# AVM-2000

# OPERATION & MAINTENANCE MANUAL

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# AVM-2000 OPERATION AND MAINTENANCE MANUAL

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**NOTE**

**This instrument utilizes two separate microcontrollers to implement the design. Each microcontroller is programmed independently. The software version for each of these microcontrollers is indicated on a version label affixed to the inside rear panel. Please reference these version numbers in any communication with PPM concerning this instrument. For reference you may wish to record these version numbers.**

**AVM-2000 HIGH SENSITIVITY ANALOG DC VOLTMETER/NULLMETER**

**WARNING**

**DANGEROUS VOLTAGES MAY BE PRESENT WHEN USING THIS INSTRUMENT. EXERCISE PROPER PRECAUTIONS!**

**NOTE**

**THIS INSTRUMENT REQUIRES A STARTUP SEQUENCE EACH TIME IT IS TURNED ON. THE SEQUENCE DURATION IS APPROXIMATELY 15 SECONDS. ALTHOUGH THE INSTRUMENT CAN BE USED IMMEDIATELY AFTER THIS EVENT, IT IS RECOMMENDED A MINIMUM WARM UP TIME BE ALLOWED TO ENSURE FULL SPECIFICATIONS ARE MET.**

## 1. INTRODUCTION

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.

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 by means of an optional AVM-2000-1RC rack mounting kit. 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 with power applied to all circuits.

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 either adjust the instrument's zero for the current range or to inject an input offset current of up to ± 2.5 nA into the instrument's input to offset the effects of input bias currents on high impedance voltage sources and 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.



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## 2. DISPLAYS , CONTROLS AND TERMINALS

### 2.1. Displays (Refer to Page 57 for Call Outs)

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.

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

| | |
|---|---|
| • RANGE : | 21 Ranges from 100 nV to 1 kV (full scale)<br>1 – 3 – 10 sequence |
| • 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 is indicated by the presence of range information on the LCD. 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.

### 2.2. Front Panel Controls (Refer to Page 56 for Call Outs)

#### 2.2.1. POWER Pushbutton Switch

Push ON / Push OFF

#### 2.2.2. RANGE Rotary Control (Push for Menu)

A rotary control selects one of 21 full scale voltage ranges of:

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 is displayed on the LCD.

NOTE: This control performs secondary functions such as instrument setup routines. Access to these functions is accomplished by depressing 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 (Refer to Table 1: Table of Ranges, Input Impedance and Available Filter Settings).

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 selections are:

0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, and 100 seconds.

These are the times over which an input signal is averaged (running average) before driving the meter movement or isolated output. NOTE: Input ranges of 10 µV and below have a restricted range of filter times (see **Table** 1).

#### 2.2.3. 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.



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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 may be adjusted up or down independently.

The digit to be adjusted is indicated by an underscore. The position of the underscore is selected using the INPUT OFFSET control <u>while the padlock icon is displayed to the left of the control</u>. Depressing and holding one of the OFFSET pushbuttons allows continuous movement of the selected OFFSET voltage digit. NOTE: Incrementing or decrementing a position within the displayed OFFSET voltage will cause a carry to higher order or lower order digit as appropriate. Depressing **both** OFFSET pushbuttons simultaneously resets the offset to zero. NOTE: Each range has a maximum permissible offset. Exceeding this offset produces no further offset and the µV icon blinks (see Error! Reference source not found.).

2.2.4. 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.

2.2.5. 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. 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

2.2.6. INPUT OFFSET Rotary Control with Momentary Push Action

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 a V and depressing the control again changes the icon to an I.

When V is displayed the control allows the user to fine tune the <u>*current range and mode*</u> 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. The user can reset the control to the center (neutral—i.e. no offset) position by depressing and holding the control depressed for 5 seconds.

When I is displayed, the control allows the user to inject currents of up to approximately ± 2.5 nA into the input amplifier and its driving source. This adjustment allows the user to offset any natural instrument and/or measurement setup bias currents flowing through driving impedances and thus causing an offset voltage. Turning the control clockwise injects a positive current and turning the control counterclockwise injects a negative current. As with the voltage offset function, holding the control depressed for 5 seconds or longer resets the offset current to zero. NOTE: The level of injected offset current does NOT change as ranges are changed; thus, the input offset current need only be set once.



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*Helpful Information: When used to null 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 will show 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.*

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** indicates unlocked status (see Page 57 for illustration of this indication). NOTE: with the padlock displayed, adjusting the INPUT OFFSET control allows the user to select which digit of the OFFSET voltage will respond to the OFFSET up and down pushbuttons. An underscore is displayed under the selected digit.

2.2.7. OUTPUT LEVEL Rotary Control with Momentary Push Action

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.

2.2.8. 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.

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.



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## 2.3. Input Terminals

### 2.3.1. HI, LO and GUARD Terminals (Refer to Page 56 for Illustration)

Two low thermal EMF terminals, for connecting the signal to be measured to the instrument input, plus a guard connection, are located on the front panel. These terminals are gold-plated, tellurium copper 5-Way Binding posts. The terminals are designated as:

| | |
|---|---|
| HI | High potential voltage input (RED) |
| LO | Low potential voltage input (BLACK) |
| GUARD | Connection for input wiring shield (WHITE) |

## 2.4. Rear Panel (Refer to Page 55 for Illustration)

### 2.4.1. POWER

A standard 0.080” (2.1 mm) DC power receptacle on the rear panel allows connection of +12 VDC to +30 VDC to power the instrument and charge the instrument’s battery. Charging a deeply discharged battery may require peak currents of up to 1.25 Amperes for a short period of time. Typically this source is from the external AC Power Module provided with the instrument. NOTE: If an external voltage is used to power and/or charge the instrument, it is preferable that this source be floating with respect to the instrument chassis, and excessive noise on this supply line may affect the instrument’s performance. CAUTION: It is not advisable to use switching supplies to provide this charging/operating power due to their excessive noise.

### 2.4.2. 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 is 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.


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## 3. SPECIFICATIONS

Operating specifications apply after a 1 hour warm-up in the measurement environment at a constant tilt level. (See accompanying notes). The power up sequence requires approximately 15 seconds for the instrument to self test.

3.1. AC Line Power Input……………………….120 VAC ±10%, 60 Hz

3.2. Battery Power………………………………Internal rechargeable battery

3.2.1. 50 hours normal operation per charge

3.2.2. 20 hours to completely charge

3.2.3. External charging 12 – 30 VDC @ 1.25 Amperes maximum

3.3. Measurement Ranges (± full scale)

100, 300 nV

1, 3, 10, 30, 100, 300 µV

1, 3, 10, 30, 100, 300 mV

1, 3, 10, 30, 100, 300 V

1 kV

3.4. Analog Meter Measurement Accuracy, Resolution, Linearity

3.4.1. Analog Meter Accuracy…………...±2% of full scale of range selected

3.4.2. Analog Meter Resolution…………1% of full scale

3.4.3. Analog Meter Linearity……………±1% of full scale of range selected

3.5. Input Resistance (Impedance)

100 nV – 1 mV full scale…………1 MΩ, 10 MΩ, 100 MΩ ± 2% or 1 Gigohm ± 10%

3 mV – 300 V full scale…………...10 MΩ or 100 MΩ

1 kV full scale…………………….100 MΩ

Input Capacitance………………….Input on all ranges shunted by 1,000 pF

3.6. Filter Response Times (see Table 1 for limitations by range)

100, 200, 500 ms

1, 2, 5, 10, 20, 50 & 100 Seconds

3.7. Meter Response Time[1] (To 90% of final reading)

3.7.1. 100 nV - 1 µV full scale……………5 seconds

3.7.2. 3 µV full scale………………………3 seconds

3.7.3. All other ranges……………………..1.5 seconds

3.8. Instrument Noise…………………………….400 pV (peak-to-peak, shorted input[2]) RTI

Equivalent noise source approximately 30 ohms



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3.9. Isolated Output

3.9.1. Accuracy ........................................±0.5% full scale (of selected range)

3.9.2. Resolution ......................................0.1% of full scale

3.9.3. Linearity ........................................±0.5% of full scale

3.9.4. Response Time ...............................Determined by Filter Response Time setting

3.9.5. Noise ..............................................400 pV (peak-to-peak, shorted input[2]) RTI

3.9.6. Level...............................................0 to ±1 volt for full scale of selected range, adjustable ±50%

3.9.7. Output Impedance ..........................Approximately 1 kΩ

3.9.8. Protection…………………………Short circuit protected but not against external voltage

3.9.9. Isolation..........................................> 100 GΩ (with respect to input terminals)

3.9.10. Maximum voltage (DC or peak)......1100 V Input LO to – Output LO (black connector)

3.10. Offset Voltage Function:

3.10.1. Range..............................................0 to ±30,000.00 µV *within constraints of a maximum offset voltage of 30 X a 1s range or 10 X a 3s range. See* Table 2: Table of Offset Voltages by Range

3.10.2. Resolution: .....................................≤ 0.1% (of Offset Voltage Full Scale)

3.10.3. Accuracy ........................................≤ ±0.5% (of Offset Voltage Full Scale)

3.11. Offset Current Function…………………..Continuously adjustable from 0 to ± 2.5 nA

3.12. AC Rejection (>50 Hz)……………………80 db greater than full scale will affect the reading <2% of full scale. Maximum 750 V rms or 1,100 V peak.

3.13. Maximum Input Overload…………………1100 VDC or peak on any range for a short time without harm. Sustained large overload voltages on the 1 mV (or lower) ranges can cause significant internal changes and affect readings.

3.14. Zero Stability (Shorted input[2])……………5 nV/day

<500 pV/°C

3.15. Physical Size……………………………..11.5"W x 6.5"H x 13.5"D, with controls

3.16. Weight……………………………………22.5 lbs.

3.17. Storage Requirements…………………….Relatively dust free environment.

-20 to +60°C

15 to 80% RH

NOTES:

1. With filter response time set to 200 ms. Otherwise, filter response times add to Meter Response Time.
2. Inputs shorted by a low-emf strap firmly connected between HI and LO input connections. (Lesser performance may be experienced when shorted input is accomplished by ZERO switch). Constant temperature.



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## Table 1: Table of Ranges, Input Impedance and Available Filter Settings

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

## Table 2: Table of Offset Voltages by Range

| | | FULL OFFSET AS A PERCENTAGE OF FULL SCALE | | | | |
|---|---|---|---|---|---|---|
| | MAXIMUM VALID OFFSET >> | ± 00,003.00 µV | ± 00,030.00 µV | ± 00,300.00 µV | ± 03,000.00 µV | ± 30,000.00 µV |
| 100 nV | 0,000.00 µV | 3000.0% | Blink | Blink | Blink | Blink |
| 300 nV | 0,000.00 µV | 1000.0% | Blink | Blink | Blink | Blink |
| 1 uV | 0,000.00 µV | 300.0% | 3000.0% | Blink | Blink | Blink |
| 3 uV | 0,000.00 µV | 100.0% | 1000.0% | Blink | Blink | Blink |
| 10 uV | 0,000.00 µV | 30.0% | 300.0% | 3000.0% | Blink | Blink |
| 30 uV | 0,000.00 µV | 10.0% | 100.0% | 1000.0% | Blink | Blink |
| 100 uV | 0,000.00 µV | 3.0% | 30.0% | 300.0% | 3000.0% | Blink |
| 300 uV | 0,000.00 µV | 1.0% | 10.0% | 100.0% | 1000.0% | Blink |
| 1 mV | 0,000.00 µV | 0.3% | 3.0% | 30.0% | 300.0% | 3000.0% |
| 3 mV | 0,000.00 µV | 0.1% | 1.0% | 10.0% | 100.0% | 1000.0% |
| 10 mV | 0,000.00 µV | 0.030% | 0.30% | 3.00% | 30.00% | 300.00% |
| 30 mV | 0,000.00 µV | 0.010% | 0.10% | 1.00% | 10.00% | 100.00% |
| 100 mV | 0,000.00 µV | 0.003% | 0.030% | 0.30% | 3.00% | 30.00% |
| 300 mV | 0,000.00 µV | 0.001% | 0.010% | 0.10% | 1.00% | 10.00% |
| 1 V | 0,000.00 µV | 0.000% | 0.003% | 0.030% | 0.30% | 3.00% |
| 3 V | 0,000.00 µV | 0.000% | 0.001% | 0.010% | 0.10% | 1.00% |
| 10 V | 0,000.00 µV | 0.000% | 0.000% | 0.003% | 0.030% | 0.30% |
| 30 V | 0,000.00 µV | 0.000% | 0.000% | 0.001% | 0.010% | 0.10% |
| 100 V | 0,000.00 µV | 0.000% | 0.000% | 0.000% | 0.003% | 0.030% |
| 300 V | 0,000.00 µV | 0.000% | 0.000% | 0.000% | 0.001% | 0.010% |
| 1000 V | 0,000.00 µV | 0.000% | 0.000% | 0.000% | 0.000% | 0.003% |

| | |
|---|---|
| Yellow | Blink (Offset Exceeds Instrument's Dynamic Range) |
| Blue | Offset beyond intended resoluton |



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# 4. ITEMS FURNISHED AND WARRANTY

## 4.1. Items Furnished

- Model AVM-2000 Analog DC Voltmeter/Nullmeter
- AC Power Module
- Rechargeable Battery
- Plug-on Input Terminal Shield
- Guard to LO Nickel plated Shorting Link
- 2 µF Filter Block Mounted on Dual Banana Jack
- Technical (Operation and Maintenance) Manual

## 4.2. Warranty

- See inside back cover of the Operation and Maintenance Manual.

# 5. INSTALLATION INSTRUCTIONS

## 5.1. Unpacking

Upon receipt, the AVM-2000 Analog DC Voltmeter/Nullmeter and its accompanying components should be carefully unpacked and removed from the shipping container. Separate the parts from the packing material and inspect the AVM-2000 for any external damage.

If any dents, broken or loose parts are seen, do not use the equipment. Notify the shipping company immediately and follow their instructions for remedial action.

## 5.2. Operating Voltage Selection

The AVM-2000 is delivered with an AC Power Module for operation from 120 ±10% VAC, 60 Hz. If the AVM-2000 will 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 PPM for a selection of input Power Modules.

## 5.3. Battery Installation and Removal

NOTE: The Model AVM-2000 is shipped with the rechargeable battery installed. For normal use, there should be no need to remove the battery; however, should removal be necessary, follow the steps below to remove the battery. These steps may be reversed as a procedure for battery installation.

5.3.1. Make sure the POWER switch is in the OFF (out) position.

5.3.2. Disconnect the AC Power Module or other charging source.

5.3.3. 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.

5.3.4. 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.

5.3.5. 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. The battery retaining plate may now be removed by removing the 4 flat head screws that hold the plate to the rear panel mounted spacers. The battery can now be lifted from its mounted position. Unsolder the battery supply wires from the battery's positive and negative terminals. Remove and save the foam padding from the rear of the battery.



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5.3.6. Replace battery of like kind set forth in the parts list at page 63 by reconnecting connector harness J3 from the old battery and reinstalling the new battery following the reverse order of the above steps. Be sure to re-install the foam padding so that the top, rear of the battery is held away from the rear panel. Please note that batteries are considered consumable items and are not covered under warranty.

**WARNING**

**ENSURE BATTERY WIRES ARE RE-CONNECTED TO THE APPROPRIATE (+ & -) TERMINALS AND THAT THE BATTERY CONNECTOR IS PROPERLY POSITIONED ON J3**

5.4. Battery Charging

The AVM-2000 battery is charging any time the instrument is connected to its AC Power Module or other source of +12 to +30 Volts DC with a capacity of at least 1.25 Amperes. The AVM-2000 rechargeable battery requires 20 hours for a full charge if the instrument is in use and 16 hours for a full charge if the instrument is turned off. To charge the battery after prolonged unit storage or after discharge from normal use, ensure the AVM-2000 is connected to a power source for at least the specified time.

When turned on, the LCD battery charge bar graph shows the approximate status of the battery's charge. A fully charged battery will provide 50 + hours of operation. Once the charge bar graph indicates two bars (each bar is 2 pixels high) between 2 and 4 hours of operation remain. When the charge bar graph shows one bar you should immediately connect a charging source.

NOTE: In the event the AVM-2000 battery is deeply discharged (for example, by uncharged operation in excess of the rated 50 hour operation followed by an extended period of storage time in the discharged state), attempting to charge the instrument may result in the display of ERR within the LCD battery symbol. If this condition exists, the AVM-2000's battery charging circuit enters a special mode to avoid damage to the battery and/or the instrument. This mode limits battery charging currents and, depending on the depth of battery discharge, the instrument may remain in the limited current charging mode for a number of hours before beginning a normal 20-hour full charge cycle.

Alternatively, if the instrument never is able to charge the battery sufficiently to cause the ERR indication to change to a normal battery status indication a damaged battery (shorted cell, for example) is indicated.

The instrument can not be used while the ERR display is showing.

Once the battery is sufficiently charged to allow normal operation, ERR is replaced by a bar graph indication of the battery charge state and normal charging resumes. The instrument may be operated simultaneously with charging any time the battery charge indication is a bar graph.

If the instrument is left on such that the battery is discharged below an operating level, a special circuit on the Power Supply Subsystem disconnects battery power to the instrument. This action turns the instrument OFF. If this condition occurs, the instrument can only be turned on by connecting a source of charging current (AC Power Module or other DC source) to the instrument. If the battery voltage does not return to a normal level, the ERR indication will show in the instrument's LCD.



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## 6. PREPARATION FOR USE

The following sequence of setup steps are provided so the user can verify basic AVM-2000 settings. It is recommended that these settings be verified before each use but no more than once daily.

6.1. After powering up, check the battery charge level. If the charge is one bar (2 pixels) high or less, there is very limited operating time on battery operation. Be sure to charge as soon as possible.

6.2. Press and hold the RANGE knob for approximately 5 seconds until the LCD indicates METER OFFSET. This action selects the instrument's Setup Menu.

6.2.1. Verify that the meter pointer reads exactly zero. If it does not perform step 6.2.2.

6.2.2. Using the OUTPUT LEVEL knob (upper right-most knob), adjust the meter pointer to read exactly Zero on the mirrored meter scale. NOTE: It is best to have previously mechanically adjusted the meter to zero via the front panel screw (this operation is performed with the instrument power off).

6.2.3. Turn the RANGE knob one step clockwise. The LCD indicates: METER GAIN +.

6.2.3.1. Verify that the meter pointer reads exactly +10 (full scale positive). If it does not, perform step 6.2.3.2.

6.2.3.2. Using the OUTPUT LEVEL knob (upper right-most knob), adjust the meter pointer to read exactly +10 (i.e. full scale positive).

6.2.4. Turn the RANGE knob one step clockwise. The LCD indicates: METER GAIN –.

6.2.4.1. Verify that the meter pointer reads exactly -10 (full scale positive). If it does not, perform step 6.2.4.2.

6.2.4.2. Using the OUTPUT LEVEL knob (upper right-most knob), adjust the meter pointer to read exactly -10 (i.e. full scale negative).

6.2.5. Turn the RANGE knob one step clockwise. The LCD indicates: OUTPUT OFFSET. Note: Omit this step from the daily check if the ISOLATED OUTPUT is not being used.

6.2.5.1. Connect a suitable voltmeter to the rear panel OUTPUT connection.

6.2.5.2. Verify the output level is Zero volts ± 200 µV. If not, perform step 6.2.5.3.

6.2.5.3. Using the OUTPUT LEVEL knob (upper right-most knob), adjust the ISOLATED OUTPUT for Zero volts ± 200 µV.

6.2.6. Turn the RANGE knob one step clockwise. The LCD indicates ZERO RANGE or ZERO ALL. When the LCD displays ZERO ALL, initiating the ZERO process zeros all of the instrument's 21 ranges. When the LCD displays ZERO RANGE, initiating the zero process only zeros the currently selected range (Range/ZIN selection for ranges above 3 mV).

NOTE: The zero process references either the ZERO or OPERATE modes depending on the mode selected at the time the zero function is initiated. This ZERO function is intended to provide a preliminary zero condition. Final zeroing is best accomplished using the INPUT OFFSET control in the V mode for each mode and range (and impedance selection for the 3 mV to 1 kV ranges),


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Depressing both OFFSET pushbuttons simultaneously toggles the instrument between ZERO RANGE and ZERO ALL. Upon power up, the instrument is automatically set to ZERO ALL. The instrument ZERO process must be initiated with the ZERO/OPERATE function in the ZERO mode. This stores a zero reference for the ZERO mode. Initiating the process in the OPERATE mode, establishes a zero reference in the OPERATE mode and reflects any offsets that may be at the instrument's input terminals during the zero function. Therefore, zeroing the instrument only in the OPERATE mode may allow non zero results when operating in the ZERO mode.

6.2.6.1. To establish a front panel terminal zero reference, connect a low thermal emf shorting strap between the HI and LO input terminals. If possible use a low thermal emf material such as pure copper or tellurium copper.

