Counters 
Frequency Meters 
PID Controllers 
Clock/Timers 
Printers 
Process Meters 
On/Off Controllers 
Recorders 
Relative Humidity 
Transmitters 
Thermocouples 
Thermistors 
Wire 
Rate Meters 
Timers 
Totalizers 
Strain Gauge Meters 
Voltmeters 
Multimeters 
Soldering Iron Testers 
pH pens 
pH Controllers 
pH Electrodes 
RTDs 
Thermowells 
Flow Sensors 

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It is the policy of NEWPORT to comply with all worldwide safety and EMC/EMI regulations that apply. NEWPORT is constantly pursuing certification of its products to the European New Approach Directives. NEWPORT will add the CE mark to every appropriate device upon certification.

The information contained in this document is believed to be correct but NEWPORT Electronics, Inc. accepts no liability for any errors it contains, and reserves the right to alter specifications without notice. 

WARNING: These products are not designed for use in, and should not be used for, patient connected applications.

This device is marked with the international caution symbol. It is important to read the Setup Guide before installing or commissioning this device as it contains important information relating to safety and EMC.
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SAFETY CONSIDERATIONS

This device is marked with the international Caution symbol. It is important to read this manual before installing or commissioning this device as it contains important information relating to Safety and EMC (Electromagnetic Compatibility).

Unpacking & Inspection

Unpack the instrument and inspect for obvious shipping damage. Do not attempt to operate the unit if damage is found.

This instrument is a panel mount device protected in accordance with Class I of EN 61010 (115/230 AC power connections). Installation of this instrument should be done by Qualified personnel. In order to ensure safe operation, the following instructions should be followed.

This instrument has no power-on switch. An external switch or circuit-breaker shall be included in the building installation as a disconnecting device. It shall be marked to indicate this function, and it shall be in close proximity to the equipment within easy reach of the operator. The switch or circuit-breaker shall not interrupt the Protective Conductor (Earth wire), and it shall meet the relevant requirements of IEC 947–1 and IEC 947-3 (International Electrotechnical Commission). The switch shall not be incorporated in the mains supply cord.

Furthermore, to provide protection against excessive energy being drawn from the mains supply in case of a fault in the equipment, an overcurrent protection device shall be installed.

- The Protective Conductor must be connected for safety reasons. Check that the power cable has the proper Earth wire, and it is properly connected. It is not safe to operate this unit without the Protective Conductor Terminal connected.

- Do not exceed voltage rating on the label located on the top of the instrument housing.
- Always disconnect power before changing signal and power connections.
- Do not use this instrument on a work bench without its case for safety reasons.
- Do not operate this instrument in flammable or explosive atmospheres.
- Do not expose this instrument to rain or moisture.

EMC Considerations

- Whenever EMC is an issue, always use shielded cables.
- Never run signal and power wires in the same conduit.
- Use signal wire connections with twisted-pair cables.
- Install Ferrite Bead(s) on signal wires close to the instrument if EMC problems persist.
1.0 DESCRIPTION

1.1 GENERAL

Newport Model 2004 Digital Panel Voltmeter is a low-cost reliable instruments for digital display of analog bipolar voltages. The display is 39999 counts on any of four ranges from 399.99 mV to 399.99 V.

The Model 2004 DPVM is a line powered meter with 14 mm high, 7-segment LED readout. The housing is a break-resistant black phenylene oxide case. Zero adjustment and full scale adjustment are easily accessible with the front lens removed.

Accuracy at the low end of each range is not degraded by normal mode noise because the Model 2004 performs true bipolar signal integration around zero. Many competitive meters rectify the signal before integration which erroneously adds the absolute value of the normal mode noise to the signal reading. The Model 2004 average value circuit provides full normal mode and superior ac line transient noise rejection at signal levels from zero to full scale.

Ratio measurements are possible with the Model 2004 without modifications or external logic. The configuration is 3-wire (common ground) and the reference must be within a specified voltage range.

