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regulations that apply. OMEGA is constantly pursuing certification of its products to the European New
Approach Directives. OMEGA will add the CE mark to every appropriate device upon certification.
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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, human applications.
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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 over-current 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.
• Unit mounting should allow for adequate ventilation to ensure instrument does not exceed operating temperature rating.
• Use electrical wires with adequate size to handle mechanical strain and power requirements. Install without exposing bare wire outside the connector to minimize electrical shock hazards.

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 GENERAL INFORMATION

This voltmeter is a 4 1/2 digit panel meter for applications which require a compact, quality DC voltmeter. This model uses dual-slope conversion. Additionally, it provides automatic zeroing before each reading and does so with a minimum of parts for increased reliability.

The voltmeter has a resolution of 1 part in ±19999 counts. By using an external DC voltage reference, any of the given ranges can be configured for 3-wire (common ground) ratio measurement with readout from 0 to 1.9999.

Standard features include selectable decimal point location, display hold, test and blanking. Each model contains the required circuitry for full range selection and easy configuration.

2.0 SPECIFICATIONS

2.1 ANALOG INPUT

<table>
<thead>
<tr>
<th>Model</th>
<th>-3</th>
<th>-4</th>
<th>-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>±1.9999 Vdc</td>
<td>±19.999 Vdc</td>
<td>±199.99 Vdc</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.1 mV</td>
<td>1 mV</td>
<td>10 mV</td>
</tr>
<tr>
<td>Maximum input</td>
<td>250 V rms, 350 Vp</td>
<td>250 V rms, 1000 Vp</td>
<td>250 V rms, 1000 Vp</td>
</tr>
<tr>
<td>Input resistance</td>
<td>1 Gohm</td>
<td>1 Mohm</td>
<td>1 Mohm</td>
</tr>
<tr>
<td>Bias current</td>
<td>10 pA</td>
<td>1 pA</td>
<td>1 pA</td>
</tr>
<tr>
<td>Configuration</td>
<td>differential</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zero</td>
<td>automatic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span adjustment</td>
<td>±5%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.2 REFERENCE INPUT FOR 3-WIRE RATIO

| Analog input range | ±2 Vdc, ±20 Vdc, ±200 Vdc |
| Reference voltage | +0.5 to +2.0 V |
| Load on reference | 80 ohm (std), 100 Mohm (opt) |
| Accuracy | 99.95% |

2.3 NOISE REJECTION

| NMR, sig hi to sig lo | 56 dB at 50/60 Hz |
| CMR, sig lo to ana gnd | 86 dB from DC to 60 Hz |
| CMV, sig lo to ana gnd | ±1.0 Vdc |
| CMR, ac gnd to ana gnd | 120 dB from DC to 60 Hz |
| CMV, ac gnd to ana gnd | 2100 Vp per HV test, 354 Vp per IEC 348 spacing |
2.4 ACCURACY AT 25°C

- Maximum error: ±0.01% of reading ±2 counts
- Span tempco: ±0.01% of reading/°C
- Step response: 1 second
- Warm-up to rated accuracy: 10 minutes

2.5 DIGITAL INPUTS  Positive true referenced to DIG GND

<table>
<thead>
<tr>
<th>Input</th>
<th>Logical 0</th>
<th>Logical 1</th>
<th>Sink</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOLD</td>
<td>0 to 0.8 V</td>
<td>2.8 to 5.0 V</td>
<td>0.1 mA</td>
<td>10 µA</td>
</tr>
<tr>
<td>LAMP TEST</td>
<td>0 to 0.6 V</td>
<td>2.0 to 5.0 V</td>
<td>1.3 mA</td>
<td>20 µA</td>
</tr>
<tr>
<td>DISPLAY BLANKING</td>
<td>0 to 0.6 V</td>
<td>2.0 to 5.0 V</td>
<td>1.3 mA</td>
<td>20 µA</td>
</tr>
</tbody>
</table>

2.6 ANALOG-TO-DIGITAL CONVERSION

- Technique: Dual-slope, average-value
- Input integration period: 100 milliseconds
- Read rate: 2.5/second

2.7 DISPLAY

- Digit type: 7 segments, 14.2 mm (0.56 in) height
- Symbols: -1.8.8.8.8
- Decimal Points: 4 positions, programmable internally or at the rear connector
- Overrange indication: 4 least-significant digits flash