6.2.6.2. Depress the OUTPUT LEVEL knob to initiate the ZERO process. The indication ZERO (ZERO RANGE or ZERO ALL) in the LCD blinks. When ZERO indication stops blinking, a zero (with respect to the EMFs present while the ZERO function is performed) is complete for the selected range or all of the AVM-2000's 21 ranges. Note: This operation will take from 20 seconds to 10 minutes to complete depending on the range selected and/or if ZERO ALL is selected.

6.2.6.3. Disconnect the shorting strap from the HI and LO input terminals.

6.3. If you have reason to believe the instrument gains are no longer within specification, perform the steps in Section 13.

6.4. Otherwise depress the range control to return the AVM-2000 to the normal instrument status.



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## 7. OPERATING INSTRUCTIONS

This section contains general operating instructions for the AVM-2000 Analog DC Voltmeter/Nullmeter. Refer to section 2.0 for a description of the controls, display and terminals. When measuring voltages in the nanovolt and microvolt ranges, be sure to follow standard practices concerning shielding and the selection of connecting leads.

> **WARNING**
>
> **DANGEROUS VOLTAGES MAY BE PRESENT WHEN USING THIS INSTRUMENT. EXERCISE PROPER PRECAUTIONS!**

> **NOTE:** The AVM-2000 must warm up for at least an hour in the measurement environment, at the selected tilt level, for specified performance, particularly on the ranges of 100 μV full scale and below. On power up, the instrument executes a self test which requires approximately 15 seconds.

> **WARNING**
>
> **Applying more than 1100 Volts across the input terminals or from either input terminal to common or ground will result 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.**

7.1. If the AVM-2000 is operated from line power, plug the AC Power Module into an appropriate power source and connect it to the AVM-2000 via the rear panel POWER jack.

7.2. Press the POWER switch to turn ON the AVM-2000. The LCD will activate and show the instrument's current status. Wait till the instrument is finished with its internal power on self test (The LCD displays SELF TEST during this operation).

7.3. Select the desired AVM-2000 full scale voltage measurement range using the RANGE control.

7.4. Make an appropriate connection between the DC voltage to be measured and the AVM-2000 HI and LO input terminals.

> **NOTE:** The AVM-2000 has a high degree of electrical isolation between its input and isolated output terminals. Connecting the AVM-2000 input LO and/or GUARD terminals to the AVM-2000 ISOLATED OUTPUT shield, either directly or through connections via external equipment, defeats this isolation. This has a detrimental effect on input common mode rejection.

7.4.1. When making measurements in the nanovolt/microvolt range, the user must ensure all electrical connections are made with an emphasis on reducing thermal EMFs generated when two metals are in contact. Low thermal-emf connectors, cables and techniques assist


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this process. Where ever possible, solid copper conductors with firm mechanical connections should be used. Larger diameter conductors are preferred to smaller diameter conductors. Additionally, the user must keep the effects of temperature variations, air currents, electric fields, magnetic fields and other similar environmental issues in mind. Remember: W*hen the AVM-2000 is being operated in the microvolt and nanovolt ranges, the effects of these external environmental issues may well substantially exceed the full scale setting of the instrument*.

7.4.2. A GUARD terminal is provided for the AVM-2000 input signals. If desired, when working with signal levels below 100 µV, this terminal can be connected to a shield for the input wires. For general use, GUARD may be connected to the LO (Black) terminal.

7.4.3. When making measurements in the nanovolt/microvolt range, thermal differentials across components or at connection points generate significant voltages which can affect the measured value. The heat from the operator's hands is sufficient to cause such voltages. Allow the connections to come to thermal equilibrium before taking a measurement. You may wish to place the terminal cover over the input connections to reduce thermal effects from local air circulation. Copper-to-copper and copper-to-gold connections cause thermal EMF voltages that change with temperature in the area of 200 – 400 nV for each degree centigrade in temperature change. Therefore, for example, a ½ degree temperature differential between the HI and LO input terminals could result in an unwanted input voltage of between ¼ and ½ of full scale on the 1 µV range.

7.4.4. Note that large overload voltages on the ranges of 1 mV full scale and below can cause significant internal disturbances. These will affect readings for some time after the overload voltage has been removed. For example, the 1000 pF input capacitance of the AVM-2000, will retain approximately 1% of an applied voltage 5 seconds after the voltage is removed when the instrument input impedance is set to 1 GΩ. Therefore a 1 volt input on the 1 mV range will leave a full scale voltage at the input 5 seconds later.

7.5. Use the OFFSET function to zero the AVM-2000 Meter by offsetting minute voltages produced in the circuit connections due to thermal and other physical effects. Depressing the up arrow button (▲) causes a positive meter deflection, and depressing the down arrow button (▼) causes a negative meter deflection. NOTE: for large offset voltage excursions, depress and hold the up arrow or down arrow buttons.

7.5.1. When making voltage measurements with the AVM-2000 in the nanovolt or microvolt range, especially for ranges of 30 µV and below, the AVM-2000 should be zeroed with the lowest possible input impedance selection and with the source to be measured switched to a low impedance OFF state (after making the input connections). Using the instrument's ZERO feature will leave uncompensated offsets from the measurement connections which may adversely affect the readings.

7.5.2. The AVM-2000 ZERO should be re-checked when making measurements using ranges of 1 mV and below each time there are changes in the setup, the ambient temperature has changed or significant time has elapsed. Final refinements of zero can be made using the Input Offset Control in the V mode.

7.6. Place the OPERATE/ZERO Switch in the OPERATE position, if not already done. Read the measured voltage on the AVM-2000 Meter. Positive input voltages (HI with respect to LO) deflect the meter to the right, and negative voltages deflect the meter to the left. For all ranges starting with a "1", for example 100 nV, 1 µV, 10 mV, 100 V, etc., read the measured voltage on the upper 0 to +10 or 0 to -10 meter scale, inserting a decimal point as appropriate. For all ranges starting with a "3", for example 300 nV, 3 µV, 30 mV, 300 V, etc., read the measured voltage on the lower 0 to +3 or 0 to -3 meter scale, inserting a decimal point as appropriate. The LCD indicates the proper measurement units for the selected ranges (i.e. nano, micro, milli or k –kilo—volts).



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## 7.7. Isolated Output Terminals

> **NOTE:** The AVM-2000 has a high degree of electrical isolation between its input and isolated output terminals. Connecting the AVM-2000 input LO and/or GUARD terminals to the AVM-2000 ISOLATED OUTPUT shield, either directly or through connections via external equipment, defeats this isolation. This has a detrimental effect on input common mode rejection.

7.7.1. Determine the input voltage requirements of the external device (up to a maximum of 1.5 volts full scale). The full scale output voltage from the AVM-2000 will be the same for all range selections.

7.7.2. Connect the external device to the AVM-2000 ISOLATED OUTPUT connector. The output impedance of this output is approximately 1 kΩ.

7.7.3. This step adjusts the rear panel output to the input range of the external device. Select the 1 V range and apply a 1 V DC input to the AVM-2000. Place the OPERATE/ZERO switch in the OPERATE position. Adjust the OUTPUT LEVEL Control to give the desired positive full scale output. Remember that the rear panel output signal is a bipolar voltage, depending on the polarity of the input signal.

7.7.4. Measure the desired voltage with the AVM-2000 as described in sections above and the scaled measurement voltage appears on the rear panel ISOLATED OUTPUT CONNECTOR.



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## 8. THEORY OF OPERATION

Basic operation of the AVM-2000 and an understanding of how it achieves its specified levels of performance follow. These paragraphs refer to the AVM-2000 block diagram **Error! Reference source not found.**Figure 1: System Block Diagram
on page 21. The block diagram shows 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 precision amplifiers to a level where they can drive a precision 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. 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.

Input signals are applied to the AVM-2000's low-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. 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 have been chosen to ensure that 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.


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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 sent to a 20-bit precision digital-to-analog converter. The digital-to-analog converter output is buffered and sent to the 41/2 inch, zero-center, mirror-backed meter. This meter provides a high-resolution readout with both 10 – 0 – 10 and 3 – 0 – 3 scales. Additionally, a second 20-bit digital-to-analog converter output is sent to a buffer amplifier where the output is normalized to ±1 V at full scale (corrected for any gain normalizations set by the operator) and is applied to the **ISOLATED OUTPUT** rear panel connector. This output allows the operator to utilize the AVM-2000 as a high-gain, high-linearity, chopper-stabilized 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 three 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 poles 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. When operated in the setup mode (special menu on the LCD selected by depressing the Range Control), the microprocessor communications are modified to contain special requests such as ZERO, GAIN and setting the 2.667 volt reference.


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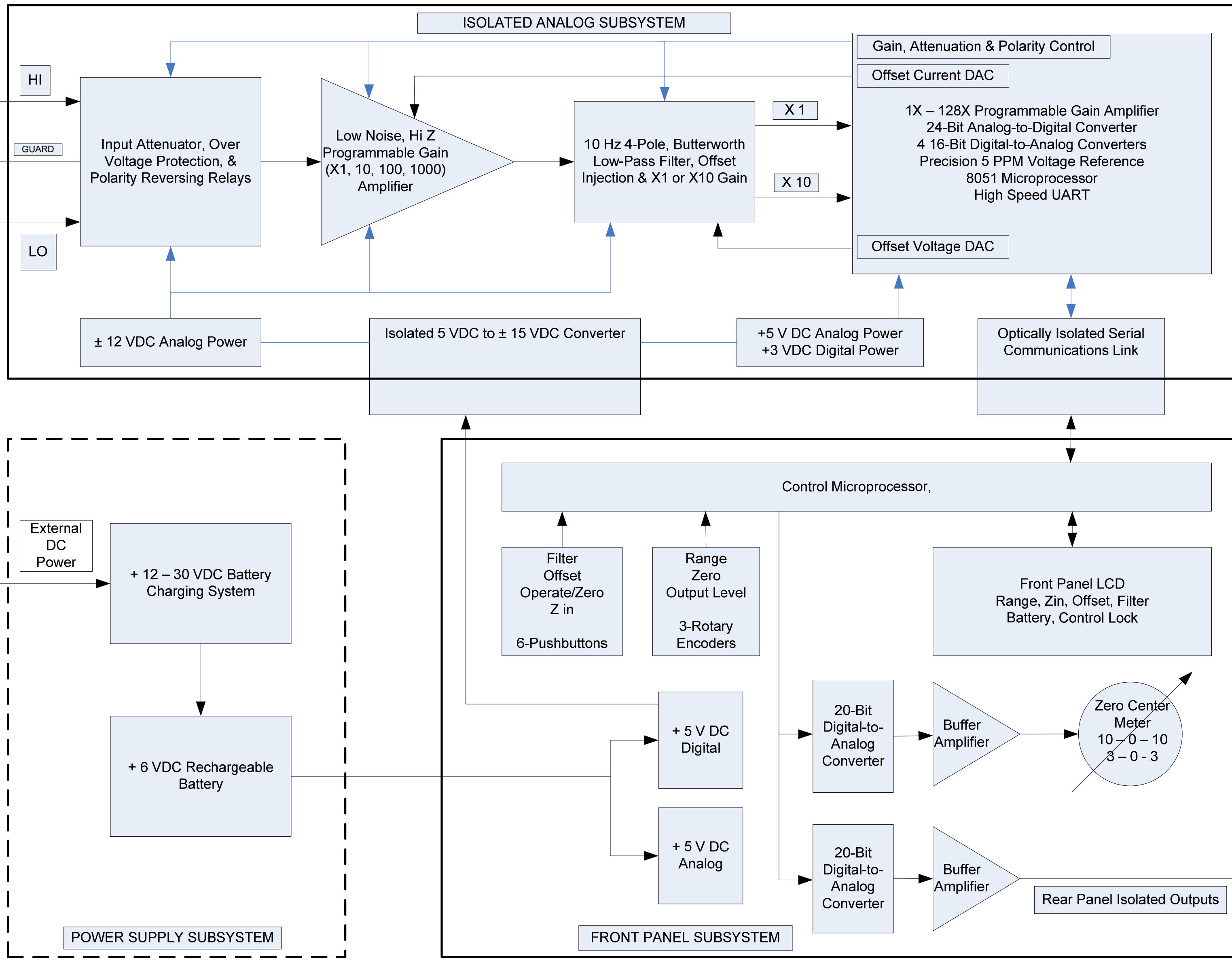
**Figure 1: System Block Diagram**



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## 9. MAINTENANCE

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

9.2. 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.

9.3. 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.

9.4. 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.



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## 10. 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. Additionally **the battery must be disconnected pursuant to paragraph 10.1 as the first step in any disassembly process**. The reader should become familiar with drawings, parts identification, parts layout and other mechanical information contained within pages 39 to 70.

**CAUTION**

**FOLLOW ESD (ELECTROSTATIC DISCHARGE) PROCEDURES WHEN HANDLING THE AVM-2000 PRINTED CIRCUIT BOARDS AND THEIR COMPONENTS.**

### 10.1. POWER SUPPLY SUBSYSTEM

10.1.1. Make sure the POWER switch is in the OFF (out) position.

10.1.2. Disconnect the AC Power Module (or other charging source) from the AVM-2000.

10.1.3. 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.

10.1.4. 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.

10.1.5. 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.

10.1.6. 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.

10.1.7. Remove the power transistor cable J2.

10.1.8. Remove the captivating nuts and lock washers from the mounting studs and remove the power supply board from the back panel.

10.1.9. 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 THAT CONNECTORS ARE INSTALLED CORRECTLY (pin-for-pin and with the proper orientation—see Appendix B)**


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10.2. Front Panel Subsystem

10.2.1. Make sure the POWER switch is in the OFF (out) position.

10.2.2. Disconnect the AC Power Module (or other charging source) from the AVM-2000.

10.2.3. 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.

10.2.4. 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.

10.2.5. 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 that must be removed. An internal tooth lock washer is located on the range control bushing.

10.2.6. 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.

10.2.7. Remove the captivating screws and lock washers from the mounting studs and remove the front panel board from the front panel.

10.2.8. Installation of a front panel board is performed by reversing the order of the above removal steps.

10.3. Isolated Analog Subsystem.

10.3.1. Make sure the POWER switch is in the OFF (out) position.

10.3.2. Disconnect the AC Power Module (or other charging source) from the AVM-2000.

10.3.3. 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.

10.3.4. With the top cover removed, disconnect the 3-pin battery cable J3 from the power supply board.

10.3.5. Disconnect the 10-pin cable coming from the Isolated Analog Subsystem to the front panel, J2.

10.3.6. Disconnect the 10-pin cable coming from the power supply board to the front panel board, J1.

10.3.7. Remove the two screws that fasten the base plate to the front panel.

10.3.8. 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.

10.3.9. 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's base plate. CAUTION: The Isolated Analog Subsystem in its metal box is very heavy. Assistance in the disassembly process will help reduce the potential of damage from dropping components during the disassembly/assembly process.

10.3.10. Remove the metal box containing the analog subsystem together with its connection cables and insulating plate from the case.

10.3.11. 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.



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10.3.12. 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.**



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## 11. PREPARATION FOR SHIPMENT OR LONG-TERM STORAGE

11.1. Fully charge the battery prior to shipment or long term storage. The battery charge should be refreshed at least once a year.

11.2. If the battery is removed for any reason, be sure to place the battery in a container in which it is not possible for any of the battery connections to be shorted through haphazard placement and possible nicks in insulating sleeves, or through contact with conducting objects.

**WARNING**

**Short-circuiting a charged battery will generate excessive heat which could result in fire, as well as possibly damaging the battery.**

11.3. The original shipping carton is not reusable.

11.4. Packaging must provide sufficient soft (non-abrasive) and resilient material to protect the AVM-2000 Meter face and controls.



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## 12. CALIBRATION VERIFICATION

12.1. Equipment and miscellaneous parts required:

- ✓ Precision Voltage source 0 to 1000 Volts DC and AC RMS such as Fluke model 5100 or 5720 Multi Product Calibrator
- ✓ Precision Voltmeter with range of 0 to ±1000 V DC and AC RMS such as Fluke model 8508A Reference Multimeter or Keithley 2000.
- ✓ 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 PPM model R1M-A
- ✓ Pure copper shorting strap
- ✓ 25Ω resistor, ¼ Watt, 1%
- ✓ 30Ω resistor, ¼ Watt, 1%
- ✓ 1MΩ resistor, ¼ Watt, 1%
- ✓ 10MΩ resistor, ¼ Watt, 2%
- ✓ 30MΩ resistor, ¼ Watt, 2%
- ✓ 1GΩ resistor, ¼ Watt, 5%

### 12.2. VERIFICATION PROCEDURE

**Prior to turning on power, check the mechanical alignment of the analog meter and adjust to zero if needed**

12.2.1. Turn on power and allow instrument to stabilize for a minimum of one hour at 22.8ºC ±3.3ºC

12.2.2. Set Filter to 2.0 seconds

12.2.3. Set input resistance to 1MΩ on ranges <3mV and 10MΩ for 3mV and above

12.2.4. Complete the appropriate steps from Table 3. NOTE: Steps 1 – 9 in Table 3 verify instrument calibration that affects measurement traceability. If the instrument fails to meet these specifications, the user should perform the steps in Section 13. Steps 10 – 22 verify specifications that are a function of the components used to construct the instrument. If the instrument fails to meet these specifications the user should refer to Section 14 TROUBLESHOOTING.



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**Table 3: Step-By-Step Calibration Verification**

| Step | Specification | Description | Action | Result |
|---|---|---|---|---|
| 1 | Input Range | 100nV to 1000 V, 21 Ranges | Verify that all 21 ranges operate by applying + and - Full Scale Voltage for each range | Verification by indication of panel meter operation and isolated output operation |
| 2 | Isolated Output | Accuracy ≤ ± 0.5% full scale of Range | Set the instrument to 1 mV range<br>Zero the instrument with source connected so Isolated Output shows 0 V ± 1 mV<br>Set calibrator to + 1 mV and adjust Isolated Output via Output Level control to read 1.000 V<br>Set calibrator to - 1 mV | Measure and record value at Isolated Output for each calibrator setting. Verify difference between + full scale readings and - full scale readings is within ±0.5% (± 5 mV). |
| 3 | Meter | Accuracy ≤ ±2% full scale of Range | Zero the instrument with the source connected prior to measurements on each range<br>Apply + and - full scale voltage for each range | Read meter and record value. Verify result is within ±2% of full scale |
| 4 | Isolated Output | Resolution ≤ 0.1% of full scale of Range | Zero the instrument with the source connected<br>Set calibrator to + full scale of selected range<br>Reduce calibrator by 0. 1% of setting. | Compare/Record. Verify output reduces by 0. 1% of full scale. |
| 5 | Meter | Resolution ≤ 1% full scale of Range | Set calibrator to + full scale of selected range<br>Reduce calibrator output to 99% of full scale | Compare/Record. Verify that meter shows 1% change from previously recorded value. |
| 6 | Isolated Output | Linearity≤0.5% of full scale | Set the instrument to the 1 mV range<br>Zero the instrument with the source connected so the Isolated Output Shows 0V ± 1 mV<br>Set calibrator to + 1 m V<br>Reduce calibrator output in 100 uV steps until calibrator output is - 1 mV | Record Isolated Output value for each calibrator position<br>Verify output values when plotted against calibrator value are within 0.5% of full scale (1 volt) |
| 7 | Meter | Linearity 1%≤full scale compensated for floor noise | Set the instrument to 1 volt range<br>Zero the instrument with the source connected<br>Set calibrator output to – 1 volt<br>Reduce calibrator output by 0.2 volts in 10 steps until calibrator output is + 1 volt | Verify meter readings for each calibrator setting are within 1% (10 mV or ½ of one minor division) of calibrator setting |



