



DATEL

DM-9000 SERIES DIGITAL PANEL METERS

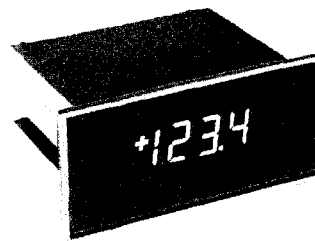
PRODUCT DATA AND USER'S GUIDE

FEATURES:

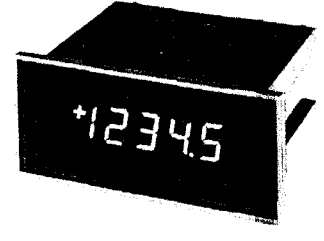
- Fit into industry standard DIN/NEMA size panel cutouts
- 3½ or 4½ digit display
- Bright 0.56" Light Emitting Diode (LED) and 0.5" Liquid Crystal Display (LCD)
- Powered by AC or dc sources
- High Resolution
0.001 V (3½ digit DPM's)
0.0001 V (4½ digit DPM's)
- Balanced High Impedance Differential Inputs
- Autozeroing Capability
- 80 dB CMRR
- Low Cost

APPLICATIONS

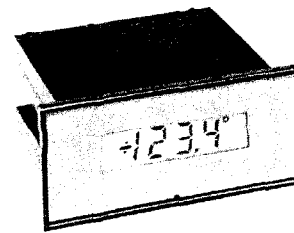
- Industrial Process Equipment
- Portable Diagnostic Instruments
- Automated Test Equipment
- Medical Instruments
- Marine and Ground Vehicle Systems
- Data Acquisition/Data Logging Systems
- Analytical Instruments



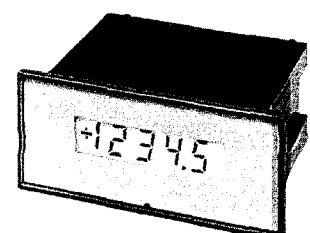
DM-9100
DM-9115



DM-9200
DM-9215



DM-9150
DM-9165



DM-9250
DM-9265

THE DM-9000 SERIES DIGITAL PANEL METERS ARE DESIGNED TO MEET INDUSTRY STANDARD DIN/NEMA PANEL CUTOUTS. THE LOW COST, HIGH PERFORMANCE SERIES INCLUDES A WIDE VARIETY OF MODELS, OFFERING FLEXIBILITY TO OEM'S AND INDIVIDUAL USERS.

GENERAL DESCRIPTION

The DM-9000 Series DPM's offer the user 3½ or 4½ digits of display, using either AC or dc power sources. This panel meter line offers two types of displays. The high-efficiency red LED's provide excellent readability from up to 23 feet (7 meters) away, even under bright ambient light. The high contrast LCD's have viewing angles of up to 75 degrees from normal and are ideally suited for low power applications.

These DPM's may be operated in Differential, Single-Ended, or Ratiometric modes. In differential mode, the balanced inputs of the DM-9000 Series provide high noise immunity and accurately measure very small signals in the presence of much larger common-mode voltages. The high impedance (100 megohms) will not load down sensitive input circuits. The single-ended mode in the DM-9000 Series DPM's is solder gap selectable and is easy to use for simple applications.

For ratiometric measurements, the DPM's reference the input voltages to the user-supplied voltage using the REF IN/OUT pin (Pin 4). The ratiometric mode of operation corrects for input errors created by drift in transducer excitation sources, i.e., bridge type applications. Circuit pads in the DM-9000 Series DPM's accept user-installed current shunts to extend full-scale input current ranges

from $\pm 20 \mu\text{A}$ to $\pm 2\text{A}$. User-supplied components may also extend the voltage ranges upwards to $\pm 1\text{KV}$ full scale. The 4½ digit panel meters (DM-92XX models) have OVERRANGE and UNDERANGE outputs, usable in autoranging circuits and a BUSY/DONE output which goes low at the end of each analog-to-digital conversion cycle.

All models accept a HOLD (or RUN/HOLD) signal from the user, inhibiting continuous sampling. The units display the last data sampled, acting as temporary single sample storage and display devices.

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Functionally, a DPM is made up of four parts: the integrator and A/D converter, decoder driver, display, and power supply (see Figure 1).

All AC models accept 100, 117, 220 or 240 VAC sources. Refer to Table 1 for power supply pin connections.

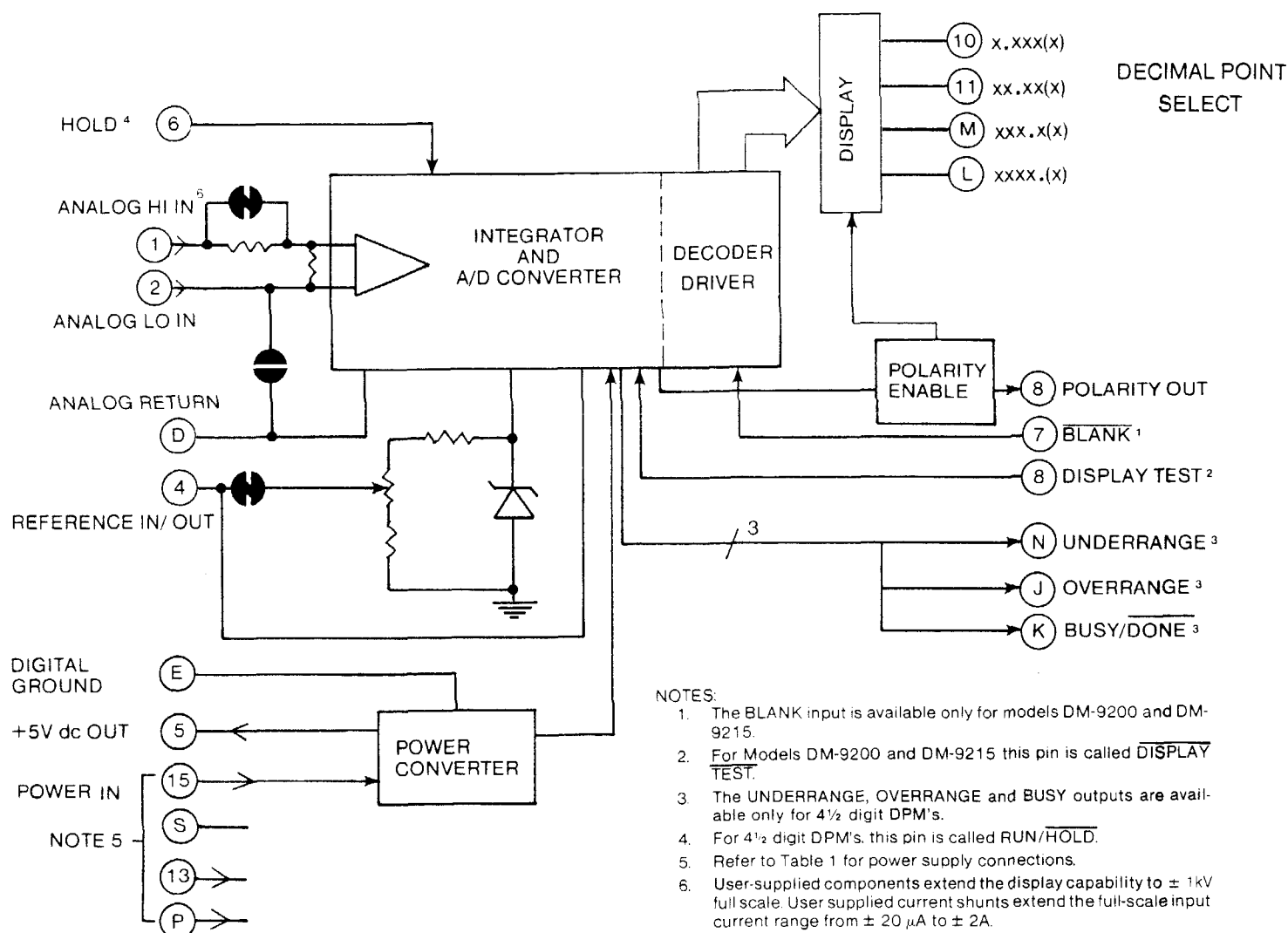


Figure 1. Simplified Block Diagram

Table 1. Power Supply Connections

PIN NUMBER INPUT VOLTAGE	15	13	S	P
5V dc				
115 VAC				
220 VAC				
240 VAC				
100 VAC				

NOTE

The DM-9000 Series DPM's uses pins P, 5, 13, 15, and S for power connections. Use of these pins is different for dc and AC models. AC models use different combinations of these pins for different power inputs. It is therefore important to check the information presented here for correct power applications.

Note 1: Pin S is POWER COMMON for dc models.

