extra Charge)

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 1 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.

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.

Document publishing dates may lag product changes.
Visit www.tegam.com to download the latest version of this manual.

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Unpacking & Inspection

Each AVM-2000 is put through a series of electrical and mechanical inspections before shipment to the customer. Upon receipt of your instrument unpack all of the items from the shipping carton and inspect for any damage that may have occurred during transit. Report any damaged items to the shipping agent. Retain and use the original packing material for reshipment if necessary.

Upon Receipt, inspect the carton for the following items:

Model AVM-2000 RF Power Meter
AC Power Module
Rechargeable Battery
Input Terminal Shield
GUARD to LO Nickel Plated Shorting Link
2 µF Filter Block Mounted on Dual Banana Jack
Technical (Operation and Maintenance) Manual

Mounting

The AVM-2000 is a free-standing bench instrument housed in a protective metal enclosure. A single unit may be mounted in a standard 19 inch rack using a conventional rack shelf. Bail front feet allow the user to tilt the instrument for optimal viewing.

Use in Proper Environment

Normal calibration laboratory practice dictates that the environment should be closely controlled. This will minimize errors introduced by temperature and humidity changes. A nominal temperature of 15 - 30 °C provides a good working condition.

CAUTION: The AVM-2000 has a specified ambient temperature range 15 - 30 °C. Operating beyond these limits can affect the accuracy of the instruments and damage internal circuitry.

CAUTION: When the AVM-2000 is to be stored for extended periods, pack the instrument into a container. Place container in a clean, dry, temperature-controlled location. If instrument is to be stored in excess of 90 days, place desiccant with items before sealing container. The safe environmental limits for storage are -20° to +60°C and 0% to 80% non-condensing relative humidity.

Do Not Use in Explosive Environments

CAUTION: The AVM-2000 is not designed for operation in explosive environments.

Ensure Power Switch is Accessible

CAUTION: Ensure that the POWER switch is easily accessible at all times and nothing is in place that would impede proper use.

Do Not Operate Without Covers

WARNING: This device should be operated with all panels and covers in place. Operation with missing panels or covers could result in personal injury.

Understanding the AVM-2000 Measurement Process

Basic operation of the AVM-2000 and an understanding of how it achieves its specified levels of performance follow. The AVM-2000 architecture consists of three main sections: an Isolated Analog Subsystem; a Front Panel Subsystem; and a Power Supply Subsystem. The Isolated Analog Subsystem is optically (and therefore electrically) isolated from the balance of the instrument to ensure minimum noise introduction into the measurement signals from control/digital signals and to ensure that, when operating as a floating null meter, the impedance to chassis/earth ground from either of the two input terminals is extremely high.

The heart of the AVM-2000 is in the Isolated Analog Subsystem. This is where nano-volt level signals are amplified via low-drift, low-noise, amplifiers to a level where they can drive a wide dynamic range 24-bit analog-to-digital converter and where initial analog filtering (10 Hz 4-pole Butterworth, low-pass) is applied. Once the signal is in digital format, it is further filtered, scaled and transferred across the isolating boundary for meter display and rear panel output as a high-speed serial signal. An ISOLATED OUTPUT is available so the AVM-2000 may be operated as a high-gain instrumentation amplifier with isolated output. When used as an instrumentation amplifier, the amplifier's gain is the inverse of the AVM-2000's range control setting. For example, at the 1 µV range and with the ISOLATED OUTPUT set to 1 V for full scale response, the amplifier gain is 1 V / 1 µV = 1,000,000.

Input signals are applied to the AVM-2000's low-thermal EMF binding posts. From here the signals are routed directly to the programmable input attenuator. Depending on the selected measurement range, the input signal is applied directly to the input amplifier (100 nV – 1 mV ranges) via a matched set of low-thermal EMF polarity reversal relays, or is attenuated to be compliant with the input amplifier's dynamic range and then applied to the input amplifier (3mV – 1000V). On all ranges, all stages of the input amplifier allow sufficient head room so peak noise does not cause limiting and very high loop gains ensure low-distortion. This allows the AVM-2000 to make full use of the digital filtering technology to eliminate unwanted noise from the measured signals.

Before signals are applied to the input amplifier, they pass through input protection circuitry. This protects the input amplifier from the direct application of excess voltage (up to 1,100 VDC/peak) on any input range. Additionally, the AVM-2000 input attenuator can be configured (in the 100-nV to 1-mV full scale ranges) as a 1 MΩ, 10 MΩ, 100 MΩ or 1 GΩ input termination resistance (user selectable). Input impedances for ranges between 3 mV full scale and 300 V full scale are 10 MΩ or 100 MΩ. The 1 kV range input impedance is fixed at 100 MΩ.

Signals that are to be applied directly to the amplifier pass through a matched set of polarity reversing relays. When measuring signals on ranges of 1 mV or less, one half of all measurements are made with the relays in the NORMAL configuration and one half of all measurements are made with the relays in the ALTERNATE (polarity reversal) configuration. When the respective signals are digitized, they are subtracted from each other thus minimizing the impact of noise, thermal drifts and other undesired signals that tend to be of a single polarity. Further, averaging of these responses also minimizes the impact of drift.

Amplification of the input signal occurs in a low-noise, low-drift, multi-stage programmable gain amplifier. The input amplifier housing is shielded to ensure minimal impact from external electro-magnetic signals and short-term temperature changes in the operating environment. The amplifier components are chosen to ensure Johnson Noise and other similar noise contributors fall below an equivalent noise resistance of 25Ω.
Early stages of the input amplifier are provided with basic filtering that permits the amplifier to maintain its DC performance characteristics with the simultaneous application of a line-frequency (50 Hz or

greater)signal up to 80 dB greater than the signal being measured. Precise and highly-stable offset current is also applied to the input amplifier via a 16-bit DAC whose output value is set by the front panel INPUT OFFSET control.

The output of the multi-stage amplifier is applied to the input of a precision 24-bit analog-to-digital converter. This high-precision, high-stability analog-to-digital converter samples the input signal (including input noise) many times per second. Various filtering/averaging algorithms are applied to this 24-bit result based on front panel FILTER settings. The processor then converts the 24-bit word into a bit stream that is optically coupled to the Front Panel Subsystem. The 24-bit conversion gives a resolution in excess of one part in 16 million to provide a high degree of overall linearity and resolution (ultimately, after processing, 18 bits—17-bits of amplitude resolution and one sign bit). The 24-bit conversion allows extensive digital filtering and manipulation to assist in the measurement and noise reduction process.

Once the digitized (and optically isolated) measurement information is received by the Front Panel Subsystem the output is converted from serial information and is sent to a 20-bit digital-to-analog converters with updates every 200 mS. The digital-to-analog converter output is buffered and sent to the 4 ½ inch, zero-center, mirror-backed meter movement. This meter provides a high-resolution readout with both 10 – 0 – 10 and 3 – 0 – 3 scales. A second 20-bit digital-to-analog converter output is sent to a buffer amplifier. This output is normalized to ±1 V at full scale (corrected for any gain normalizations set by the operator who can make gain adjustments which set the ISOLATED OUTPUT full scale level at ±0.5 V - ± 1.5 V for a full scale input) and is applied to the ISOLATED OUTPUT rear panel terminals. This output allows the operator to utilize the AVM-2000 as a high-gain, high-linearity, (chopper-stabilized for ranges of 1mV and below) instrumentation amplifier with isolated output. A front panel knob allows operator adjustment of the isolated output amplitude.

The Front Panel Subsystem control circuits consist of a microprocessor, LCD, 6 pushbuttons and 3 rotary encoders. The microprocessor continuously scans the switches and rotary encoders to detect any changes. It also regularly updates the LCD with the current AVM-2000 status as selected by the user with the pushbuttons and rotary encoder.

