DATEL

PRODUCT DATA AND USER'S GUIDE

FEATURES

- Low Cost 4½ Digit DPM with LED Display
- Balanced Differential Inputs
- *Digit Serial BCD Outputs — Can Drive Remote Slave Display (DM-4102)*
- High Brightness .3" High LED Display
- 1000 Megohm CMOS Input with 5 pA Bias Currents
- Autozeroing with Ratiometric Reference for Drift Correction
- +5 Vdc Power — provides −5 Vdc at 15 mA Output to Power User Circuits
- Low Profile Polycarbonate Case — 2.53"W × 3.34"D × 0.94"H

APPLICATIONS

- Ammeter — Accepts user-supplied shunts for ±20 μA to ±2A Full Scale Ranges
- Voltmeter — Accepts user-supplied attenuators for ±2V to ±1 kV Full Scale Ranges

GENERAL DESCRIPTION

The DM-4200 is a 4½ digit DPM (Digital Panel Meter) with differential inputs and an LED display. The meter accepts analog dc input voltages from −1.9999V to +1.9999V.

A dual slope A/D converter changes these inputs to a BCD digital code. Decoder drivers cause the input voltage to be displayed on .3" high LED numerals. The BCD-encoded numerals (digit serial) are also output to a rear-panel connector where they may be used to drive a slave display, or become A/D inputs to a printer or microcomputer.

The DM-4200 is housed in a compact, low profile polycarbonate case only .94" high. The DM-4200 can be used in process control panels, OEM products, and medical instrumentation to provide a clear, unambiguous display of d.c. voltages.

CMOS input circuitry gives the DM-4200 very high input impedance (1000 MΩ typical, 100 MΩ minimum), and a very low input bias current (5 pA typical, 50 pA maximum). The meter's input amplifier is auto-

zeroed to minimize zero drift. The reference voltage is brought out on a rear panel pin (Reference Out), where it can correct drift in external ratiometric bridge circuits.

Circuit pads on the DM-4200's converter board will accept current shunts and voltage dividers to extend the input range to ±1 kV full scale on voltage, and ±20 μA to ±2A full scale on current measurements. BCD outputs, multiplexed by digit, are available. The outputs are 1 TTL load, and can be used to drive a remote display.

Overscale and Underscale outputs can be used with external circuits to autorange the meter. A Run/Hold output can be tied low to stop the meter's A/D conversions, and to continuously display the last reading. A Busy/Done output goes low to indicate the end of an A/D conversion.

A built-in dc to dc converter provides −5V Out (at 15 mA max.) to power user circuits. Power input is +5Vdc (±.25V) regulated at 200 mA typical and 250 mA max.

MECHANICAL DIMENSIONS

INCHES (MM)
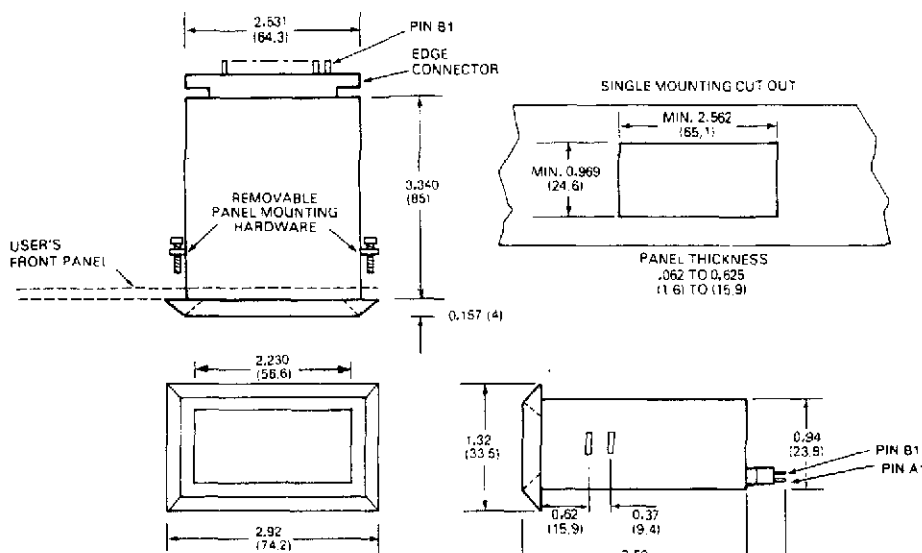
DM-4200 4½ Digit LED Differential BCD DPM

SPECIFICATIONS
(typical at +25°C, unless noted)

ANALOG INPUT

Configuration ....
True, balanced differential bipolar inputs (Note: The user may close SG5 if single-ended inputs are preferred.)