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| Step | Specification | Description | Action | Result |
|---|---|---|---|---|
| 8 | Offset Accuracy (note 12.3.2and 12.3.3) | Adjustable ± 0 to 30,000.00 µV<br>Offset within ± 0.5% of Offset full scale | Set the instrument to a 1s range (e.g. 1 mV)<br>Zero the instrument with the source connected<br>Set the instrument Offset to + 30 X full scale (e.g. 30 mV) Note: The µV symbol will blink at full scale offset for ranges other than 1 mV (where blinking occurs for 10 nV above 30 mV of offset)<br>Apply - 30 X full scale to the instrument input (e.g. - 30 mV)<br>Next, change the instrument Offset to – 30 X full scale and apply a + 30 X full scale to the instrument input (e.g. + 30 mV)<br>Change to a 3s range (e.g. 300 µV) and repeat the above procedure using offsets of 10 X full scale | Verify calibrator output to bring instrument meter to zero (center scale on meter) and isolated output is within ± 0.5% of maximum offset at. ±30 or ±10 X of full scale for selected range. |
| 9 | Offset Resolution (note 12.3.3) | ≤0.01% of full scale offset | Repeat the above procedure for 1 mV and 300 µ V ranges. With the respective full scale offsets applied to the instrument and from the calibrator, reduce source by 0.01% of full scale | Verify meter and/or Isolated Output indicates change in offset of 0.01% of full scale for offset (Note: this requires observing a change of approximately ±3 mV on the 1s range and ± 1 mV on the 3s range at the Isolated Output. The meter changes ±0.3 % or ± 0.1%, changes that are quite difficult to see) |
| 10 | Noise | Equivalent noise resistance ~25Ω | Measure noise with input shorted for any given filter setting. | Compare noise with 25Ω across input terminals. Value should be approximately twice (or less) of the shorted value. |
| 11 | Source Resistance | Constant from 30Ω to 0<br>Minimal change to 1MΩ<br>Noise increases @≤20dB per decade of source resistance. | Set input resistance to 1MΩ.<br>Measure noise at 0Ω and 30Ω across input.<br>Measure noise with 1MΩ resistor across input.<br>Measure noise with 10MΩ resistor across input.<br>Measure noise with 100MΩ resistor across input. | Little to no change in noise<br>(Minor increase in noise above Johnson Noise of source resistance is permitted.).<br>Record value.<br>Measure & record noise ≤ +20dB; compare.<br>Measure & record noise ≤ +20dB from prior. |



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| Step | Specification | Description | Action | Result |
|---|---|---|---|---|
| 12 | Input Impedance | >30MΩ 3 seconds after step input | Select Voltage Range up to 1 mV. Select 1GΩ input resistance. Connect 30MΩ resistor in series between source and input. Apply full scale DC voltage step. (Note: This measurement is highly susceptible to significant inaccuracies due to resistor noise, temperature coefficient and or uncompensated input currents of any nature). | Measure >= 50%full scale within 3 seconds |
| 13 | Continued | Approaches 1GΩ with time. | Remove voltage from step 13.<br>Replace 30MΩ with 1GΩ.<br>Apply full scale DC voltage step input. (Note: This measurement is highly susceptible to significant inaccuracies due to resistor noise, temperature coefficient and or uncompensated input currents of any nature). | Reading on front panel meter reaches 33% of full scale within approximately 1100 seconds. |
| 14 | Response Time Constant | Min 100 msec | Measure time with Oscilloscope triggered by the input source or sync pulse from the input source. | Set filter to 100 msec and measure isolated output response as indicated on the oscilloscope. |
| 15 | Continued | Max 100 sec | Same as above. | Set filter to 100 sec and proceed as above |
| 16 | Series Mode Rejection (note: 12.3.3) | >80dB @60 Hz<br>Ranges up to 300 mV | Input low distortion 60 Hz sine wave of RMS voltage 1000X full scale coupled through low leakage 10 µF capacitor to eliminate DC offset. (Note: Any uncompensated DC offsets introduced in this process will lead to erroneous readings). | Verify that the output on both the meter and the isolated output is ≤10% of full scale |
| 17 | Continued | Ranges 1V to 10V | Change sine wave to 100X full scale | Output ≤ 1% of full scale |
| 18 | Continued | Ranges 100 V to 1000V | Change sine wave to 1X full scale | Output ≤ 0.01% of full scale |
| 19 | Output | 0 to ±1 Volt | Verified as above. | |
| 20 | Isolation See Caution | Input to case or output >100MΩ | Measure DC resistance.<br>SEE CAUTION BELOW | Verify that resistance is > 100MΩ between either input terminal and either output terminal |



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| Step | Specification | Description | Action | Result |
|---|---|---|---|---|
| 21 | Zero Drift Isolated Output | ≤500pV/ºC | Elevate temperature and stabilize meter to 10°C above ambient (Environmental Chamber required—stabilize for at least 1 hour). Set calibrator to 50% of selected range. | Measure and record analog meter and Isolated output for comparison in step 22. |
| 22 | Zero Drift Isolated Output | ≤500pV/ºC | Reduce temperature by 20°C and stabilize meter (Environmental Chamber required—stabilize for at least 1 hour). | Compare ½ scale readings recorded in step 21 and verify that they are within ±10nV. |

12.3. Notes to Calibration Verification Procedure

12.3.1. All checks with no filter and at 22.8°C ±3.3°C unless otherwise specified

12.3.2. Offset conditions are limited to the useful operating range of the instrument's OFFSET function (see Table 2)

12.3.3. Input voltage must not exceed equipment ratings ±1,100 volts. It is not necessary to check all ranges.

12.3.4. All tests on ranges below 10µV should be performed with test apparatus housed within suitable Faraday enclosure

12.3.5. If testing indicates the instrument does not meet the indicated specification, refer to INSTRUMENT CALIBRATION PROCESS (Section 13) and perform the relevant setup steps. If this does not correct the problem, refer to Section 14 TROUBLESHOOTING.

**CAUTION**

Extreme care needs to be taken not to damage the isolated output stage by inadvertently applying any source voltage or causing any voltage to back drive the isolated output stage of the instrument. In measuring the insulation resistance, make sure that no other equipment is connected, that power is not applied or turned on in the instrument and that the input terminals are not shorted or connected externally in any way other than to the Megohmmeter.



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## 13. INSTRUMENT CALIBRATION PROCESS

13.1. The following sequence is provided so the user can adjust the AVM-2000 user settings. It is recommended that these steps be performed at any time there is an indication the instrument is not operating within specifications. Note: for best results, the instrument should have been charged for at least 24-hours prior to completing the following steps.

13.1.1. To initiate the user adjustable calibration processes, press and hold the RANGE knob for approximately 5 seconds until the LCD indicates METER OFFSET. This action selects the instrument's Setup Menu.

13.1.1.1. Using the OUTPUT LEVEL knob (upper right-most knob), adjust the meter pointer to read exactly Zero on the mirrored meter scale. NOTE: It is best to have previously mechanically adjusted the meter to zero via the front panel screw (this operation is performed with the instrument power off).

13.1.2. Turn the RANGE knob one step clockwise. The LCD indicates: METER GAIN +.

13.1.2.1. Using the OUTPUT LEVEL knob (upper right-most knob), adjust the meter pointer to read exactly +10 (i.e. full scale positive).

13.1.3. Turn the RANGE knob one step clockwise. The LCD indicates: METER GAIN –.

13.1.3.1. Using the OUTPUT LEVEL knob (upper right-most knob), adjust the meter pointer to read exactly -10 (i.e. full scale negative).

13.1.3.2. NOTE: The AVM-2000 setup includes a sub-menu that allows the user to adjust the instrument for non-linearity in the meter movement. Although mainly used when the meter movement is replaced this setup may be performed at this time. To perform a meter linearization setup, follow the steps outlined in Section 19.3 and then return to this sequence of steps.

13.1.4. Turn the RANGE knob one step clockwise. The LCD indicates: OUTPUT OFFSET.

13.1.4.1. Connect a suitable voltmeter to the rear panel OUTPUT connection.

13.1.4.2. Using the OUTPUT LEVEL knob (upper right-most knob), adjust the ISOLATED OUTPUT for Zero volts ± 200 µV.

13.1.5. Turn the RANGE knob one step clockwise. The LCD indicates ZERO RANGE or ZERO ALL. When the LCD displays ZERO ALL, initiating the ZERO process zeros all of the instrument's 21 ranges. When the LCD displays ZERO RANGE, initiating the zero process only zeros the currently selected range (Range/ZIN selection for ranges above 3 mV).

NOTE: The zero process references either the ZERO or OPERATE modes depending on the mode selected at the time the zero function is initiated. This ZERO function is intended to provide a preliminary zero condition. Final zeroing is best accomplished using the INPUT OFFSET control in the V mode for each mode and range (and impedance selection for the 3 mV to 1 kV ranges),

Depressing both OFFSET pushbuttons simultaneously toggles the instrument between ZERO RANGE and ZERO ALL. Upon power up, the instrument is automatically set to ZERO ALL. The instrument ZERO process must be initiated with the ZERO/OPERATE function in the ZERO mode. This stores a zero reference for the ZERO mode. Initiating the process in the OPERATE mode, establishes a zero reference in the OPERATE mode and reflects any offsets that may be at the instrument's input terminals during the zero function.


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Therefore, zeroing the instrument only in the OPERATE mode may allow non zero results when operating in the ZERO mode.

13.1.5.1. To establish a front panel terminal zero reference, connect a low thermal emf shorting strap between the HI and LO input terminals. If possible use a low thermal emf material such as pure copper or tellurium copper.

13.1.5.2. Depress the OUTPUT LEVEL knob to initiate the ZERO process. The indication ZERO (ZERO RANGE or ZERO ALL) in the LCD blinks. When ZERO indication stops blinking, a zero (with respect to the EMFs present while the ZERO function is performed) is complete for the selected range or all of the AVM-2000's 21 ranges. Note: This operation will take from 20 seconds to 10 minutes to complete depending on the range selected and/or if ZERO ALL is selected.

13.1.5.3. Disconnect the shorting strap from the HI and LO input terminals.

13.1.6. Turn the RANGE knob one position clockwise. The LCD indicates 2.667 V. NOTE: In these steps you set the AVM-2000's reference voltage. Avoid enabling this function with a shorting strap across the instrument's HI and LO input terminals.

13.1.6.1. Connect a suitable voltmeter between the AVM-2000's HI and LO input terminals.

13.1.6.2. Using the OUTPUT LEVEL knob (upper right-most knob), adjust the voltage appearing at the AVM-2000's terminals for 2.667 Volts ± 0.001 Volts.

13.1.6.3. Disconnect the voltmeter from the HI and LO input terminals.

13.1.7. Turn the RANGE knob one position clockwise. The LCD indicates GAIN.

13.1.7.1. Depress the OUTPUT LEVEL knob to initiate the GAIN process. The indication GAIN in the LCD blinks. When GAIN indication stops blinking, a gain setup (with respect to the previously established 2.667 volt reference) is complete for each of the AVM-2000's 21 ranges. This process will take approximately 15 minutes. *NOTE: Be sure nothing is connected to/across the AVM-2000 input terminals during this gain setting process.*

13.1.8. Momentarily depress the range control to return the AVM-2000 to normal meter operation. The LCD will display normal instrument status.



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## 14. 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 Section 10 for disassembly instructions to gain access to the indicated areas, as well as re-assembly instructions. Refer to Section 8 for the theory of operation for the affected section. The parts layout, test points and control/adjustment locations and schematics are found in Pages 39 through 51. Replacement parts lists are found starting on Page 62. When replacing any soldered component on one of the printed circuit boards, particularly the Isolated Analog Section, make sure to completely clean 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.

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
- 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.



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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.

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

14.1.1. AC Power Module is not plugged in or is not connected. Action: Check the connections at both ends.

14.1.2. Power Supply Subsystem fuse is blown. Action: Replace the fuse with one of the same type and value.

14.1.3. If the Power Supply Subsystem fuse continues to blow, the Power Supply Subsystem or one of the subsystems it feeds is defective.

14.1.3.1. Action: Disconnect the balance of the AVM-2000 from the Power Supply Subsystem by removing connector J4. See Page 48.

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

14.1.3.1.1.1. 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.

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

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

14.1.3.1.2.1. Disconnect the Isolated Analog Subsystem from the Front Panel Subsystem by unplugging connector J2 of the Front Panel Subsystem. See Page 45.

14.1.3.1.3. If the fuse continues to blow, the Front Panel Subsystem is defective. Action: Replace the Front Panel Subsystem.

14.1.3.1.4. If the fuse no longer blows, the Isolated Analog Subsystem is defective. Action: Replace the Isolated Analog Subsystem.

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

14.2.1. Internal rechargeable battery needs to be charged. Action: Charge battery as described in the instructions in this manual.

14.2.2. There is a problem with the battery charging circuit. 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 either a failed Power Supply Subsystem, a failed rechargeable battery or a deeply discharged battery (allow sufficient time to charge the battery).

14.2.2.1. 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.

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


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

14.3.1. 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.

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

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

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

14.4.2. If not above, check that the power supply voltage being delivered to the Isolated Analog Subsystem as measured between pins 1,2 and 3,4 at connector J1 is + 5 VDC ± 0.25 volts. See Page 40.

14.4.2.1. 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. See Page 45.

14.4.2.1.1. 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.

14.4.2.1.2. 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.

14.4.3. 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. See Page 45.

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

14.4.3.2. 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. See Page 45.

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

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

14.5. 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.


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

14.6.1. Make sure the Meter connector J5 (see page 47) 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 will include special setup instructions required to ensure proper system linearity.

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

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

14.7.1. 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. See page 47.

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

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

14.8. Symptom: Poor 60 Hz AC noise rejection.

14.8.1. 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.

14.8.2. 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 Subsystem.



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## 15. OVERHAUL INSTRUCTIONS

15.1. The AVM-2000 is a solid state electronic instrument that requires no periodic overhaul, other than routine cleaning, inspection of switch and control knobs, and setup adjustment.

15.2. Calibration verification should be done on a yearly basis, or after a repair.

15.3. The only consumable component is the rechargeable battery. Expected life for this consumable is 3 to 5 years. The battery designation is listed on the Replacement Parts List. Battery installation and removal is detailed in previous sections.

15.4. Troubleshooting suggestions are given in the previous section.


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## 16. APPENDIX A -- Schematic Diagrams and Board Component Placement

The following pages contain schematic diagrams for various sections of the AVM-2000. The schematic diagrams for each major subsystem are broken into one or more sheets as required.


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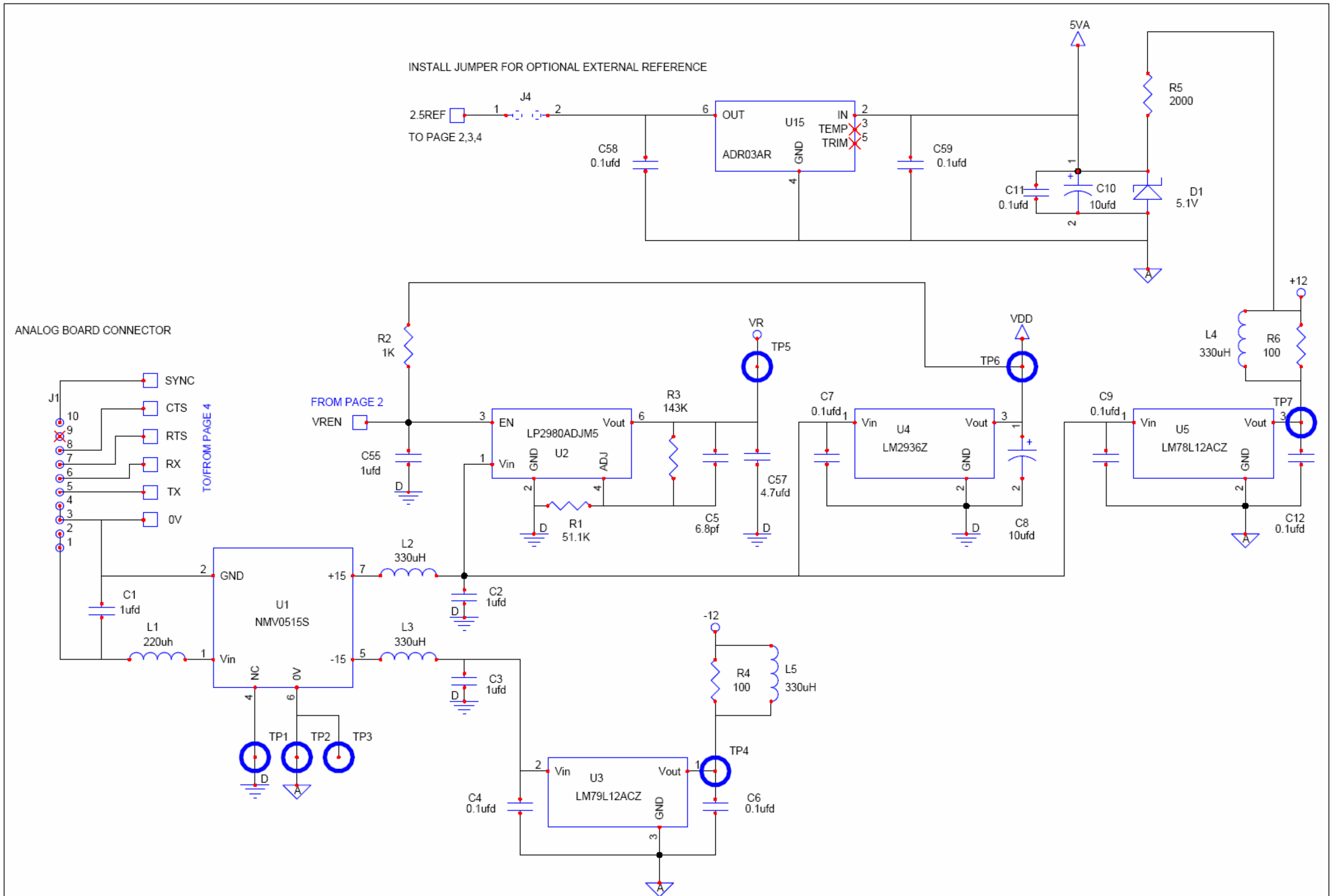
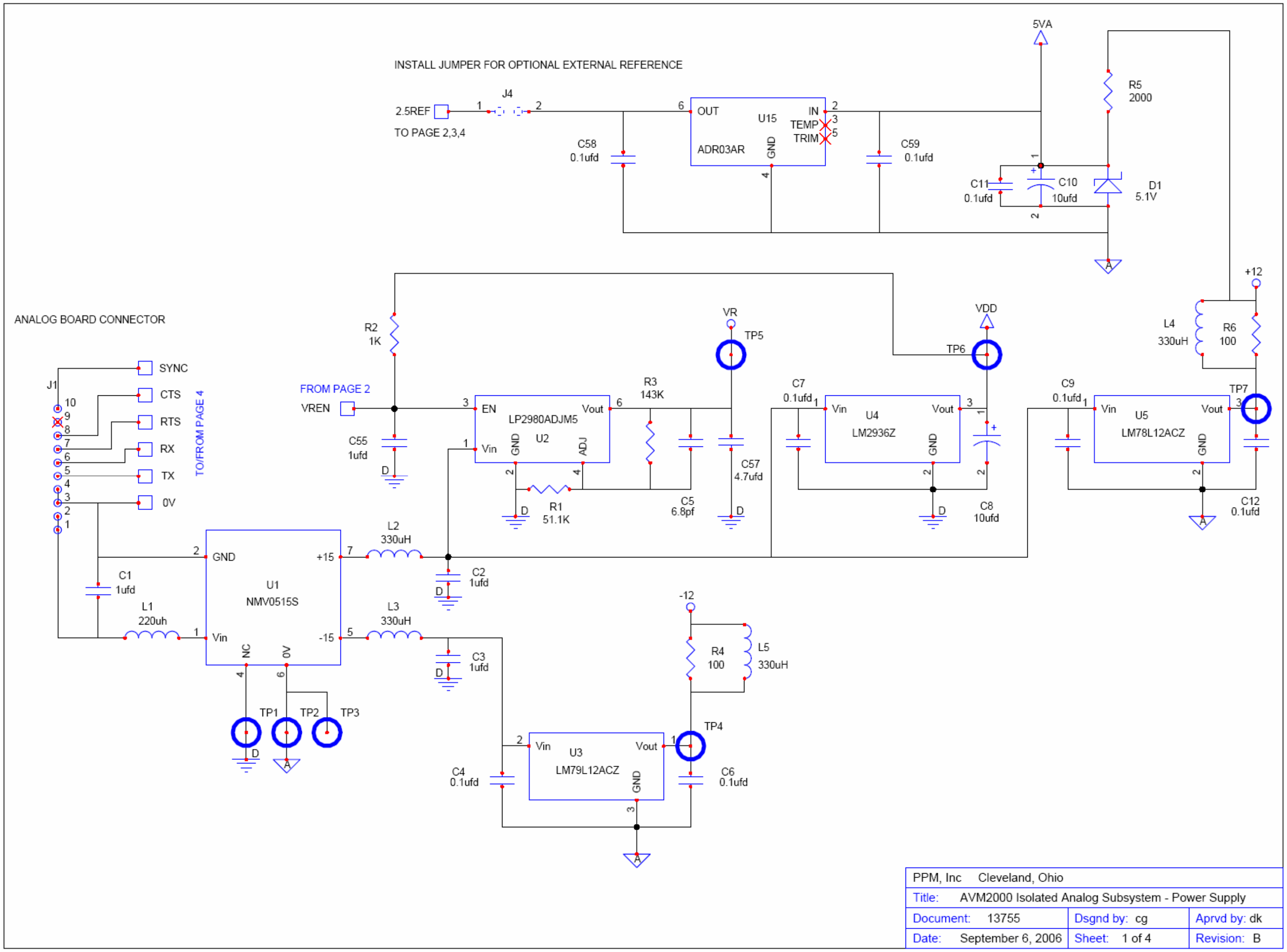
## 16.1. AVM-2000 Interconnect Drawing




| PPM, Inc Cleveland, Ohio | | |
|---|---|---|
| Title: AVM2000 Isolated Analog Subsystem - Power Supply | | |
| Document: 13755 | Dsgnd by: cg | Aprvd by: dk |
| Date: September 6, 2006 | Sheet: 1 of 4 | Revision: B |