The microprocessor regularly polls the Isolated Analog Subsystem via a high-speed optically isolated serial communications bus. The Isolated Analog Subsystem responds, supplying the results of the current analog to digital conversions of the applied input signal. In addition to polling the Isolated Analog Subsystem, Front Panel Subsystem communications include information such as current RANGE, FILTER, OFFSET, OPERATE/ZERO, ZIN, and ZERO selections.

Front Panel Displays

LCD Display:
Instrument operating status is indicated on the front panel LCD. Information displayed includes:

RANGE :	21 Ranges from 100 nV to 1 kV (full scale)
INPUT IMPEDANCE:	1, 10, 100 MΩ, 1 GΩ or ZERO (Shorted input)
OFFSET:	±30,000.00 µV in 0.01 µV steps
BATTERY STATUS:	Vertical bar graph showing 0 – Full Charge
VARIABLE CONTROL LOCK:	Status of variable control locks
FILTER:	Filter times from 0.1 s to 100 s in 1-2-5 sequence

Power ON indication is also on the LCD display indicating the amount of battery life remaining. The LCD blinks CHARGING if the instrument is connected to a charging source with power turned OFF. The battery graph indicates ERR if the battery voltage is abnormally low with charging current applied.

Analog Display:
Voltage readings are displayed on a taut-band 4 1/2 inch, zero center, mirror-backed meter with dual scales (± 0 - 3 or ± 0 – 10). The scale used depends on the range selected.

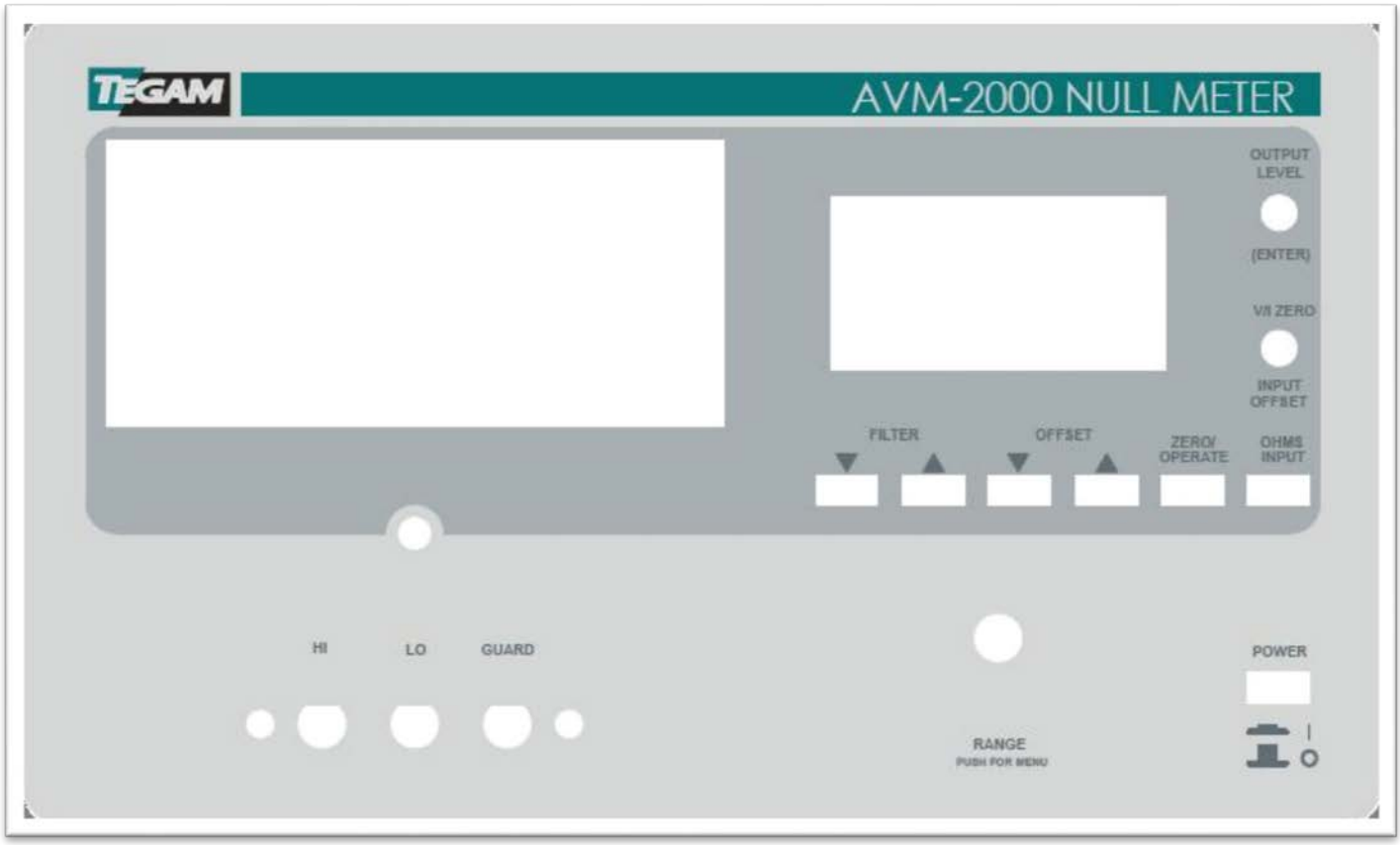

Figure 4.1 - AVM-2000 Front Panel

Front Panel Controls

Power -- Pushbutton
Push ON / Push OFF

RANGE/PUSH FOR MENU -- Rotary Control/Knob
This is a multi-function button and should be thoroughly understood prior to operating any other controls on the AVM-2000.

- The Range knob changes the range for the unit
- Depressing the Range knob for 5 seconds enters the user menus

Range:
In the default position, meaning the rotary button was not pressed only rotated, the rotary control button selects one of 21 full scale voltage ranges: 100 nV, 300 nV, 1 µV, 3 µV, 10 µV, 30 µV, 100 µV, 300 µV, 1 mV, 10 mV, 30 mV, 100 mV, 300 mV, 1 V, 3 V, 10 V, 30 V, 100 V, 300 V, 1 kV (1000 V). The selected range full-scale value displays on the LCD.

Push For Menu:
This control performs secondary functions such as instrument setup routines. To access to these functions depress the RANGE control for approximately 5 seconds, after which the set up menu appears in the LCD. Rotating the RANGE control in this mode causes the LCD to display various setup options.

FILTER -- Pushbuttons
Two momentary action FILTER pushbuttons allow the user to increase (+) or decrease (-) the filter setting. Filter integration time is shown on the LCD. The available filters: 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, and 100 seconds. An input signal is averaged (running average) before driving the meter movement or isolated output over these times.

NOTE: Input ranges of 10 µV and below have a restricted range of filter times (see Table 4-1).

Range	Filter	Input Ω
100 nV	2 sec to 100 sec	1 MΩ, 10 MΩ, 100 MΩ, 1 GΩ
300 nV	2 sec to 100 sec	1 MΩ, 10 MΩ, 100 MΩ, 1 GΩ
1 µV	1 sec to 100 sec	1 MΩ, 10 MΩ, 100 MΩ, 1 GΩ
3 µV	0.5 sec to 100 sec	1 MΩ, 10 MΩ, 100 MΩ, 1 GΩ
10 µV	0.5 sec to 100 sec	1 MΩ, 10 MΩ, 100 MΩ, 1 GΩ
30 µV	0.1 sec to 100 sec	1 MΩ, 10 MΩ, 100 MΩ, 1 GΩ
100 µV	0.1 sec to 100 sec	1 MΩ, 10 MΩ, 100 MΩ, 1 GΩ
300 µV	0.1 sec to 100 sec	1 MΩ, 10 MΩ, 100 MΩ, 1 GΩ
1 mV	0.1 sec to 100 sec	1 MΩ, 10 MΩ, 100 MΩ, 1 GΩ
3 mV through 300 V	0.1 sec to 100 sec	10 MΩ, 100 MΩ
1000 V	0.1 sec to 100 sec	100 MΩ

Table 4-1 - Table of Ranges, Input Impedance and Available Filter Settings

OFFSET -- Pushbuttons
Two momentary action OFFSET pushbuttons allow the user to increase (+) or decrease (-) an internal offset voltage that is applied when the instrument is in the OPERATE mode. The indication displayed on the meter (or output at the rear panel) is the sum of the input voltage and the displayed (LCD) value of offset voltage. The offset voltage can be varied from -30,000.00 µV to + 30,000.00 µV in 0.01 µV steps. Each digit within the offset voltage display is adjusted up or down independently.