Full Scale Input Range ....
−1.9999 VDC to +1.9999 VDC

Optional Ranges* ....
Ammeter—Accepts user-supplied shunts for ±20µA to ±2A Full Scale Ranges
Voltmeter—Accepts user-supplied attenuators for ±2V to ±1KV Full Scale Ranges

* NOTE — The optional ranges require the installation of extra components within the DPM by the user. Or, optional ranges are available on special order in OEM quantities from DATEL.

Input Bias Current ....
5 pA (typical); 50 pA (maximum)

Displayed Accuracy @ +25°C ....
Adjustable to ±0.02% of reading, ±2 counts

Resolution ....
100 µV in last digit

Temperature Drift of Zero ....
Autozeroed ±1 count over 0 to +50°C

Temperature Drift of Gain ....
±50 ppm of Reading /°C typical
±100 ppm of Reading /°C maximum

Input Impedance ....
100 Megohms (minimum); 1000 megohms (typical)

Input Overvoltage ....
±250 VDC, 175 VRMS continuous maximum, ±300 volts intermittent maximum

Reference ....
Internal, referred to Analog Return. An external, user supplied reference is optional for ratiometric operation.

External Reference Range ....
+100 mV to +2V, referred to Analog Return

Common Mode Rejection ....
86 db typical to Analog Return

Common Mode Voltage Range ....
Both inputs must remain within ±4V of Power Common

DISPLAY

Number of Digits ....
Four decimal digits and most significant "1" digit (4½ digits)

Display Type ....
Red, light-emitting diode (LED), self-illuminated

Display Height ....
0.3 inches (7,6 mm)

Overscale ....
Inputs exceeding the full scale range cause the display to blink.

Autopolarity ....
A minus sign (−) is automatically displayed for negative voltage inputs, and may also be blanked.

Sampling Rate ....
Approximately 3 conversions per second

Decimal Points ....
Right-of-digit selectable decimal points are included for scale multipliers.

Busy/Done OUT (Pin A5) ....
This output is HI during A/D conversion. The falling edge indicates that a new valid data Strobe output will appear in 1.3 milliseconds. The HI Busy level may be used by automatic equipment to prevent changing the input voltage during conversion. See the timing diagram.

Strobe Out (Pin A6) ....
Consists of 5 and only 5 negative pulses per A/D conversion of approximately 6.7 microseconds width and approximately 1.3 milliseconds apart issued after an A/D conversion. They indicate that valid multiplexed data is available on the BCD data output lines, starting with the Most Significant Digit (MSD). Note that the Polarity output is not part of the BCD data and that the BCD, when taken as 4 multiplexed bits only will be unsigned. A fifth line (Polarity Out, Pin A3), must be polled to determine the sign. Refer to the timing diagram.

Overscale Out (Pin B13) ....
Should be sampled after the Busy falling edge. Overscale is HI if the previous input exceeds the A/D converter range of ±19999 counts.

Underscale Out (Pin B12) ....
Should be sampled after the Busy falling edge. Underscale is HI if the previous input display ±1800 counts or less. Underscale and Overscale are normally used as up/downranging gain selection controls for an auto-ranging input section.

Decimal Point Inputs (Pins A1, A2, B1, B2) .....
Should be connected to Decimal Point Common (B11) according to the desired display scaling. Note that decimal point selection does not change the ±2V input range.

Display Enable In (Pin B10) ....
Should be connected to +5V power (Pin B14) to illuminate the display. Leave open to blank the display but keep the A/D converter cycling (use to save power but eliminate turn-on drift).

Run/Hold In (Pin A4) ....
For normal operation, leave this pin open or tie HI for continuous sampling. Grounding this pin will hold and display the last sample to copy down a reading.