## 16.2. Schematic—Isolated Analog Subsystem Sheet 1



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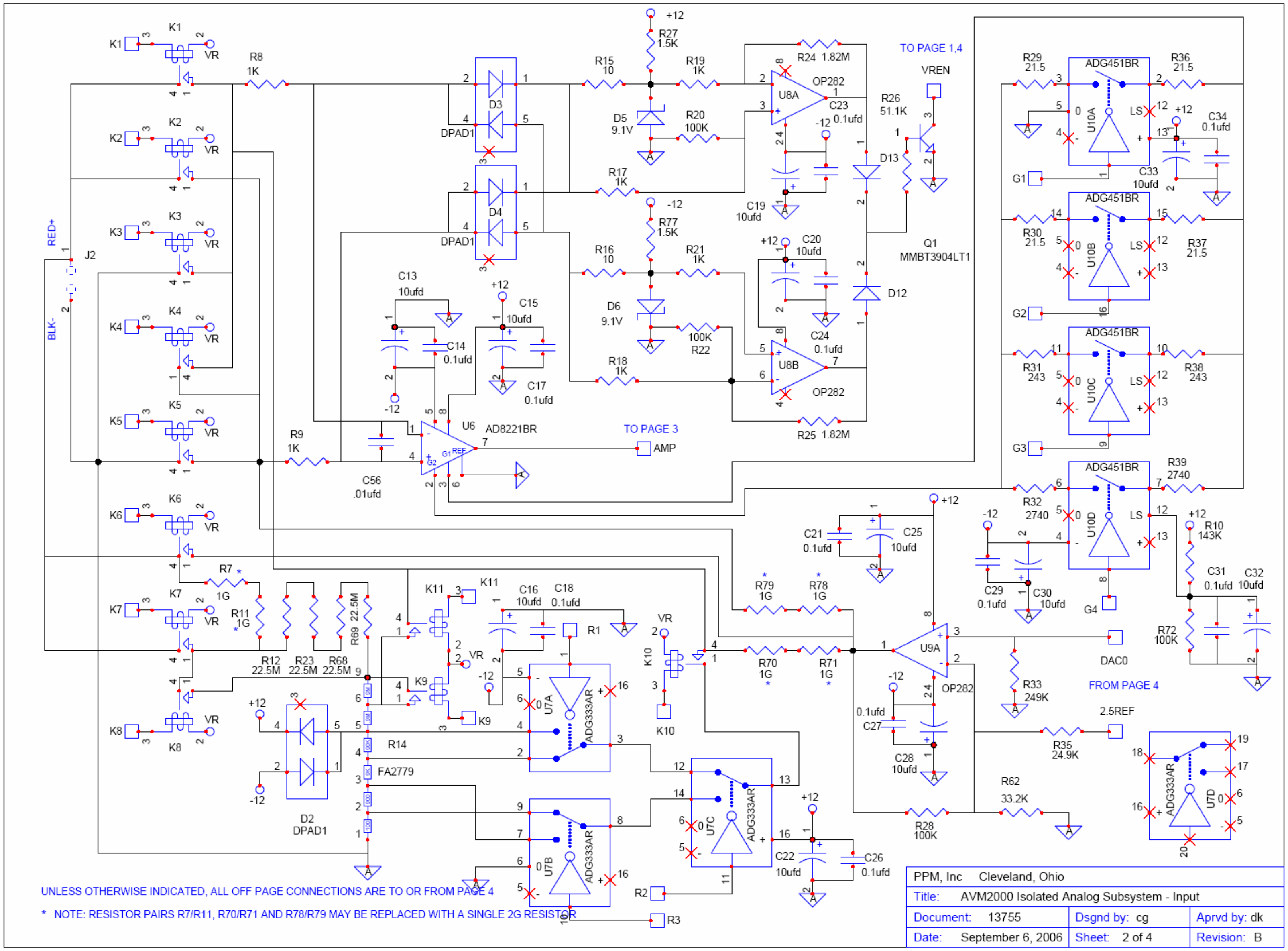
## 16.3. Schematic—Isolated Analog Subsystem Sheet 2



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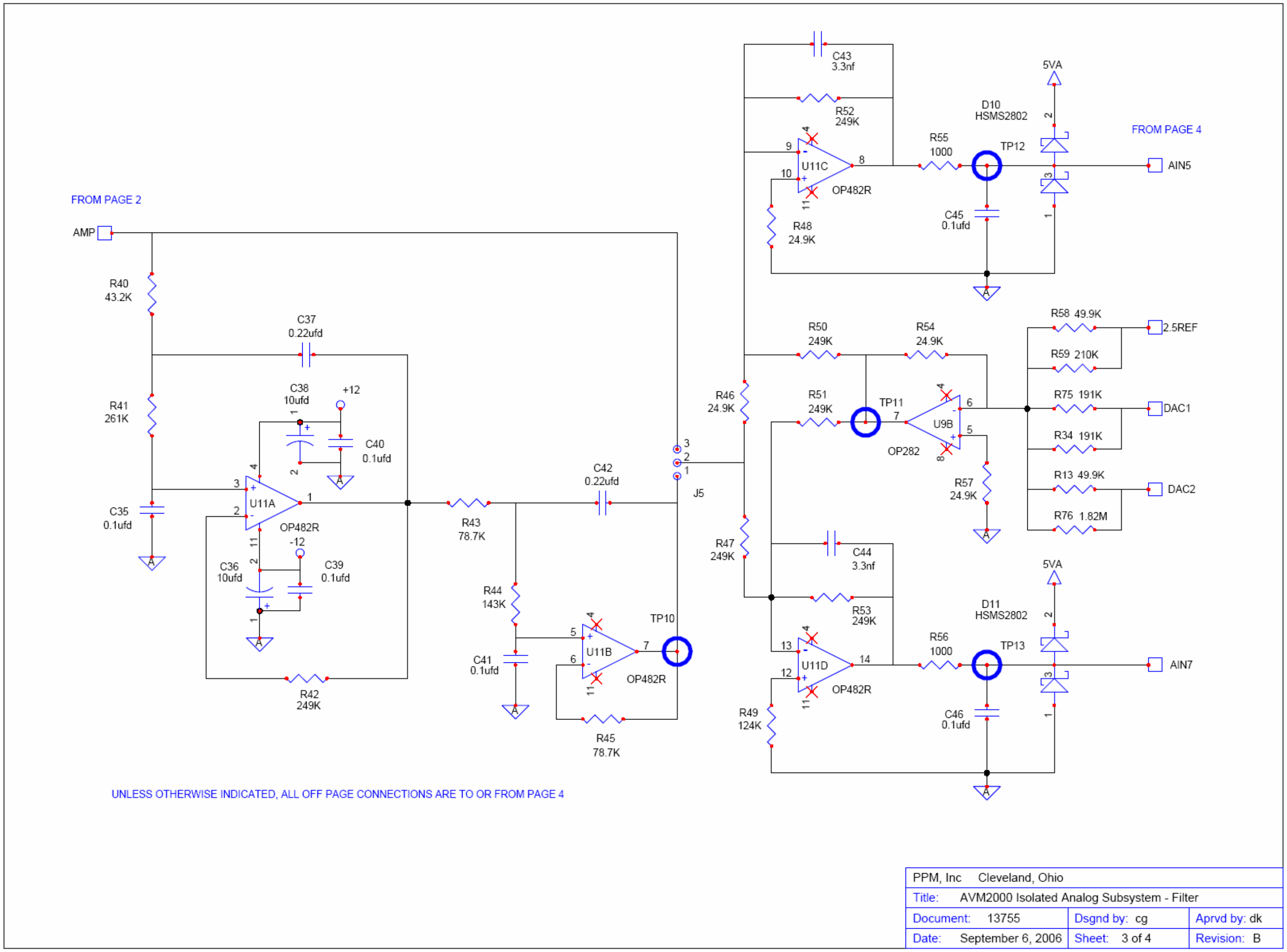
## 16.4. Schematic—Isolated Analog Subsystem Sheet 3





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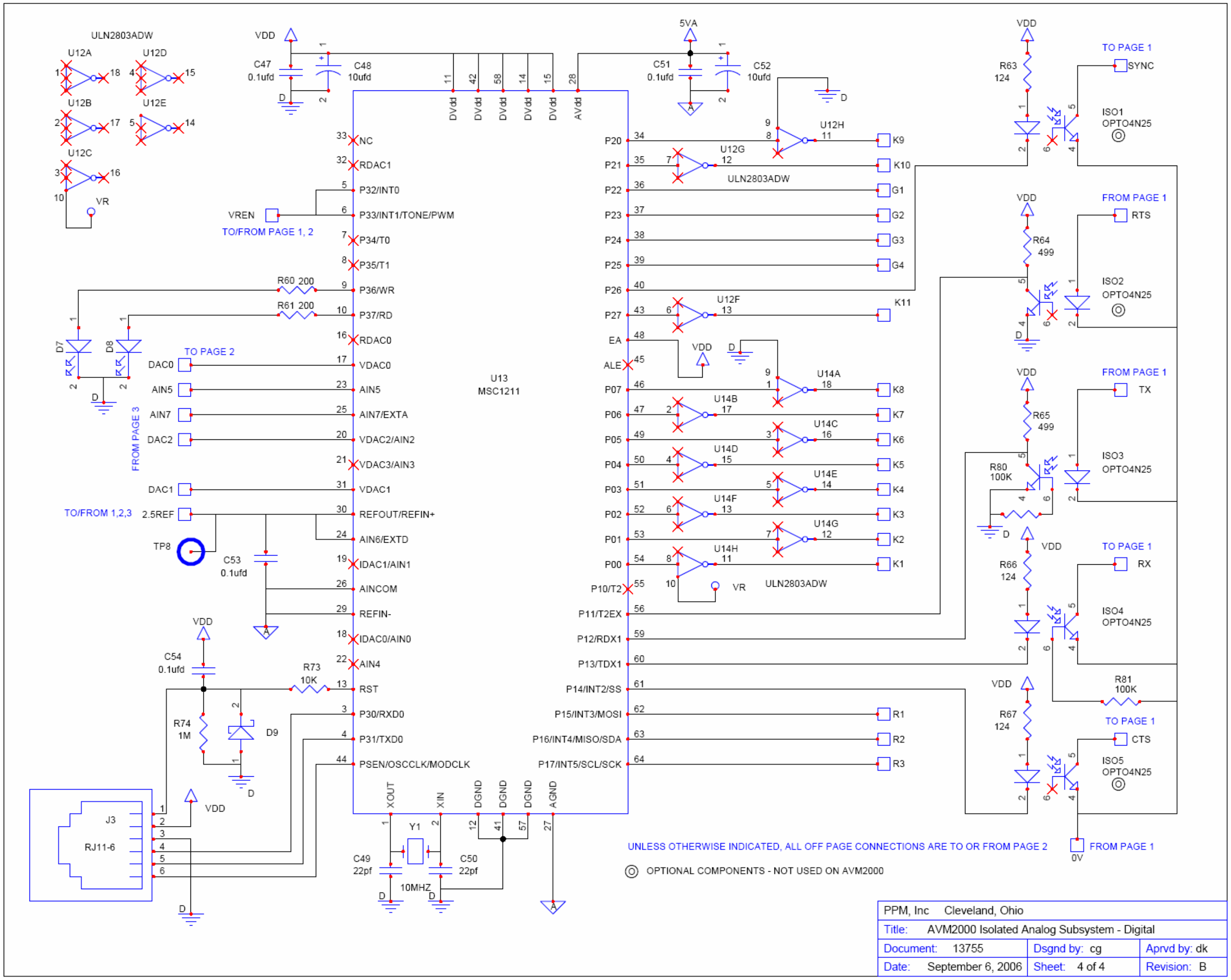
## 16.5. Schematic—Isolated Analog Subsystem Sheet 4



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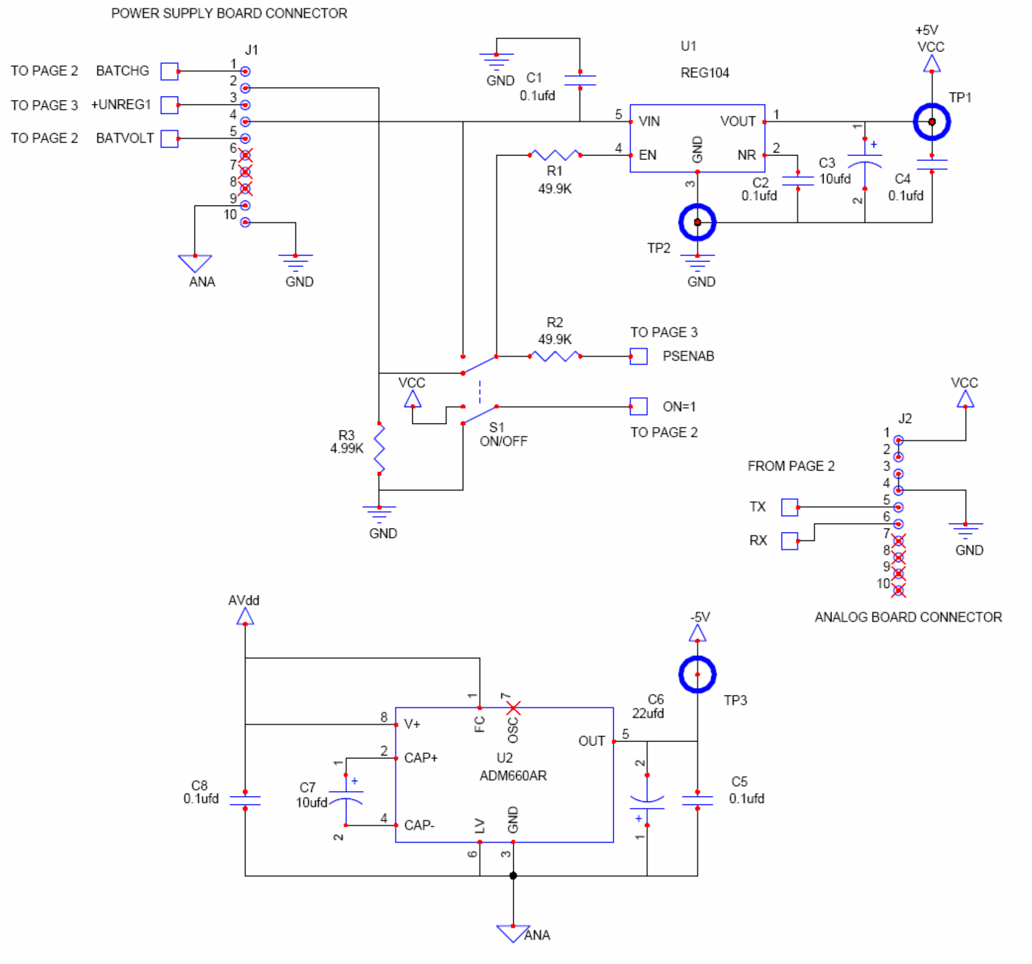
## 16.6. Schematic—Front Panel Subsystem Sheet 1




| PORT | DESCRIPTION | I/O |
|---|---|---|
| A0 | BATTERY VOLTAGE/2 ANALOG | I |
| A1 | ON=1 | I |
| A2 | BATTERY CHARGE/INDICATING LED | O |
| A3 | OUTPUT SCALING ENCODER SWITCH | O |
| A4 | TEST LED | I |
| A5 | FILTER + SWITCH | I |
| A6 | UNAVAILABLE | NA |
| A7 | UNAVAILABLE | NA |
| B0 | INPUT BIAS ENCODER ZONE A | I |
| B1 | RANGE ENCODER ZONE A | I |
| B2 | OUTPUT ENCODER ZONE A | I |
| B3 | INPUT BIAS ENCODER SWITCH | I |
| B4 | OUTPUT SCALING ENCODER ZONE B | I |
| B5 | RANGE ENCODER SWITCH | I |
| B6 | PROGRAMMING CONNECTION | I |
| B7 | PROGRAMMING CONNECTION | NA |
| C0 | DAC1 DATA | O |
| C1 | DAC CLOCK | O |
| C2 | DAC TIMING CLOCK | O |
| C3 | DAC2 DATA | O |
| C4 | DAC2 CLOCK | O |
| C5 | FILTER - SWITCH | I |
| C6 | TX FOR RS232 COMMUNICATION | O |
| C7 | RX DATA FOR RS232 COMMUNICATION | I |
| D0 | OFFSET - SWITCH | I |
| D1 | OFFSET + SWITCH | I |
| D2 | MODE SWITCH | I |
| D3 | IMPEDANCE SWITCH | I |
| D4 | DISPLAY DATA LATCHES ON FALLING EDGE | O |
| D5 | DISPLAY LEFT HALF SELECT=1 | O |
| D6 | DISPLAY RIGHT HALF=1 | O |
| D7 | DISPLAY DATA/INSTRUCTION 1=DISPLAY DATA | O |
| E0 | INPUT ENCODER ZONE B | I |
| E1 | RANGE ENCODER ZONE B | I |
| E2 | CLOCK TO DISPLAY SER/PAR CONV - CLOCKS ON RISING EDGE | O |

| | | |
|---|---|---|
| PPM, Inc Cleveland, Ohio | | |
| Title: AVM2000 Front Panel Subsystem - Power Supply/I-O | | |
| Document: 13754 | Dsgnd by: dk | Aprvd by: cg |
| Date: September 6, 2006 | Sheet: 1 of 3 | Revision: A |



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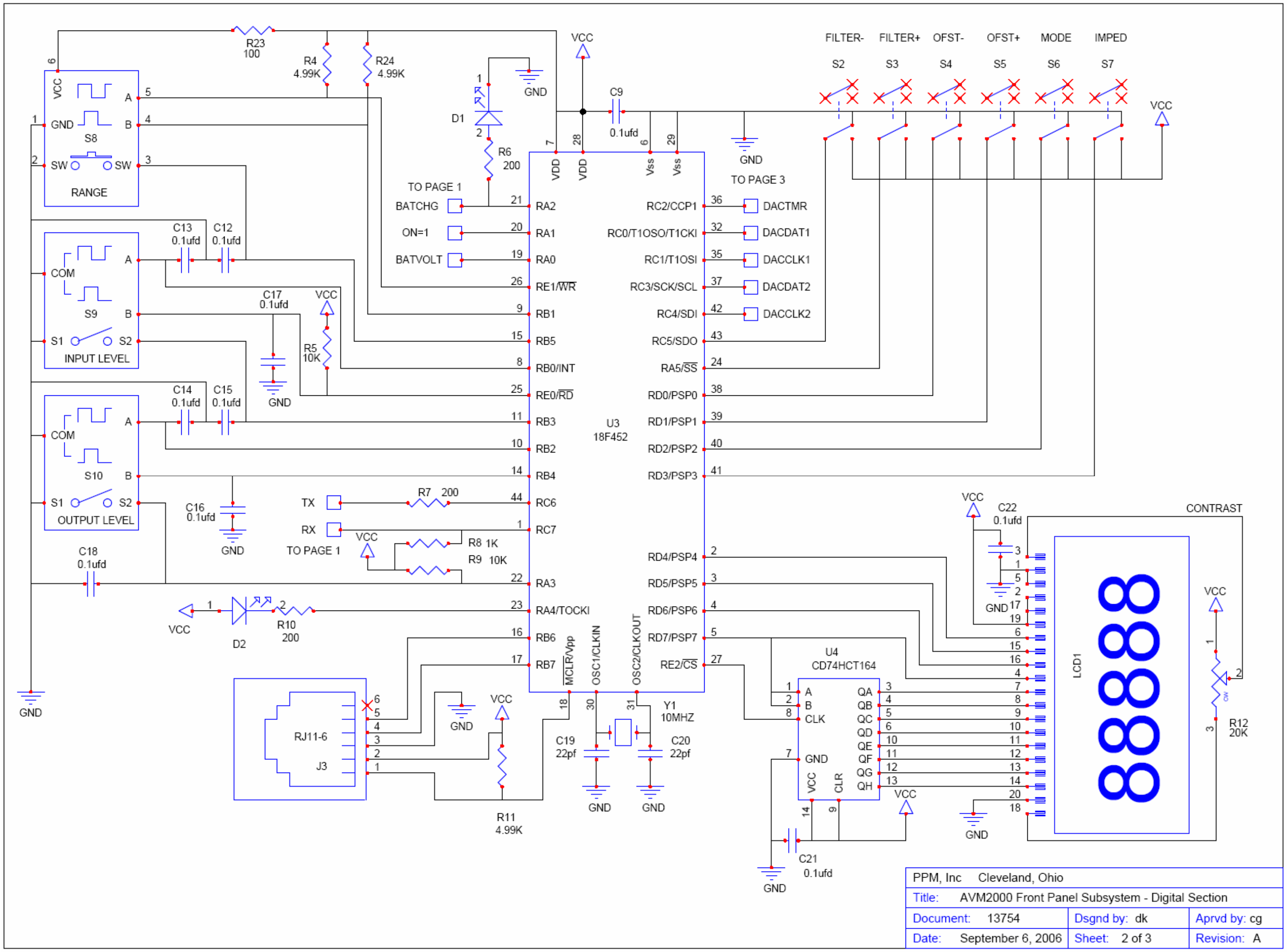
## 16.7. Schematic—Front Panel Subsystem Sheet 2