FUNCTIONAL SPECIFICATIONS

(Typical @ 25°C)

ANALOG INPUT

Full Scale Input Range	..... -1.999(9) to +1.999(9)V dc. Circuit pads accept user-installed components for other ranges.
Input Impedance	..... 100 Megohms (minimum)
Input Bias Current	..... 5 pA (typical) 50 pA (maximum)
Input Over Voltage	..... ANALOG LO IN } $\pm 100V$ dc ANALOG HI IN } continuous, referenced to POWER COMMON. $\pm 250V$ dc (5 seconds maximum) referenced to POWER COMMON.
External Ref. Range	... +100 mV to +2V dc referenced to ANALOG RETURN.
Common-Mode Rejection	..... 80 dB (typical); from dc to 60 Hz, with 1 K ohm unbalance
Common-Mode Voltage Range	..... Both the inputs must remain within 0.5V dc below +5V dc supply and 1.0V dc above -5V dc supply
Resolution	..... 1 mV, 3½ digit DPM's 100 μ V, 4½ digit DPM's
Accuracy	..... Adjustable to $\pm 0.02\%$ of reading (maximum), ± 2 counts
Temperature Drift of Zero	..... Autozeroed ± 1 count over a 0 to +50°C temperature range
Temperature Drift of Gain ± 50 ppm of reading/°C (typical) ± 100 ppm of reading/°C (maximum)
Warm-Up Time	..... 5 minutes (typical)

	3½ digit DPM's	4½ digit DPM's
Sampling Time (nom.)	83.3 ms	74 ms
Conversion Time (nom.)	333 ms	296 ms

DISPLAY SPECIFICATIONS

Number of Digits	..... DM-91XX models, three decimal digits and most significant "1" digit. DM-92XX models, four decimal digits and most significant "1" digit.
Decimal Points	..... Selectable decimal points are included for scale multipliers. (In 4½ digit DPM's, decimal point after least significant digit can be blanked using solder gap option.)
Display Type	..... LED (Red, high efficiency) LCD (Liquid crystal with high contrast ratio, high temperature fluid)

Display Height	..... LED 0.56" (14,22 mm) LCD 0.5" (12,70 mm)
Auto Polarity	..... A + sign is automatically displayed for positive inputs and a - sign is for negative inputs. The user may blank the polarity using solder gap options.
Over Scale	..... The display indicates inputs exceeding the full-scale range. Refer to the table below.

Model Number	Overscale Display
DM-9100, DM-9115, DM-9150, DM-9165	Blanks the display leaving a "1" MSD and sign.
DM-9200, 9215	Blanks "1" MSD and displays all other digits as zeroes and flashes.
DM-9250, DM-9265	Blanks "1" MSD, displays all other digits as zeros and flashes error sign (Δ in the top left corner).

POWER CONSIDERATIONS
Power Consumption with no external load

MODEL	Typical	Maximum
DM-9100	0.9 W	1.1W
DM-9115	2.6W	3.2W
DM-9150	0.02W	0.025W
DM-9165	0.9W	1.1W
DM-9200	0.9W	1.1W
DM-9215	2.6W	3.2W
DM-9250	0.02W	0.025W
DM-9265	0.9W	1.1W

Power output for AC models: +5V dc @ 100mA (maximum)

Power output for dc models: Limited by user's dc source

CALIBRATION

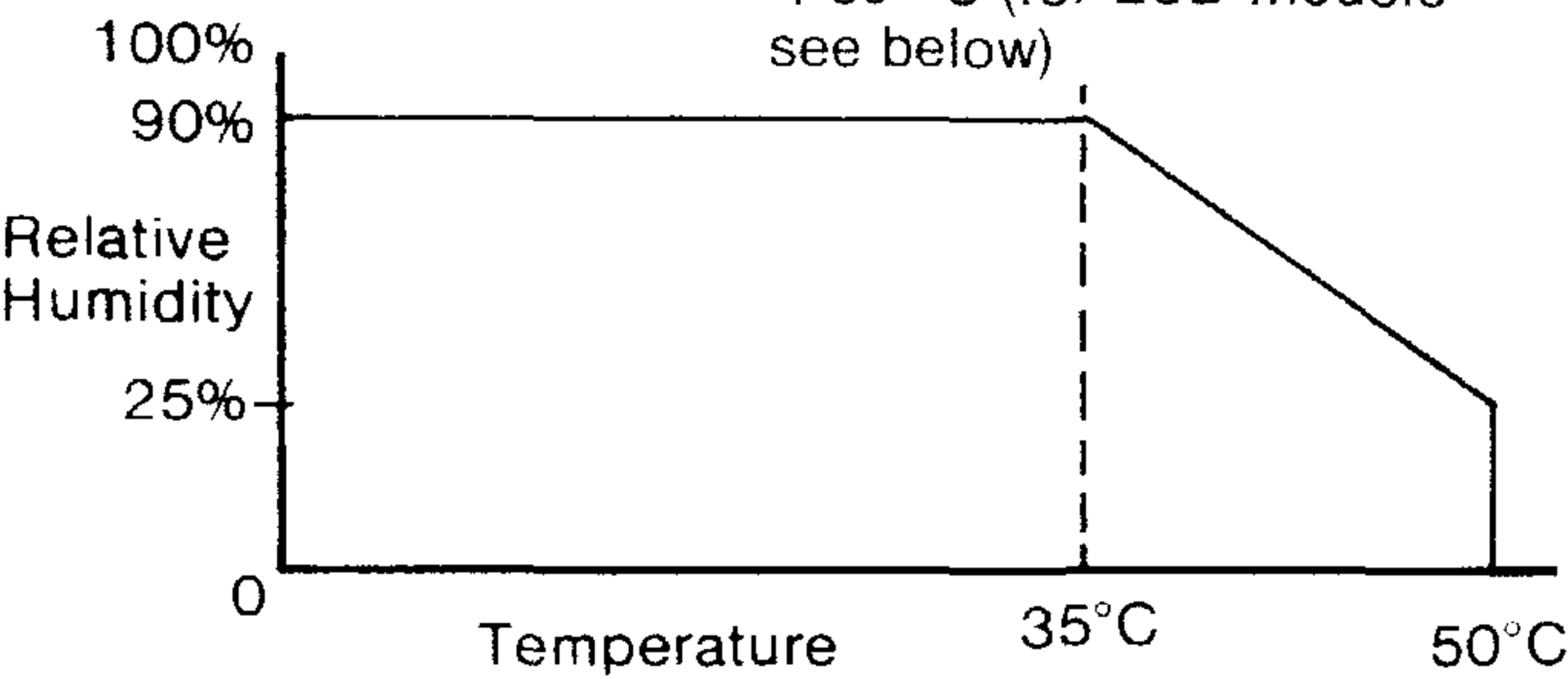
A screwdriver pot allows adjusting the full scale reading (gain). Zero is automatic (autozeroing). Suggested recalibration period under normal operating conditions is 90 days.

Procedure:

1. Apply +1.900V to the DPM using a voltage calibrator such as a DVC-350 or DVC-8500.
2. Adjust the gain-adjust potentiometer until the DPM displays the reading +1900(0).
3. To check linearity, apply different known voltages and observe the reading on the DPM. The readings should be within ± 3 counts.

PHYSICAL-ENVIRONMENTAL

External Dimensions	3.6"W X 3.57"D X 1.67"H (91,44 mm x 90,68 mm x 42,42 mm)
Panel Cutout Dimensions	NEMA Standard: 3.924" X 1.682" (99,67 mm x 42,72 mm) DIN Standard: 3.622" X 1.772" (92 mm x 45 mm)
Weight	AC models: 11 Ounces (311.8 grams) dc models: 6 Ounces (170.1 grams)
Altitude	0 to 15,000 feet (4900 m)
Temperature Ranges	
Operating	0° to 50° Celsius
Storage	-25° to 85° Celsius
Relative Humidity	10% to 90%, non-condensing (for LED models) 0 to 90% (non-condensing) from -25° to +35° C, derated linearly to 25% at +50° C (for LCD models see below)



INTERNAL GROUNDING CONNECTIONS:

The internal connections for ANALOG RETURN (Pin D), DIGITAL GROUND (Pin E) and POWER COMMON (Pin S) differ based on the DPM model. For 3½ digit DPM's DIGITAL GROUND and POWER COMMON are internally connected. For 4½ digit DPM's ANALOG RETURN, DIGITAL GROUND and POWER COMMON are internally connected. Depending on the application and input configuration, the user may have to make the grounding connections. *POWER COMMON is internal for AC models and is not user accessible.*

PIN DETAILS

Figure 2 shows the pin connections for the different models in the DM-9000 Series.

CAUTION

Refer to Table 3 for solder gap functions before installing the DPM in the application circuit. The internal connections for ANALOG RETURN, DIGITAL GROUND and POWER COMMON differ based on the DPM. To eliminate the possibility of ground loops, do not make these grounding connections if they already exist within the DPM.