Data output lines are parallel BCD, compatible with TTL and DTL. External control signals are also TTL and DTL compatible and increase the flexibility and ease of interfacing the Model 2004 with other instruments.
1.2 SPECIFICATIONS  
1.2.1 Input

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>0.4</td>
<td>4</td>
<td>40</td>
<td>400</td>
<td>V</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.01</td>
<td>0.1</td>
<td>1</td>
<td>10</td>
<td>mV</td>
</tr>
<tr>
<td>Overdrive Protection</td>
<td>100</td>
<td>100</td>
<td>250</td>
<td>500</td>
<td>V</td>
</tr>
<tr>
<td>Input Resistance</td>
<td>1000</td>
<td>1000</td>
<td>1.1</td>
<td>1</td>
<td>MΩ</td>
</tr>
<tr>
<td>Input Bias Current</td>
<td>2</td>
<td>2</td>
<td>0.2</td>
<td>0.02</td>
<td>nA</td>
</tr>
<tr>
<td>Reading Tempco (Typ)</td>
<td>.0015</td>
<td>.001</td>
<td>.002</td>
<td>.002</td>
<td>%R/°C</td>
</tr>
<tr>
<td>Zero Noise Digits (Typ)</td>
<td>.4</td>
<td>.3</td>
<td></td>
<td></td>
<td>P-P</td>
</tr>
<tr>
<td>Full Scale Noise Digits (Typ)</td>
<td>.7</td>
<td>.5</td>
<td></td>
<td></td>
<td>P-P</td>
</tr>
<tr>
<td>Non-linearity</td>
<td>&lt;1.5</td>
<td>&lt;1</td>
<td></td>
<td></td>
<td>counts</td>
</tr>
<tr>
<td>External Reference Voltage</td>
<td>+.1÷+.4</td>
<td>+1.00 ÷+4.00</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Ratio Accuracy</td>
<td>[1]</td>
<td>[2]</td>
<td>99.95</td>
<td>±.05</td>
<td>%R</td>
</tr>
<tr>
<td>Ratio Linearity</td>
<td>&lt;±.05 (±.03 Typ)</td>
<td></td>
<td></td>
<td></td>
<td>%R</td>
</tr>
</tbody>
</table>

[1] The HZ option must be used with the 2004-2 to meet specified accuracy.
[2] R40 may be used as a limited ratio accuracy adjustment in Models 2004-3, -4, and -5 (without HZ option).
[3] A higher resistance is available with the HZ option.
1.2.2 **Accuracy @ 25°C**
- Total Error: ±0.005%R ±10 μV ±1 count
- Offset Tempco: (±2 μV ±1 count)/°C
- Warmup Time: 1 hour

1.2.3 **Conversion**
- Technique: Dual Slope, average value
- Signal Integration Period: 33 mSec (60 Hz); 40 mSec (50 Hz)
- Read Rate: 3.3/Sec (60 Hz) or 2.8/Sec (50 Hz); 0-3.3/Sec (60 Hz) or 0-2.8/Sec (50 Hz) with external control.
- Polarity: Automatic

1.2.4 **Input Characteristics**
- Type: Single-ended (analog ground common to signal low)
- Settling Time: 2 readings (asynchronous input step)
- NMR: 75 dB @ 50 Hz or 60 Hz
- CMR: 120 dB @ 50 Hz or 60 Hz
- Zero: Automatic
- Ratio Measurement: 3-wire

1.2.5 **Calibration Controls**
- Full Scale Adjust (R41): 20 turn, accessible behind front lens; ±1.25%, 7.2°/count @ full scale
- Full Scale Turnover (R40): 1 turn, factory adjustment only, ±.075%, 5°/count @ full scale
- Input Offset (R42): 20 turn, accessible behind front lens; ±25 counts (±2.5 mV), 144°/count.
- Zero Width (R39): 1 turn, factory adjustment only; -2 +5 counts

1.2.6 **Display**
- Type: 14.2mm (.56"), 7-segment LED
- Symbols: -3.8.8.8.8
- Decimal Points: Four (to the left of the four LSD's)
- Overload Indicator: Display flashes
- Polarity Sign: Minus
- Color: Red filter
1.2.7 Digital Signals

