CE

User's Guide

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DP3001
DIGITAL PANEL VOLTMETER

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It is the policy of OMEGA Engineering, Inc. to comply with all worldwide safety and EMC/EMI 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.

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

Model	-3	-4	-5
Range	±1.9999 Vdc	±19.999 Vdc	±199.99 Vdc
Resolution	0.1 mV	1 mV	10 mV
Maximum input	250 V rms, 350 Vp	250 V rms, 1000 Vp	250 V rms,1000 Vp
Input resistance	1 Gohm	1 Mohm	1 Mohm
Bias current	10 pA	1 pA	1 pA

Configuration	differential
Zero	automatic
Span adjustment	±5%

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

Input	Logical 0	Logical 1	Sink	Source
$\overline{\text{HOLD}}$	0 to 0.8 V	2.8 to 5.0 V	0.1 mA	10 µA
$\overline{\text{LAMP TEST}}$	0 to 0.6 V	2.0 to 5.0 V	1.3 mA	20 µA
DISPLAY $\overline{\text{BLANKING}}$	0 to 0.6 V	2.0 to 5.0 V	1.3 mA	20 µA

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	96 x 48 x 5.1 mm (3.78 x 1.89 x 0.20 in)
Depth behind bezel (with connector)	104 mm (4.09 in)
Panel cutout	92 x 45 mm (3.62 x 1.77 in)
Weight	400 g (14 oz)
Case material	94V-0 UL-rated polycarbonate
D1 connector option (non-CE)	PCB edge connector with a double row of 18-pins, 3.96 mm (0.156 in) spacing between pins
D4 connector option (CE)	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