2.8 POWER

- Standard AC power voltage: 115 or 230 Vac ±15%
- AC frequency range: 49 to 440 Hz
- Optional DC power voltage: 9-32 or 26-56 Vdc, isolated to 300 Vp
- Power consumption: 2.4 W
- Output voltages: +4.7 Vdc ±5% at 10 mA max
- -4.6 Vdc ±5% at 10 mA max

2.9 ENVIRONMENTAL

- Operating temperature: 0 to +60°C
- Storage temperature: -40 to +85°C
- Relative humidity: 95% RH to +40°C (non-condensing)
2.10 MECHANICAL

Bezel
Depth behind bezel (with connector)
Panel cutout
Weight
Case material
D1 connector option
D4 connector option
96 x 48 x 5.1 mm (3.78 x 1.89 x 0.20 in)
104 mm (4.09 in)
92 x 45 mm (3.62 x 1.77 in)
400 g (14 oz)
94V-0 UL-rated polycarbonate
PCB edge connector with a double row of 18-pins, 3.96 mm (0.156 in) spacing between pins
Barrier terminal strip with six #6 screw connections for signal and power (removes these inputs from D1)

3.0 MECHANICAL ASSEMBLY AND INSTALLATION

3.1 CASE DIMENSIONS

Figure 3.1 DIN Case Dimensions
3.2 PANEL MOUNTING

1. Remove main board connector J1, if installed. Loosen the two clamp screws (with a #8 Phillips screwdriver) on the rear of case and rotate the slide clamps. Push the two slide retainers toward the rear of the unit and remove them.

2. Working from the front of the panel, insert the meter into the panel cutout (refer to case dimensions shown below).

3. Push the slide retainers onto the case to fit tightly against the panel rear. Rotate slide clamps back into original position and tighten clamp screws just enough to hold the case in place. Never over-tighten clamp screws.

4. Reinstall any connectors and snap on the terminal block cover.
4.0 POWER AND SIGNAL

AC versions of the voltmeter are factory-set for 115 Vac in the USA and 230 Vac in Europe (using C1 option) ±15% operation. DC versions are preset for 9-32 Vdc or 26-56 Vdc operation. It is not possible to change the meter from 9-32 Vdc to 26-56 Vdc or vice versa. Different static inverters are installed by the factory.

Refer to Safety Considerations prior to connecting power.

4.1 CHANGING OPERATING VOLTAGE

Remove power lines from the meter, then remove the meter from the case.

<table>
<thead>
<tr>
<th>Input</th>
<th>Jumper Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>230 Vac ±15% (Option C1)</td>
<td>Remove W8 and W9 on the transformer</td>
</tr>
<tr>
<td></td>
<td>Install W4 on the printed circuit board</td>
</tr>
<tr>
<td>115 Vac ±15% (Standard)</td>
<td>Remove W8 and W9 on the transformer</td>
</tr>
<tr>
<td></td>
<td>Install W4 on the printed circuit board</td>
</tr>
</tbody>
</table>

![Figure 4.1](image-url)  
Side View of Transformer

4.2 POWER AND SIGNAL CONNECTIONS

Use shielded, twisted cable for the input signal, with the shield terminated to analog ground at the connector. Both analog and digital ground are internally connected and should not be connected externally. For proper grounding, connect the low signal to SIG LO (signal low).

A jumper at S3-A (Figure 5-2 Main Board) ties SIG LO to ANA GND (analog ground) internally. The common for digital inputs/outputs is connected to DIG GND (digital ground). This allows current to flow only in the digital ground and prevents IR drop in the analog ground that would be misread as a signal. A small voltage may exist between analog and digital grounds on connector J1.
### Figure 4.2

#### Rear Terminal Hookups

<table>
<thead>
<tr>
<th>Model</th>
<th>Power</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1 Connector</td>
<td>1</td>
<td>17 High</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>16 Low</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>T Analog Ground</td>
</tr>
<tr>
<td>D4 Connector</td>
<td>2</td>
<td>6 High</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4 Analog Ground</td>
</tr>
<tr>
<td><strong>DC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1 Connector</td>
<td>2</td>
<td>17 High</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>T Analog Ground</td>
</tr>
<tr>
<td>D4 Connector</td>
<td>2</td>
<td>6 High</td>
</tr>
</tbody>
</table>