TOP		BOTTOM
ANALOG HI IN (+)	1 A	NO CONNECTION
ANALOG LO IN (-)	2 B	NO CONNECTION
NO CONNECTION	3 C	NO CONNECTION
REF.IN/OUT	4 D	ANALOG RETURN
KEYWAY		KEYWAY
+5VDC OUT	5 E	DIGITAL GND
HOLD	6 F	NO CONNECTION
NO CONNECTION	7 H	NO CONNECTION
POLARITY OUT	8 J	NO CONNECTION
KEYWAY		KEYWAY
DISPLAY TEST	9 K	NO CONNECTION
DEC. PT. 1.999	10 L	DEC. PT. 1999.
DEC. PT. 19.99	11 M	DEC. PT. 199.9
NO ETCH	12 N	NO ETCH
NO CONNECTION	13 P	NO CONNECTION
NO ETCH	14 R	NO ETCH
+5VDC PWR IN	15 S	POWER COMMON

DM-9100

TOP		BOTTOM
ANALOG HI IN (+)	1 A	NO CONNECTION
ANALOG LO IN (-)	2 B	NO CONNECTION
NO CONNECTION	3 C	NO CONNECTION
REF.IN/OUT	4 D	ANALOG RETURN
KEYWAY		KEYWAY
+5VDC OUT	5 E	DIGITAL GND
HOLD	6 F	NO CONNECTION
NO CONNECTION	7 H	NO CONNECTION
POLARITY OUT	8 J	NO CONNECTION
KEYWAY		KEYWAY
DISPLAY TEST	9 K	NO CONNECTION
DEC. PT. 1.999	10 L	DEC. PT. 1999.
DEC. PT. 19.99	11 M	DEC. PT. 199.9
NO ETCH	12 N	NO ETCH
AC LINE (220/240 VAC)	13 P	AC LINE (100/117/120 VAC)
NO ETCH	14 R	NO ETCH
AC LINE (100/220 VAC)	15 S	AC LINE (117/120/240 VAC)

DM-9115

TOP		BOTTOM
ANALOG HI IN (+)	1 A	NO CONNECTION
ANALOG LO IN (-)	2 B	NO CONNECTION
NO CONNECTION	3 C	NO CONNECTION
REF.IN/OUT	4 D	ANALOG RETURN
KEYWAY		KEYWAY
+5VDC OUT	5 E	DIGITAL GND
HOLD	6 F	NO CONNECTION
NO CONNECTION	7 H	NO CONNECTION
NO CONNECTION	8 J	NO CONNECTION
KEYWAY		KEYWAY
DISPLAY TEST	9 K	NO CONNECTION
DEC. PT. 1.999	10 L	DEC. PT. 1999.
DEC. PT. 19.99	11 M	DEC. PT. 199.9
NO ETCH	12 N	NO ETCH
NO CONNECTION	13 P	NO CONNECTION
NO ETCH	14 R	NO ETCH
+5VDC PWR IN	15 S	POWER COMMON

DM-9150

TOP		BOTTOM
ANALOG HI IN (+)	1 A	NO CONNECTION
ANALOG LO IN (-)	2 B	NO CONNECTION
NO CONNECTION	3 C	NO CONNECTION
REF.IN/OUT	4 D	ANALOG RETURN
KEYWAY		KEYWAY
+5VDC OUT	5 E	DIGITAL GND
HOLD	6 F	NO CONNECTION
NO CONNECTION	7 H	NO CONNECTION
NO CONNECTION	8 J	NO CONNECTION
KEYWAY		KEYWAY
DISPLAY TEST	9 K	NO CONNECTION
DEC. PT. 1.999	10 L	DEC. PT. 1999.
DEC. PT. 19.99	11 M	DEC. PT. 199.9
NO ETCH	12 N	NO ETCH
AC LINE (220/240 VAC)	13 P	AC LINE (100/117/120 VAC)
NO ETCH	14 R	NO ETCH
AC LINE (100/220 VAC)	15 S	AC LINE (117/120/240 VAC)

DM-9165

Figure 2. Pin Details of DM-9000 Series DPM's

CAUTION

The DPM's employ CMOS circuits. Use ground protection techniques when wiring or handling MOS inputs to prevent damage by static discharge voltage spikes. Do not plug DPM's into live circuitry.

<p>TOP</p> <p>ANALOG HI IN (+) 1 A NO CONNECTION ANALOG LO IN (-) 2 B NO CONNECTION NO CONNECTION 3 C NO CONNECTION REF IN/OUT 4 D ANALOG RETURN</p> <p>KEYWAY</p> <p>+5VDC OUT 5 E DIGITAL GND RUN/HOLD 6 F NO CONNECTION BLANK 7 H UNDERRANGE POLARITY OUT 8 J OVERRANGE</p> <p>KEYWAY</p> <p>DISPLAY TEST 9 K BUSY/DONE DEC. PT. 1.9999 10 L DEC. PT. 1999.9 DEC. PT. 19.999 11 M DEC. PT. 199.99 NO ETCH 12 N NO ETCH NO CONNECTION 13 P NO CONNECTION NO ETCH 14 R NO ETCH +5VDC PWR IN 15 S POWER COMMON</p> <p>DM-9200</p>	<p>BOTTOM</p> <p>ANALOG HI IN (+) 1 A NO CONNECTION ANALOG LO IN (-) 2 B NO CONNECTION NO CONNECTION 3 C NO CONNECTION REF IN/OUT 4 D ANALOG RETURN</p> <p>KEYWAY</p> <p>+5VDC OUT 5 E DIGITAL GND RUN/HOLD 6 F NO CONNECTION BLANK 7 H UNDERRANGE POLARITY OUT 8 J OVERRANGE</p> <p>KEYWAY</p> <p>DISPLAY TEST 9 K BUSY/DONE DEC. PT. 1.9999 10 L DEC. PT. 1999.9 DEC. PT. 19.999 11 M DEC. PT. 199.99 NO ETCH 12 N NO ETCH AC LINE (220/240 VAC) 13 P AC LINE (100/117/120 VAC) NO ETCH 14 R NO ETCH AC LINE (100/220 VAC) 15 S AC LINE (117/120/240 VAC)</p> <p>DM-9215</p>
<p>TOP</p> <p>ANALOG HI IN (+) 1 A NO CONNECTION ANALOG LO IN (-) 2 B NO CONNECTION NO CONNECTION 3 C NO CONNECTION REF IN/OUT 4 D ANALOG RETURN</p> <p>KEYWAY</p> <p>+5VDC OUT 5 E DIGITAL GND RUN/HOLD 6 F NO CONNECTION NO CONNECTION 7 H UNDERRANGE NO CONNECTION 8 J OVERRANGE</p> <p>KEYWAY</p> <p>NO CONNECTION 9 K BUSY/DONE DEC. PT. 1.9999 10 L DEC. PT. 1999.9 DEC. PT. 19.999 11 M DEC. PT. 199.99 NO ETCH 12 N NO ETCH NO CONNECTION 13 P NO CONNECTION NO ETCH 14 R NO ETCH +5VDC PWR IN 15 S POWER COMMON</p> <p>DM-9250</p>	<p>BOTTOM</p> <p>ANALOG HI IN (+) 1 A NO CONNECTION ANALOG LO IN (-) 2 B NO CONNECTION NO CONNECTION 3 C NO CONNECTION REF IN/OUT 4 D ANALOG RETURN</p> <p>KEYWAY</p> <p>+5VDC OUT 5 E DIGITAL GND RUN/HOLD 6 F NO CONNECTION NO CONNECTION 7 H UNDERRANGE NO CONNECTION 8 J OVERRANGE</p> <p>KEYWAY</p> <p>NO CONNECTION 9 K BUSY/DONE DEC. PT. 1.9999 10 L DEC. PT. 1999.9 DEC. PT. 19.999 11 M DEC. PT. 199.99 NO ETCH 12 N NO ETCH AC LINE (220/240 VAC) 13 P AC LINE (100/117/120 VAC) NO ETCH 14 R NO ETCH AC LINE (100/220 VAC) 15 S AC LINE (117/120/240 VAC)</p> <p>DM-9265</p>

Figure 2. Pin Details of DM-9000 Series DPM's (cont.)

Table 2 lists the voltage and current levels on the DM-9000 Series DPM's input/output pins.

Table 2. Logic Levels for Input/Output Pins

Model Number	Pin Number	Pin	Parameter	Minimum	Typical	Maximum	Units
9100 9115	6	HOLD IN	V_{IL}	--	--	1.5	Volts
			V_{IH}	3.5	--	--	Volts
	8	POLARITY OUT	Positive Inputs	2.5	--	--	Volts
			Negative Inputs	--	--	0.5	Volts
9150 9165	6	HOLD IN	V_{IL}	--	--	1.5	Volts
			V_{IH}	3.5	--	--	Volts
9200 9215 9250 9265	6	RUN/HOLD IN	V_{IH}	2.8	2.2	--	Volts
			V_{IL}	--	1.6	0.8	Volts
			$I_{IL} (@V = 0V)$	--	0.02	0.1	milli-amperes
			$I_{IH} (@V = 5V)$	--	0.1	10	milli-amperes
	K 8 H J	BUSY/DONE POLARITY OUT OVERRANGE OUT UNDERRANGE OUT	$V_{OL} (@I = 1.6mA)$	--	0.25	0.4	Volts
			$V_{OH} (@I = -1mA)$	2.4	4.2	--	Volts
			$V_{OH} (@I = -10\mu A)$	4.9	4.99	--	Volts
9200 9215	7	BLANK IN	V_{IL}	--	--	0.8	Volts