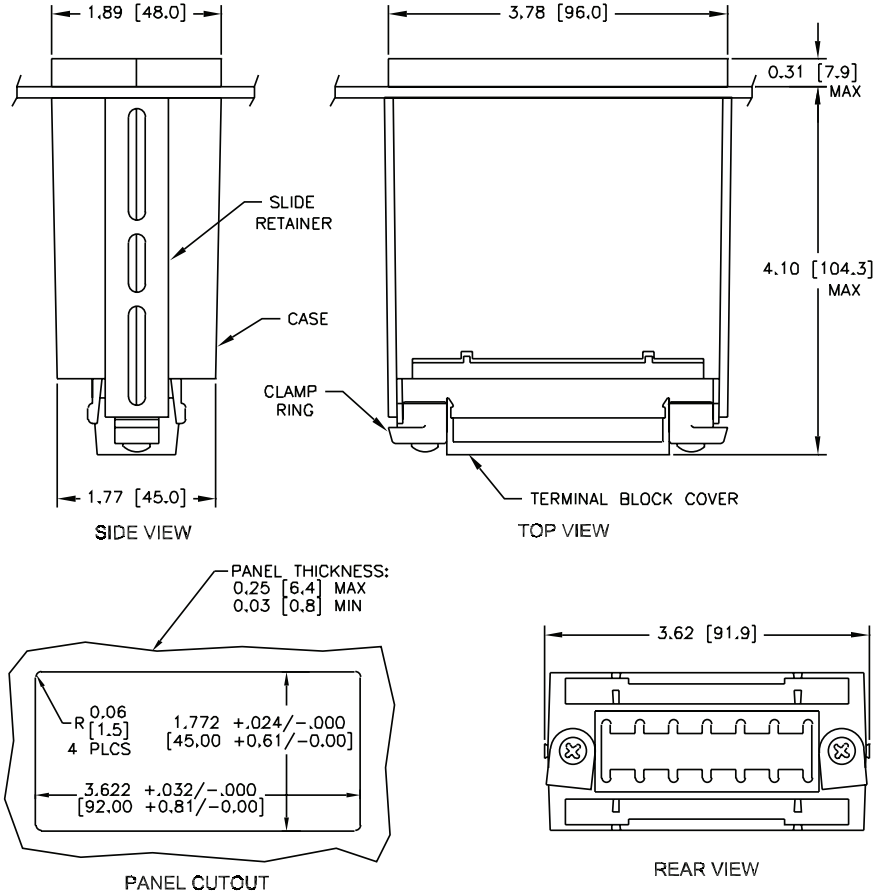

Figure 3.1 DIN Case Dimensions

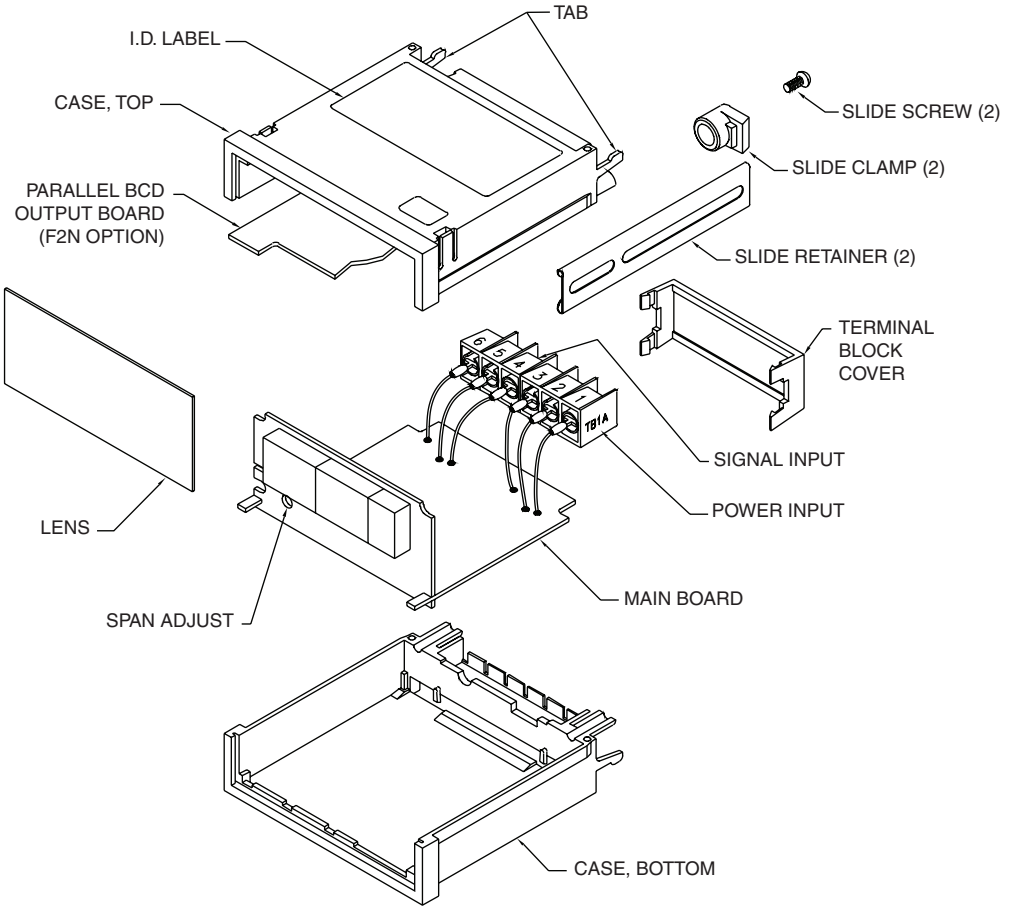

Figure 3.2 Exploded View

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.