**Wire Color for AC Power**

- (High) USA: Black
- (Low) USA: White
- (Ground) USA: Green
- (High) Other: Brown
- (Low) Other: Blue
- (Ground) Other: Green
## 4.3 MAIN BOARD PIN ASSIGNMENTS (J1 Card Edge)

*Left to right, looking at rear of case*

<table>
<thead>
<tr>
<th>P1 Connection</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Spare (E16)</td>
</tr>
<tr>
<td>1</td>
<td>No connection</td>
</tr>
<tr>
<td>B</td>
<td>No connection</td>
</tr>
<tr>
<td>2</td>
<td>Spare (E18)</td>
</tr>
<tr>
<td>C</td>
<td>Spare (E19)</td>
</tr>
<tr>
<td>3</td>
<td>No connection</td>
</tr>
<tr>
<td>D</td>
<td>No connection</td>
</tr>
<tr>
<td>4</td>
<td>No connection</td>
</tr>
<tr>
<td>E</td>
<td>Spare (E43)</td>
</tr>
<tr>
<td>5</td>
<td>No connection</td>
</tr>
<tr>
<td>F</td>
<td>1999.9 (DP4)</td>
</tr>
<tr>
<td>6</td>
<td>Spare (E24)</td>
</tr>
<tr>
<td>H</td>
<td>199.99 (DP3)</td>
</tr>
<tr>
<td>7</td>
<td>Spare (E23)</td>
</tr>
<tr>
<td>J</td>
<td>19.999 (DP2)</td>
</tr>
<tr>
<td>8</td>
<td>Spare (E22)</td>
</tr>
<tr>
<td>K</td>
<td>1.9999 (DP1)</td>
</tr>
<tr>
<td>9</td>
<td>Spare (E25)</td>
</tr>
<tr>
<td>L</td>
<td>Decimal point select</td>
</tr>
<tr>
<td>10</td>
<td>Spare (E26)</td>
</tr>
<tr>
<td>M</td>
<td>Spare (E27)</td>
</tr>
<tr>
<td>11</td>
<td>−4.6 Vdc power output</td>
</tr>
<tr>
<td>N</td>
<td>Spare (E29)</td>
</tr>
<tr>
<td>12</td>
<td>+4.7 Vdc power output</td>
</tr>
<tr>
<td>P</td>
<td>− Excitation voltage</td>
</tr>
<tr>
<td>13</td>
<td>+ Reference voltage</td>
</tr>
<tr>
<td>R</td>
<td>LAMP TEST (lights display segments)</td>
</tr>
<tr>
<td>14</td>
<td>+ Excitation voltage</td>
</tr>
<tr>
<td>S</td>
<td>Digital ground</td>
</tr>
<tr>
<td>15</td>
<td>HOLD (holds last display reading)</td>
</tr>
<tr>
<td>T</td>
<td>Analog Ground</td>
</tr>
<tr>
<td>16</td>
<td>Spare (E32)</td>
</tr>
<tr>
<td>U</td>
<td>BLANKING (blanks 4 least-significant digits)</td>
</tr>
<tr>
<td>17</td>
<td>Spare (E34)</td>
</tr>
<tr>
<td>V</td>
<td>Oscillator (100 kHz output)</td>
</tr>
<tr>
<td>18</td>
<td>No connection</td>
</tr>
</tbody>
</table>
4.4 SIGNAL INPUTS

**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.

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

On the 20 V and 200 V ranges, the signal voltage must be scaled by 1/10 and 1/100, respectively. For all ranges, the standard reference input impedance ratio is 80 ohm. For 100 Mohm, open solder switch F on the main board (Figure 5.3). The reference voltage must be between the limits specified, +0.5 to +2.0 V, and must be positive with respect to analog ground.