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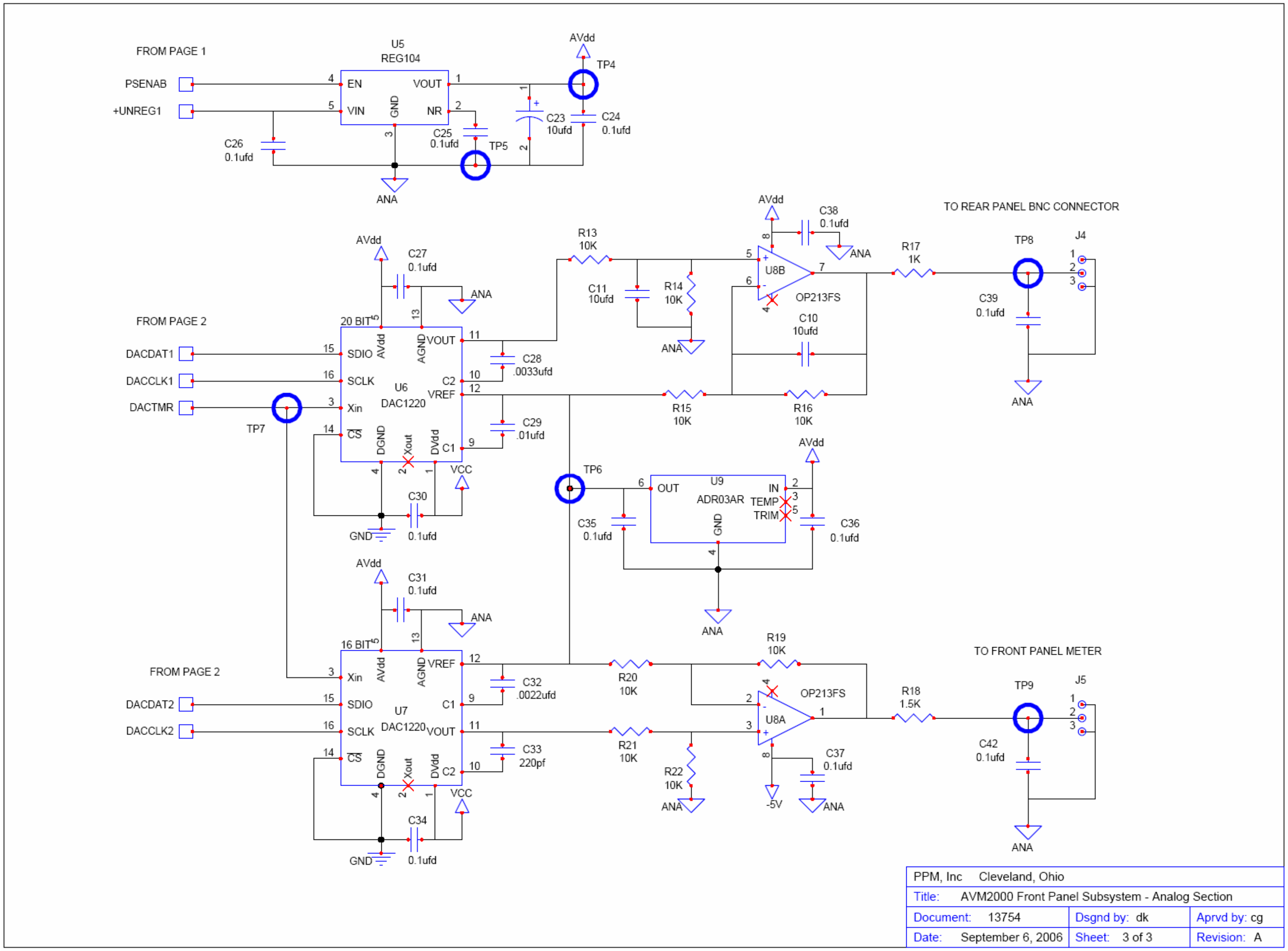
## 16.8. Schematic—Front Panel Subsystem Sheet 3



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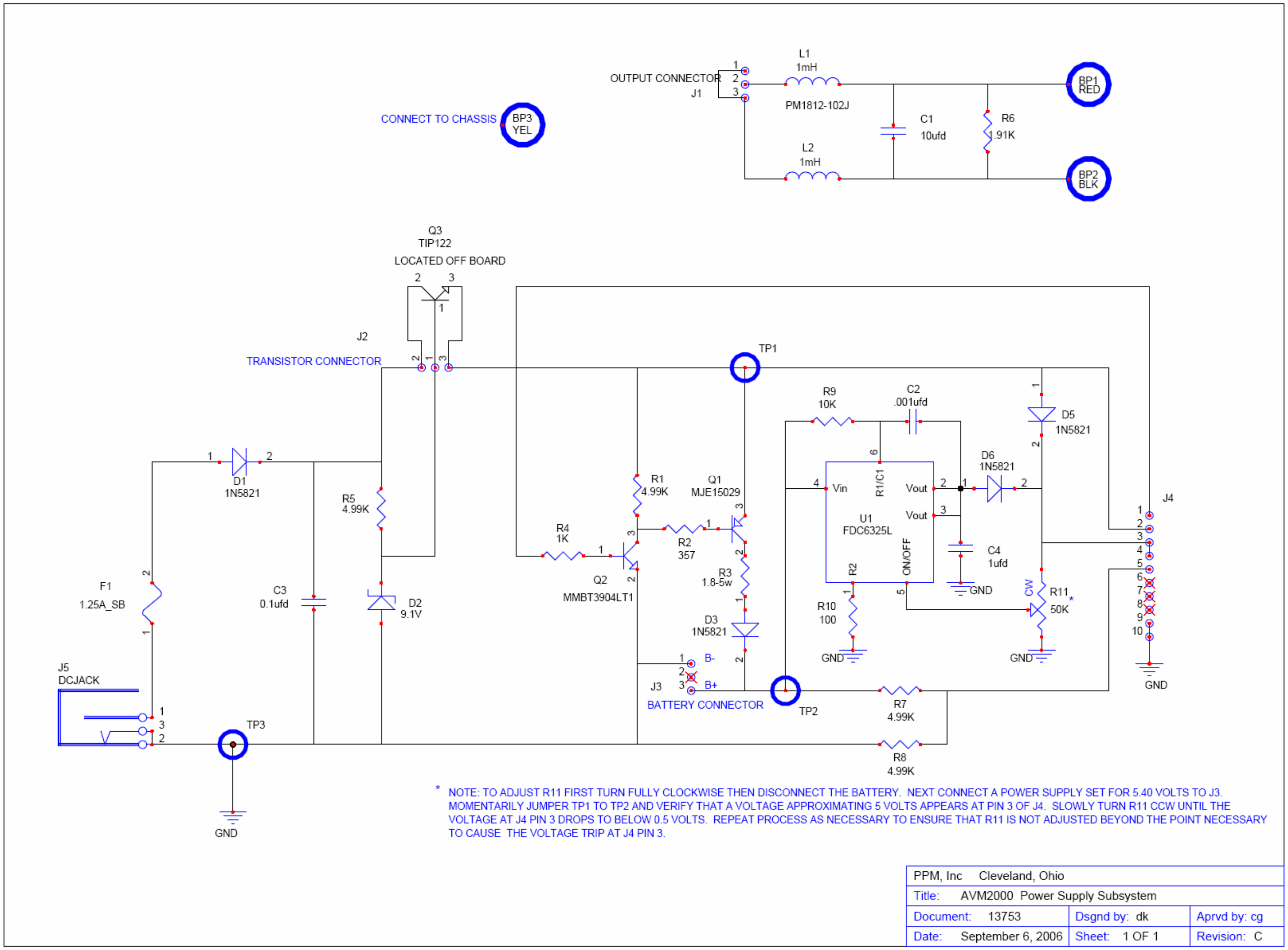
## 16.9. Schematic—Power Supply Subsystem Sheet 1



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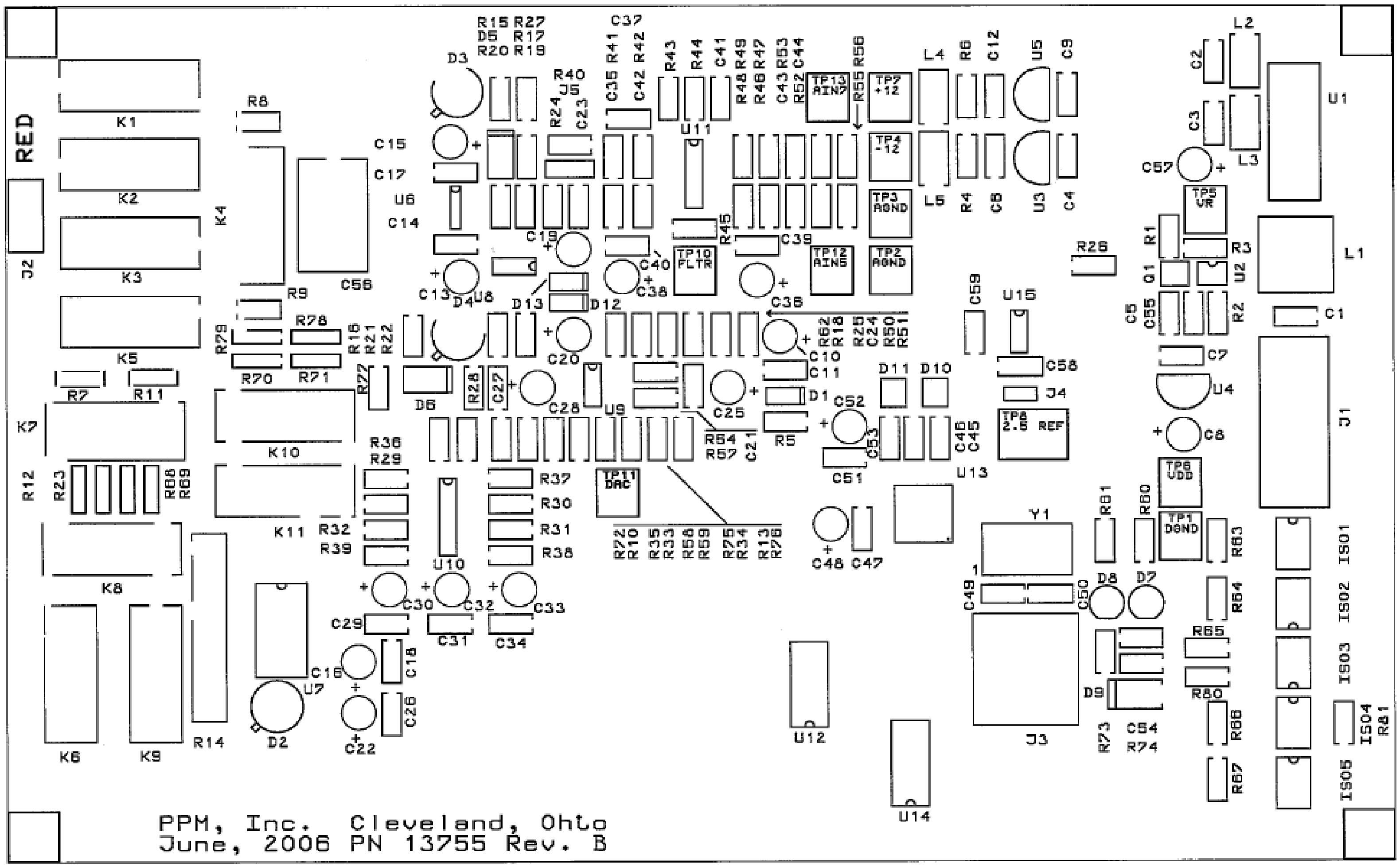
## 16.10. Circuit Board Parts Layout – Isolated Analog Subsystem



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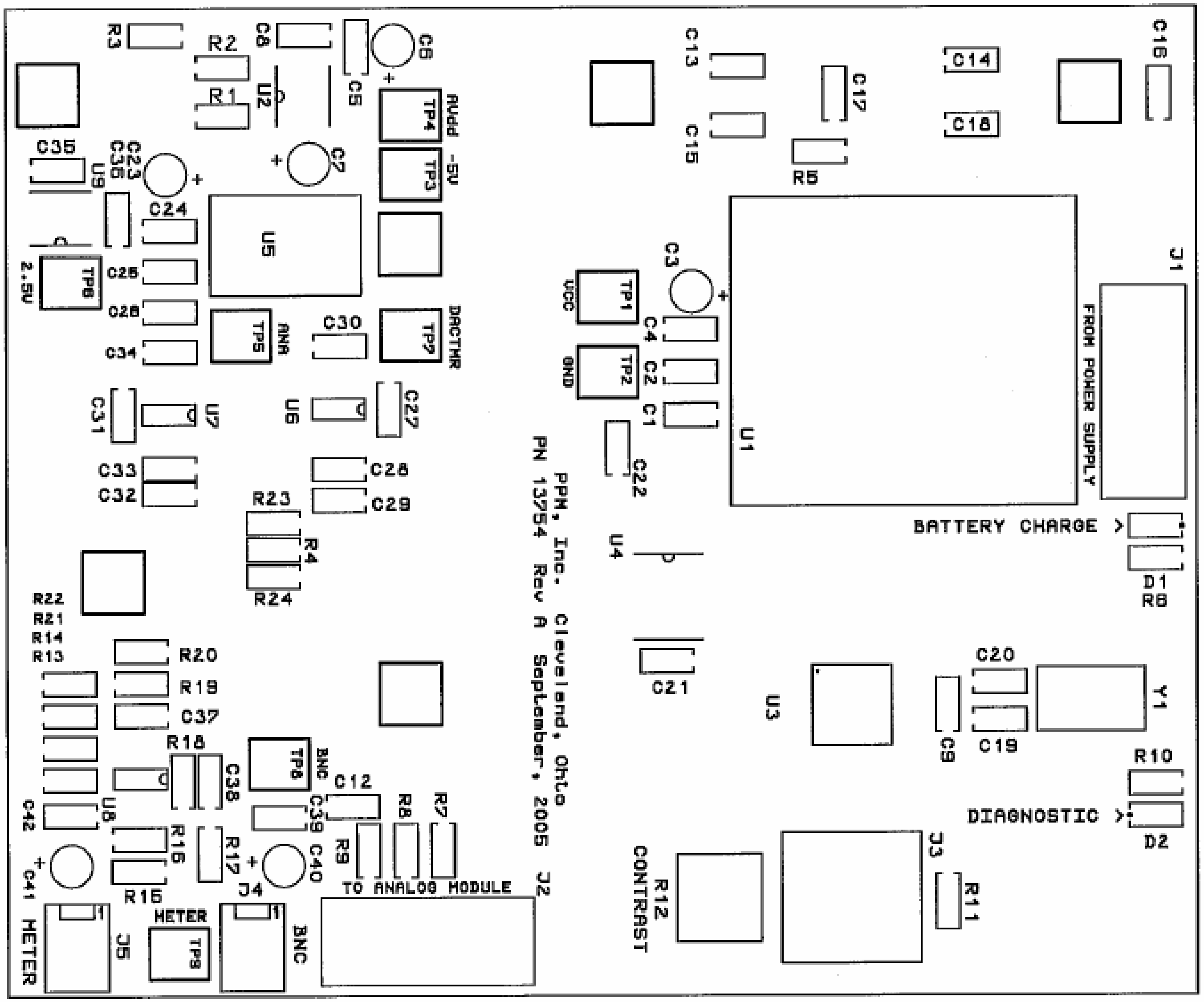
## 16.11. Circuit Board Parts Layout – Front Panel Subsystem





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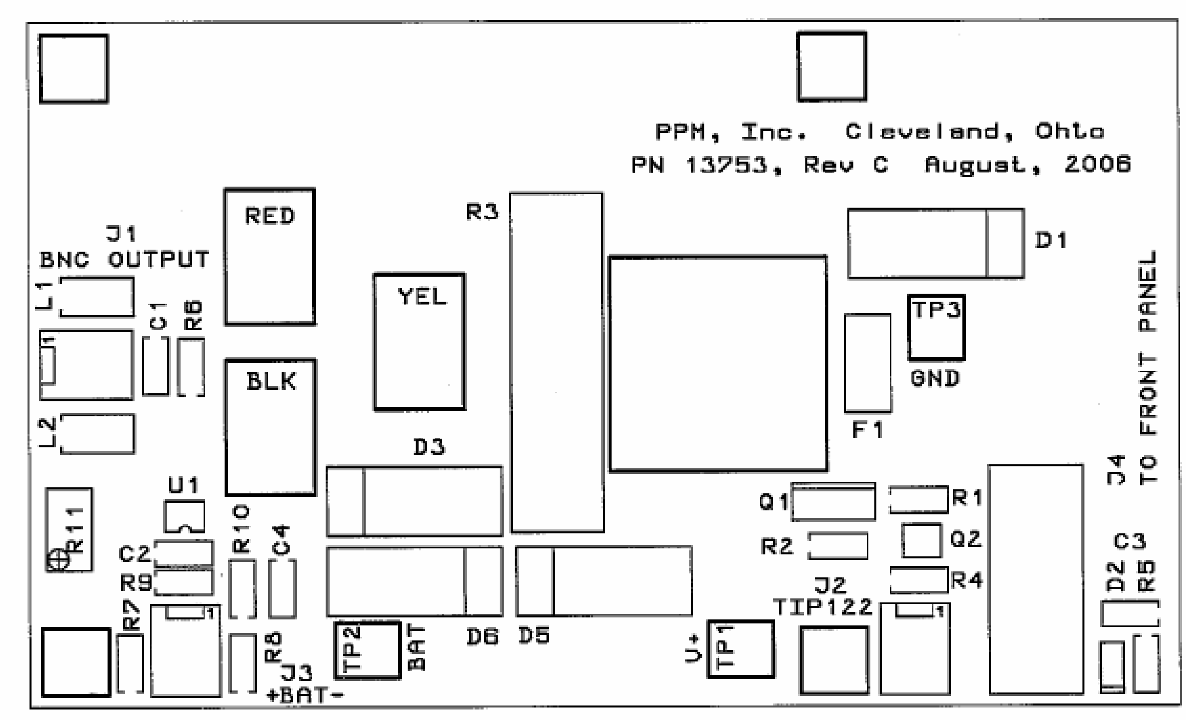
## 16.12. Circuit Board Parts Layout – Power Supply Subsystem



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## 17. APPENDIX B -- EQUIPMENT PHOTOGRAPHS

The following photographs provide illustrations showing the user the instrument's overall view, indications of the locations of controls, displays and terminals and the instrument's internal construction.