DIGITAL I/O DRIVE REQUIREMENTS

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>LOGICAL '0'</th>
<th>LOGICAL '1'</th>
<th>ISINK</th>
<th>ISOURCE</th>
<th>INPUT</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallel BCD</td>
<td>0 V - 5 V</td>
<td>2.4 V - 5.0 V</td>
<td>4.8 mA</td>
<td>.4 mA</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>+ POLARITY</td>
<td>0 V - .4 V</td>
<td>2.4 V - 5.0 V</td>
<td>14.4 mA</td>
<td>.4 mA</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>HOLD</td>
<td>0 V - .6 V</td>
<td>2.0 V - 5.0 V</td>
<td>.3 mA</td>
<td>1.7 mA</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>DATA READY</td>
<td>0 V - .4 V</td>
<td>2.4 V - 5.0 V</td>
<td>4.8 mA</td>
<td>.4 mA</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Overload</td>
<td>0 V - .5 V</td>
<td>2.4 V - 5.0 V</td>
<td>4.8 mA</td>
<td>.4 mA</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

1.2.8 AC Power

- **Input Voltage**: 115 V ac ±10%
- **Frequency Range**: 47 to 63 Hz
- **Input Power**: 4.5W (5W max)
- **Optional Input Voltages**:
  - C6 - 115 V ac, ±10%, 50 Hz
  - C7 - 230 V ac, ±10%, 60 Hz
  - C1 - 230 V ac, ±10%, 50 Hz
  - C5 - 100 V ac, ±10%, 50 Hz
  - C8 - 24 V ac, ±10%, 60 Hz
  - C9 - 24 V ac, ±10%, 50 Hz
  - C3 - 5 V dc, ±5% (60 Hz rejection)
  - C4 - 5 V dc, ±5% (50 Hz rejection)

1.2.9 Temperature

- **Operating Temp.**: 0°C to 50°C
- **Storage Temp.**: -40°C to 75°C
- **Humidity**: Up to 95% non-condensing at ≤40°C

1.2.10 Mechanical

- **Weight**: 480g
- **Case Material**: Black Phenylene Oxide

- **Case Size - DIN 1A**
  - Bezel(WxHxT): 96x48x6 mm (3.78x1.89x0.24 in)
  - Depth Behind Bezel w/Conn.: 135.4 mm (5.33 in)
  - Panel Cutout: 92x45 mm (3.62x1.77 in)
Case Size - NEMA (Optional)
Bezel 104x48x19 mm (4.09x1.88x0.75 in)
Depth Behind Bezel w/Conn. 125 mm (4.91 in)
Panel Cutout 99.6x42.9 mm (3.92x1.69 in)

2.0 RECEIVING AND INSTALLATION

2.1 UNPACKING AND INSPECTION

Your Model 2004 was fully inspected and tested, then carefully packed before shipment. Unpack the meter carefully and inspect it for obvious shipping damage.

2.2 INITIAL CHECKOUT PROCEDURE

CAUTION

Meters are internally connected for 24, 100, 115 or 230 V ac or 5 V dc power. Check label on meter for proper supply voltage.

2.2.1 Required Equipment

(1) Appropriate power source (5 W) as indicated by the label.
(2) Calibrated voltage source.

Test Procedure

(1) Connect signal as follows:
   SIGNAL IN to Pin 17.
   ANALOG GND IN to Pin 16.

(2) Connect power as follows:
   AC HI to Pin A.
   AC LO to Pin 2.
   AC GND to Pin C.

(3) Verify that a key is between Pins 3 and 4.
(4) Pins 1, 3 and B must be removed from connector.
(5) Apply power and check that the meter reads correctly for its specified range.

![Diagram of test procedure](image_url)
2.3 MECHANICAL INSTRUCTIONS

2.3.1 DIN IA
The drawing number 06896 illustrates the mounting method for your panel voltmeter. The unit is inserted from the front of the panel and held in place by two extrusions. The panel thickness may be between .8 mm (.03") and 6.4 mm (.25").

2.3.2 NEMA (Optional)
The drawing number 05169 illustrates the mounting method for your panel voltmeter. The unit is inserted from the front of the panel and held in place by a "U" bracket. The panel thickness may be between .75 mm (.03") and 6.35 mm (.25").