PIN#	SIGNAL	DESCRIPTION	PIN#	SIGNAL	DESCRIPTION
1	ANALOG HI IN	Differential input voltages connect to these inputs. A bias current path to POWER COMMON (if + 5V dc powered) or ANALOG RETURN from both these inputs must be externally provided. External circuits must restrict these inputs to be within the common-mode voltage range.	10	DECIMAL POINT SELECT (active low) x.xxx(x)	Connect the selected decimal point to Pin E, Digital Ground.
2	ANALOG LO IN		11	DECIMAL POINT SELECT (active low) xx.xx(x)	
			M	DECIMAL POINT SELECT (active low) xxx.x(x)	
			L	DECIMAL POINT SELECT (active low) xxxx(x)	
4	REF IN/OUT	The instrument is calibrated when a + 1.0V dc drop exists between this pin and ANALOG RETURN (Pin D). The DPM's are provided with a solder gap option to allow an external ratiometric reference. The external source must be biased against ANALOG RETURN (Pin D).	D	ANALOG RETURN IN	This pin may be used as a reference for some floating inputs. If not possible, inputs may be referenced to POWER COMMON (if + 5V dc powered). ANALOG RETURN is approximately - 2.8V below + Vs and can sink 30 mA to - Vs.
5	+ 5V dc OUT	This pin delivers + 5V dc (@ 100mA maximum for AC models) for user circuits. The dc model output is limited to the user's dc source limit.	H	UNDERRANGE OUT (active high)	This pin goes high if the previous input displays + 1800 counts or less. The pin remains high until the beginning of signal integration in the next measurement cycle.
6	RUN/HOLD IN (low = HOLD)	For models DM-9200, DM-9215, DM-9250, and DM-9265 a TTL high (or open) on this pin enables continuous sampling. A TTL low (or ground) will hold and display the last sample for temporary single sample storage. For models DM-9100, DM-9115, DM-9150, and DM-9165 a TTL low (or open) on this pin enables continuous sampling. A TTL high holds the display.	J	OVERRANGE OUT (active high)	This pin is high if the previous input signal exceeds the A/D converter range of + 19999 counts. The pin remains high until the beginning of reference integration in the next measurement cycle. UNDERRANGE and OVERRANGE are normally used as up/down ranging gain selection controls for an auto-ranging input selection.
7	BLANK IN (active low)	This pin's function is available only on models DM-9200 and DM-9215. A TTL low (or ground) on this pin blanks the display, excluding the selected decimal points and the polarity sign. Data remains valid even with the display blanked.	K	BUSY/DONE OUT (low=DONE).	This pin goes high during A/D conversions. The pin remains high until the conversion is complete or until the end of a measurement in the case of an OVERRANGE. The pin may be used to prevent the input voltage from changing during conversions.
8	POLARITY OUT	This pin goes low when the DPM receives a negative input signal. It is valid even for a zero reading. A display of +0000 means the signal is positive but less than the least significant digit.			
9	DISPLAY TEST IN	To test the display, apply + 5V dc to this pin for models DM-9100, DM-9115, DM-9150, and DM-9165 or ground this pin for models DM-9200 and DM-9215. The display will read 1.888(8). This pin is not available in models DM-9250 and DM-9265.			

DM-9000 Series DPM mounting details

The DM-9000 Series DPM case is designed to fit into industry standard DIN or NEMA size panel cutouts. The case has eight plastic positioning pins as shown in Figure 3a. The user may remove pins 1, 2, 3, and 4 to fit the DPM into a NEMA size panel cutout, or, pins 5, 6, 7, and 8 to fit the DPM into a DIN size panel cutout. The DM-9000 Series package, as shipped from the factory, has the mounting clips and screws packed separately. Insert the screws into the threaded holes in the clips for a few turns. This simplifies the mounting procedure.

Procedure

1. Remove the plastic positioning pins depending on NEMA or DIN size panel cutout requirements.
2. Install the DPM into the panel cutout as shown in Figure 3b.
3. The DPM case has two slots at the sides to accommodate the clips. Slide the clips into the slots.

4. The clips are provided with screws. Tighten the screws against the front panel as shown in Figure 3b inset.

NOTE

For the user's convenience, Figure 13 at the end of this document is a 100% size panel cutout template.

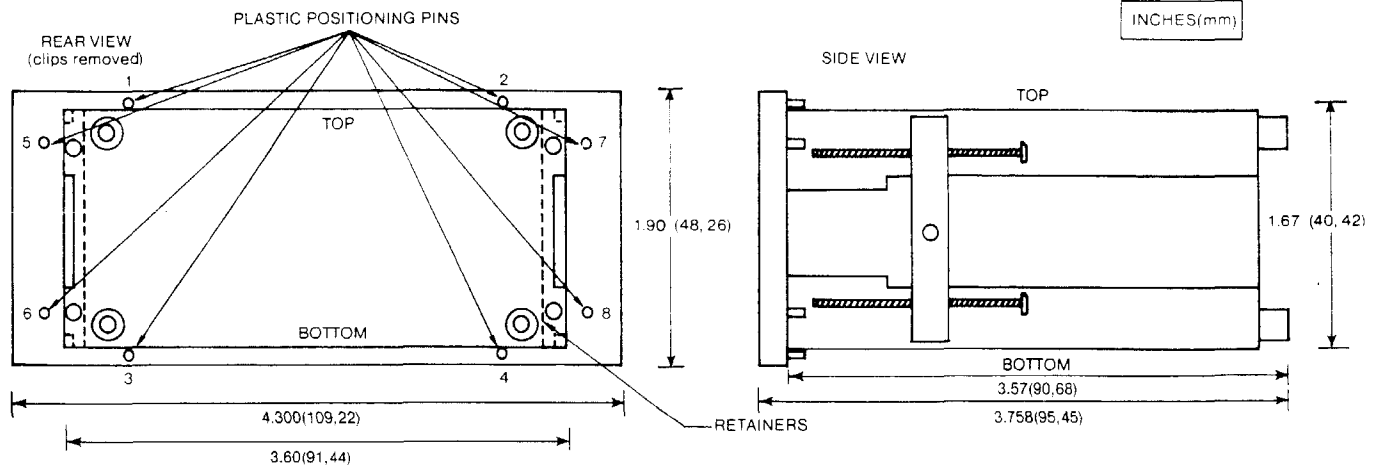


Figure 3a. Mechanical Dimensions

Circuit board access

The user may access the circuit board in the DPM to make internal modifications concerning solder gaps or attenuation or shunt resistors.

Procedure

1. Remove power.
2. Remove the edge connector connected to the DPM case.
3. Remove the front filter by placing a small screwdriver into the hole at the bottom of the filter and flexing the filter gently.

4. The DPM is held in its case by two retainers. The retainers are located at either side of the display. Remove the retainers by removing the four screws holding them in place.
5. Gently withdraw the DPM from its case.

CAUTION

The DPM's employ CMOS circuits. Use ground protection techniques when wiring or handling CMOS inputs to prevent damage by static discharge voltage spikes. Do not plug DPM's into live circuitry.

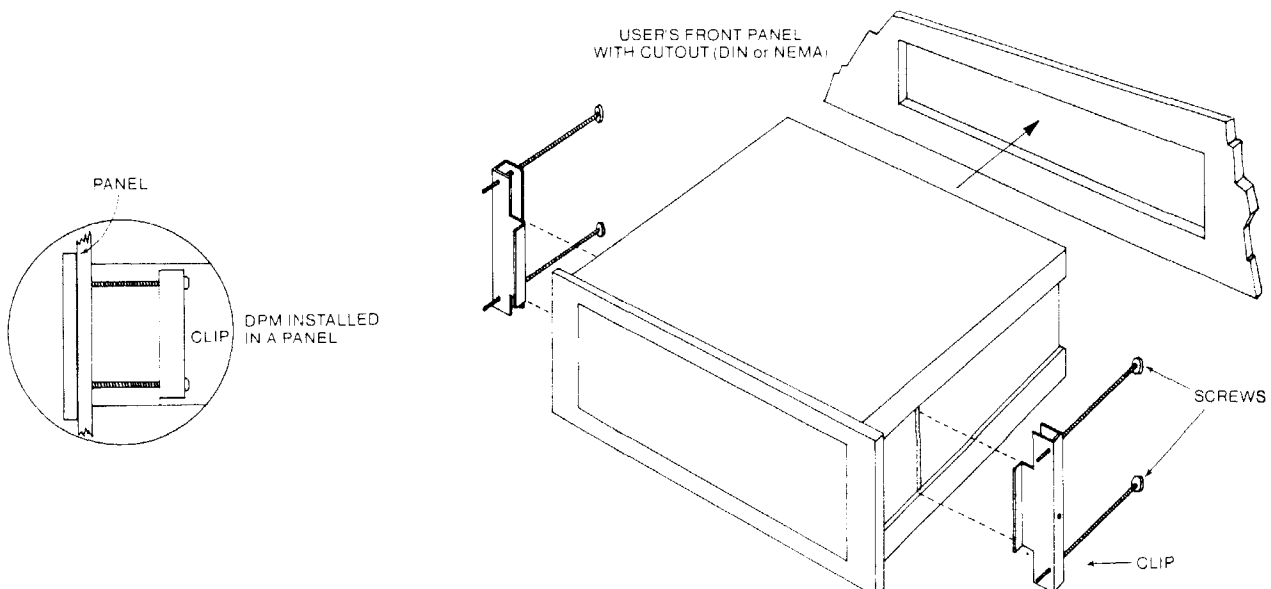


Figure 3b. Panel Installation

INTERNAL MODIFICATIONS

Solder Gaps, Attenuator and Shunt Resistors.

The DM-9000 Series DPM's allow user modifications for higher current or voltage range operations. Attenuator and shunt resistor pads for these modifications are located on the component side of the DPM printed wiring boards. Refer to Figure 5 to locate the resistor pads and solder gaps. The solder gap numbers appear on the printed wiring side of the DPM boards. Table 3 gives the description of solder gap functions.

CAUTION

Internal modifications should only be attempted by users skilled at miniature electronic assembly. Improper soldering or fabrication procedures can damage the DPM and void the product warranty.