Input	Jumper Installation
230 Vac ±15% (Option C1)	Remove W8 and W9 on the transformer
	Install W4 on the printed circuit board
115 Vac ±15% (Standard)	Remove W8 and W9 on the transformer
	Install W4 on the printed circuit board

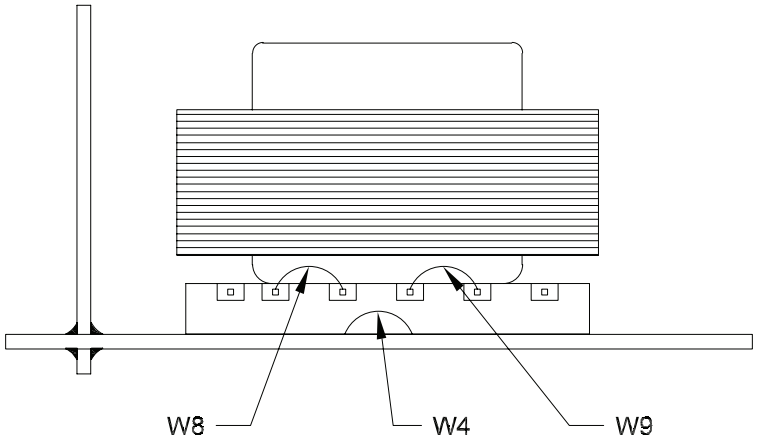

Figure 4.1
Side View of Transformer

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.

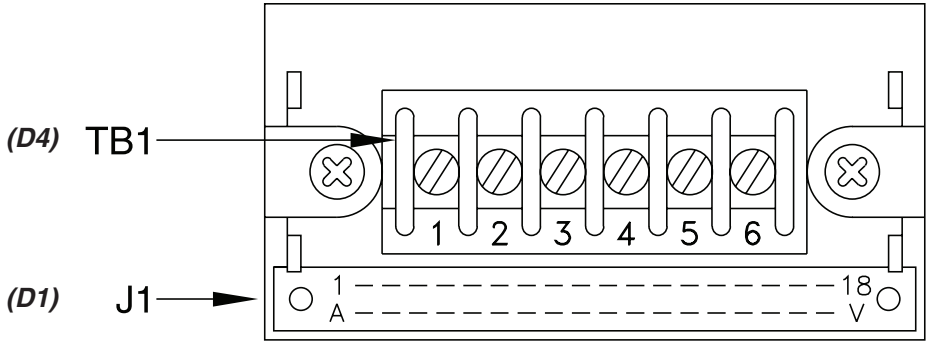

Figure 4.2
Rear Terminal Hookups

Model		Power		Signal	
AC	D1 Connector	A	High	17	High
		2	Low	16	Low
		C	Earth Ground	T	Analog Ground
	D4 Connector	1	High	6	High
		2	Low	5	Low
		3	Earth Ground	4	Analog Ground
DC	D1 Connector	2	+ DC	17	High
		C	- DC (return)	16	Low
				T	Analog Ground
	D4 Connector	2	+ DC	6	High
		3	- DC (return)	5	Low
				4	Analog Ground

Wire Color for AC Power	***USA***	***Other***
(High)	*Black*	*Brown*
(Low)	*White*	*Blue*
(Ground)	*Green*	*Green*

4.3 MAIN BOARD PIN ASSIGNMENTS (J1 Card Edge)

Left to right, looking at rear of case

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

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.

$\overline{\text{HOLD}}$: 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 $\overline{\text{HOLD}}$ 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 $\overline{\text{HOLD}}$ has been low for at least 101 counts, the converter is holding and ready to start a new measurement when pulsed high.

$\overline{\text{BLANKING}}$: The display may be blanked by grounding the $\overline{\text{BLANKING}}$ 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