3.0 OPERATING INSTRUCTIONS

3.1 PIN ASSIGNMENTS

<table>
<thead>
<tr>
<th>PIN</th>
<th>NAME</th>
<th>PIN</th>
<th>NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No Connection</td>
<td>A</td>
<td>AC HI</td>
</tr>
<tr>
<td>2</td>
<td>AC LO</td>
<td>B</td>
<td>No Connection</td>
</tr>
<tr>
<td>3</td>
<td>No Connection</td>
<td>C</td>
<td>AC GND</td>
</tr>
<tr>
<td>4</td>
<td>BCD 8</td>
<td>D</td>
<td>BCD 10</td>
</tr>
<tr>
<td>5</td>
<td>BCD 4</td>
<td>E</td>
<td>BCD 20</td>
</tr>
<tr>
<td>6</td>
<td>BCD 2</td>
<td>F</td>
<td>BCD 40</td>
</tr>
<tr>
<td>7</td>
<td>BCD 1</td>
<td>H</td>
<td>BCD 80</td>
</tr>
<tr>
<td>8</td>
<td>BCD 800</td>
<td>J</td>
<td>BCD 1 K</td>
</tr>
<tr>
<td>9</td>
<td>BCD 400</td>
<td>K</td>
<td>BCD 2 K</td>
</tr>
<tr>
<td>10</td>
<td>BCD 200</td>
<td>L</td>
<td>BCD 4 K</td>
</tr>
<tr>
<td>11</td>
<td>BCD 100</td>
<td>M</td>
<td>BCD 8 K</td>
</tr>
<tr>
<td>12</td>
<td>BCD 10 K</td>
<td>N</td>
<td>+ POLARITY</td>
</tr>
<tr>
<td>13</td>
<td>BCD 20 K</td>
<td>P</td>
<td>DATA READY</td>
</tr>
<tr>
<td>14</td>
<td>DECIMAL POINT B</td>
<td>R</td>
<td>HOLD</td>
</tr>
<tr>
<td>15</td>
<td>BCD 40 K (Overload)</td>
<td>S</td>
<td>DECIMAL POINT A</td>
</tr>
<tr>
<td>16</td>
<td>ANALOG GND IN</td>
<td>T</td>
<td>DIGITAL GND</td>
</tr>
<tr>
<td>17</td>
<td>SIGNAL IN</td>
<td>U</td>
<td>Spare</td>
</tr>
<tr>
<td>18</td>
<td>Spare</td>
<td>V</td>
<td>REFERENCE HI IN</td>
</tr>
</tbody>
</table>

3.1.1 Connector Type

SAE  
ELCO  

#SCC18D/1-2*  
#00-6007-036-450-012*
3.2 POWER

3.2.1 Input Voltage
The standard meter operates from 115 V ±10%, 60 Hz. It consumes about 4.5 watts. A three-wire connection should be used to connect power to the meter. Two conductors provide power and the third provides a ground for noise rejection. See Section 1.2.8 for optional 50 Hz and 60 Hz input voltages.

3.2.2 Input Voltage Change
To change the input voltage requirements of the meter from 115 V to 230 V, in the field, the following procedure should be used:

(1) Remove power lines from the meter and remove the meter from the case.

(2) Remove the two jumpers, W1 and W2, located on the transformer.

(3) Add jumper W3 on the printed circuit board. The meter is now wired for 230 V.

To change from 230 V to 115 V input use the reverse of the above procedure.

If other input voltages are required, contact the factory.

3.2.3 Input Frequency Change
The standard Model 2004 is shipped from the factory for 60 Hz operation. If a frequency change is required, the clock frequency must be changed.

Figure 2
*Pins 1, 3, & B must be removed.

Connector pin orientation as viewed from the rear of the meter.
The following table summarizes the part changes required to operate from 50 or 60 Hz power.