For higher full-scale voltage ranges, open the solder gap on ANALOG HI IN line (see note 2 in Table 3) and use resistors R_A and R_S . Table 4 shows the full-scale voltage ranges and the values of R_A and R_S . For higher full-scale current ranges, close the solder gap on the ANALOG HI IN Line (see note 2 in Table 3) and use resistor R_S . Table 4 shows the full-scale current ranges and the value of R_S .

Table 3. Description of Solder Gaps for Internal Modifications

Solder Gap Signal/Function	9100/9115	9200/9215	9150/9165	9250/9265	SEE NOTES
REF IN/OUT	SG2	SG3	SG5	SG4	1
ANALOG HI IN	SG3	SG4	SG4	SG6	2
ANALOG LO IN and ANALOG RETURN	SG4	SG5	SG6	SG5	3
Polarity Enable	SG1/SG5	SG2	SG3/SG2	SG3/SG7	4
Decimal Point (Least Significant Digit)	NA	SG1	NA	SG2	5
Degree	NA	NA	SG1	SG1	6

NOTES:

- Solder gaps are normally closed allowing internal generation of the reference voltage. The instrument is calibrated when a +1V dc potential exists between REF IN/OUT (Pin 4) and ANALOG RETURN (Pin D). Opening the solder gap allows using an external reference input to Pin 4 biased against Pin D.
- Solder gaps are normally closed, providing no attenuation. Open the solder gaps for internal attenuation through resistors R_A and R_S . Refer to Figure 5.
- Solder gaps are normally open, setting the meter to differential mode operation. Close the solder gaps for single-ended operation.
- Solder gaps for polarity enable are normally closed allowing polarity display (+, -). Open both solder gaps (only SG2 for 9200 and 9215 DPM's) to disable polarity display.
- When closed, these solder gaps place the decimal point for the least significant digit. Solder gaps are normally open, disabling the decimal point.
- When closed, these solder gaps enable the degree symbol. These solder gaps are normally open, disabling the degree symbol.

Table 4. User-Installed Attenuation and Shunt Resistors for Higher Voltage and Current Ranges

Full-Scale Range	R_A	R_S
$\pm 2V$	Close Solder Gap ¹	Open
$\pm 20V$	10M Ω	1.1M Ω
$\pm 200V$	10M Ω	100K Ω
$\pm 1000V$	10M Ω	20K Ω
$\pm 200mA$	-----	10 Ω , 1W
$\pm 20mA$	-----	100 Ω
$\pm 2mA$	-----	1K Ω
$\pm 200\mu A$	-----	10K Ω
$\pm 20\mu A$	-----	100K Ω

NOTES:

- See note 2 in Table 3.
- Use $\frac{1}{4}$ W (unless noted) 1% metal-film resistors.
- For accurate readings adjust the Gain Adjust Potentiometer shown in Figure 4.

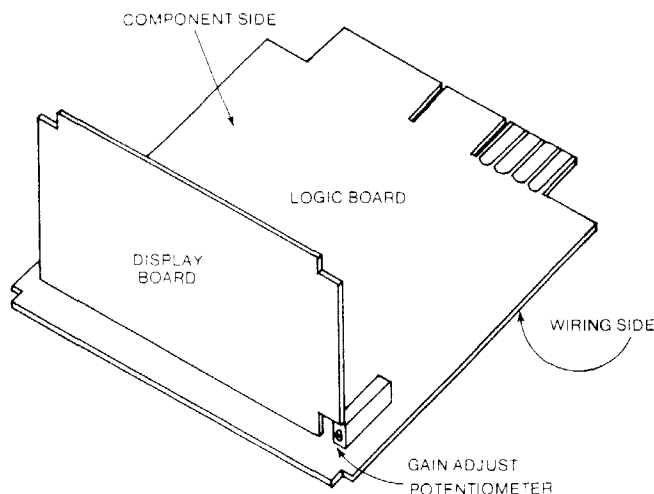


Figure 4. Location of Gain Adjust Potentiometer

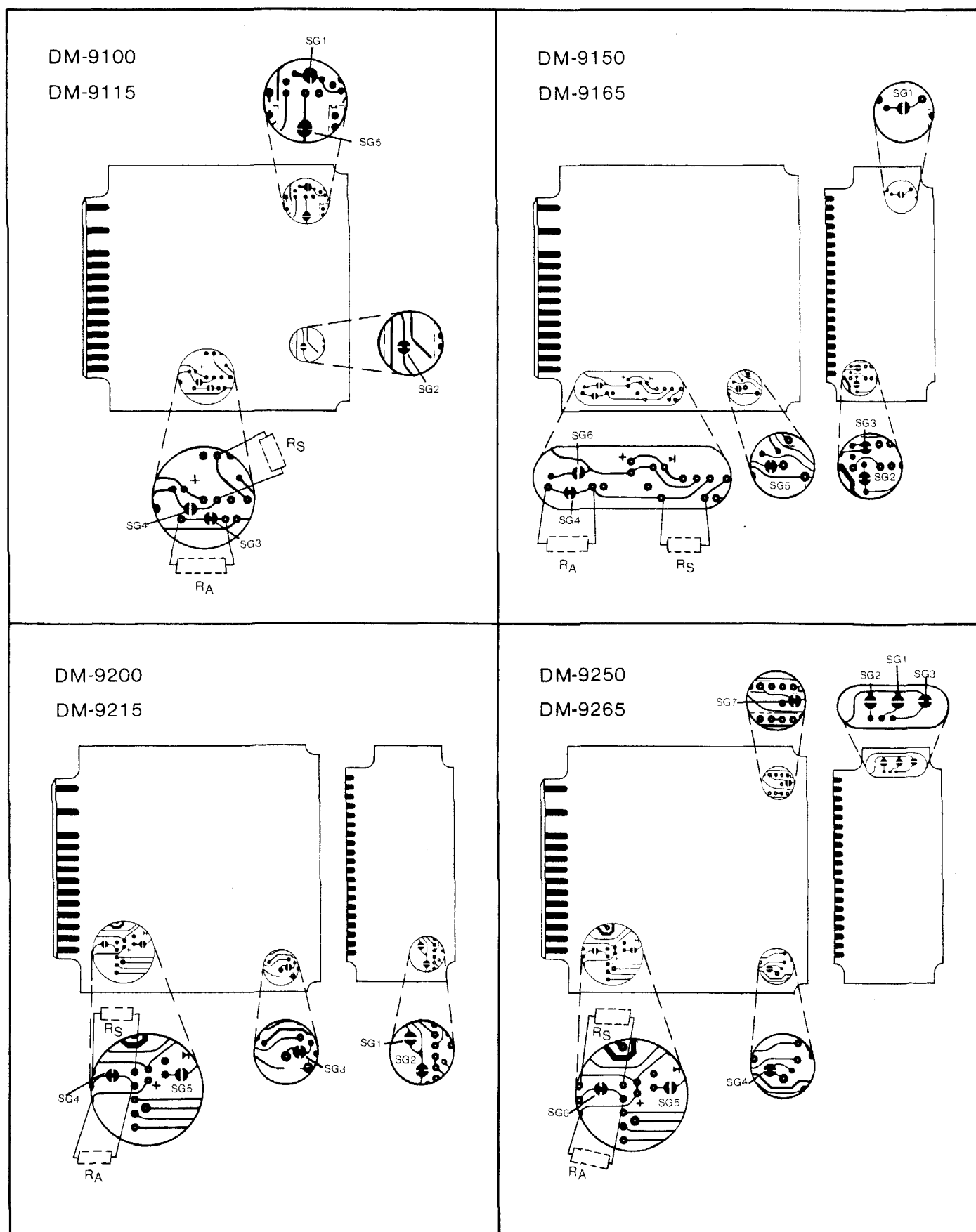
 **Normally Closed**
 **Normally Open**


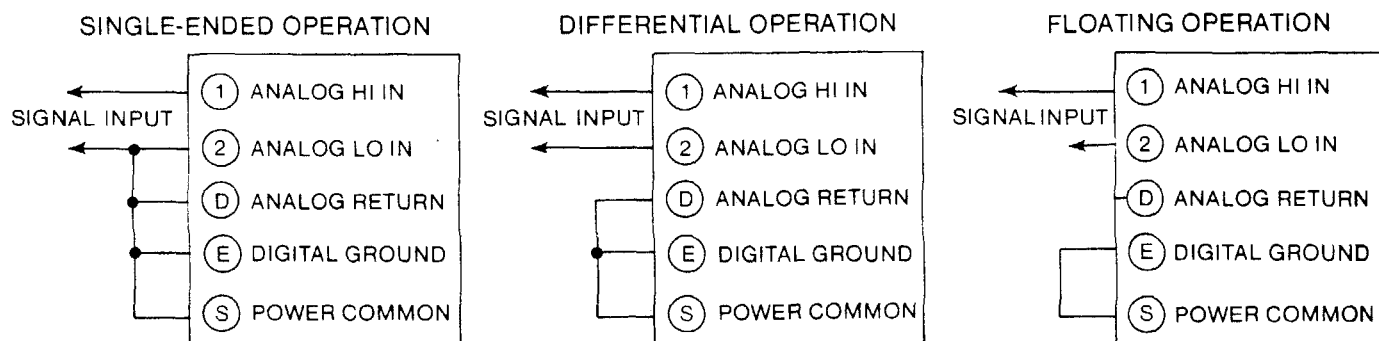
Figure 5. Location of Solder Gaps and Resistor Pads

Input Configurations

The DM-9000 Series DPM's may be operated in single-ended, differential or floating configurations. Refer to Figure 6 for input and grounding connections for these configurations.