**HOLD**: When high (or open), the A/D will free-run with equally spaced measurement cycles every 40,002 clock pulses. If taken low, the converter will complete the full measurement cycle and then hold this reading as long as HOLD is low. A positive pulse (greater than 300 ns) will now initiate a new measurement cycle, beginning with between 9,001 and 10,001 counts of auto-zero time. If the pulse terminates before the full measurement cycle (40,002 counts) is complete, it will not be recognized and the converter will simply complete the present measurement. An external indication that a full measurement cycle has been completed is that the first strobe pulse will occur 101 counts after the end of this cycle. Thus, if HOLD has been low for at least 101 counts, the converter is holding and ready to start a new measurement when pulsed high.

**BLANKING**: The display may be blanked by grounding the BLANKING input. The blanking input must be open for normal display operation. The polarity sign and decimal points are not blanked, but they will flash if the displayed reading exceeds ±19999 counts.
5.0 CONFIGURATION

Select the desired configurations from the following charts. Install jumpers and open/close solder switches as indicated. Remove all push-on jumpers not used.

5.1 DECIMAL POINT SELECTION

**Figure 5.1 Display Board Jumper Locations**

<table>
<thead>
<tr>
<th>Decimal Point</th>
<th>S1</th>
<th>Alternate decimal point configuration using main board connector J1.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.9999</td>
<td>A</td>
<td>Connect K to L</td>
</tr>
<tr>
<td>19.999</td>
<td>B</td>
<td>Connect J to L</td>
</tr>
<tr>
<td>199.99</td>
<td>C</td>
<td>Connect H to L</td>
</tr>
<tr>
<td>1999.9</td>
<td>D</td>
<td>Connect F to L</td>
</tr>
</tbody>
</table>
5.2 VOLTAGE RANGE SELECTION

Figure 5.2 Main Board Jumper Locations

<table>
<thead>
<tr>
<th>Input Configuration</th>
<th>Solder Switches*</th>
<th>Push-on Jumpers</th>
<th>Wire Jumper</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Open</td>
<td>Close</td>
<td>S2</td>
</tr>
<tr>
<td>2 Vdc</td>
<td>J, L</td>
<td>H, I, K</td>
<td>-</td>
</tr>
<tr>
<td>20 Vdc</td>
<td>J, L</td>
<td>H, I, K</td>
<td>A</td>
</tr>
<tr>
<td>200 Vdc</td>
<td>J, L</td>
<td>H, I, K</td>
<td>A</td>
</tr>
</tbody>
</table>

*Refer to Figure 5.3.

S3-A is used for signal connections. Refer to Section 4 for more information.
Figure 5.3 Solder Switch Locations

Solder switch F is used for reference input impedance ratio. Refer to Section 4 for more information.

6.0 CALIBRATION

This unit was factory-calibrated with a precision voltage source. Frequent calibration is not necessary due to the stability and internal accuracy. If calibration is needed, use the following procedure.

1. Remove the front lens. Insert a blade screwdriver under the notch at the bottom of the lens and gently pry it off.

2. Short the input signal connections and verify that the display reads zero.

3. Apply an input voltage equal to 95% of the high end of the range selected.

4. At the front panel, adjust the Span potentiometer (shown in Figure 3.2) until the display reads 19000 ±1 count.
Figure 7.1
Assembly Diagram, Main and Display Board
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:

$$E_{C\text{int}} = \frac{T_1}{E_{\text{sig}} R_{\text{int}} C_{\text{int}}}$$

At the end of a fixed period of 10000 counts, $T_1$, the counters are reset to 00000. 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, $T_2$, 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. The relationship between the signal integration time, $T_1$, and the reference integration time, $T_2$, can be expressed by the formula:

$$E_{\text{ref}} T_2 = E_{\text{sig}} T_1$$

After the clock is stopped by the capacitor voltage reaching zero, a third period, $T_3$, allows the circuit to auto-zero the integrator and comparator for the next reading. A low level on the HOLD input prevents the reset pulse from starting the counters.

---

**Figure 8.1**

Dual-slope Conversion Diagram
WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of one (1) year from the date of purchase. In addition to OMEGA’s standard warranty period, OMEGA Engineering will extend the warranty period for one (1) additional year if the warranty card enclosed with each instrument is returned to OMEGA.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA’s Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA’s WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA’s control. Components which wear are not warranted, including but not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by it will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESS OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive, and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a “Basic Component” under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and, additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA’S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR WARRANTY RETURNS, please have the following information available BEFORE contacting OMEGA:
1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR NON-WARRANTY REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:
1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA’s policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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