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17.1. AVM-2000 Front View with Accessory Terminal Cover Box




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## 17.2. AVM-2000 Front View with Accessory Terminal Cover Box Installed




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## 17.3. AVM-2000 Rear View




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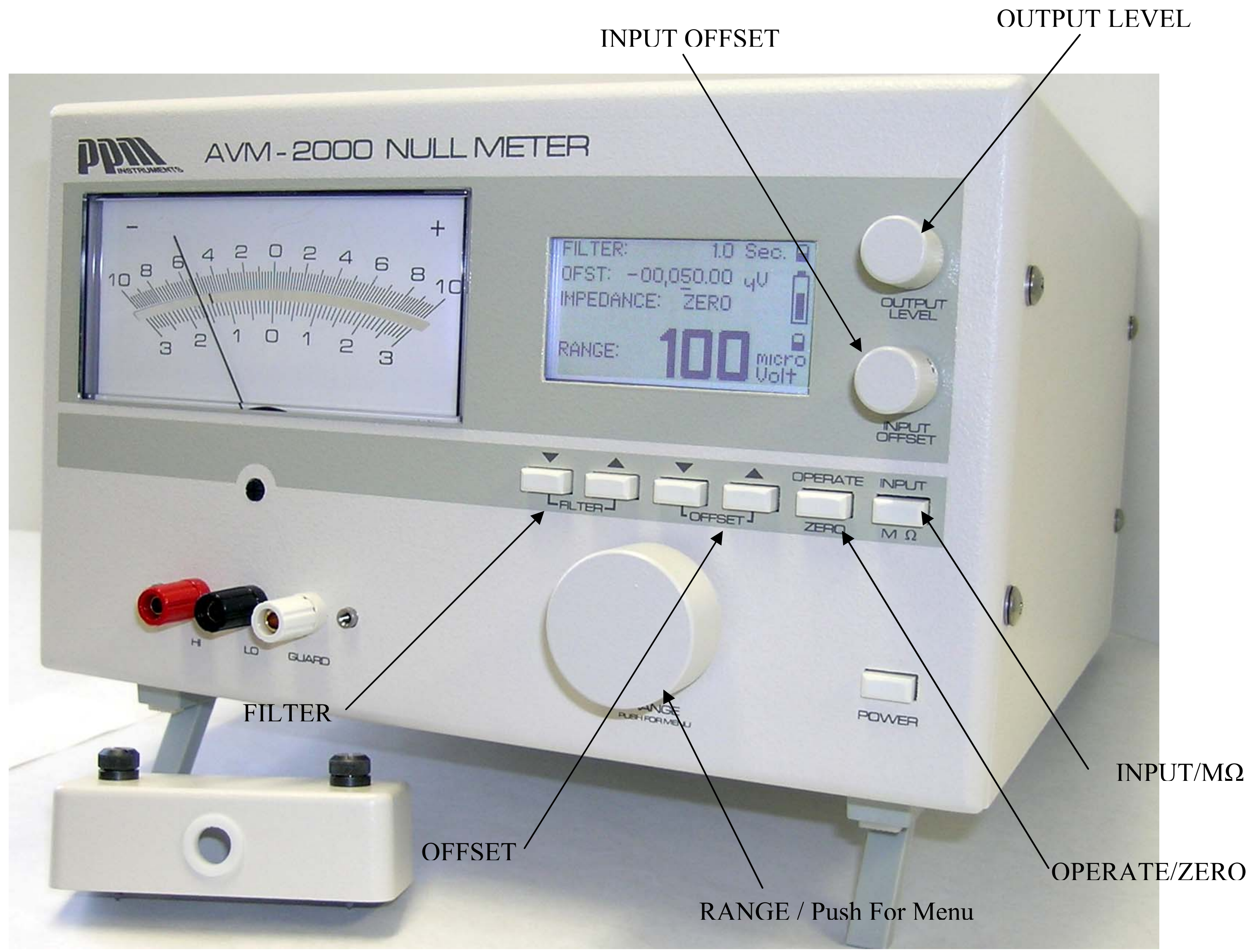
## 17.4. AVM-2000 Front Panel Call Outs





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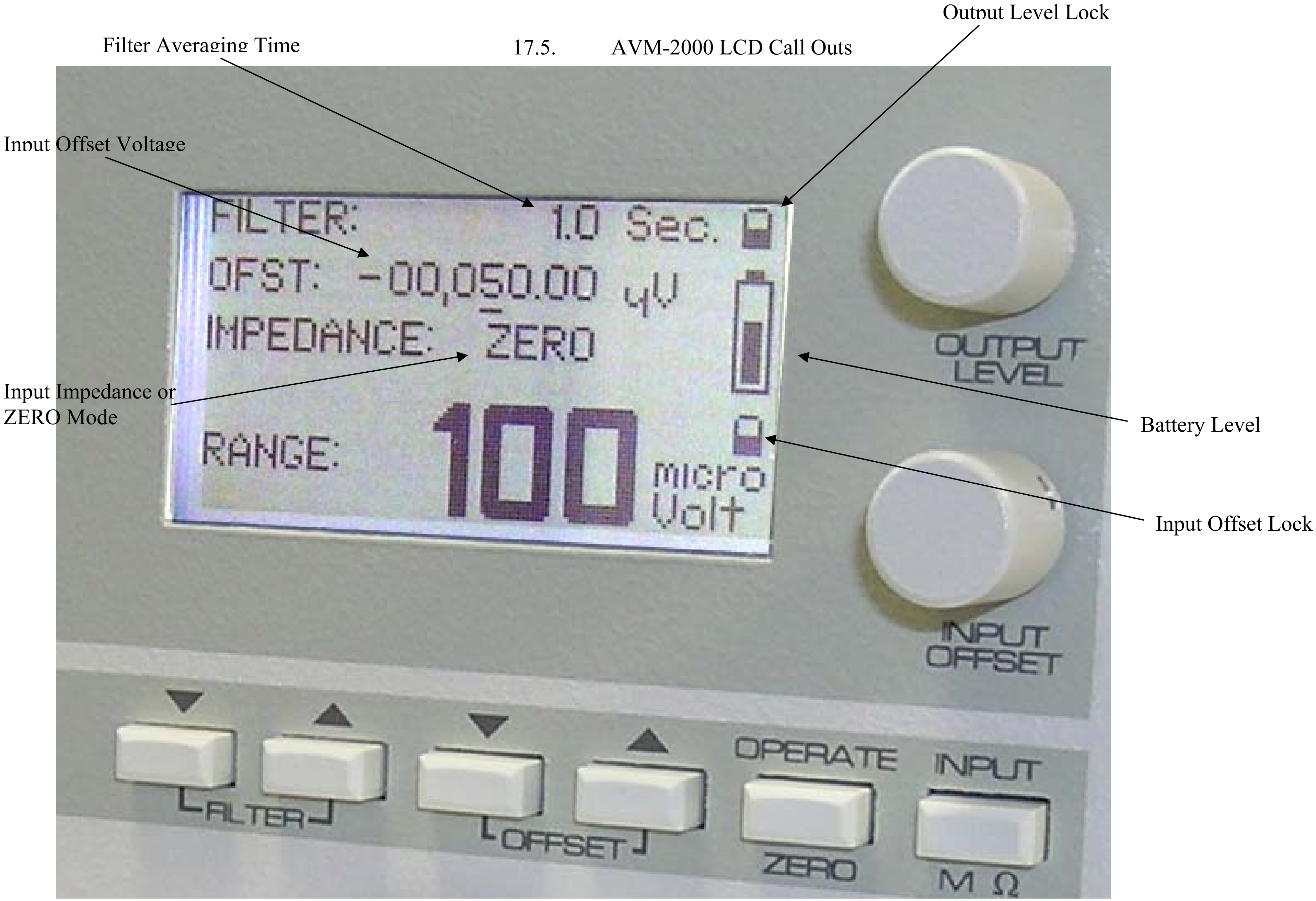
## 17.5. AVM-2000 LCD Call Outs





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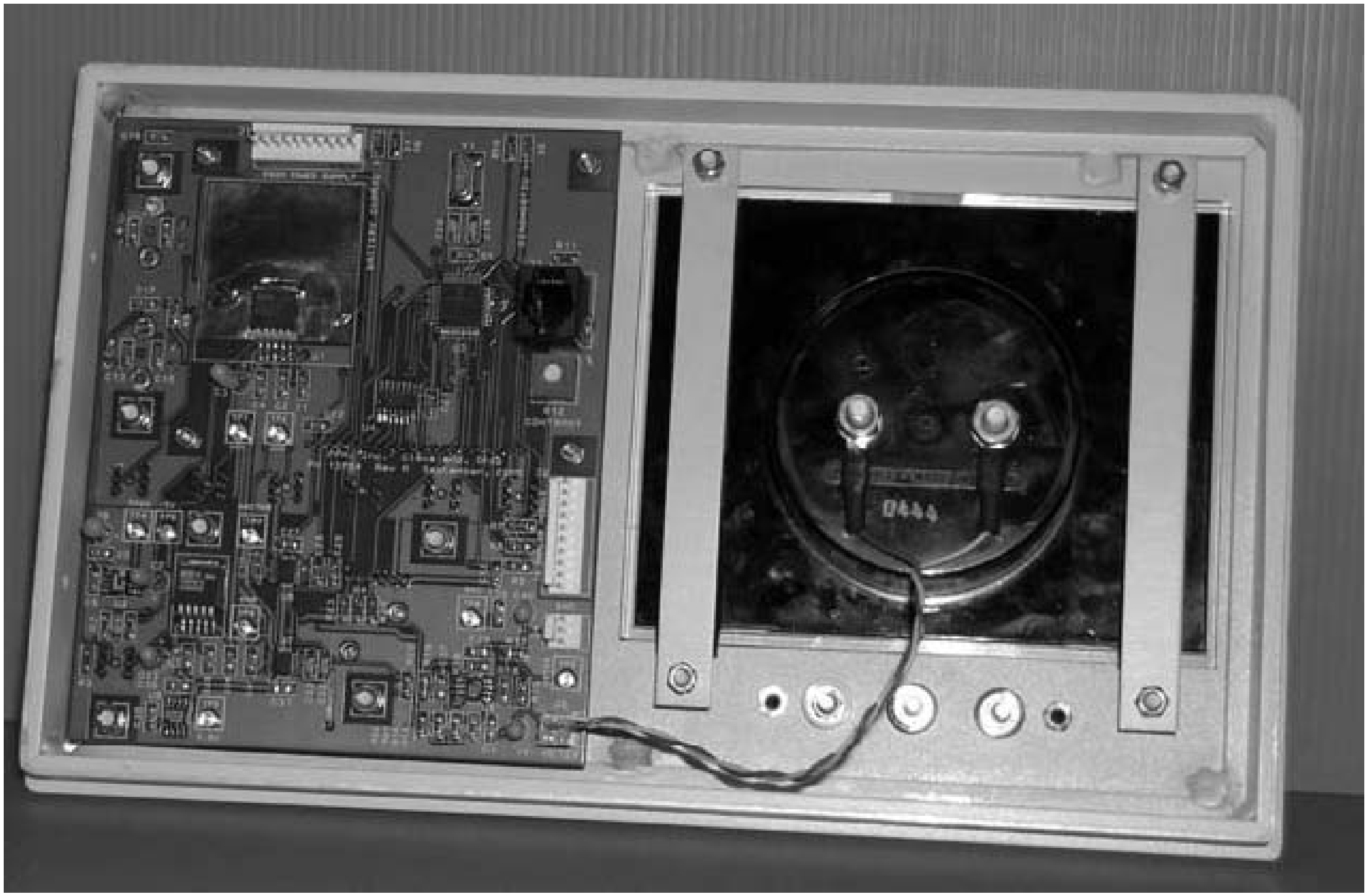
## 17.6. AVM-2000 Interior View – Inside Rear Front Panel





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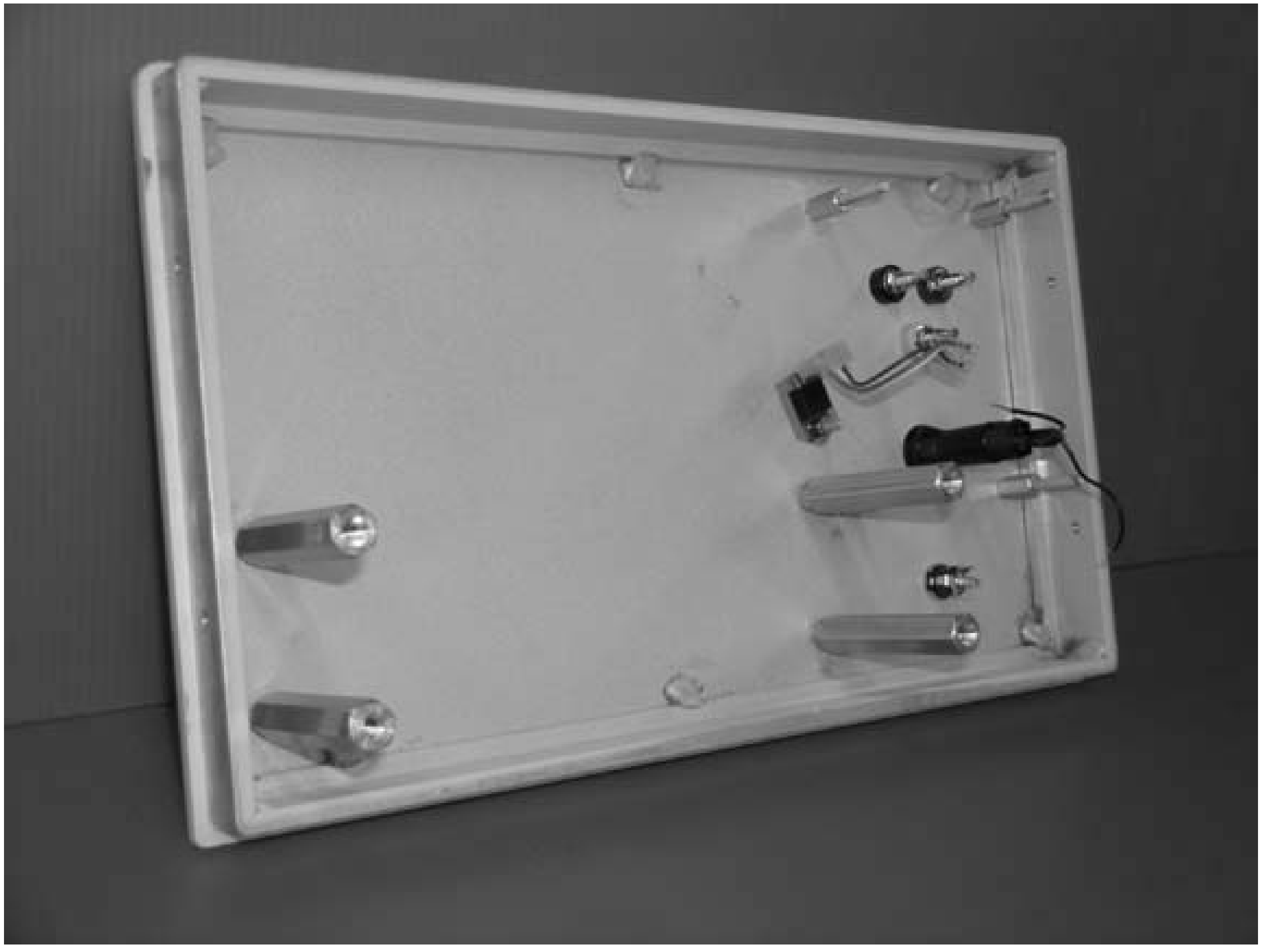
17.7. AVM-2000 Interior View – Inside Rear Panel
Without Battery or Power Supply Board





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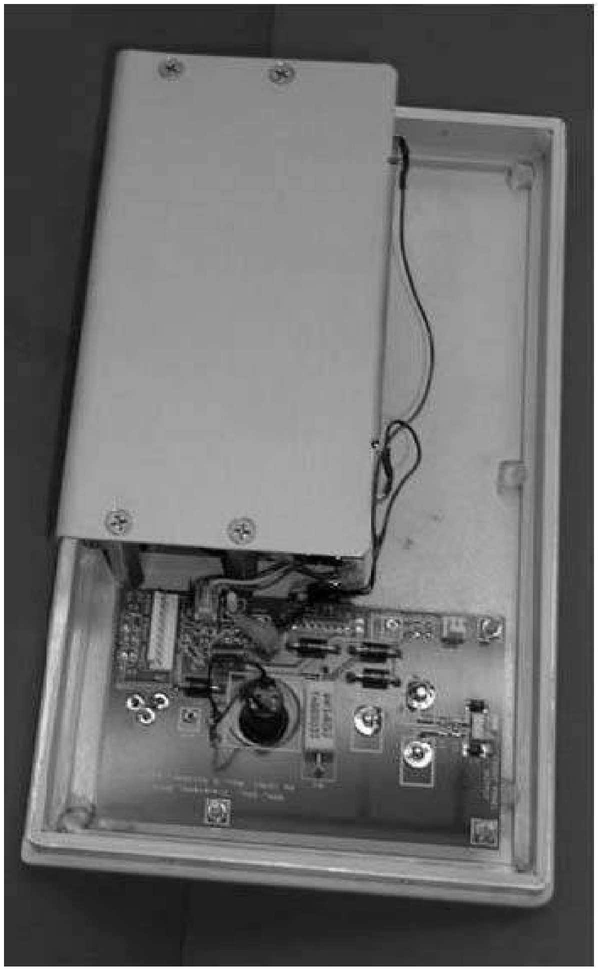
## 17.8. AVM-2000 Interior View – Inside Rear Panel

(A) Battery and Power Supply Board Fully Installed

(B) Battery Installation Prior to Installing Battery Retaining Bracket



(A)


(B)



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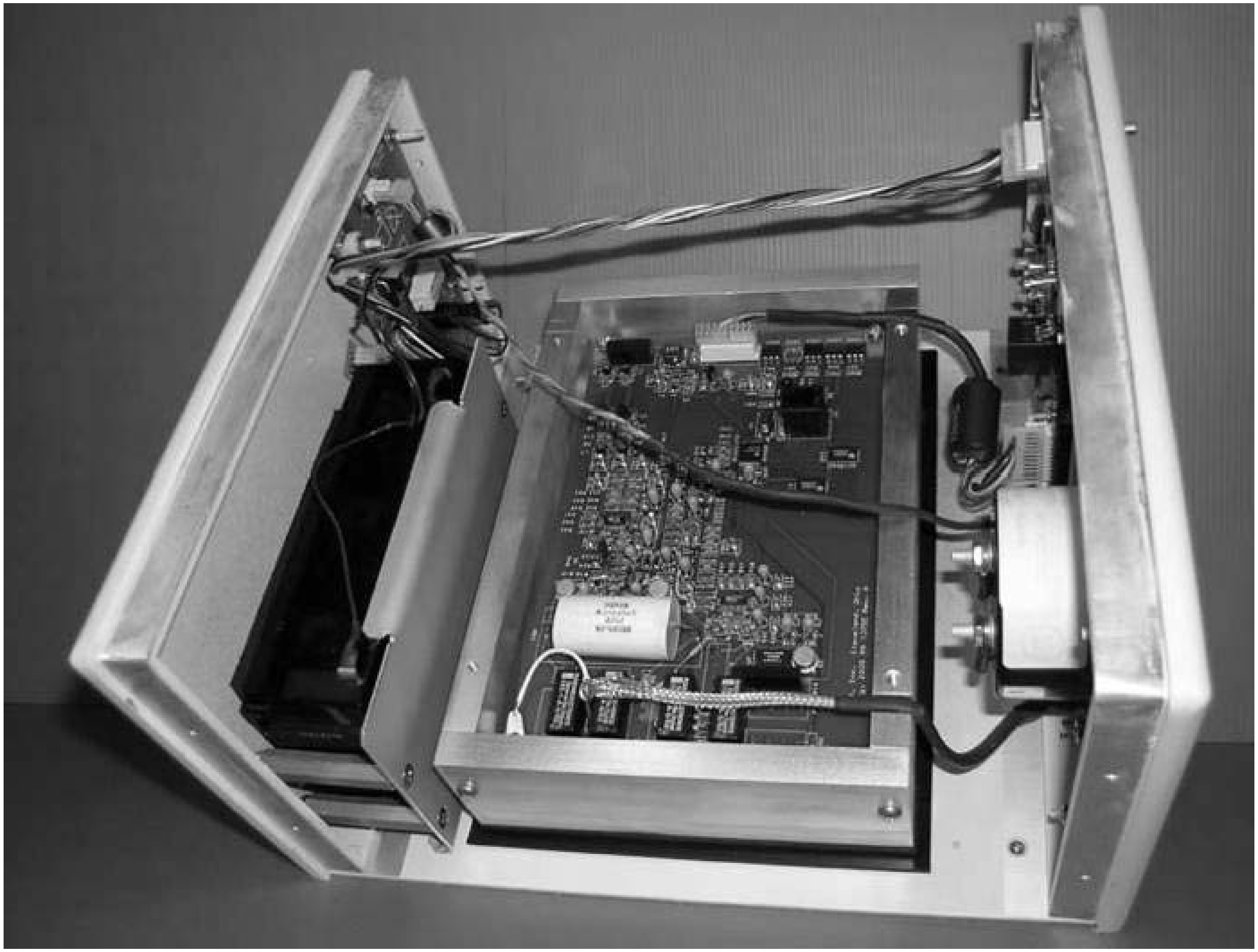
## 17.9. AVM-2000 Interior View – Cable Routing

Isolated Analog Subsystem Top Cover Removed





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## 18. APPENDIX C -- PARTS LISTS

The following parts lists detail the AVM-2000 components and their sources.

The Systems Parts List includes the mechanical (chassis) components as well as the electronic sub systems.

Each of the three major electronic subsystem printed circuit boards and their components are shown on individual parts lists.