CAUTION

The floating configuration is possible only with 3½ digit DPM's. In the floating configuration, the ANALOG RETURN (Pin D) should not exceed a range of -5 to +2.2V dc.



Note:

For 3½ digit models externally connect ANALOG RETURN (Pin D) to DIGITAL GROUND (Pin E). For 4½ digit models these pins are internally connected.

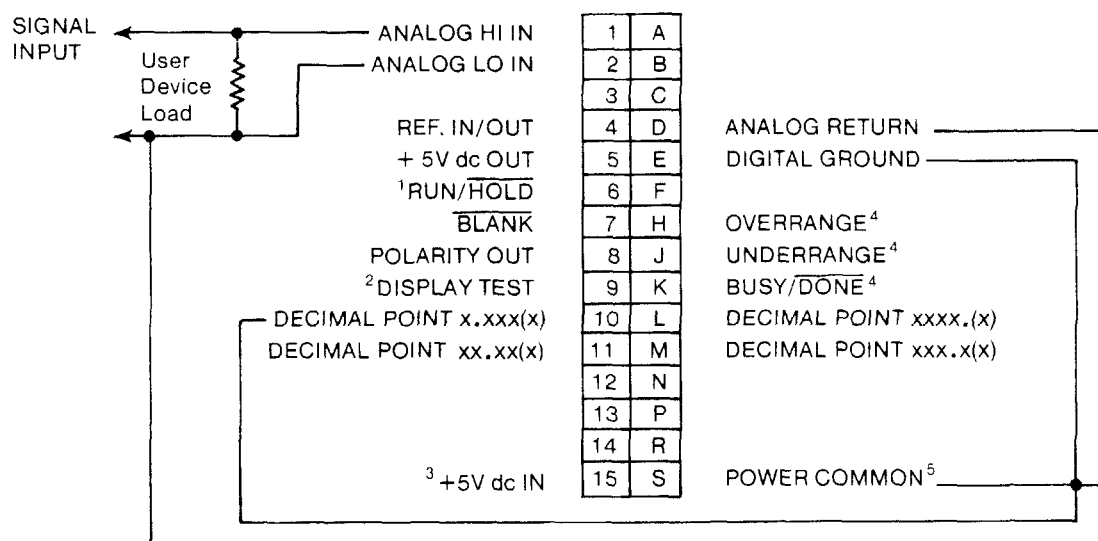
Figure 6. Typical Input Configurations for DM-9000 Series DPM's

APPLICATIONS

Application #1: Typical Single-Ended Operation

For Single-ended operation, ANALOG LO IN must be connected to ANALOG RETURN. The connection may be made externally or by closing solder gaps SG4 for models DM-9100 and DM-9115, SG5 for models DM-

9200, DM-9215, DM-9250, and DM-9265, or SG6 for models DM-9150 and DM-9165. Refer to Figure 5 for the location of these solder gaps. Figure 7 shows the typical I/O connections for a DPM configured for single-ended operation.



NOTES:

- For models DM-9100, DM-9115, DM-9250, and DM-9165, pin 6 is called HOLD.
- For models DM-9200 and DM-9215, pin 9 is called DISPLAY TEST. For models DM-9250 and DM-9265, pin 9 has no connection.
- For AC models, see Table 1 for details on pins 13, 15, P, S.
- Available only with 4½ digit DPM's.
- For 3½ digit models, externally connect ANALOG RETURN (Pin D) to DIGITAL GROUND (Pin E). For 4½ digit models these pins are internally connected.

Figure 7. Typical Connections for Single-Ended Operation

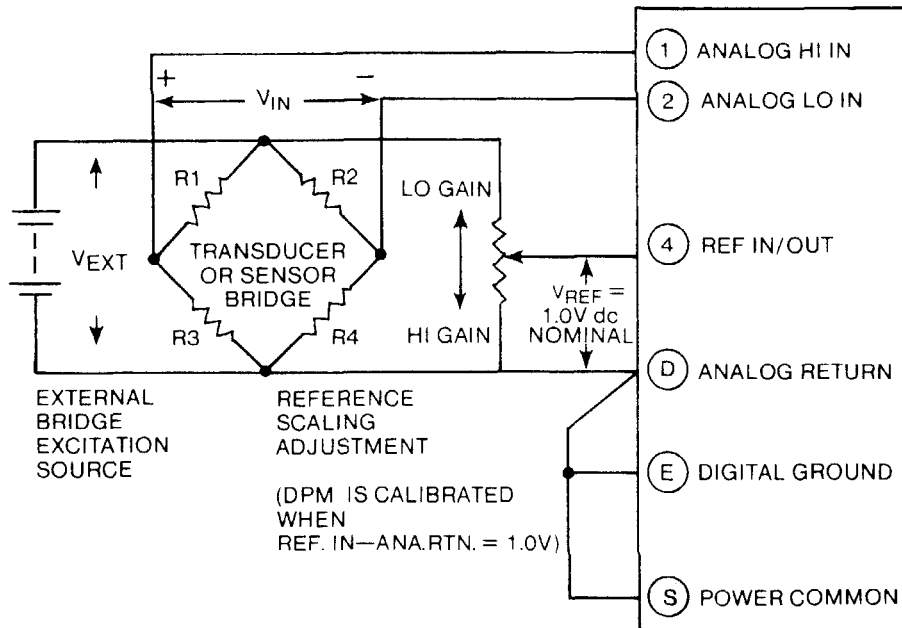
Application #2: Ratiometric Operation with Bridge-type Differential Inputs

Figure 8 shows typical connections for a DPM in a ratiometric configuration, with bridge-type differential inputs. An external source (V_{EXT}) provides the excitation voltage to the bridge circuit. The output of the bridge circuit provides the input (V_{IN}) to the DPM. The reference input voltage (V_{REF}) to the DPM is also derived from V_{EXT}

through a high precision potentiometer. This potentiometer provides full scale adjustment of V_{REF} over a range of + 0.1 to + 2.0V dc.

The bridge output (V_{IN}) and V_{REF} reflect fluctuations in V_{EXT} . Since the DPM display is inversely proportional to V_{REF} , the common voltage source for the bridge configuration shown in Figure 8 eliminates any display error due to V_{EXT} variations.

USER'S CIRCUITS



NOTE: For 3½ digit models, externally connect ANALOG RETURN (Pin D) to DIGITAL GROUND (Pin E). For 4½ digit models these pins are internally connected.

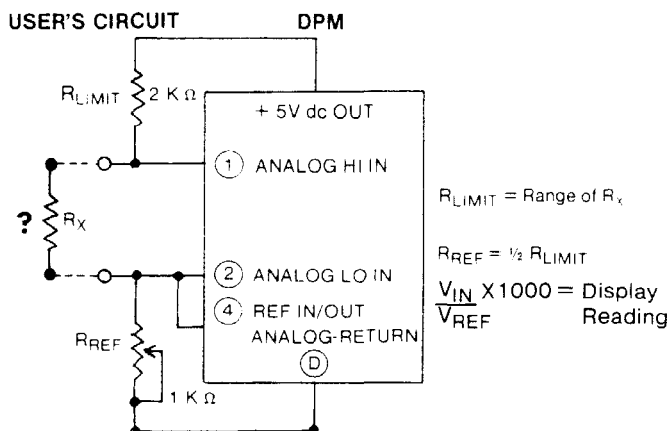
Figure 8. Using the DPM Ratiometric Configuration With Bridge Type Differential Inputs

Application #3: Using the DPM as an Ohmmeter.

A DM-9000 Series DPM connected ratiometrically, as shown in Figure 9, functions as an ohmmeter. In the figure, R_X is the unknown resistor that is connected in series with a known resistor R_{REF} . A common current through R_X and R_{REF} develops voltage drops across them. Since the current through the resistors is identical, the voltage drops are proportional only to the values of

R_X and R_{REF} . Refer to equations in Figure 9 to determine the display reading.

The inputs to the DPM are configured in differential mode. Therefore, the DPM displays the voltage drop across R_X with reference to the drop across R_{REF} . The range of R_X that the DPM displays depends on the values of R_{REF} and R_{LIMIT} . Depending on the range of R_X , the user may connect the appropriate decimal point line to DIGITAL GROUND. Refer to Table in Figure 9 for ranges of R_X and the values of R_{REF} .



Note: For 3½ digit models, externally connect ANALOG RETURN (Pin D) to DIGITAL GROUND (Pin E). For 4½ digit models these pins are internally connected.

Figure 9. Using the DPM as a Ohmmeter

RESOLUTION

Range of R_X	R_{LIMIT}	R_{REF}	3½ DIGIT DPM's	4½ DIGIT DPM's
199.9 Ω	200 Ω	100 Ω	0.1	0.01
1.999 K Ω	2 K Ω	1 K Ω	1.0	0.1
19.99 K Ω	20 K Ω	10 K Ω	10.0	1.0
199.9 K Ω	200 K Ω	100 K Ω	100.0	10.0
1.999 M Ω	2 M Ω	1 M Ω	1 K	100.0

Application #4: Using the DPM With 4 to 20mA Current Loops.

This application is suitable for use with ISA type L, H, and U transmitters.

Figure 10 shows a DPM driven by a current loop. The current loop is connected to the DPM's ANALOG HI IN and ANALOG RETURN through a shunt resistor, R. The value of R depends on the user's scaling requirements. A 50K ohm potentiometer, connected between REF IN/OUT and ANALOG RETURN, supplies input to the ANALOG LO IN pin. Adjust this pot for the desired low limit reading (or zero) to be displayed by the DPM.