The digit to be adjusted is indicated by an underscore (e.g. 0<u>3</u>,000.00 or 00,<u>3</u>00.00). The position of the underscore is selected using the INPUT OFFSET control while the padlock icon (🔒) is displayed to the left of the control.

NOTE: Incrementing or decrementing a position within the displayed OFFSET voltage causes a carry to higher order or lower order digit as appropriate. Depressing **both** OFFSET pushbuttons simultaneously resets the offset to 00,000.00 µV.

NOTE: Each range has a maximum permissible offset. Exceeding this offset produces ADC saturation error. Refer to table 4-2 for Maximum Offset Voltages.

Range	Offset Limit
100 nV	±3 µV
300 nV	±3 µV
1 µV	±30 µV
3 µV	±30 µV
10 µV	±30 µV
30 µV	±300 µV
100 µV	±300 µV
300 µV	±300 µV
1 mV	±3 mV
3 mV	±3 mV
10 mV	±30 mV
30 mV through 1000 V	±30 mV

Table 4-2 - Table of Offset Voltage by Range

OPERATE/ZERO -- Pushbutton
A momentary action pushbutton switch selects the OPERATE (measurement) or ZERO mode. In the ZERO mode the connection between the HI input terminal and the internal amplifiers is opened, the amplifier input is shorted to the amplifier common and any OFFSET voltage is removed. When the ZERO mode is selected, the instrument input impedance setting (as displayed on the LCD) is replaced with ZERO. In the OPERATE mode the voltage to be measured is applied to the input amplifier and the displayed/output voltage is the sum of the input voltage and the indicated OFFSET voltage.

NOTE: This is NOT the button used to zero the meter.

INPUT/MΩ -- Pushbutton
The INPUT / MΩ momentary action pushbutton allows the user to select the value of resistance present between the HI and LO input terminals. By successively depressing the momentary INPUT/MΩ pushbutton increments through: 1 MΩ, 10 MΩ, 100 MΩ and 1 GΩ for ranges 100nV through 1mV, 10MΩ, 100MΩ, from 3mV through 300V ranges 100MΩ 1,000 V range.

NOTE: This button is not active when OPERATE/ZERO button is set to ZERO.

INPUT OFFSET -- Rotary Control/Knob
This is a multi-function button and should be thoroughly understood prior to operating any other controls on the AVM-2000.

- Depressing the Input Offset knob changes between setting voltage and current offsets to the input on the unit
- Depressing the Input Offset knob for 4 seconds while in the voltage offset mode will cause the unit to Zero the current range

The INPUT OFFSET rotary control is a rotary encoder that, when enabled by momentarily depressing the control, allows the user to perform a number of zeroing functions. When the instrument is first initialized, the control is locked. This is shown by a 🔒 (a padlock icon) adjacent to the control in the LCD. Depressing the control once changes the padlock icon to **V** and depressing the control again changes the icon to **I**. When **V** is displayed the control allows the user to fine tune the *current range and mode* zero position. Turning the control clockwise moves the meter upscale and turning the control counterclockwise moves the meter downscale. The control has a range of approximately ± full scale. The zero adjustment setting is stored at anytime a range, zero/operate or input impedance change occurs or if the control's position is reset to the center or neutral position. Depressing the Input offset knob for 4 seconds while in the voltage offset mode will cause the unit to Zero the current range.

When **I** is displayed, the control allows the user to inject currents of ± 2.5 nA into the input amplifier and its driving source. This adjustment allows the user to offset any natural instrument and/or measurement bias currents flowing through driving impedances (causing an offset voltage). Turning the control clockwise injects a positive current and counterclockwise injects a negative current.

NOTE: The level of injected offset current does NOT change as ranges are changed; thus, the input offset current need only be set once.

NOTE: When nulling input bias currents, the user may find using a 100kΩ low-noise resistor or a low-noise resistor value approximating the source impedance of the device connected between the HI and LO input terminals is beneficial. When using a 100 kΩ resistor, the 30 µV range is a good choice as a starting point. The 30 µV range and a 100 kΩ resistance shows input bias currents of ± 300 pA (full scale) and allows nulling these input bias currents to substantially less than 1 pA. If the initial indication is off scale, change the range to 100 µV and then downrange to 30 µV. Alternatively, the 1 MΩ input impedance selection may be used.

Once the range is zeroed or a desired level of input offset current is selected, the INPUT OFFSET control may be locked (by depressing the control until the padlock icon is displayed). This prevents further adjustment of the range zero function or input offset current. The control's locked/unlocked status is shown in an adjacent area of the status LCD. A 🔒 (closed padlock) indicates locked status. Either **V** or **I** indicate unlocked status.

NOTE: with the padlock displayed, adjusting the INPUT OFFSET control allows the user to select which digit of the OFFSET voltage responds to the OFFSET up and down pushbuttons. An underscore is displayed under the selected digit (e.g. 03,000.00 or 00,300.00).

OUTPUT LEVEL -- Rotary Control/Knob
This is a multi-function button and should be thoroughly understood. The OUTPUT LEVEL rotary control is a rotary encoder that allows the user to adjust the ISOLATED OUTPUT level. The range of this control allows the user to adjust the ISOLATED OUTPUT voltage from ± 0.5 volt to ± 1.5 volt when the meter is deflected to full scale. The OUTPUT LEVEL control also serves to set the ISOLATED OUTPUT zero voltage when in Setup mode. The OUTPUT LEVEL control is unlocked or locked by depressing the control once. The control's locked/unlocked status is shown in an adjacent area of the LCD. A 🔒 (closed padlock) indicates locked status.

OVER VOLTAGE
If a potentially harmful over voltage exists at the instrument's input amplifier, the Over Voltage circuit is activated. Once activated, the instrument is disconnected from the input terminals and an over voltage status is shown on the LCD.

NOTE: The Over Voltage only operates when the instrument Range is 1 mV or below unless an extreme over voltage occurs (> 1,300 V) on the 3 mV and above ranges—such voltages are likely to damage the instrument.

When an over voltage condition occurs, the first step is to remove the source of input over voltage. After the over voltage source is cleared, depressing the OPERATE/ZERO pushbutton once returns the instrument to operation in the ZERO mode. Depressing the OPERATE /ZERO pushbutton once again returns the instrument to the OPERATE mode.

WARNING: FAILURE TO REMOVE THE SOURCE OF INPUT OVER VOLTAGE BEFORE RESTORING NORMAL INSTRUMENT OPERATION MAY CAUSE SERIOUS DAMAGE TO THE INSTRUMENT!

NOTE: Although the over voltage circuits protect the instrument from substantial excessive voltages at its inputs, it cannot protect the instrument against damage from extremely high voltage spikes that can occur when the over voltage condition is transient in nature and the voltage spikes are very high due to inductive spiking. For this reason, great care should be taken when using the instrument in high-sensitivity modes (especially on ranges of 1 mV and lower) with very high measurement differential voltages.