<table>
<thead>
<tr>
<th>Model</th>
<th>R29</th>
<th>Y1</th>
<th>R29</th>
<th>Y1</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-2</td>
<td>2.80 k</td>
<td>250 k Hz</td>
<td>2.32 k</td>
<td>300 k Hz</td>
</tr>
<tr>
<td>2004-3,4,5</td>
<td>28.0 k</td>
<td>250 k Hz</td>
<td>23.2 k</td>
<td>300 k Hz</td>
</tr>
</tbody>
</table>

3. Resistor, 1/8W, metal film resistor, NEI P/N 8212801
4. Resistor, 1/8W, metal film resistor, NEI P/N 8212802
5. Resonator, NEI P/N 05797
6. Resistor, 1/8W, metal film resistor, NEI P/N 8212321
7. Resistor, 1/8W, metal film resistor, NEI P/N 8212322
8. Resonator, NEI P/N 05798

3.3 SIGNAL INPUT

For best results, shielded, twisted cable should be used for the input signal, with the shield terminated to ANALOG GND IN (Pin 16) at the connector. Analog Ground and Digital Ground are internally connected and should not be connected externally.
3.3.2 Range Change

The standard meter is a 2004-3. To change from ±3.9999 V to ±399.99 mV full scale, use Procedure A; from ±3.9999 to ±39.999 V full scale, use Procedure B; from ±3.9999 V to ±399.99 full scale, use Procedure C.

PROCEDURE A; from ±3.9999 V to ±399.99 mV

1. Remove and replace R29 with a 2.32 k, ±1%, 1/8W, Metal Film resistor (P/N 8212321) for 60 Hz operation or a 2.80 k, ±1%, 1/8W, Metal Film resistor (P/N 8212801) for 50 Hz operation and R28, a 10 k, ±5%, 1/4W, Carbon Film resistor (P/N 8045103).

2. Add C23, a 33 uF/d, 6.3 V dip tantalum capacitor (P/N 7111336).

3. Add R31, 292.1 ohm, ±1%, 1/8W, wire wound resistor (P/N 8529218).

4. Add jumper E26-E27 (P/N 9001401, 1XX.XX d.p.).

5. Recalibrate the meter for +399.99 mV full scale.

PROCEDURE B; from ±3.9999 V to ±39.999 V

1. Remove and replace R21 with a 1 megohm, ±1%, 1/8W, wire wound resistor (P/N 8510003).

2. Add R20, 111 k ohm, ±1%, 1/8W, wire wound resistor (P/N 8511102).

3. Remove and discard jumper E22-23.


5. Recalibrate the meter for ±39.999 V full scale.

PROCEDURE C; from ±3.9999 V to ±399.99 V

1. Remove and replace R21 with a 1 megohm, ±1%, 1/8W, wire wound resistor (P/N 8510003).

2. Add R20, 10 k ohm, ±1%, 1/8W, wire wound resistor (P/N 8510001).

3. Add jumper E26-E27 for the 1XX.XX d.p. (Decimal Point A, P1-Pin 5).

4. Recalibrate the meter for ±399.99 V full scale.

When changing any range, the span of the full scale pot may not be sufficient to recalibrate the meter. In this event, R32 (604 k ±1% Metal Film P/N 8216043) must be clipped out or soldered into the circuit board. If the meter reads too high, R32 must be soldered in. If the meter reads too low, R32 must be removed.
3.3.3 Ground Precautions

It is essential that the ground connections to the Model 2004 be proper for accurate readings. The input stage is single-ended and analog ground is internally connected to digital ground through a low internal resistance.

![Figure 3](image)

Model 2004 Internal Grounds

The contact resistances resulting from the connection between the connector and the printed circuit board are shown as lumped resistors, $RC_{17}$, $RC_{16}$, and $RcT$. The internal resistance between the analog and digital grounds is shown as $Ri$.

**CORRECT GROUNDING**

The correct grounding method is to connect the low side of the signal to ANALOG GND IN and the common for the digital outputs to DIGITAL GND. This allows the digital current to flow only through $RcT$, causing a voltage drop on the digital line only. There will be no voltage drop across $RC_{16}$ or $Ri$ and the meter will read the signal correctly. There will exist a small voltage difference between Pin 16 and Pin T.