To determine the value of R, the user should determine the maximum value in volts the DPM will display. For example, if the maximum value the DPM will display is 1500, it corresponds to an input voltage to the DPM of 1.5 Volts. Refer to the equations in Figure 10 to calculate the value of R.

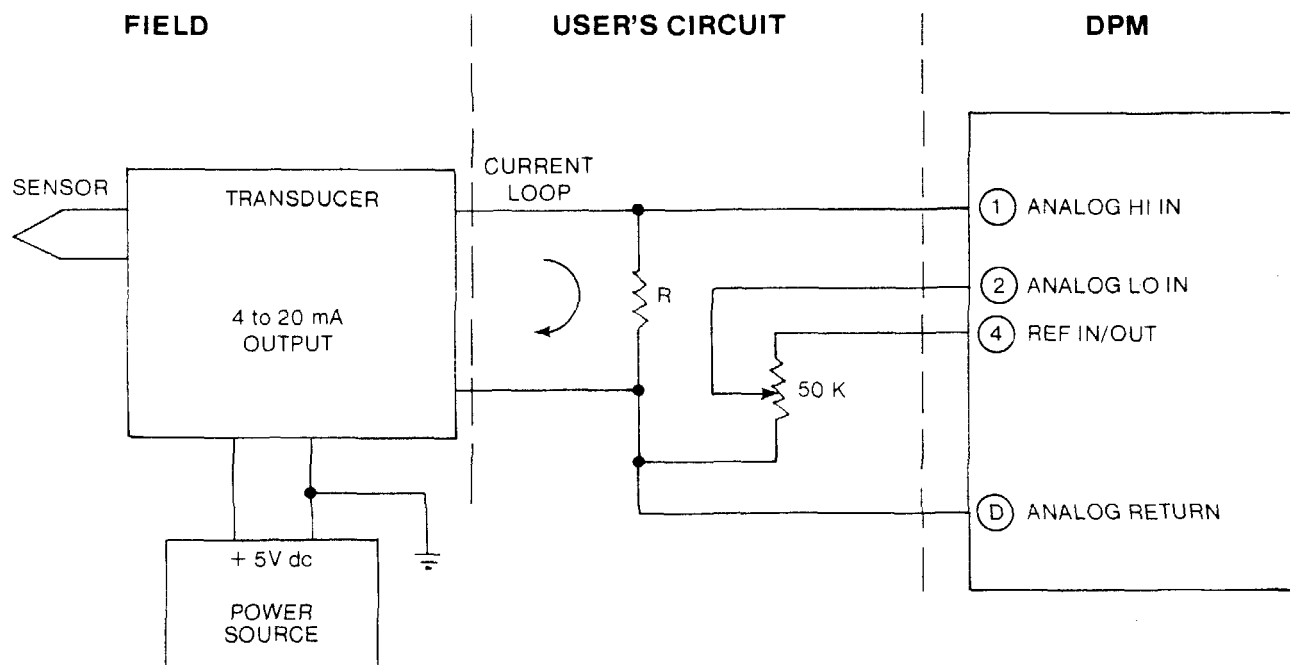
Finding R

Maximum value to be displayed in volts = 1.5 V

$$R = \frac{1.5 \text{ V}}{(20-4) \text{ mA}} = 93.75 \text{ ohms}$$

CALIBRATION

- 1) Apply 4mA in the current loop.
- 2) Adjust the 50K ohm pot to display the desired low reading.
- 3) Apply 20mA in the current loop.
- 4) Adjust the gain adjust pot to display the desired high reading.
- 5) Repeat the steps 1 through 4 until the DPM displays the low and high readings without any adjustment.



NOTES

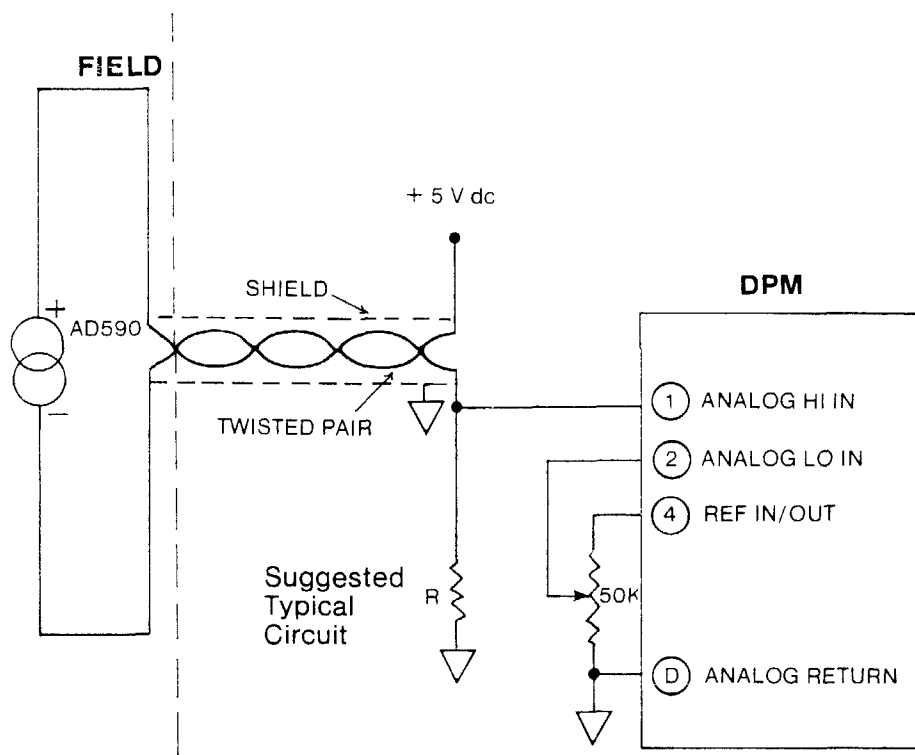
1. Resistor R must have a very good temperature coefficient. Use 1% metal film resistors; do not use carbon resistors.
2. There must not be any path between the 4 to 20 mA current loop and ground. The current source must use separate, or isolated ground source when using the ANALOG RETURN line.

Figure 10. Using the DPM With 4 to 20 mA Current Loops

Application #5: Using the DPM As A Digital Thermometer.

Using an AD590 IC temperature transducer, a DM-9000 Series DPM can be made to display temperature either in Celsius or in Fahrenheit. The AD590 used in this circuit measures temperatures from -55°C to $+155^{\circ}\text{C}$. The unit

of measurement ($^{\circ}\text{C}$ or $^{\circ}\text{F}$) determines the value of R in the circuit shown in Figure 11. The DPM can measure temperature to an accuracy of 1° for $3\frac{1}{2}$ digit DPM's and 0.1° for $4\frac{1}{2}$ digit DPM's.



Notes:

1. $R = 1K$ ohm for measuring temperature in $^{\circ}C$ and $R = 1.8K$ ohms for measuring temperature in $^{\circ}F$. Use 1% metal film resistors.
2. For $3\frac{1}{2}$ digit models, externally connect ANALOG RETURN (Pin D) to DIGITAL GROUND (Pin E). For $4\frac{1}{2}$ digit models these pins are internally connected.
3. Calibrate the DPM for the range of operation, setting the low reading using the 50K pot and the high reading using the gain-adjust pot.

Figure 11. Using the DPM as a Digital Thermometer

Procedure to Test the DPM

If the external circuits are designed to the specifications and if the DPM does not function as expected, test the functionality of the DPM as follows:

- 1) Remove all external connections to the DPM.
- 2) Connect the DPM in the configuration shown in Figure 12. The DPM should display +.0.0.0(.0). Grounding the inputs causes this display.
- 3) If the display jitters excessively, check the power supply for ripple, noise or spikes. Spikes should be less than 50 mV.

Note:

For $3\frac{1}{2}$ digit models, externally connect ANALOG RETURN (Pin D) to DIGITAL GROUND (Pin E). For $4\frac{1}{2}$ digit models these pins are internally connected.