Normal Operation

Normal calibration laboratory practice dictates that the environment should be closely controlled. This will minimize errors introduced by temperature and humidity changes. A nominal temperature of +23°C provides a good working condition. A tolerance of ±5°C gives allowable temperature spread. Controlled temperatures also stabilize the aging process of the standards.

Setting Zero Procedure (Standard Method)

Purpose:
The AVM-2000 zeroing procedure is significantly different from older Null Meters such as the Fluke 845 and the AVM-100. With significant improvements from the original release of the AVM-2000, the zeroing procedure is significantly different to the early AVM-2000 Null Meters.

There are two distinctly different methods for zeroing the AVM-2000. This section will cover the standard and preferred zeroing method. The secondary method is the Alternate Zero mode which will also be explain in a separate procedure later in the manual.

Equipment:
- TEGAM AVM-2000 Null Meter

Connections:
1. Plug in all test and measurement equipment
2. Connect shorting strap between the HI(red) and LO(black) terminal of the AVM-2000.

NOTE: A zero may be accomplished while in a test configuration such as a Kelvin-Varley Divider calibration. For this type of zero it is important to insure the voltage source is connected and power output is set to 0 and the output is off. This will give you a zero through the entire configuration rather than simply shorting the AVM-2000 at the input.

Procedure for Zeroing the AVM-2000:

1. Power On the AVM-2000 and allow for normal instrument warm up.
2. Set the Filter to 2.0 sec.
    a. Press the Filter push button(s) until the display shows 2.0 sec.
    b. Other Filter ranges may be used but 2.0 sec is the optimal for zeroing.
3. Clear all offsets (Clear Trim)
    a. Press and hold Range rotary knob until the menu appears in display (about 5 seconds),
    b. Rotate Range knob until Clear Trim and select clear trim by pushing the Input Offset Rotary knob.
    c. Exit menus by pressing the Range Rotary knob.
4. Select what Ranges need zeroing (Example: 1 µV range with 10 MΩ impedance).

NOTE: Knowing what ranges to zero can reduce your procedure time. For example; to achieve sub-part per million results while calibrating a 10 V source the operator would calibrate from 10 V to 1 µV. There would really be no need to calibrate the ranges above 10 V or below 1 µV.

5. Place the AVM-2000 in OPERATE mode.
    a. Press the OPERATE/ZERO button until the 10 MΩ appears in the display.

NOTE: The user can select the desired impedances at this point. It is important to note that a separate zero needs to be performed for each impedance as well as range. It is not typical to changes impedances during a calibration.

6. Dial the Range -- Rotary Control/Knob to the range on the display changes to 1 µV.
7. Press the INPUT OFFSET -- Rotary Control/Knob until the 🔒 (closed padlock) changes to V.

8. Press and hold the INPUT OFFSET-- Rotary Control/Knob for 4 seconds; this will start an automatic zeroing algorithm. Once the zeroing algorithm is complete it may be necessary to fine tune the zero by turning the INPUT OFFSET – Rotary Control/Knob until a satisfactory zero is obtained.
9. Dial the Range -- Rotary Control/Knob changing the range to 3 µV and repeat step 8 and repeat on every range up to and including 10 V.

Setting Zero Procedure (Alternate Zero Method)

Purpose:
The Alternate Zero method allows the user to zero the AVM-2000 at two distinctly different locations, whereas the Standard Zero method only requires one zero in the operate mode. The Alternate Zero method is available for those who wish to zero the AVM-2000 in operate mode as well as in zero mode. Even though zeroing with the impedance set to zero in unnecessary, several customers have this built into their procedures so we want to make it available.

NOTE: When the impedance mode is set to zero there is an internal short inside the AVM-2000, this is much different from the short across the terminals on the outside of the AVM-2000. The difference between the two zeros may be as much as 6 µV.

Equipment:
- TEGAM AVM-2000 Null Meter

Connections:
1. Plug in all test and measurement equipment
2. Connect shorting strap between the HI(red) and LO(black) terminal of the AVM-2000.

NOTE: A zero may be accomplished while in a test configuration such as a Kelvin-Varley Divider calibration. For this type of zero it is important to insure the voltage source is connected and power output is set to 0 and the output is off. This will give you a zero through the entire configuration rather than simply shorting the AVM-2000 at the input.

Procedure for Zeroing the AVM-2000 in ZERO mode:

1. Power On the AVM-2000 and allow for normal instrument warm up.
2. To enter the user menus, depress the Range Knob for approximately 5 seconds.
    a. The Range Knob changes the active menu option; turn range knob until Alternate Zero appears on display.
    b. Depressing the Input Offset knob turns the Alternate Zero Mode On or Off.
    c. Depressing the Range Knob exits the user menus, saving any options that may have been changed.
3. Set the Filter to 2.0 sec.
    a. Press the Filter push button(s) until the display shows 2.0 sec.
    b. Other Filter ranges may be used but 2.0 sec is the optimal for zeroing.
4. Clear all offsets (Clear Trim)
    a. Press and hold Range rotary knob until the menu appears in display (about 5 seconds),
    b. Rotate Range knob until Clear Trim and select clear trim by pushing the Input Offset Rotary knob.
    c. Exit menus by pressing the Range Rotary knob.
5. Select what Ranges need zeroing. (Example:1 µV range with 10 MΩ impedance).

NOTE: Knowing what ranges to zero can reduce your procedure time. For example to achieve sub-part per million results while calibrating a 10 V source the operator would calibrate from 10 V to 1 µV. There would really be no need to calibrate the ranges above 10 V or below 1 µV.

6. Place the AVM-2000 in ZERO mode.
    a. Press the OPERATE/ZERO button until the ZERO appears in the display.
    b. Other impedance settings are ignored at this point.
7. Dial the Range -- Rotary Control/Knob to the range on the display changes to 1 µV.
8. Press the INPUT OFFSET -- Rotary Control/Knob until the (closed padlock) changes to V.
9. Dial the INPUT OFFSET -- Rotary Control/Knob until zero is attained on the analog display.
10. Dial the Range -- Rotary Control/Knob changing the range to 3 µV and repeat step 8 and repeat on every range up to and including 10 V.

Procedure for Zeroing the AVM-2000 in OPERATE mode:

1. Keep the AVM-2000 in Alternate Zero mode.
2. Set the Filter to 2.0 sec.
    a. Press the Filter push button(s) until the display shows 2.0 sec.
    b. Other Filter ranges may be used but 2.0 sec is the optimal for zeroing.
3. Select what Ranges need zeroing.

NOTE: Knowing what ranges to zero can reduce your procedure time. For example to achieve sub-part per million results while calibrating a 10 V source the operator would calibrate from 10 V to 1 µV. There would really be no need to calibrate the ranges above 10 V or below 1 µV.

4. Place the AVM-2000 in OPERATE mode.
    a. Press the OPERATE/ZERO button until the 10 MΩ appears in the display.

NOTE: The user can select the desired impedances at this point. It is important to note that a separate zero needs to be performed for each impedance as well as range. It is not typical to changes impedances during a calibration.

5. Dial the Range -- Rotary Control/Knob to the range on the display changes to 1 µV.
6. Press the INPUT OFFSET -- Rotary Control/Knob until the (closed padlock) changes to V.
7. Dial the INPUT OFFSET -- Rotary Control/Knob until zero is attained on the analog display.
8. Dial the Range -- Rotary Control/Knob changing the range to 3 µV and repeat step 7 and repeat on every range up to and including 10 V.

Maintenance

No regular maintenance is required, other than to keep the internal battery charged. Calibration Verification should be performed yearly or as required.