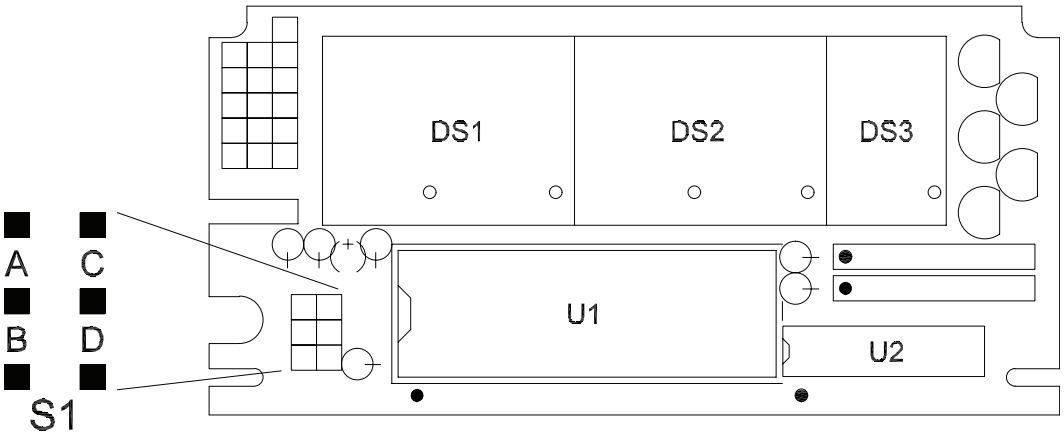

Figure 5.1 Display Board Jumper Locations

Decimal Point	S1	Alternate decimal point configuration using main board connector J1.
1.9999	A	Connect K to L
19.999	B	Connect J to L
199.99	C	Connect H to L
1999.9	D	Connect F to L

5.2 VOLTAGE RANGE SELECTION

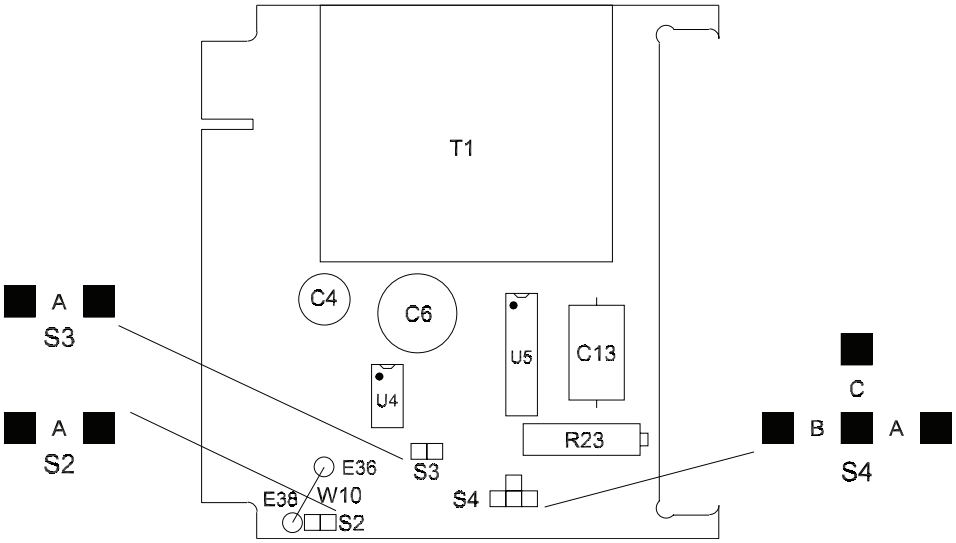

Figure 5.2 Main Board Jumper Locations

Input Configuration	Solder Switches*		Push-on Jumpers		Wire Jumper
	Open	Close	S2	S4	W10
2 Vdc	J, L	H, I, K	-	-	Install
20 Vdc	J, L	H, I, K	A	B	Remove
200 Vdc	J, L	H, I, K	A	C	Remove

*Refer to **Figure 5.3**.

S3-A is used for signal connections. Refer to **Section 4** for more information.