INPUT/OUTPUT CONNECTIONS

Analog HI Input (Pin A7) ....
Analog LO Input (Pin A8) ....
Differential input voltages are connected between these inputs. A bias current path to POWER COMMON or ANALOG RETURN from both these inputs must be externally provided. External circuits must constrain these inputs to be within the common mode voltage range.

Analog Return (Pin B3) ....
This analog common bias return must be externally connected to Power Common (Pin A14).

Reference IN/OUT (Pin B4) ....
The instrument is calibrated when a +1.0 Vdc drop exists between ref. IN/OUT (Pin B4) and analog Return (Pin B3). An external reference input to Pin B4 which is biased against Pin B3 may be used by opening solder gap 2. Ratiometric drift-correcting action may then be achieved over the reference input range of +0.1 Vdc to +2.0 Vdc (see diagram).

Display Test In (Pin B5) ....
Ground this pin to display "18888". Otherwise leave this pin open.

Polarity Output (Pin A3) ....
This output should be sampled at the Busy falling edge. HI indicates a positive input; LO indicates a negative input.
Polarity output may be disabled by opening solder gap 6. This would be used for unsigned reverse sensing (implied positive) applications with negative inputs.

Digit Drive Outputs (Pins A9 to A13) ....
Refer to the timing diagram. Digit drives HI sequentially turn on the five displays with multiplexed BCD data at approximately 150 complete scans per second (1.3 milliseconds per digit). Non-addressed displays (Digit Drive LO) remain dark. Persistence of vision creates a non-blinking image in the eye. Digit Drives may be used for companion remote slave displays.

−5V Power Out (Pin A15) ....
Up to 15 mA of −5 VDC power may be taken to power external user-supplied circuits such as signal conditioners, connected by SG3, (supplied closed). Caution: Pin B14 is not short circuit protected. The −5V output is loosely regulated and may require an external user-supplied filter for DC/DC converter ripple depending on the application.

+5V Power Out (Pin B15) ....
Is connected by solder gap 4 (supplied closed) for an additional +5V power pin.

Digital Outputs ....
MOS compatible; will drive 1 TTL/LS load
$0V \leq$ "0" = LO $\leq +0.4V$
$+2.4V \leq$ "1" = HI $\leq +5.0V$

Digital Inputs ....
MOS compatible; MOS drivers or open collector drivers pulled up to +5V are preferred. Use pullups on totem-pole drivers. $0 \leq$ "0" = LO $\leq +0.8V$
$+2.0V \leq$ "1" = HI $\leq +5.0V$
Caution: MOS inputs may be damaged by static discharge voltage spikes. Use ground protection when wiring or handling.

Data Outputs ....
4 wire Binary Coded Decimal (BCD 1-2-4-8) per digit, multiplexed. See timing diagram. Polarity display may be disabled by opening solder gap 6. This would be used for unsigned reverse sensing (implied positive) applications with negative inputs.