The exterior of the Model AVM-2000 should be cleaned periodically, as is necessary, using a soft cloth dampened with a mild non-abrasive, water soluble, detergent, and then rinsed with a water dampened soft cloth. DO NOT use alcohol, solvents, harsh chemicals, or abrasive materials to clean the AVM-2000 Meter, or other plastic knobs and connectors.

Clean the AVM-2000 Meter exterior face using a soft cloth dampened with a mild non-abrasive, water soluble, detergent, and then rinse with a water dampened soft cloth. Wipe dry with another soft cloth. DO NOT use common paper towel products in place of a soft cloth, as some brands may contain fibers which could scratch the AVM-2000 Meter. DO NOT use alcohol, solvents, harsh chemicals, or abrasive materials to clean the AVM-2000 Meter.

Periodically inspect the AVM-2000 to make sure all the switch and control knobs are on tight. If they are loose, tighten with the proper size Allen wrench or a small flat blade screw driver as appropriate.

Disassembly and Re-Assembly

Make sure the AC Power Module (or any other source of charging current) is disconnected and removed from the AVM-2000 before any disassembly or reassembly of the instrument. The reader should become familiar with drawings, parts identification, parts layout and other mechanical information.

CAUTION: The battery must be disconnected as the first step in any disassembly process.

CAUTION: Follow ESD (ELECTROSTATIC DISCHARGE) Procedures when handling the AVM-2000 printed circuit boards and their components.

POWER SUPPLY SUBSYSTEM

1. Make sure the POWER switch is in the OFF (out) position.
2. Disconnect the AC Power Module (or other charging source) from the AVM-2000.
3. Remove the 8 screws (left and right sides of the instrument case) that attach the top cover to the front and rear panels. Slide the top cover vertically from the instrument.
4. With the top cover removed, disconnect the 3-pin battery cable J3, 10-pin power cable J4, and, the 3-pin ISOLATED OUTPUT interconnect cable, J1, from the power supply board to facilitate access.
5. With the battery and power supply board completely disconnected from the balance of the instrument, remove the two screws that fasten the base plate to the rear panel.
6. With the back panel free from the case, unsolder the charging jack pins, the ISOLATED OUTPUT binding posts and the fuse wires from the power supply board.
7. Remove the power transistor cable J2.
8. Remove the captivating nuts, lock washers from the mounting studs, and remove the power supply board from the back panel.
9. If the power transistor is to be replaced, remove the transistor by first removing the retaining nut from the mounting stud. Clean any residual heat sink compound from the back panel with denatured alcohol and reapply fresh compound prior to the installation of the new transistor. Be sure a new isolating shoulder washer is placed over the stud and centered in the power transistor's mounting hole before the nut is tightened.

CAUTION: Many connectors are similar in appearance. When re-assembling the instrument, be sure connector and jack numbers match and those connectors are installed correctly.

Front Panel Subsystem

1. Make sure the POWER switch is in the OFF (out) position.
2. Disconnect the AC Power Module (or other charging source) from the AVM-2000.
3. Remove the 8 screws (left and right sides of the instrument case) that attach the top cover to the front and rear panels. Slide the top cover vertically from the instrument.
4. With the top cover removed, disconnect the 3-pin battery cable, J3, from the power supply board. At the front panel, disconnect the 10-pin power cable, J1, the 3-pin rear panel, J4, and meter, J5, connections from the front panel board as well as the 10-pin Isolated Analog Subsystem connector, J2, from the front panel board.
5. Using a hex key, loosen the set screws holding the three front panel knobs on their respective shafts and remove the knobs. Additionally, the range control is secured to the front panel by a hex nut and flat washer that must be removed. An internal tooth lock washer is located on the range control bushing.
6. With the front panel board completely disconnected from the balance of the instrument, remove the two screws that fasten the base plate to the front panel.
7. Remove the captivating screws, lock washers from the mounting studs, and remove the front panel board from the front panel.
8. Installation of a front panel board is performed by reversing the order of the above removal steps.

Isolated Analog Subsystem

1. Make sure the POWER switch is in the OFF (out) position.
2. Disconnect the AC Power Module (or other charging source) from the AVM-2000.
3. Remove the 8 screws (left and right sides of the instrument case) that attach the top cover to the front and rear panels. Slide the top cover vertically from the instrument.
4. With the top cover removed, disconnect the 3-pin battery cable J3 from the power supply board.
5. Disconnect the 10-pin cable coming from the Isolated Analog Subsystem to the front panel, J2.
6. Disconnect the 10-pin cable coming from the power supply board to the front panel board, J1.
7. Remove the two screws that fasten the base plate to the front panel.
8. Tip the front panel forward sufficiently to expose the rear of the three front panel binding posts, unsolder the HI and LO input terminal connections (NOTE: These connections are made with high-quality silver solder to minimize input thermal EMF) and disconnect the Isolated Analog Subsystem from the GUARD binding post.
9. To remove the Isolated Analog Subsystem as a unit, place the instrument on its side and remove the 8 nylon bolts that connect the Isolated Analog Subsystem to the instrument base plate.

CAUTION: The Isolated Analog Subsystem in its metal box is very heavy. Assistance in the disassembly process helps reduce the potential of damage from dropping components during the disassembly/assembly process.

10. Remove the metal box containing the analog subsystem together with its connection cables and insulating plate from the case.
11. If access to the internal Isolated Analog Subsystem board is required, remove the top cover, retaining screws and top cover. Next remove the captivating screws and lock washers from the 4 mounting studs to free the Isolated Analog Subsystem board. If the board is being replaced, the inter-connect cables must also be removed for reinstallation on the replacement board.
12. Installation of the isolated analog subsystem and/or the analog subsystem board is performed by reversing the order of the above removal steps. Be sure to use silver solder to re-connect the Isolated Analog Subsystem input cable to the input binding posts.

NOTE: Failure to keep components and/or the printed circuit board in the Isolated Analog Section clean of contaminants may compromise the performance of the AVM-2000. Avoid touching the electrical surfaces of the printed circuits, unless wearing clean gloves.

Calibration Process

Required Equipment

METER CALIBRATOR:
Range: 0 to 1020 VDC; 0 to 0.306 ADC
Accuracy: VDC, ±0.239% of output; ADC, ±0.072% of output
Suggestion: Fluke 5700A

CURRENT SHUNT:
Range: 0.01 Ω
Accuracy: ±0.072% of value
Suggestion: Guildline 9211A

DIGITAL MULTIMETER:
Range: 0 to 1.5 VDC Agilent
Accuracy: ±0.072% of rdg
Suggestion: Agilent 3458A

Mechanical Zero Calibration

1. This calibration step is preformed with power off.
2. Mechanically zero the meter using the screw on front panel.

Input Impedance Calibration

1. Connect INPUT of AVM-2000 to DMM,
2. Set DMM for Resistance.

Note: During testing, allow meter to stabilize

3. Set AVM-2000 to 1mV, 2 sec., 1 MΩ.
4. Place AVM-2000 in ZERO IMPEDENCE mode.
5. Verify a DMM reading of about ~1MΩ.
6. Set AVM-2000 to 1mV, 2 sec., 10 MΩ.
7. Place AVM-2000 in ZERO IMPEDENCE mode.
8. Verify a DMM reading of about ~10 MΩ.
9. Set AVM-2000 to 1mV, 2 sec., 100 MΩ.
10. Place AVM-2000 in ZERO IMPEDENCE mode.
11. Verify a DMM reading of about ~100 MΩ.
12. Set AVM-2000 to 1mV, 2 sec., 1 GΩ.
13. Place AVM-2000 in ZERO IMPEDENCE mode.
14. Verify a DMM reading of greater than 1 GΩ.