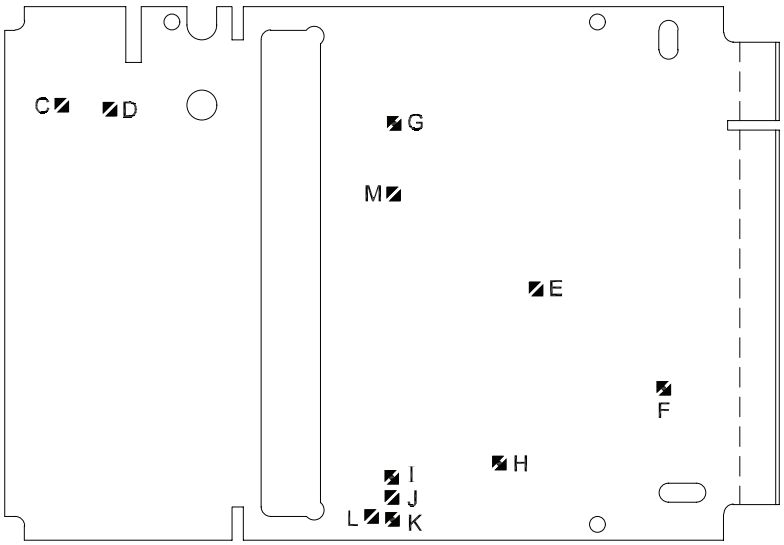

Figure 5.3 Solder Switch Locations

Note ☞ 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.