**INCORRECT GROUNDING**

An improper ground connection is to use a single ground pin for both analog and digital ground. When this is done, the return current for the digital outputs flows through either $RC_{16}$ or $RcT$. This causes a voltage drop in series with the input signal and the meter reading will be incorrect. An improper system ground connection for the Model 2004 is to tie the two ground connections together at the source. This creates a ground loop and the voltage drop across $RcT$ appears across $RC_{16}$ and $Ri$ simultaneously. This presents an erroneous reading as in the previous case with a single tie point at the connector.
3.4 RATIO

The reference input allows an external voltage to be used as the reference source for conversion. In this mode, the meter reads the ratio of the signal voltage to the reference voltage rather than the true value of the input.

\[
\text{Reading in Counts} = 10000 \times \frac{\text{Signal voltage}}{\text{Reference voltage}}
\]

On the 40 V and 400 V ranges, the reference voltage must be scaled by 1/10 or 1/100 respectively. The reference input impedance for the 400 mV range is about 260 ohms. For the 4 V, 40 V, and 400 V ranges the impedance is 2.6 k ohms. The reference voltage must be between the limits specified and must be positive with respect to signal low.

3.5 DIGITAL SIGNALS

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>LOGICAL '0'</th>
<th>LOGICAL '1'</th>
<th>ISINK</th>
<th>ISOURCE</th>
<th>IN</th>
<th>OUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallel BCD</td>
<td>0 V - .5 V</td>
<td>2.4 V - 5.0 V</td>
<td>4.8 mA</td>
<td>.4 mA</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>+POLARITY</td>
<td>0 V - .4 V</td>
<td>2.4 V - 5.0 V</td>
<td>14.4 mA</td>
<td>.4 mA</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>HOLD</td>
<td>0 V - .6 V</td>
<td>2.0 V - 5.0 V</td>
<td>.3 mA</td>
<td>1.7 mA</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>DATA READY</td>
<td>0 V - .4 V</td>
<td>2.4 V - 5.0 V</td>
<td>4.8 mA</td>
<td>.4 mA</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Overload</td>
<td>0 V - .5 V</td>
<td>2.4 V - 5.0 V</td>
<td>4.8 mA</td>
<td>.4 mA</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

**DIGITAL I/O DRIVE REQUIREMENTS**

3.5.1 Parallel BCD Outputs

The data outputs are parallel BCD and are TTL and DTL compatible. The outputs are stable and valid while DATA READY (Pin P) is low.

3.5.2 + POLARITY (Pin N)

The + POLARITY output is a logical '1' when the meter indicates a positive reading.

3.5.3 HOLD (Pin R)

When a logical '0' is applied to the HOLD input, the meter will finish the conversion cycle it is on and will hold that reading. If it is applied before the beginning of a conversion, the meter will not start that conversion. Upon a logical '1' at the HOLD input, a new conversion will begin within 125 ±8.3 msec.
3.5.4 **DATA READY (Pin P)**

DATA READY will go to a logical '0' at the end of a conversion cycle and to logical '1' at the beginning of a conversion cycle. 
**NOTE:** DATA READY actually overlaps both ends of the conversion cycle; a full clock cycle before conversion starts and a half clock cycle after conversion ends, allowing adequate set-up times for either edge of Data Ready to transfer data (one clock cycle: 3.3 us at 60 Hz operation, 4 us at 50 Hz operation).

3.5.5 **Overload (Pin 15)**

Overload is the parallel BCD 40 k bit. Overload will go to a logical '1' if the display is greater than 39999. It is stable while **DATA READY** is low.

3.6 **DECIMAL POINTS**

Any of the four decimal points to the left of the four least significant digits can be lighted. The decimal points blank during overload. Two wire jumpers located at the front of the main board select of the two rightmost decimal points and one of the two leftmost decimal points to be controlled by pins on the rear connector. **DECIMAL POINT A** (Pin S) is one of the two rightmost decimal points, **DECIMAL POINT B** (Pin 14) is one of the two leftmost decimal points.

<table>
<thead>
<tr>
<th>JUMPER</th>
<th>DECIMAL POINT</th>
<th>GROUND PIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>E22-E23</td>
<td>X. XXXX (DP1)</td>
<td>14</td>
</tr>
<tr>
<td>E23-E24</td>
<td>XX. XXX (DP2)</td>
<td>14</td>
</tr>
<tr>
<td>E26-E27</td>
<td>XXX. XX (DP3)</td>
<td>S</td>
</tr>
<tr>
<td>E27-E28</td>
<td>XXXX.X (DP4)</td>
<td>S</td>
</tr>
</tbody>
</table>

**DECIMAL POINT CONFIGURATION**

Decimal points are lit by grounding the appropriate pin (to J1-Pin T). If a pin is grounded, the grounding device must be capable of sinking .5 mA.