Meter Offset, Full Scale, and Linearization Calibration

1. Hold down Range button until AVM-2000 enters Menu Mode.
2. Turn RANGE knob to 'CAL MENU'. Depress the INPUT OFFSET knob.
3. Turn RANGE knob to 'METER GAIN +' position and adjust OUTPUT LEVEL knob to set meter pointer exactly at + 10.
4. Turn RANGE knob to 'METER GAIN –' position and adjust OUTPUT LEVEL knob to set meter pointer exactly – 10.
5. Turn RANGE knob to 'METER GAIN +' position.
6. Depress the INPUT OFFSET knob. The display should now read '-9'.
7. The meter should move to approximately -9, adjust to -9 by turning the INPUT OFFSET knob.

8. Depress the INPUT OFFSET knob. Meter should move to approximately -8, adjust to -8 by turning the INPUT OFFSET knob.
9. Repeat above for -7, -6, -5, -4, -3, -2, -1, +1, +2, +3, +4, +5, +6, +7, +8, and +9.
10. At the end of calibration the AVM-2000 will display 'METER GAIN +' again.
11. Exit menu mode.

Note: Unit should be in a 23°C environment for at least 24 hours before continuing.

Zero All Ranges

1. Hold down Range button until AVM-2000 enters Menu Mode.
2. Turn RANGE knob to 'CAL MENU'.
3. Depress the INPUT OFFSET knob.
4. Turn RANGE knob to ZERO ALL.
5. Attach a copper shorting bar across the inputs on the front of the AVM-2000.
6. Depress the INPUT OFFSET knob to being the zeroing operation.
7. The AVM-2000 will display 'ZERO ALL' while processing this operation.

Full Scale Calibration

1. Hold down Range button until AVM-2000 enters Menu Mode.
2. Turn RANGE knob to 'CAL MENU'.
3. Depress the INPUT OFFSET knob.
4. Turn RANGE knob to 'GAIN'.
5. Depress the INPUT OFFSET to begin gain calibration operation.
6. Turn the RANGE knob to select the range to be calibrated.
7. Apply 0 VDC to the AVM-2000.
8. Depress the OUTPUT LEVEL knob to set the ADC zero value.
9. Apply full scale voltage to the UTT.
10. Depress the INPUT OFFSET knob to set the ADC full scale deflection value.
11. Repeat steps 6 through 10 for all the ranges on the AVM-2000.
12. When all ranges are finished exit gain by pressing range button, and cycle power on AVM-2000.

30 mV Voltage Offset Calibration

1. Select the 30mV range on AVM-2000.
2. Attach a copper shorting bar across the AVM-2000 inputs.
3. Zero the 30mV range.
4. Hold down Range button until AVM-2000 enters Menu Mode.
5. Turn RANGE knob to 'CAL MENU'.
6. Depress the INPUT OFFSET knob.
7. Turn RANGE knob to VOFFSET CAL.
8. Depress the INPUT OFFSET knob to begin the calibration operation.

I Offset Calibration

1. Exit all calibration menus.
2. Attach a 1M Ohm resistor and shorting banana plug to the inputs on the front of the AVM-2000.
3. Set the AVM-2000 to the 30uV range.
4. Depress the INPUT OFFSET knob to change the selection to 'V'.
5. Turn the INPUT OFFSET knob to zero the AVM-2000.
6. Remove the shorting banana plug.
7. Depress the INPUT OFFSET to change the selection to 'I'.
8. Turn the INPUT OFFSET knob to zero the unit again.
9. Hold down Range button until AVM-2000 enters Menu Mode.

10. Turn RANGE knob to 'CAL MENU'.
11. Depress the INPUT OFFSET knob.
12. Turn the RANGE knob until 'I OFFSET CAL' is displayed.
13. Depress the INPUT OFFSET knob to set the value.

Verify Offset Trim

1. Set AVM-2000 to 1 mV, 2 sec., 1 MΩ, OFFSET zero.
2. Zero the meter with 0V applied to the input of the AVM-2000 using the INPUT OFFSET knob set to V mode.
3. Set the INPUT OFFSET knob to the padlock position and set an offset of 03,000.00 µV and apply -3 mV from the calibrator to the AVM-2000 input.
4. Using the error mode on the calibrator adjust the input voltage to zero the meter and record the actual voltage output from the calibrator on the data collection sheet.
5. Change OFFSET to 2 mV and apply -2 mV from calibrator.
6. Using the error mode on the calibrator adjust the input voltage to zero the meter and record the actual voltage output from the calibrator.
7. Repeat steps 5-6 for 1 mV, -1 mV, -2 mV, and -3 mV. (For negative OFFSET use positive input)
8. Zero OFFSET and Input Voltages.
9. Change AVM-2000 to 300µV Range, zero the AVM-2000.
10. Set OFFSET to 300uV and Input -300uV from the calibrator.
11. Using the error mode on the calibrator adjust the input voltage to zero the meter and record the actual voltage output from the calibrator on data collection sheet.
12. Repeat 2-3 for 200u V, 100u V, -100u V, -200u v, and -300u V. (For negative OFFSET use positive input)
13. Disconnect calibrator and set OFFSET to 00,000.00µV.

Output Offset Calibration

1. Connect AVM-2000 to calibrator in parallel shunt resistor.
2. Set calibrator to 0A output and AVM-2000 to 1mV range.
3. Connect isolated output to DVM.
4. Zero AVM-2000 (front panel) and make note of DVM reading.
5. Hold down Range button until AVM-2000 enters Menu Mode.
6. Turn RANGE knob to 'CAL MENU'.
7. Depress the INPUT OFFSET knob.
8. Turn RANGE knob to OUTPUT OFFSET.
9. Turn the INPUT OFFSET knob until DVM reads noted value from step 4.
10. Exit cal menu.
11. Set calibrator to 0A, zero AVM-2000 (front panel) and make note of DVM reading.
12. Hold down Range button until AVM-2000 enters Menu Mode.
13. Turn RANGE knob to 'CAL MENU'.
14. Depress the INPUT OFFSET knob.
15. Turn RANGE knob to OUTPUT OFFSET.
16. Adjust output by the amount noted in step 11.
17. Exit cal menu.
18. Confirm AVM-2000 reads zero on DVM +/- 1mV.
19. Repeat steps 11-18 as needed.
20. Output 100mA from calibrator.
21. Press output level knob to unlock and adjust to 1V full scale output.
22. Confirm both + and – full scale are within 4mV of 1V. Push output level knob to lock. , and repeat steps 11-21 as needed.
23. Remove shunt resistor.

Overload Function Check

1. Set AVM-2000 to 1 mV, 2 sec., 1 MΩ.
2. Apply 25V from Calibrator to AVM-2000 INPUT.
3. AVM-2000 should instantly display OVERLOAD.
4. Set INPUT voltage to 0V.
5. Depress the OPERATE/ZER0 button twice.
6. Verify that the 1mV range functions normally.
7. Apply -25V from Calibrator to AVM-2000 INPUT.
8. AVM-2000 should instantly display OVERLOAD.
9. Set INPUT voltage to 0V.
10. Depress the OPERATE/ZER0 button twice.
11. Verify that the 1mV range functions normally.