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# 18.1. AVM-2000 SYSTEM—PARTS LIST Sheet 1

| Item | Product/ Value | Reference Designators Part Use | Description | Manufacturer Name | Manufacturer Part Number | Source |
|---|---|---|---|---|---|---|
| 1 | | M1 | 10-0-10/3-0-3 Mirrored scale Meter | Modutec (PPM Design) | 04K100 | Ram Meter |
| 2 | | BP1 | Binding post, low thermal EMF. Tellurium-Copper, Gold-plated, Black | Pomona Electronics | 3770-0 | 123eDistribution.com |
| 3 | | BP2 | Binding post, low thermal EMF. Tellurium-Copper, Gold-plated, Red | Pomona Electronics | 3770-2 | 123eDistribution.com |
| 4 | | BP3 | Binding post, low thermal EMF. Tellurium-Copper, Gold-plated, White | Pomona Electronics | 3770-9 | 123eDistribution.com |
| 5 | | | Case, Front Panel | PPM | 13760 | PPM |
| 6 | | | Case, Base Plate | PPM | 13761 | PPM |
| 7 | | | Case, Rear Panel | PPM | 13762 | PPM |
| 8 | | | Case, Top Cover | PPM | 137762 | PPM |
| 9 | | | Analog subsystem shield enclosure | PPM | 13763 | PPM |
| 10 | | B1 | 6 V 12 AH Lead Acid Battery | Panasonic | LC-R0612P | Newark |
| 11 | | PS1 | 12VDC 1500 mA Wall Cube | Jameco | 136881CE | Jameco |
| 12 | | | AVM-2000 Operation and Maintenance Manual | PPM | M658-11 | PPM |
| 13 | | M659 | AVM-2000 Isolated Analog Subsystem Module | PPM | M659 | PPM |
| 14 | | M660 | AVM-2000 Power Supply Circuit Board Assembly | PPM | M660 | PPM |
| 15 | | M661 | AVM-2000 Front Panel Module | PPM | M661 | PPM |
| 16 | | | Instrument rear foot | ELMA | 63-346 | ELMA |
| 17 | | | Instrument front foot with bail | ELMA | 63-345 | ELMA |
| 18 | | Shield Enclosure Spacing | Teflon Spacer 3/4" OD X 1/4" ID X 3/8" | Unicorp | S-1921-M14-F16-K | McMaster |
| 19 | | | Range Knob | PPM | 13782 | PPM |
| 20 | | | Input/Output Knob | PPM | 13783 | PPM |
| 21 | | | AVM-2000 Input terminal shield box | PPM | 13767 | PPM |
| 22 | | | Battery mounting bracket | PPM | 13768 | PPM |
| 23 | | | Meter mounting bracket | PPM | 13769 | PPM |
| 24 | | | Fuse Holder | Littlefuse | H3453LF1 | Newark |
| 25 | | | Battery mounting standoffs | PPM | 13770 | PPM |
| 26 | | | Window | PPM | 13771 | PPM |
| 27 | | | Miscellaneous hardware | | | Various |
| 28 | 0.001 uF | C1 | 0.001 uF 2kV Polypropylene Radial | Illinois Capacitor | 102PPB202KE | Newark |
| 29 | 0.082 uF | C2 | 0.082 uF V Polypropylene Radial | Panasonic | ECW-H12822JV | Digikey |
| 30 | | Shield Enclosure Mounting | Reinforced Polyurethane 1/4 - 20 by 1 " Hex Fiberglas Bolt | McMaster | 91345A556 | McMaster |
| 31 | | | Software Revision ID Label | PPM | | PPM |
| 32 | | | Serial Number Label | PPM | | PPM |
| 33 | | | Calibration Label | PPM | | PPM |
| 34 | | | Front Panel to Power Supply Cable Assembly | PPM | | PPM |
| 35 | | | Front Panel to Analog Subsystem Cable Assembly | PPM | | PPM |



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# 18.2. AVM-2000 SYSTEM—PARTS LIST Sheet 2

| Item | Product/ Value | Reference Designators Part Use | Description | Manufacturer Name | Manufacturer Part Number | Source |
|---|---|---|---|---|---|---|
| 36 | | | Isolated Output Cable Assembly | PPM | | PPM |
| 37 | | | Battery Cable Assembly | PPM | | PPM |
| 38 | | | Pass Transistor Cable Assembly | PPM | | PPM |
| 39 | | | Meter Cable Assembly | PPM | | PPM |
| 40 | | | Input Signal Cable Assembly | PPM | | PPM |
| 41 | | | 2 uF Filter Block on Dual Banana Plug | PPM | | |
| 42 | 1 1/4 A SB | F1 | 1 1/4A, 3AG Fuse | Littlefuse | H3453LF1 | Newark |
| 43 | DC JACK | J5 | Charging Jack | Switchcraft | PC722A | Newark |
| 44 | TIP122 | Q3--Chassis Mount | Transistor | Fairchild | TIP122 | NewarkInOne |
| 45 | | BP1 | Binding post, Gold-plated, Red | Pomona Electronics | 3750-0 | 123eDistribution.com |
| 46 | | BP2 | Binding post, Gold-plated, Black | Pomona Electronics | 3750-2 | 123eDistribution.com |
| 47 | | BP3 | Binding post, Gold-plated, Yellow | Pomona Electronics | 3750-4 | 123eDistribution.com |
| 48 | | | Transistor Insulating Pad | Bergquist | SP4000007001212 | NewarkInOne |
| 49 | | | Transistor Insulating Shoulder Washer | AAVID THERMALLOY | 7721-7PPS | NewarkInOne |
| 50 | | | Shorting Link (Nickel Plated Brass) | Pomona Electronics | 4115 | NewarkInOne |
| 51 | | C1 Mounting | 26-24 Non-Insulated Butted Seam Ring Tongue Terminal | 3M | 1010 | NewarkInOne |
| 52 | | C2 Mounting | Ring Tongue Non-Insulated Terminal | Molex | 190560137 | NewarkInOne |
| 53 | | Front Panel Mounting | #6 X 11/16" X 5/16" Round Nylon Spacer | McMaster | 94639A047 | McMaster |
| 54 | | Power Supply Mounting | #6 X 1/2" X 5/16" Round Nylon Spacer | McMaster | 94639A118 | McMaster |
| 55 | | Battery Mounting | #8 X 2" X 3/8" Threaded Hex Al Spacer | McMaster | 94639A118 | McMaster |
| 56 | | Battery Mounting | #8 X 1/8" X 3/8" Al Round Spacer | McMaster | 91780A900 | McMaster |



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# 18.3. AVM-2000 ISOLATED ANALOG SUBSYSTEM BOARD—PARTS LIST Sheet 1

| Item | Product/ Value | Reference Designators | Description | Manufacturer Name | Manufacturer Part Number | Source |
|---|---|---|---|---|---|---|
| 1 | 1ufd | C1 C2 C3 C55 | 1 uF 25V X7R 10% Ceramic 1206 | Kemet | C1206C105K3RAC | NewarkInOne |
| 2 | 0.22ufd | C37 C42 | 0.22 uF 50V 20% 1206 Ceramic | Kemet | C1206C224J5RAC | NewarkInOne |
| 3 | 0.1ufd | C4 C6 C7 C9 C11 C12 C14 C17 C18 C21 C23 C24 C26 C27 C29 C31 C34 C35 C39 C40 C41 C45 C46 C47 C51 C53 C54 C58 C59 | 0.1 uF 50V 5% 1206 Ceramic X7R | Kemet | C1206C104J5RAC | NewarkInOne |
| 4 | 3.3nf | C43 C44 | 0.0033 uF 50V 20% 1206 Ceramic | Yageo Corporation | CC1206KRX7R9BB332 | Digikey |
| 5 | 22pf | C49 C50 | 22 pF 50V COG 5% Ceramic 1206 | Kemet | C1206C220J5GAC | NewarkInOne |
| 6 | 6.8pF | C5 | 6.8 pF 50V C0G 10% Ceramic 1206 | Yageo Corporation | CC1206DRNPO9BN6R8 | Digikey |
| 7 | 0.01 µF | C56 | 0.01 uF 200 V Polypropylene Film | Vishay Sprague | 715P10352JD3 | NewarkInOne |
| 8 | 4.7ufd | C57 | 4.7 uF 25V Tantalum | Kemet | T350E475K025AS | NewarkInOne |
| 9 | 10ufd | C8 C10 C13 C15 C16 C19 C20 C22 C25 C28 C30 C32 C33 C36 C38 C48 C52 | 10 uF 25V Tantalum | Kemet | T350E106K025AS | NewarkInOne |
| 10 | 5.1V | D1 | 5.1 V Zener | ON Semi | MMSZ5231BT1 | NewarkInOne |
| 11 | Dual Diode | D10 D11 | Dual series Schottky diode | Agilent Technologies | HSMS-2802 | NewarkInOne |
| 12 | 1N4148 | D12 D13 | Small signal diode | Fairchild | MMSD4148 | NewarkInOne |
| 13 | DPAD1 | D2 D3 D4 | Low leakage Dual Diode | Siliconix | DPAD1 | Mouser |
| 14 | 9.1V | D5 D6 | 9.1 V 500 mW Zener | ON Semi | MMSZ5V1T1G | NewarkInOne |
| 15 | * | D7 D8 | LED, Red High Effic. | Ch Min Lmp | HLMP3301 | NewarkInOne |
| 16 | * | D9 | Diode Schottky | International Rectifier | 10MQ100N-ND | Mouser |
| 17 | 4N35 | ISO1 ISO2 ISO5 | Single channel Opto Isolator Optional --Do not populate | Vishay/Fairchild | 4N35 | NewarkInOne |
| 18 | 4N35 | ISO3 ISO4 | Single channel Opto Isolator | Vishay/Fairchild | 4N35 | NewarkInOne |
| 19 | * | J1 | Header, 10 Pin 0.1" Ctr. | ITW Panc. | MLSS100-10-C | NewarkInOne |
| 20 | * | J2 | Board connection only--no physical part | | | |
| 21 | RJ11-6 | J3 | Mod. Jack 6-6, RJ11-6 | Amp | 520425-3 | NewarkInOne |
| 22 | * | J5 | Header, 3 Pin 0.1"C Gold Install 2-Pin Jumper Between Pin 1 & 2 | SPC Tech. | 8431-0722 | NewarkInOne |
| 23 | | J6 | Header, 2 Pin 0.1"C Gold | SPC Tech. | 8431-0720 | NewarkInOne |
| 24 | * | K1 K2 K3 K4 K5 K6 K7 K8 K9 K10 K11 | Relay, SPST Reed, Coil 5V 2000 ohms, 1 kV Contacts, Low emf | Pickering Electronics Limited | 100-1-A-5/4 | Pickering |
| 25 | 220uh | L1 | 220 µH SMT Power Inductor | J.W. Miller | PM105-221K | Mouser |
| 26 | 330uH | L2 L3 L4 L5 | 330 µH surface mount choke | Bourns | CM453232-331K | NewarkInOne |
| 27 | | | Shorting Plug, 2 Pin Gold | FCI Electr. | 71363-202 | NewarkInOne |
| 28 | | PCB | AVM-2000 Analog Printed Circuit Board | PPM | | PPM |
| 29 | MMBT3904 | Q1 | Transistor, NPN SOT-23 | ON Semi. | MMBT3904LT1 | NewarkInOne |
| 30 | 1G | R7 R11 R70 R71 R78 R79 | 1G 1/4W 1% 100 PPM 2 Resistor for 2 GOhm Alternate | EBG | OSX10 1GGC1 R | EBG |
| 31 | 2G | R7-R11 R70-R71 R78-R79 | 2G 1/4W 1% 100 PPM 1 Resistor for 2 GOhm Alternate | EBG | OSX10 2GGC1 R | EBG |
| 31 | 51.1k | R1 R26 | 51.1k 1/8W 1% 1206 | CRC | CRCW12065112FK | NewarkInOne |
| 32 | 22.5M | R12 R23 R68 R69 | 22.5M 1/4W 1% 100 PPM | RCD | RG1/4 2225 FB 101 | RCD |
| 33 | 49.9k | R13 R58 | 49.9k 1/4 W 0.1% 1206 25ppm | IRC | PFC-W1206R-03-4992-B | Mouser |



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# 18.4. AVM-2000 ISOLATED ANALOG SUBSYSTEM BOARD –PARTS LIST Sheet 2

| Item | Product/ Value | Reference Designators | Description | Manufacturer Name | Manufacturer Part Number | Source |
|---|---|---|---|---|---|---|
| 34 | FA2779 | R14 | 6-Decade 9M Divider String | RCD | FA2779 | RCD |
| 35 | 10 | R15 R16 | 10 1/8W 1% 1206 | CRC | CRCW120610R0FK | NewarkInOne |
| 36 | 1k | R2 R17 R18 R19 R21 R55 R56 | 1k 1/8W 1% 1206 | CRC | CRCW12061001FK | NewarkInOne |
| 37 | 100k | R20 R22 R28 R72 R80 R81 | 100k 1/8W 1% 1206 | CRC | CRCW12061003FK | NewarkInOne |
| 38 | 1.82M | R24 R25 R76 | 1.82M 1/8W 1% 1206 | CRC | CRCW12061824FK | NewarkInOne |
| 39 | 1.5k | R27 R77 | 1.5k 1/8W 1% 1206 | CRC | CRCW12061501FK | NewarkInOne |
| 40 | 21.5 | R29 R30 R36 R37 | 21.5 1/4 W 0.1% 1206 25 ppm | IRC | PFC-W1206R-03-21R5-B | Mouser |
| 41 | 143k | R3 R10 R44 | 143k 1/8W 1% 1206 | CRC | CRCW12061433FK | NewarkInOne |
| 42 | 243 | R31 R38 | 243 1/8 W 0.1% 1206 25 ppm | IRC | PFC-W1206R-03-2430-B | Mouser |
| 43 | 2740 | R32 R39 | 2740 1/4 W 0.1% 1206 25 ppm | IRC | PFC-W1206R-03-2741-B | Mouser |
| 44 | 249k | R33 R42 | 249k 1/8W 1% 1206 | CRC | CRCW12062493FK | NewarkInOne |
| 45 | 191k | R34 R75 | 191k 1/4 W 0.1% 1206 25ppm | IRC | PFC-W1206LF-03-1913-B | Mouser |
| 46 | 100 | R4 R6 | 100 1/8W 1% 1206 | CRC | CRCW12061000FK | NewarkInOne |
| 47 | 43.2k | R40 | 43.2k 1/8W 1% 1206 | CRC | CRCW12064322FK | NewarkInOne |
| 48 | 261k | R41 | 261k 1/8W 1% 1206 | CRC | CRCW12062613FK | NewarkInOne |
| 49 | 78.7k | R43 R45 | 78.7k 1/8W 1% 1206 | CRC | CRCW12067872FK | NewarkInOne |
| 50 | 24.9k | R46 R54 | 24.9k 1/4 W 0.1% 1206 25ppm | IRC | PFC-W1206R-03-2492-B | Mouser |
| 51 | 249k | R47 R50 R51 R52 R53 | 249k 1/4 W 0.1% 1206 25ppm | IRC | PFC-W1206R-03-2493-B | Mouser |
| 52 | 24.9k | R48 R35 R57 | 24.9k 1/8W 1% 1206 | CRC | CRCW12062492FK | NewarkInOne |
| 53 | 124k | R49 | 124k 1/8W 1% 1206 | CRC | CRCW12061243FK | NewarkInOne |
| 54 | 2000 | R5 | 2000 1/4W 1% 1206 | CRC | CRCW12062001FK | NewarkInOne |
| 55 | 210k | R59 | 210k 1/8W 1% 1206 | CRC | CRCW12062103FK | NewarkInOne |
| 56 | 200 | R60 R61 | 200 1/8W 1% 1206 | CRC | CRCW12062000FK | NewarkInOne |
| 57 | 33.2k | R62 | 33.2k 1/8W 1% 1206 | CRC | CRCW12063322FK | NewarkInOne |
| 58 | 124 | R63 R66 R67 | 124 1/8W 1% 1206 | CRC | CRCW12061240FK | NewarkInOne |
| 59 | 499 | R64 R65 | 499 1/8W 1% 1206 | CRC | CRCW1204990FK | NewarkInOne |
| 60 | 10k | R73 | 10k 1/8W 1% 1206 | CRC | CRCW12061002FK | NewarkInOne |
| 61 | 1M | R74 | 1M 1/8W 1% 1206 | CRC | CRCW12061004FK | NewarkInOne |
| 62 | 1k | R8 R9 | 1k 1/4 W 0.1% 1206 25ppm | IRC | PFC-W1206R-03-1001-B | Mouser |
| 63 | * | TP1 TP2 TP3 TP4 TP5 TP7 TP10 TP11 TP12 TP13 | Turret Lug, Silver Plate | Elpacko | 5S4-86B | Elpacko |
| 64 | NMV0515S | U1 | 5 Volt to ±15 Volt DC-DC Isolated Converter | C&D Technologies | NMV0515S | NewarkInOne |
| 65 | ADG451B | U10 | Analog Sw. 4 Ch. SOIC | Analog Devices | ADG451BR | Digikey |
| 66 | OP482GS | U11 | Op Amp Quad JFET SOIC | Analog Devices | OP482GS | Digikey |
| 67 | ULN2803 | U12 U14 | 8 Darlington Transistor Array 18-SOIC | Texas Instruments | ULN2803ADW | NewarkInOne |
| 68 | MSC1211 | U13 | 24-Bit A/D with 8051 | Texas Instruments | MSC1211 | NewarkInOne |
| 69 | LP2980ADJM5 | U2 | Adjustable Regulator | National | LP2980ADJM5 | NewarkInOne |
| 70 | LM79L12ACZ | U3 | -12 VDC Low Power Regulator NOTE: Mount with flat facing curve on screen | National | LM79L12ACZ | NewarkInOne |


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## 18.5. AVM-2000 ISOLATED ANALOG SUBSYSTEM BOARD –PARTS LIST Sheet 3

| Item | Product/ Value | Reference Designators | Description | Manufacturer Name | Manufacturer Part Number | Source |
|---|---|---|---|---|---|---|
| 71 | LM2936Z | U4 | 3.0 V Regulator<br>NOTE: Mount with flat facing curve on screen | National | LM2936Z-3.0 | NewarkInOne |
| 72 | LM78L12ACZ | U5 | 12 V Low Power Regulator<br>NOTE: Mount with flat facing curve on screen | Fairchild | LM78L12ACZ | NewarkInOne |
| 73 | AD8221BR | U6 | Instrumentation Amp SOIC | Analog Devices | AD8221BR | Digikey |
| 74 | ADG333AR | U7 | Analog Sw. 4 Ch. SPDT SOIC | Analog Devices | ADG333AR | Digikey |
| 75 | OP282 | U8 U9 | Op Amp Dual JFET SOIC | Analog Devices | OP282GS | Digikey |
| 76 | ADR03AR | U15 | Precision 2.5 V reference SOIC | Analog Devices | ADR03AR | NewarkInOne |
| 77 | 10MHZ | Y1 | 10 MHz Low Profile Quartz Crystal | ECS International, Inc. | ECS-100-20-28A | Digikey |