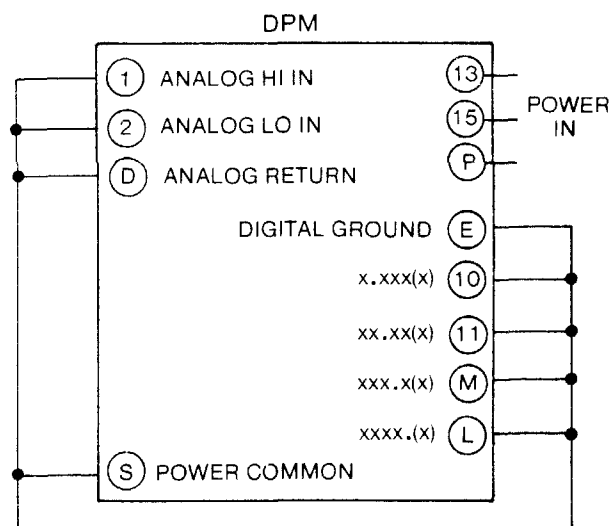
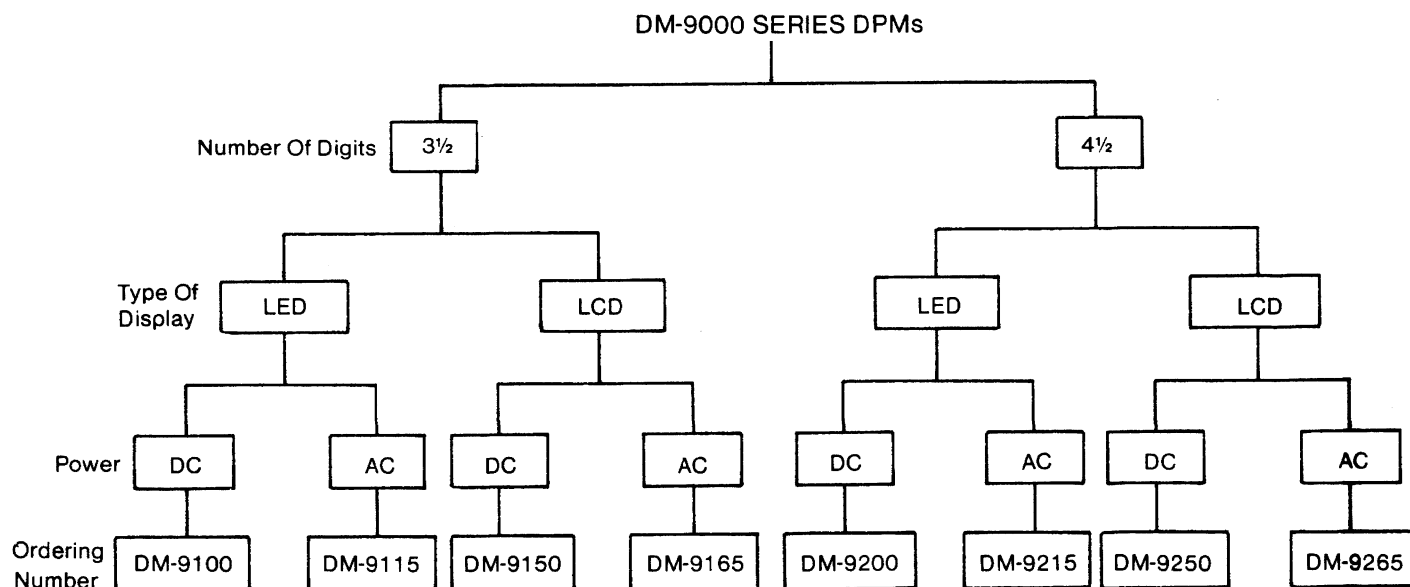


Figure 12: Connections for Testing the DPM's

NOTICE

The applications circuits shown in this document are typical, illustrating design examples. Since DATTEL has no control over the selection and use of external apparatus and components to the DM-9000 Series DPM's, specific performance cannot be warranted.

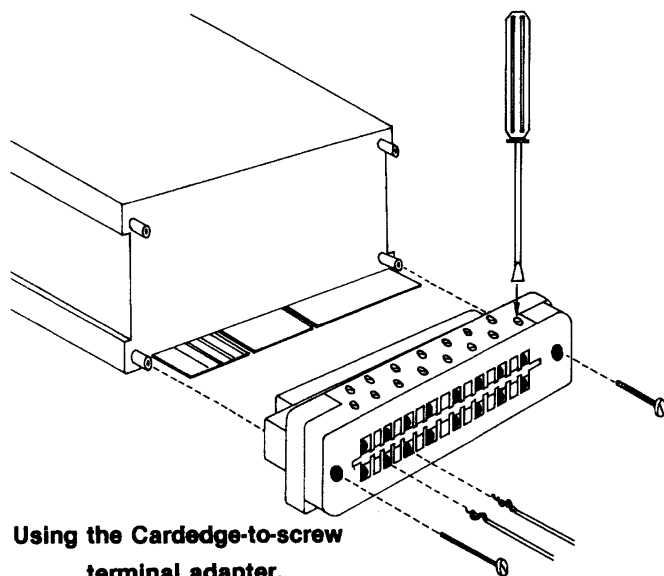
DM-9000 Series DPM Selection Guide/Ordering Information



Example:

For a 3½ digit, LED, AC-powered DPM, order DM-9115.

ACCESSORY	DATTEL PART NUMBER
Dual 15-pin edge connector	58-2073078
115AC-to-5V dc power adapter	UPA-5/500
Cardedge-to-screw terminal adapter	39-21025



**Using the Cardedge-to-screw
terminal adapter.**

WARRANTY

Datel warrants this product to be free of defects in material and workmanship for a period of one year from the date of shipment, under normal use and service. Datel's obligations under this warranty are limited to replacing or repairing the product, at its option, at its factory or facility. The defective product must be shipped to Datel's facility for repair or replacing within the warranty period, transportation and charges prepaid. This warranty shall not apply to a product which has been repaired or altered, except by Datel, or which has been subjected to misuse, negligence, or accident. In no case shall Datel's liability exceed the original purchase price. The aforementioned provisions do not extend the original warranty period of this product which has either been repaired or replaced by Datel.

ORDERING INFORMATION**MODEL****DM-9000 Series****To Order, Specify:****Features**

3½ Digits	1
4½ Digits	2
LED, dc Power	00
LED, AC Power	15
LCD, dc Power	50
LCD, AC Power	65

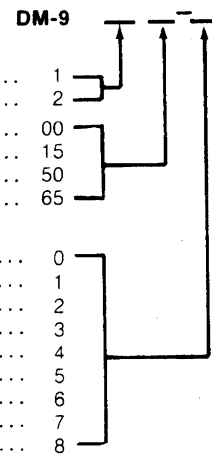
Range, Full Scale

* 200 mV	0
2V	1
20V	2
200V	3
200 mA	4
20 mA	5
2 mA	6
200 µA	7
20 µA	8

* 3½ Digit Meters Only

ACCESSORIES (See Section 5)

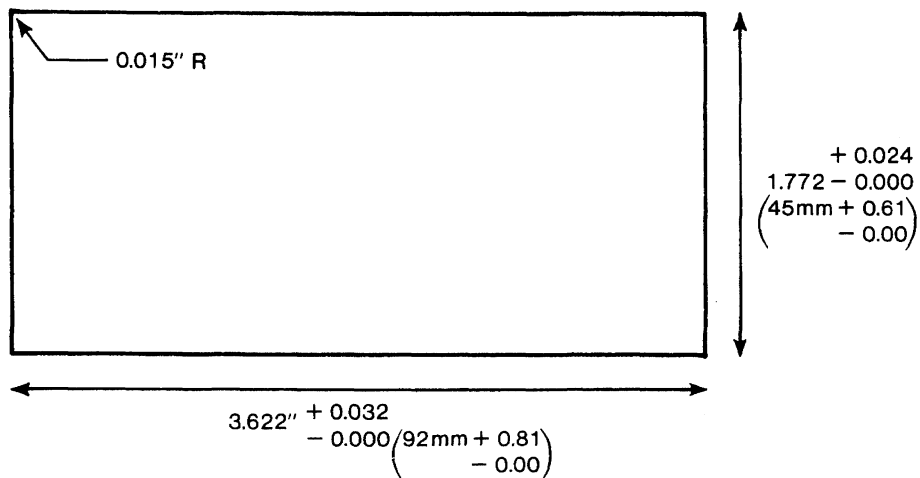
Part Number	Description
39-21025	Screw Terminal Block Connector
58-2073078	Dual 15-pin edge connector
UPA-5/500	115V AC to 5V dc power adapter



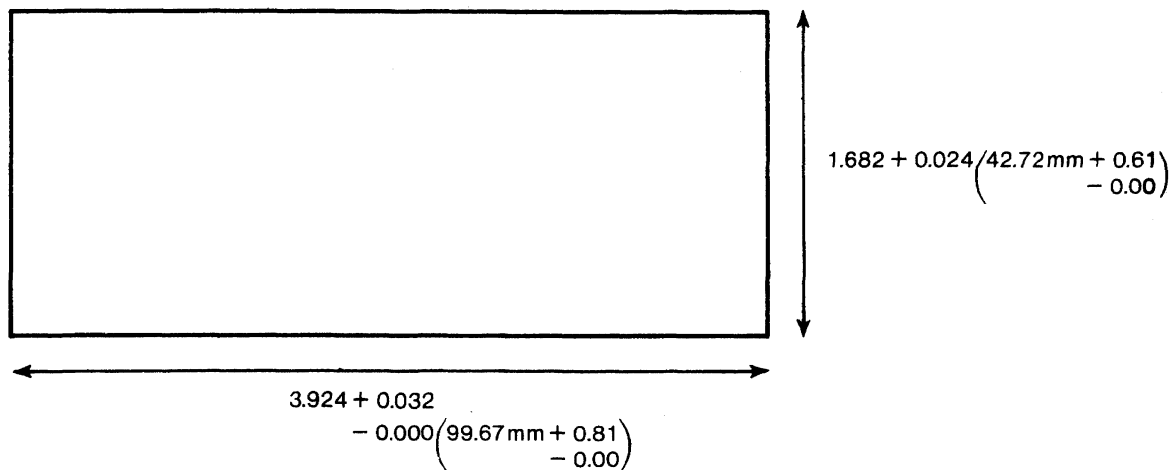
TEMPLATE (Actual Size)

DIN CUTOUT

INCHES	(mm)
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NEMA CUTOUT

**Note:**

Some small percentage of reduction is inherent in the printing process. Physically check the dimensions of the DM-9000 Series DPM before using this drawing.

Figure 13: Template

DS-0002