Meter Linearity Check

1. Set AVM-2000 to 1 V, 10 MΩ, 2 sec., OFFSET Zero.
2. Apply 0 V from Calibrator and zero the meter.
3. Apply 1V and verify Full Scale. Adjust calibrator for 1 V on meter.
4. Apply .9V and verify the meter reads a positive deflection of 9 within less than ½ of a minor division on the upper scale.
5. Adjust calibrator for .9V on meter movement.
6. Apply .8V and verify the meter reads a positive deflection of 8 within less than ½ of a minor division on the upper scale.
7. Adjust calibrator for .8V on meter movement.
8. Repeat for .7V, .6V, .5V, .4V, .3V, .2V, and .1V
9. Apply -.1V and verify the meter reads a negative deflection of 1 within less than ½ of a minor division on the upper scale.
10. Repeat for -.2V, -.3V, -.4V, -.5V, -.6V, -.7V, -.8V, -.9V, and -1V.
11. Set AVM-2000 to 3 V, 10 MΩ, 2 sec., OFFSET Zero.
12. Apply 3V and verify Full Scale.
13. Apply 2.5V and verify the meter reads a positive deflection of 2.5 within less than ½ of a minor division on the lower scale.
14. Repeat for 2V, 1.5V, and 1V. Record.
15. Apply -1V and verify the meter reads a negative deflection of 1 within less than ½ of a minor division on the lower scale.
16. Repeat for -1.5V, -2V, -2.5V, and 3V.

Gain and Zero Check for Each Range

Upper Ranges

1. Set AVM-2000 to 1000 V, ZERO, 2 sec., OFFSET Zero.
2. Apply 0V to the INPUT.
3. Verify meter zero. (May have to adjust with INPUT OFFSET knob, meter should zero easily).
4. Change AVM-2000 to 100MΩ impedance.
5. Verify meter zero (May have to adjust with INPUT OFFSET knob, meter should zero easily).
6. Apply 1000V from the Calibrator and verify a positive Full Scale meter deflection.
7. Apply -1000V from the Calibrator and verify a negative Full Scale meter deflection.
8. Set AVM-2000 to 300 V, ZERO, 2 sec., OFFSET Zero.
9. Apply 0 V to the INPUT.
10. Verify meter zero. (May have to adjust with INPUT OFFSET knob, meter should zero easily).
11. Change AVM-2000 to 100MΩ impedance.
12. Verify meter zero (May have to adjust with INPUT OFFSET knob, meter should zero easily).
13. Change AVM-2000 to 10MΩ impedance.

14. Verify meter zero (May have to adjust with INPUT OFFSET knob, meter should zero easily).
15. Apply 300V from the Calibrator and verify a positive Full Scale meter deflection.
16. Apply -300V from the Calibrator and verify a negative Full Scale meter deflection.
17. Repeat steps 8-16 for all RANGES down to and including 10mV, using the correct Full Scale voltage for each range on the INPUT.

Lower Ranges

1. Attach the 10 mΩ shunt in parallel with Calibrator and AVM-2000 INPUT.
2. Set AVM-2000 to 3 mV, ZERO, 2 sec., OFFSET Zero.
3. Apply 0V to the INPUT.
4. Verify meter zero (May have to adjust with INPUT OFFSET knob, meter should zero easily).
5. Change AVM-2000 to 100MΩ impedance.
6. Verify meter zero (May have to adjust with INPUT OFFSET knob, meter should zero easily).
7. Change AVM-2000 to 10MΩ impedance.
8. Verify meter zero (May have to adjust with INPUT OFFSET knob, meter should zero easily).
9. Apply 300mA from the Calibrator and verify a positive Full Scale meter deflection.
10. Apply -300mA from the Calibrator and verify a negative Full Scale meter deflection.
11. Set AVM-2000 to 1 mV, ZERO, 2 sec., OFFSET Zero.
12. Apply 0V to the INPUT.
13. Verify meter zero (May have to adjust with INPUT OFFSET knob, meter should zero easily).
14. Change AVM-2000 to 100 MΩ impedance.
15. Verify meter zero (May have to adjust with INPUT OFFSET knob, meter should zero easily).
16. Change AVM-2000 to 1 MΩ impedance.
17. Verify meter zero (May have to adjust with INPUT OFFSET knob, meter should zero easily).
18. Apply 100mA from the Calibrator and verify a positive Full Scale meter deflection.
19. Apply -100mA from the Calibrator and verify a negative Full Scale meter deflection.
20. Change AVM-2000 to 1 GΩ impedance.
21. Verify meter zero (May have to adjust with INPUT OFFSET knob, meter should zero easily).
22. Apply 100 mA from the Calibrator and verify a positive Full Scale meter deflection.
23. Apply -100 mA from the Calibrator and verify a negative Full Scale meter deflection.
24. Repeat steps 11-19 for all RANGES down to and including 100nV, using Table 5-1 for each range for full scale deflection on the INPUT:

Range	Upper Limit	Lower Limit
300µV	+30mA	-30mA
100µV	+10mA	-10mA
30µV	+3mA	-3mA
10µV	+1mA	-1mA
3µV	+300µA	-300µA
1µV	+100µA	-100µA
300nV	+30µA	-30µA
100nV	+10µA	-10µA

Table 5-1

25. Remove shunt resistor.

TROUBLESHOOTING

WARNING: Dangerous voltages from the ac power line, test instruments, and measured source can be present when troubleshooting the AVM-2000. Exercise proper safety precautions!

CAUTION: Follow esd (electrostatic discharge) procedures when handling the AVM-2000 printed circuit boards and their components.

NOTE: The AVM-2000 setup processes must be performed after making any repairs.

Depending on the observed symptom, probable areas for investigation or repair in the AVM-2000 are indicated. Refer to disassembly instructions to gain access to the indicated areas, as well as reassembly instructions. Refer to the theory of operation for the affected section. The parts layout, test points and control/adjustment locations and schematics are found in parts list. When replacing any soldered component on one of the printed circuit boards, particularly the Isolated Analog Section, make sure to clean completely away any solder flux residue.

The AVM-2000's operation is highly dependent on internal software-based functions within the two microprocessor-based subsystems. Any component level troubleshooting requires access to software development tools and the accompanying interfaces to connect the software development system to the two microprocessors. Troubleshooting in this manual is limited to identifying problems with the instrument's major subsystems, which can be returned to PPM for repair/exchange if a defective subsystem is identified.

Techniques are presented below to identify a need to replace/exchange one of the following:
AC Power Module
Rechargeable Battery
Power Supply Subsystem
Front Panel Subsystem
Isolated Analog Subsystem
Meter Movement
Interconnection Cables

NOTE: Failure to keep the Isolated Analog Subsystem Board clean of contaminants may compromise the performance of the AVM-2000. Avoid touching the electrical surfaces of this board, unless wearing clean gloves.

Troubleshooting Tip: Always check signals/voltages at BOTH ends of the indicated cable/connector. If the indicated signal is present at one end of the cable but not at the other, a defective cable is indicated rather than a defective subsystem. In the steps below, only one end of the cable is called out in each step. If the indicated positive results are not obtained in the step, always check the like connection (i.e. red wire, #5 pin, etc.) at the other end of the cable to eliminate a defective interconnection cable.

Symptom: AVM-2000 does not operate with line power and internal rechargeable battery does not charge or the battery charge indicator continuously displays ERR.

AC Power Module is not plugged in or is not connected.

Action: Check the connections at both ends. Power Supply Subsystem fuse is blown.

Action: Replace the fuse with one of the same type and value. If the Power Supply Subsystem fuse continues to blow, the Power Supply Subsystem or one of the subsystems it feeds is defective.

Action: Disconnect the balance of the AVM-2000 from the Power Supply Subsystem by removing connector J4.

- If the fuse continues to blow, disconnect the battery, J3, and measure the open circuit battery voltage.

If the open circuit battery voltage lies between 5.3 and 7.0 volts, the Power Supply Subsystem is defective.

Action: replace the Power Supply Subsystem.

If the open circuit battery voltage is substantially below 5.3 volts, the battery has one or more shorted cells.

Action: Replace the battery.

If the fuse does not continue to blow, the problem lies with either the Front Panel or Isolated Analog Subsystem.

Action: Disconnect the Isolated Analog Subsystem from the Front Panel Subsystem by unplugging connector J2 of the Front Panel Subsystem.

If the fuse continues to blow, the Front Panel Subsystem is defective.