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# 18.6. AVM-2000 FRONT PANEL SUBSYSTEM BOARD—PARTS LIST Sheet 1

| Item | Product/ Value | Reference Designators | Description | Manufacturer Name | Manufacturer Part Number | Source |
|---|---|---|---|---|---|---|
| 1 | .0022ufd | C 28 C32 | 2200 pF 50V 5% 1206 Ceramic X7R | Yageo Corporation | CC1206KRX7R9BB222 | Digikey |
| 2 | 0.1ufd | C1 C2 C4 C5 C8 C9 C12 C13 C14 C15 C16 C17 C18 C21 C22 C24 C25 C26 C27 C30 C31 C34 C35 C36 C37 C38 C39 C42 | 0.1 uF 50V 5% 1206 Ceramic X7R | Kemet | C1206C104J5RAC | NewarkInOne |
| 3 | 10ufd | C10 C11 | 10 uF Ceramic Mount On Top Of R16 & R14 | Panasonic - ECG | ECJ-3YB1E106K | Digikey |
| 4 | 22pf | C19 C20 | 22 pF 50V COG 5% Ceramic 1206 | Kemet | C1206C220J5GAC | NewarkInOne |
| 5 | .01ufd | C29 C33 | 0.01 uF 50V 5% 1206 Ceramic X7R | Kemet | C1206C103J5RAC | NewarkInOne |
| 6 | 10ufd | C3 C7 C23 | 10 uF 25V Tantalum | Kemet | T350E106K025AS | NewarkInOne |
| 7 | 22ufd | C6 | 22 uF 25V Tantalum | MULTICOMP | MCDTR22M35-1-RH | NewarkInOne |
| 8 | * | D1 D2 | LED, Red High Effic. | Lumex | SML-LX1206SIC-TR | NewarkInOne |
| 9 | * | J1 J2 | Header, 10 Pin 0.1" Ctr. | ITW Panc. | MLSS100-10-C | NewarkInOne |
| 10 | RJ11-6 | J3 | Mod. Jack 6-6, RJ11-6 | Amp | 520425-3 | NewarkInOne |
| 11 | * | J4 J5 | Header, 3 Pin 0.1" Ctr | ITW Panc. | MLSS100-3-D | NewarkInOne |
| 12 | | | Pushbutton key caps For SW1-SW7 | Cannon | PEWH | NewarkInOne |
| 13 | * | LCD1 | 128 X 64 LCD Module with Backlight | FEMA Electronics Corporation | FDS128X64(88X64)XBG-FWS-WW-6WT | FEMA Electronics Corporation |
| 14 | | | AVM-2000 Front Panel Printed Circuit Board | PPM | | |
| 15 | 10k | R5 R9 R13 R14 R15 R16 R19 R20 R21 R22 | 10k 1/8W 1% 1206 | CRC | CRCW12061002F100 | NewarkInOne |
| 16 | 49.9k | R1 R2 | 49.9k 1/8W 1% 1206 | CRC | CRCW12064992F100 | NewarkInOne |
| 17 | 20k | R12 | 20 k Trimmer Potentiometer | Bourns | 3386P-203-ND | NewarkInOne |
| 18 | 1.5k | R18 | 1.5 k 1/8W 1% 1206 | CRC | CRCW12061501F100 | NewarkInOne |
| 19 | 100 | R23 | 100 1/8W 1% 1206 | CRC | CRCW12061000F100 | NewarkInOne |
| 20 | 4.99k | R3 R4 R11 R24 | 4.99k 1/8W 1% 1206 | CRC | CRCW12064991F100 | NewarkInOne |
| 21 | 200 | R6 R7 R10 | 200 1/8W 1% 1206 | CRC | CRCW12062000F100 | NewarkInOne |
| 22 | 1k | R8 R17 | 1k 1/8W 1% 1206 | CRC | CRCW12061001F100 | NewarkInOne |
| 23 | | S1 | Push-On/Push-Off DPDT | ITT Cannon | PVA2-EE-H1 | NewarkInOne |
| 24 | * | S2 S3 S4 S5 S6 S7 | Momentary--DPDT | ITT Cannon | PVA2-OA-H1 | NewarkInOne |
| 25 | * | S8 | OHMRANGER::ROT_ENC Mount Base of Encoder 5/32" above PCB Surface | Grayhill | 62A18-02-P | NewarkInOne |
| 26 | * | S9 S10 | Incremental Rotary Encoder | Bourns | PEC11-4 1 25 F - S 0018 | Mouser |
| 27 | * | TP1 TP2 TP3 TP4 TP5 TP6 TP7 TP8 TP9 | Turret Lug, Silver Plate | Elpacko | 5S4-86B | |
| 28 | REG104 | U1 U5 | DMOS 1 A Low-Dropout Regulator 5V | Texas Instruments | REG104FA-5 | NewarkInOne |
| 29 | ADM660AR | U2 | Switched-Capacitor Voltage Converter | Analog Devices | ADM660AR | Digikey |
| 30 | 18F452 | U3 | Microcontroller | Microchip | PIC18F452-I/PT | Digikey |
| 31 | CD74HCT164 | U4 | 8-Bit Serial-In/Parallel-Out Shift Register | Texas Instruments | CD74HCT164 | NewarkInOne |


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## 18.7. AVM-2000 FRONT PANEL SUBSYSTEM BOARD—PARTS LIST Sheet 2

| Item | Product/ Value | Reference Designators | Description | Manufacturer Name | Manufacturer Part Number | Source |
|---|---|---|---|---|---|---|
| 32 | DAC1220 | U6 U7 | 20-Bit Low Power DAC | Texas Instruments | DAC1220E | NewarkInOne |
| 33 | OP213 | U8 | Op Amp Dual JFET SOIC | Analog Devices | OP213FS | Digikey |
| 34 | ADR03AR | U9 | Precision 2.5 V reference SOIC | Analog Devices | ADR03AR | Digikey |
| 35 | 10MHZ | Y1 | 10 MHz Low Profile Quartz Crystal | ECS International, Inc. | ECS-100-20-28A | Digikey |
| 36 | | | Spacer 1/4" D 1/4" L #2 Hole | McMaster | 94639A103 | McMaster |
| 37 | | | SS Machine Screw Pan Head 2-56 1/2" | McMaster | 91772A081 | McMaster |
| 38 | | | SS Nut 2-56 | McMaster | 91841A003 | McMaster |
| 39 | | | SS Lock washer #2 Split | McMaster | 92146A520 | McMaster |
| 40 | * | | Header, 20 Pin 0.1"C Gold Create by cutting 40 pin Display to Front Panel PCB | SPC Tech. | 8431-0730 | NewarkInOne |


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# 18.8. AVM-2000 POWER SUPPLY SUBSYSTEM BOARD—PARTS LIST

| Item | Product/ Value | Reference Designators | Description | Manufacturer Name | Manufacturer Part Number | Source |
|---|---|---|---|---|---|---|
| 1 | 10 ufd | C1 | 10 uF Ceramic | TAIYO YUDEN | JMK316BJ106Kd-T | NewarkInOne |
| 2 | 0.001ufd | C2 | 0.001 uF 50V 5% 1206 Ceramic X7R | Kemet | C1206C102K5RAC | NewarkInOne |
| 3 | 0.1ufd | C3 | 0.1 uF 50V 5% 1206 Ceramic X7R | Kemet | C1206C104J5RAC | NewarkInOne |
| 4 | 1ufd | C4 | 1 uF 50V 5% 1206 Ceramic X7R | TAIYO YUDEN | GMK316BJ105KL-T | NewarkInOne |
| 5 | 1N5821 | D1 D3 D5 D6 | 30 V 3 A Schottky Rectifier | ON Semi. | 1N5821RLG | Digikey |
| 6 | 9.1V | D2 | 9.1V Zener | ON Semi. | MMSZ9V1T1 | NewarkInOne |
| 7 | | J1 J2 J3 | Header, 3 Pin 0.1" | ITW-PANCON | MLSS100-3 | NewarkInOne |
| 8 | * | J4 | Header, 10 Pin | ITW-PANCON | MLSS100-10-C | NewarkInOne |
| 9 | 1mH | L1 L2 | 1 mH | EPCOS Inc | B82432C1105K | Digikey |
| 10 | | PCB | AVM-2000 Power Supply Printed Circuit Board | PPM | | PPM |
| 11 | MJE15029 | Q1 | Transistor, PNP | ON Semi. | MJE15029 | NewarkInOne |
| 12 | MMBT3904 | Q2 | Transistor, NPN | ON Semi. | MMBT3904LT1 | NewarkInOne |
| 13 | 4.99k | R1 R5 R7 R8 | 4.99K 1/8W 1% 1206 | CRC | CRCW12064991F100 | NewarkInOne |
| 14 | 100 | R10 | 1001/8W 1% 1206 | CRC | CRCW12061000F100 | NewarkInOne |
| 15 | 100 | R10 | 100 1/8W 1% 1206 | CRC | CRCW12061000F100 | NewarkInOne |
| 16 | 50k | R11 | 50 k Trimmer Potentiometer | Cermet | 3296Y-1-503 | NewarkInOne |
| 17 | 357 | R2 | 357 ohm, 1/8W 1% 1206 | CRC | CRCW12063570F100 | NewarkInOne |
| 18 | 1.8 | R3 | 1.8 ohm, 5 watt | Yageo | SQP500JB-1R8 | Digikey |
| 19 | 1k | R4 | 1k 1/8W 1% 1206 | CRC | CRCW12061001F100 | NewarkInOne |
| 20 | 1.91k | R6 | 1.91k 1/8W 1% 1206 | CRC | CRCW12061911F100 | NewarkInOne |
| 21 | 10 | R9 | 10k 1/8W 1% 1206 | CRC | CRCW12061002F100 | NewarkInOne |
| 22 | * | TP1 TP2 TP3 | Turret Lug, Silver Plate | Elpacko | 5S4-86B | Elpacko |
| 23 | FDC6325L | U1 | Integrated Load Switch | Fairchild | FDC6325L | NewarkInOne |


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# 18.9. Cable Assemblies – Sheet 1

| Item | Product/ Value | Description | Manufacturer Name | Manufacturer Part Number | Source |
|---|---|---|---|---|---|
| | | | | | |
| Front Panel to Power Supply Cable Assembly | | | | | |
| 1 | | 10-Pin Pancon Connectors | Pancon | CE-100F24-10-C | NewarkInOne |
| 2 | | Ferrite Bead | Steward | 28B0625-100 | Digikey |
| 3 | | #24 Stranded wire (1 each of 10 colors) | Alpha wire | | NewarkInOne |
| | | | | | |
| Front Panel to Analog Subsystem Cable Assembly | | | | | |
| 1 | | 10-Pin Pancon Connectors | Pancon | CE-100F24-10-C | NewarkInOne |
| 2 | | Ferrite Bead | Steward | 28B0625-100 | Digikey |
| 3 | | #24 Stranded wire (1 each of 6 colors--Brown - Blue) | Alpha wire | | NewarkInOne |
| 4 | | Length of 1" Heat shrink Tubing | TYCO ELECTRONICS/RAYCHEM | RNF-100-1-BK-STK | NewarkInOne |
| 5 | | Length of 1/4" Heat shrink Tubing | TYCO ELECTRONICS/RAYCHEM | RNF-100-1/4-BK-STK | NewarkInOne |
| 6 | | Length of 1/4" Heat shrink Tubing | TYCO ELECTRONICS/RAYCHEM | RNF-100-1/4-BK-STK | NewarkInOne |
| | | | | | |
| Isolated Output Cable Assembly | | | | | |
| 1 | | 3-Pin Pancon Connector | Pancon | CE-100F24-03-C | NewarkInOne |
| 2 | | Ferrite Bead | Steward | 28B0562-000 | Digikey |
| 3 | | #24 Stranded wire (3 lengths 2 colors, 2-Green, 1-Blue) | Alpha wire | | NewarkInOne |
| 4 | | Length of 1/4" Heat shrink Tubing | TYCO ELECTRONICS/RAYCHEM | RNF-100-1/4-BK-STK | NewarkInOne |
| 5 | | Length of 1/4" Heat shrink Tubing | TYCO ELECTRONICS/RAYCHEM | RNF-100-1/4-BK-STK | NewarkInOne |
| | | | | | |
| Battery Cable Assembly | | | | | |
| 1 | | 3-Pin Pancon Connector | Pancon | | NewarkInOne |
| 2 | | #24 Red Stranded wire | Alpha wire | | NewarkInOne |
| 3 | | #24 Black Stranded wire | Alpha wire | | NewarkInOne |

| Pass Transistor Cable Assembly | | | | | |
|---|---|---|---|---|---|
| 1 | | 3-Pin Pancon Connectors | Pancon | CE-100F24-03-C | NewarkInOne |
| 2 | | #24 White Stranded wire | Alpha wire | | NewarkInOne |
| 3 | | #24 Gray Stranded wire | Alpha wire | | NewarkInOne |
| 4 | | #24 Violet Stranded wire | Alpha wire | | NewarkInOne |


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## 18.10. Cable Assemblies – Sheet 2

| Item | Product/ Value | Description | Manufacturer Name | Manufacturer Part Number | Source |
|---|---|---|---|---|---|
| Meter Cable Assembly | | | | | |
| 1 | | 3-Pin Pancon Connectors | Pancon | CE-100F24-03-C | NewarkInOne |
| 2 | | #24 Orange Stranded wire | Alpha wire | | NewarkInOne |
| 3 | | #24 Yellow Stranded wire | Alpha wire | | NewarkInOne |
| Input Signal Cable Assembly | | | | | |
| 1 | | #18 Solid Red Teflon Silver Plated Wire | Weico Wire & Cable, Inc. | 2818 | Weico Wire & Cable, Inc. |
| 2 | | Tubular Braid | Weico Wire & Cable, Inc. | BT 1/8 | Weico Wire & Cable, Inc. |
| 3 | | White Teflon Stranded Wire | Belden | 83026-009100 | NewarkInOne |
| 4 | | 1/4" Heat Shrink | TYCO ELECTRONICS/RAYCHEM | RNF-100-1/4-BK-STK | NewarkInOne |
| 5 | | Ring Tongue Non-Insulated Terminal | Molex | 190560137 | NewarkInOne |


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## 19. APPENDIX E -- SPECIAL OPERATING CODES

This section describes special operating codes used if basic instrument setup -is required due to a repair, major fault and/or other unforeseen condition.

19.1. Total Instrument Reset (TIR).

If the instrument basic functions do not seem to operate (ranges cannot be selected, meter is always pegged, the meter is unresponsive to ZERO functions, etc.), a total instrument reset may be indicated. Before this action is performed, ensure a reasonable level of battery charge is shown on the battery charge level indicator (at least ½ scale). NOTE: A TIR does not correct problems with the instrument Front Panel Subsystem. Such problems are indicated by incomplete LCD indications (missing or partial characters, for example). If this is the case, proceed to Section 14 TROUBLESHOOTING

To perform a total instrument reset:

- Turn the instrument OFF.
- Allow the instrument to remain off for at least 5 minutes with the power adaptor disconnected (or any source of charging current disconnected).
- Reconnect the power adaptor.
- Turn the instrument ON.
- Verify the problem continues to exist.
- Depress and hold the RANGE control until the LCD reads METER OFFSET.
- Simultaneously depress and then release both FILTER pushbuttons.
- Wait at least 10 seconds.
- Simultaneously depress and then release both OFFSET pushbuttons.
- The LCD momentarily displays OFFSET TRIM and then returns to displaying METER OFFSET.
- Depress the RANGE control to return the instrument to the normal operating mode.
- If a Total Instrument Reset is successfully performed, the instrument, when in ZERO Mode, with no OFFSET should display meter indications of zero ± 1/3 of full scale for all ranges greater than 3 µV.
- Once a successful Total Instrument Reset is performed, the instrument requires re-zeroing of each range (in both ZERO and OPERATE modes). Gain calibration may or may not be required.

19.2. OFFSET TRIM Adjustment

The offset trim adjustment function allows the user to compensate the AVM-2000 for changes in input amplifier chain bias currents and offset voltages. These changes are NOT anticipated in normal operation and this adjustment should only be performed following a repair, significant and permanent change in ambient operating temperature, or following significant aging.

To perform an offset trim adjustment:

- Turn the instrument OFF.
- Allow the instrument to remain off for at least 15 minutes with the power adaptor disconnected (or any source of charging current disconnected).
- Reconnect the power adaptor.
- Turn the instrument ON.


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- Verify the problem continues to exist.
- Allow the instrument to warm up and to become thoroughly saturated at ambient temperature. (If possible a 24 hour soak at the intended operating environment is recommended.)
- Disconnect any charging source from the instrument.
- Connect a low-thermal-emf shorting strap between the instrument's HI and LO input terminals. The GUARD terminal should be strapped to the LO input terminal.
- Mount the Input Terminal Shield.
- Depress and hold the RANGE control until the LCD reads METER OFFSET.
- Simultaneously depress and then release both OFFSET pushbuttons.
- The LCD displays OFFSET TRIM (blinking). The blinking OFFSET TRIM indication will continue for approximately 20 minutes. When complete the display returns to METER OFFSET.
- Depress the RANGE control to return the instrument to the normal operating mode.
- If an OFFSET TRIM is successfully performed, the instrument, when in ZERO Mode, with no OFFSET should display meter indications of zero ± 1/3 of full scale for all ranges greater than 3 μV.
- If some ranges do not show a zero reading within $1/3^{rd}$ of full scale, further manual adjustment of Offset Trim may be required. This is accomplished, after the above procedure is performed, by:
    - Depressing and holding the RANGE control until METER OFFSET is displayed.
    - Simultaneously depressing and then releasing both FILTER pushbuttons.
    - Depress the RANGE control to return to the conventional instrument operating display. (NOTE: At this time the instrument is in the Manual Offset Trim Mode and should not be used in conventional operation until conventional operating mode is restored by cycling the instrument through a complete power up i.e., powered up from a condition with no charging power applied to the instrument).
    - Depress the INPUT OFFSET control once to display V in place of the padlock icon.
    - Starting with instrument's Range set to 1,000 V, ZIN set to 10 MΩ (Zin for the 1,000 V Range is always 100 MΩ) and OPERATE/ZERO in the ZERO mode, adjust the INPUT OFFSET control to position the meter at zero within one minor division on the 10s scale.
    - Change the RANGE control to 300 V and repeat the above process. Once the reading stabilizes at zero, change the Range control to the next higher range, allow the meter to stabilize, and then return the Range control to the original range. NOTE: If, the meter does not return to zero within two minor divisions on the 10s scale, repeat the zeroing and zero check process. Once zeroing is satisfactorally performed on the range in question, wait a few seconds before changing to the next lower range.


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- Once you have completed the adjustment for the 3 mV range, wait 10 seconds following the last adjustment before proceeding to the following steps.
- Change the OPERATE/ZERO control to the OPERATE mode and repeat the above zeroing process starting at the 1,000 volt range and working to the 3 mV range.
- Once you have completed the adjustment for the 3 mV range, wait 10 seconds following the last adjustment before proceeding to the following steps.
- Change the OPERATE/ZERO control to the OPERATE mode and change ZIN to 100 MΩ. Repeat the zeroing process starting at the 1,000 volt range and working to the 3 mV range.
- Once you have completed the adjustment for the 3 mV range, wait 10 seconds following the last adjustment before proceeding to the following steps.
- Change the OPERATE/ZERO control to the ZERO mode and repeat the zeroing process starting at the 1,000 volt range and working to the 3 mV range.
- When the above 4 cycles (1000 volt range to the 3 mV range) are complete, check each range, mode and ZIN (1000 volt to 3 mV) to ensure proper zeroing. If any fail to remain essentially at zero, adjust that setting for zero. Once you complete a correcting adjustment, wait 10 seconds following the adjustment and then depress and hold the INPUT OFFSET control for 10 seconds.
- Repeat the above zeroing process for each of the milli-volt ranges (i.e. starting at 1 mV and working to 100 nV) for a) ZERO; b) OPERATE at 1 MΩ and c) OPERATE at 100 MΩ. Always start at the 1 mV range and work down to the 100 nV range.
- Once you complete an adjustment for the 100 nV range, wait 10 seconds following the adjustment before returning the Range control to the 1 mV position. NOTE: the 300 nV and 100 nV ranges are VERY sensitive. Any changes in ambient temperature or other environmental characteristics will cause significant drift. Normally a zero within the center third of the meter scale is adequate for these ranges.
- Check each range/zero-operate and ZIN setting to ensure a near-zero offset trim is achieved.
- When complete, return the Range control to the 1 mV position, power the instrument OFF (ensuring no charging activity) and re-power the instrument.
- At this time a check of each RANGE, ZIN and Mode position should show zero within a few minor divisions for all ranges above 3 µV.
- Proceed to Zero the instrument and, if necessary, perform a gain setup.


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## 19.3. METER LINEARIZATION

The Meter Linearization process compensates for non-linearity in the meter movement's physical response (needle displacement) vs. applied current. This procedure is normally only required if the meter movement is replaced; however, in extreme situations the process may be required to compensate for significant changes in ambient operating environments.

To perform a meter linearization:

- Turn the instrument OFF.
- Allow the instrument to remain off for at least 5 minutes with the power adaptor disconnected (or any source of charging current disconnected).
- Observe the meter needle position with no power applied. If the meter needle does not rest at zero, use a small flat-blade screw driver to adjust the needle to zero using the front panel adjustment screw located directly below the meter.
- Reconnect the power adaptor.
- Turn the instrument ON.
- Verify the problem continues to exist.
- Allow the instrument to warm up and to become thoroughly saturated at ambient temperature (if possible a 2 hour soak at the intended operating environment is recommended).
- Depress and hold the RANGE control until the LCD reads METER OFFSET.
- Using the OUTPUT LEVEL control, adjust the meter's needle to fall exactly over the center zero mark.
- Rotate the RANGE control one step until the LCD reads METER GAIN +.
- Using the OUTPUT LEVEL control, adjust the needle position to fall exactly over the 10 mark at positive full scale.
- Rotate the RANGE control one step until the LCD reads METER GAIN –.
- Using the OUTPUT LEVEL control, adjust the needle position to fall exactly over the -10 mark at negative full scale.
- Depress the INPUT OFFSET control once, the LCD now reads METER GAIN (note the – symbol is no longer shown).
- Using the INPUT OFFSET control, (NOTE: The change from adjustment with the OUTPUT LEVEL control to adjustment with the INPUT OFFSET *control is necess*ary) ensure the meter's needle is positioned exactly over the – 10 mark.
- Depress the INPUT OFFSET control once. The meter now indicates approximately – 8 on the 10s scale. Using the INPUT OFFSET control, adjust the indication to place the needle exactly over the – 8 mark on the 10s scale.
- Successive repetition of the above step moves the meter indication through the points of: - 6, - 4, - 2, + 2, + 4, + 6, + 8 and finally returning to + 10. NOTE: There is no adjustment position at 0. At each point in the process, use the INPUT OFFSET control to position the meter needle precisely over the indicated position.
- Once any final adjustment at + 10 is complete, depress the INPUT OFFSET control once more. The LCD display now indicates METER GAIN – (note the reappearance of the – indication).
- Depress the RANGE control once to return the instrument to conventional measurement operation.



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NOTES



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# NOTES



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