7.0 DRAWINGS

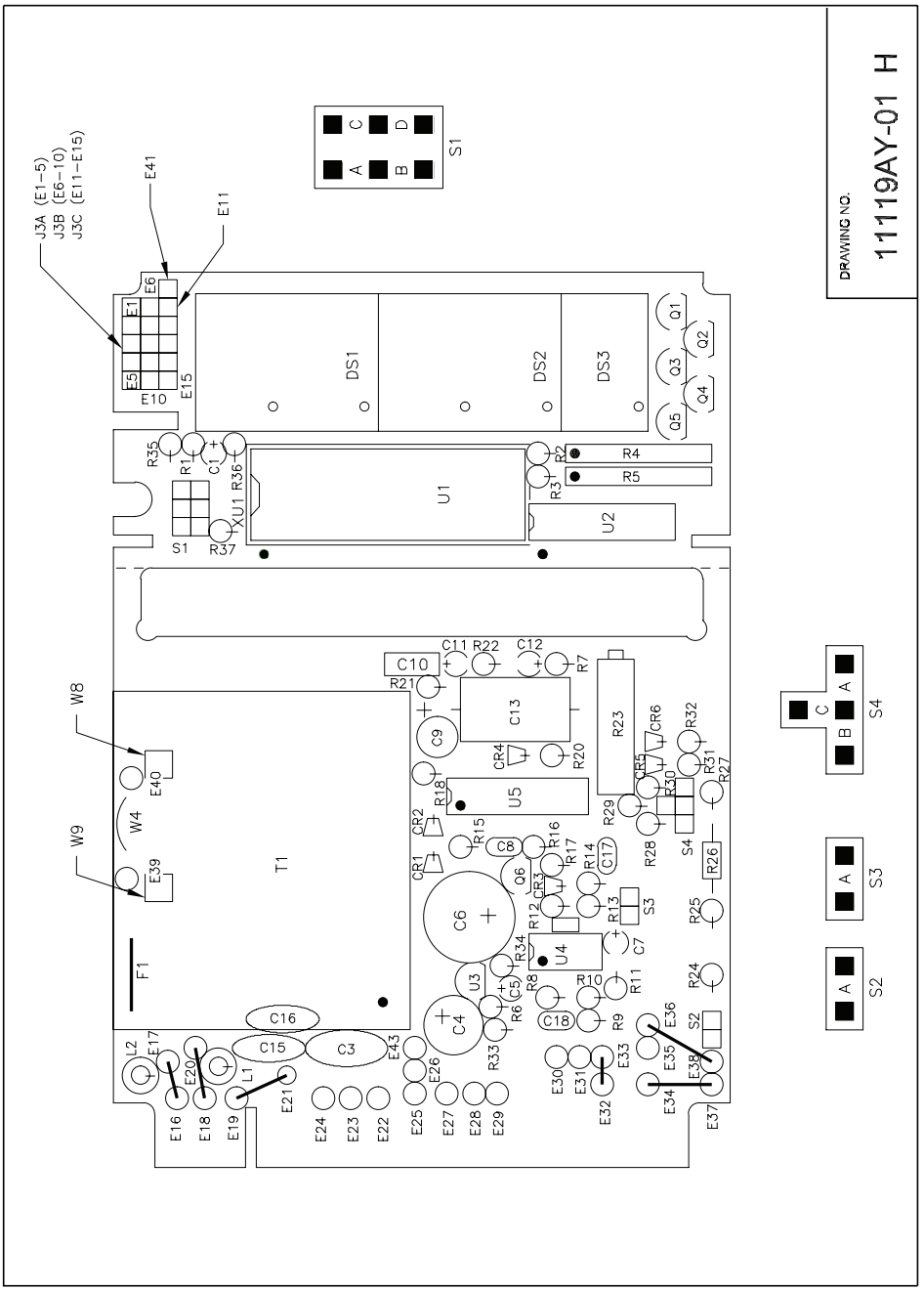

Figure 7.1
Assembly Diagram, Main and Display Board

8.0 DUAL-SLOPE CONVERSION

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

$$E_{Cint} = Esig \frac{T1}{R_{int}C_{int}}$$

At the end of a fixed period of 10000 counts, T1, 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, 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. The relationship between the signal integration time, T1, and the reference integration time, T2, can be expressed by the formula:

$$E_{ref}\, T2 = E_{sig}\, T1$$

After the clock is stopped by the capacitor voltage reaching zero, a third period, T3, allows the circuit to auto-zero the integrator and comparator for the next reading. A low level on the $\overline{HOLD}$ input prevents the reset pulse from starting the counters.

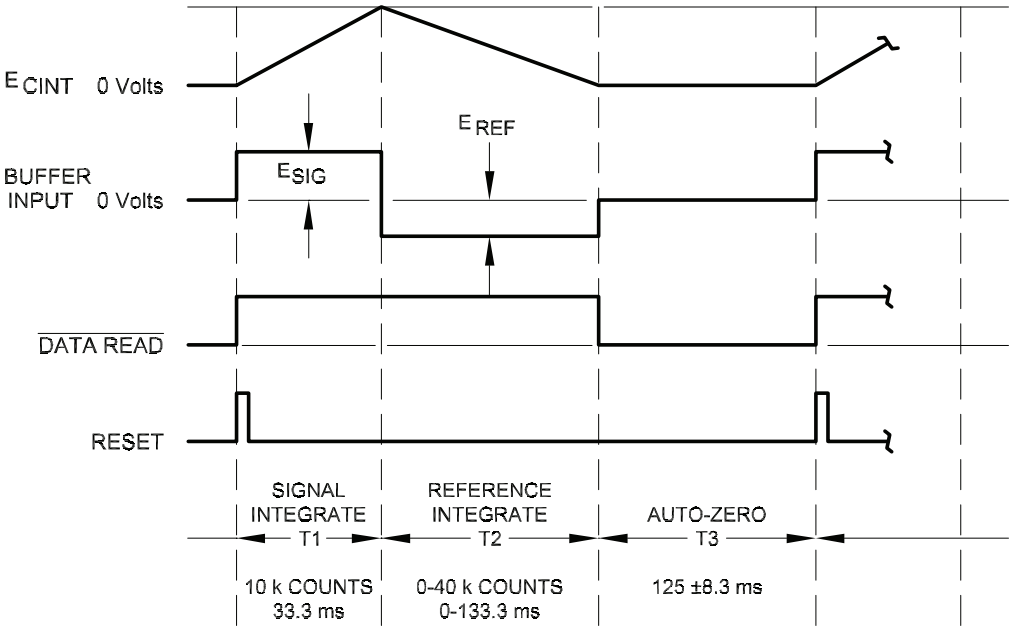

Figure 8.1
Dual-slope Conversion Diagram

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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.

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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:

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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.

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