X.XXXX (DP1) —— O E22
XX.XXX (DP2) —— O E24
XXX.XX (DP3) —— O E26
XXXX.X (DP4) —— O E28

E23 O—— DECIMAL POINT B (Pin 14)
E27 O—— DECIMAL POINT A (Pin S)

In practice, E23 and E27 can be configured to light any two of the four decimal points in any of the possible combinations.
4.0 THEORY OF OPERATION

The Model 2004 Panel Voltmeter uses the dual slope method of conversion. Many state-of-the-art panel meters use dual slope conversion, but the Model 2004 includes automatic zeroing before each reading and does so with a minimum of parts for increased reliability.

At the beginning of a conversion, the voltage across \( C_{\text{int}} \) is zero. The signal is then applied to the integrator and the voltage across \( C_{\text{int}} \) rises by the formula;

\[
E_{C_{\text{int}}} = E_{\text{sig}} \left( \frac{T_1}{R_{\text{int}}C_{\text{int}}} \right)
\]

At the end of a fixed period of 10000 counts (T1), the counters are reset to 000000. The signal input is turned off and a stable reference voltage of the opposite polarity is now applied to the input. Since the reference voltage is constant, the slope, in volts/sec, during this second period (T2) is constant and independent of input signal levels. The time required to discharge the capacitor back to zero volts is then proportional to the signal voltage.

After the clock is stopped by the capacitor voltage reaching zero, a third period (T3) allows the circuit to zero the integrator and comparator for the next reading.

The readings are synchronized to the ac power since the read-rate generator is clocked by the ac line frequency. A '0' on the HOLD input prevents the reset pulse from starting the counters. The relationship between T1 (signal integrate) and T2 (reference integrate) time can be expressed by the formula;

\[
E_{\text{ref}} T_2 = E_{\text{sig}} T_1
\]
FIGURE 5 - CONVERSION CYCLE WAVE FORMS
5.0 ADJUSTMENT AND CALIBRATION

The Model 2004 was calibrated at the factory with a precision voltage source. Frequent calibration is not necessary due to the stability and internal accuracy of the meter. If recalibration is necessary, use the following procedure:

5.1 Plug the Model 2004 to be tested into an appropriate test cable.
5.2 Turn on the power and adjust for 115 V ac.
5.3 With the voltage source set to 0 V, adjust R42 (input-offset; 200 k) until the polarity sign is bouncing between plus and minus polarity.
5.4 Apply an input signal equal to +10.5 counts and adjust R39 (zero width; 100 ohm) until the display is bouncing between +00010 and +00011.
5.5 Apply an input signal equal to -10.5 counts and verify that the display indicated -00010 or -00011 or bouncing between -00010 and -00011 (the error between + and - polarities should only be a few tenths of a digit).
5.6 Apply an input signal equal to -39000.5 and slowly adjust R41 (full scale; 500 ohm) until the display is bouncing between -39000 and -39001.
5.7 Apply an input signal equal to +39000.5 and adjust R40 (turnover; 50 ohm) until the display is bouncing between +39000 and +39001.
5.8 Using the voltage source, check linearity at 10, 100, 1000, 5000, 10000, 20000, 30000, and 39990 counts. Verify that linearity is not worse than 1 count throughout this range in both polarities.

NOTE: This test requires the effects of zero offset and full scale turnover to be taken into account.

5.9 Using the voltage source, observe the DPM readout.
5.9.1 Check all numbers for proper decoding.
5.9.2 Check for Dim/Dead/Bright segments.
5.9.3 Check individual displays for the same relative intensity/illumination.
5.9.4 Check minus polarity sign.
OUTLINE AND MOUNTING FOR DIN 1A CASE

Notes: Dimensions are in inches ±0.01" with millimeters in [ ] ±0.25 mm.

REAR VIEW
(Terminal block cover and bezel not shown for clarity) Slide clamps rotated and slide retainers removed as shown for installation.

Panel thickness
6.4 (.25) MAX
0.8 (.03) MIN

Panel cutout

Note: Dimensions in millimeters (inches)
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