Action: Replace the Front Panel Subsystem.

If the fuse no longer blows, the Isolated Analog Subsystem is defective.

Action: Replace the Isolated Analog Subsystem.

Symptom: AVM-2000 operates with the AC Power Module connected, but not properly on the internal rechargeable battery.

Internal rechargeable battery needs to be charged.

Action: Charge battery as described.

There is a problem with the battery charging circuit.

Action: Check the voltage across the battery terminals (the voltage should be between 6.0 and 7.5 volts DC when the AC Power Module is connected—i.e. when the battery is charging). A lower voltage indicates a failed Power Supply Subsystem, a failed rechargeable battery or a deeply discharged battery (allow sufficient time to charge the battery).

Disconnect the battery and measure its open circuit voltage. If the open circuit battery voltage lies between 5.3 and 7.0 volts, the Power Supply Subsystem is defective.

Action: Replace the Power Supply Subsystem.

If the open circuit battery voltage is substantially below 5.3 volts, the battery has one or more shorted cells. Action: Replace the battery.

Symptom: AVM-2000 internal rechargeable battery charges, but the level displayed on the AVM-2000 LCD does not show the normal fully charged reading.

Disconnect the battery and measure its open circuit voltage. If the open circuit battery voltage lies between 5.3 and 7.0 volts, the Front Panel Subsystem battery monitoring circuit is defective.

Action: Replace the Front Panel Subsystem.

If the open circuit battery voltage is substantially below 5.3 volts, the battery has one or more shorted cells.

Action: Replace the battery.

Symptom: No AVM-2000 Meter readings and no signal at the ISOLATED OUTPUT on all ranges.

Action: Ensure the AVM-2000 front panel OPERATE/ZERO Switch is in the OPERATE position.

If not above, check that the power supply voltage being delivered to the Isolated Analog Subsystem as measured between pins 1,2 and ,4 at connector J1 is + 5 VDC ± 0.25 volts.

If + 5 volts is not being delivered to the Isolated Analog Subsystem, check the voltage into the Front Panel Subsystem at connector J1 (pin 3 to 9 and pin 4 to 10). This should be between +5.3 and 7.0 volts.

If no voltage is present, there is a Power Supply Subsystem / Battery problem.

Action: Use the steps above to isolate a Power Supply Subsystem / Battery problem.

If the voltage is present at the input to the Front Panel Subsystem but not being delivered to the Isolated Analog Subsystem, the Front Panel Subsystem is defective.

Action: Replace the Front Panel Subsystem.

If not above, rotate the AVM-2000 RANGE control to the 100 mV range, and apply a 100 mV DC input signal to the AVM-2000. Using an oscilloscope (or pulse detecting logic probe), check for serial communications from the Isolated Analog Subsystem to the Front Panel Subsystem--19,200 baud 10 character bursts should be present at connector J2 Pin 6.

If bursts are present, the Front Panel Subsystem is not properly detecting and interpreting them.

Action: Replace the Front Panel Subsystem. If no bursts are present, look for similar bursts from the Front Panel Subsystem to the Isolated Analog Subsystem at connecter J2, Pin 5 of the Front Panel Subsystem.

If no bursts are present, the Front Panel Subsystem is not properly generating them.

Action: Replace the Front Panel Subsystem.

If bursts are present, the Isolated Analog Subsystem is not properly detecting and interpreting them.
Action: Replace the Isolated Analog Subsystem.

Symptom: AVM-2000 does not operate properly in some RANGE control positions but operates correctly on other ranges or the OFFSET function, FILTER function, Z IN function or ZERO function fails to operate, a defective Isolated Analog Subsystem is indicated.

Action: Replace the Isolated Analog Subsystem.

Symptom: No output on AVM-2000 Meter, but signal at ISOLATED OUTPUT.

Make sure the Meter connector J5 (see page 49) is properly seated and that a voltage is being developed across the meter terminals (approximately 35 mV for a full scale deflection). If a voltage is being developed and there is no meter movement, the meter movement is defective.

Action: Replace the meter movement.

NOTE: If the meter movement requires replacement, the replacement includes special setup instructions required to ensure proper system linearity.

If there is no voltage present across the meter terminals, the Front Panel Subsystem is defective.

Action: Replace the Front Panel Subsystem.

Symptom: Output on AVM-2000 Meter, but no signal at ISOLATED OUTPUT.

Check for the appropriate DC signal (i.e. a scaled ± 1 volt for ± full-scale meter deflection) at connector J4 pin 2 or TP8 of the Front Panel Subsystem.

If the signal is present at J4 pin 2 or TP8, the output cable is defective.

Action: Replace the output cable.

If no signal is present at J4 pin 2 or TP8, the Front Panel Subsystem is defective.

Action: Replace the Front Panel Subsystem.

Symptom: Poor 60 Hz AC noise rejection.

Most frequently, poor 50/60 Hz noise rejection is a function of improper measurement configuration.

Action: Carefully check all cable routing, ground connections, sequencing of connections, etc.

NOTE: Ground loops (i.e. multiple paths for ground currents) can be a significant source of undesirable/interfering electrical noise. Disconnecting the instrument from any non-measurement related connections to other apparatus (recorders, chargers, etc.) is a good way to isolate such problems.

If the problem persists and all indications point to a problem with the AVM-2000, the problem lies with the Isolated Analog Subsystem.

Action: Replace the Isolated Analog

Instrument Recovery

This section was referred to as TIR or total instrument reset. With the improvements to the AVM-2000 zeroing process TIR is no longer valid and has been replaced with Clear Trim.

Clear Trim Procedure

1. Press and hold the Range rotary knob for approximately 5 seconds to enter the AVM-2000 menus.
2. Depressing the Input Offset knob clears any voltage and current offset that may be applied to the system, and exits back to the main screen.
3. Depressing the Range Knob exits the user menus, saving any options that may have been changed

Memory Sanitization Procedure

Since there is no external access to the any of the AVM-2000 memory, there is no memory system to sanitize on the AVM-2000.

Returning AVM-2000 for Service

Use the information in this section if you need to return your AVM-2000 to TEGAM.

Package AVM-2000 for Shipment

Use the following steps to package the AVM-2000 for shipment to TEGAM for service:

1. Fill the EXPEDITE REPAIR & CALIBRATION FORM (found in Section I) and attach it to the AVM-2000. Please be as specific as possible about the nature of the problem. Send a copy of any or all of the following information:
   - Any error messages that appeared on the power meter display.
   - Any information on the performance of the AVM-2000.

2. Use the original packaging materials or a strong shipping container. The carton must be both large enough and strong enough to accommodate the power meter and allow at least three to four inches on all sides of the power meter for packing material.

   CAUTION: AVM-2000 power switch requires a hard cover to prevent accidental power up during shipment.

3. Surround the power meter with at least three to four inches of packing material or enough to prevent the power meter from moving in the carton.

4. Seal the shipping container securely with strong nylon adhesive tape.

5. Mark the shipping container “FRAGILE, HANDLE WITH CARE” to ensure careful handling.

CAUTION: AVM-2000 damage can result from using packaging materials other than those specified.

6. Retain copies of all shipping papers.

NOTE: Refer to page 1-6 of the introduction for information on how to obtain a RMA from TEGAM.

Storage

When the AVM-2000 is to be stored for extended periods, pack the instrument into a container. Place container in a clean, dry, temperature-controlled location. If instrument is to be stored in excess of 90 days, place desiccant with items before sealing container. The safe environmental limits for storing the AVM-2000 are -20 to + 60 °C / 0 - 80% non- condensing.

CAUTION: AVM-2000 has a rechargeable battery. It is essential to either remove the battery if storing periods longer than 6 months. Another solution is to charge the battery periodically (within 6 months) during the storage period.