POWER REQUIREMENTS

External +5, ±0.25 VDC regulated required at 200 mA typical, 250 mA max. (65 mA typical with display and polarity disabled). Logic spikes must not exceed 50 mV. Power current varies rapidly so that unregulated supplies cannot be used. (−5V OUT current must be added to the +5V power requirements.)
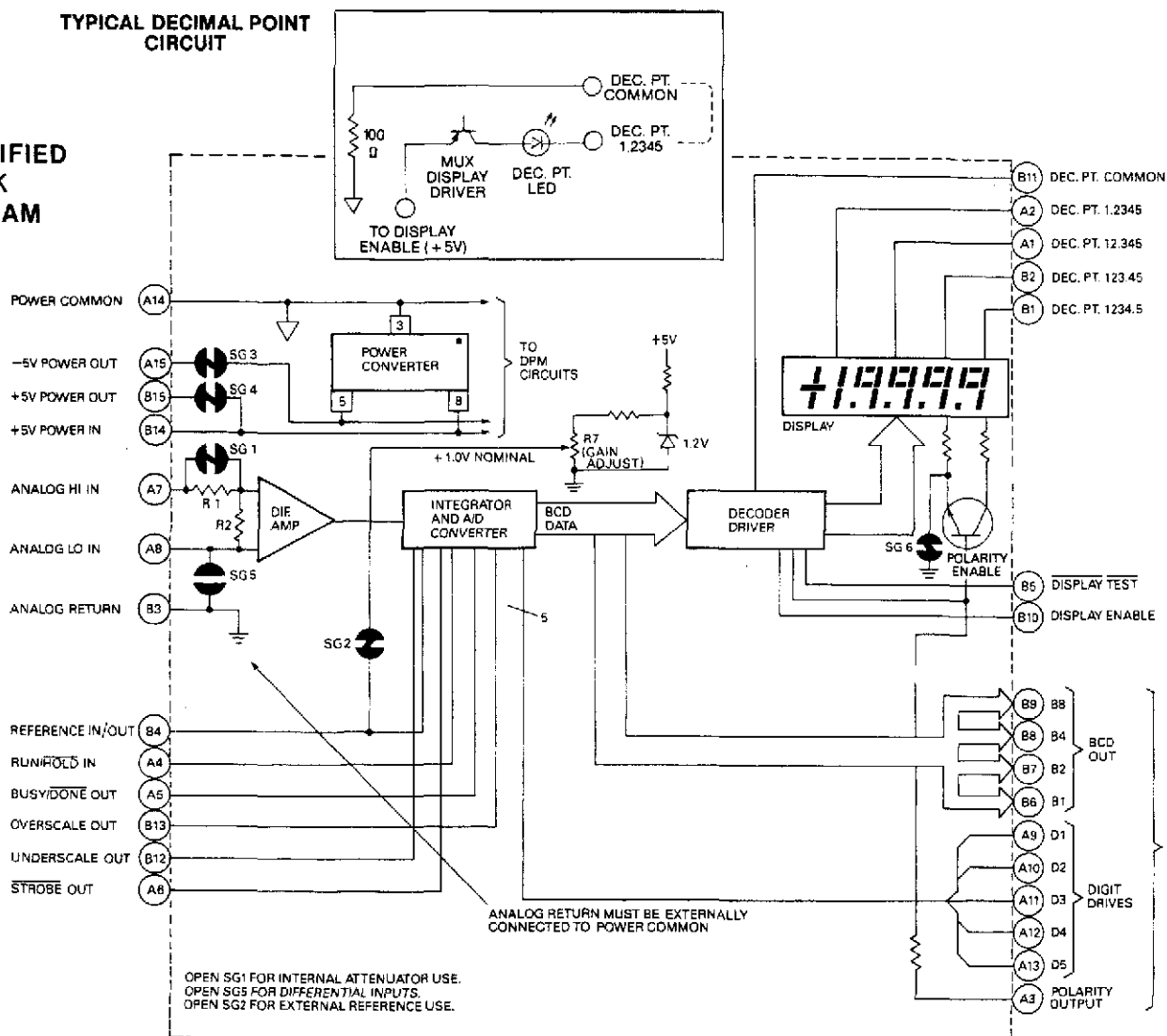
PHYSICAL-ENVIRONMENTAL

Outline Dimensions ....
2.53"W × 3.34"D × 0.94"H (64,3 × 84,8 × 23,8 mm)

Panel Cutout Dimensions ....
2.562"W × 0.97"H min (65,1 x 24,6 mm)

Mounting Method ....
Through a front panel cutout secured by brackets and two removable side case screws. Panel thickness up to 0.62" (15,9 mm)

Weight ....
Approximately 5 ounces (142g)

Connector ....
Dual 15-pin, 0.100" centers, Datel-Intersil #58-2073083, (not included).

Mounting Position ....
Any

Operating Temperature Range ....
0 to +50°C

Storage Temperature Range ....
−25°C to +85°C

SIMPLIFIED BLOCK DIAGRAM

TYPICAL DECIMAL POINT CIRCUIT

OPEN SG1 FOR INTERNAL ATTENUATOR USE.
OPEN SG5 FOR DIFFERENTIAL INPUTS.
OPEN SG2 FOR EXTERNAL REFERENCE USE.

ANALOG RETURN MUST BE EXTERNALLY CONNECTED TO POWER COMMON

TYPICAL INPUT/OUTPUT CONNECTIONS

WIRING SIDE (BOTTOM)		PIN # A	PIN # B	COMPONENT SIDE (TOP)	
DECIMAL POINT 12.345		1	1	DECIMAL POINT 1234.5	
DECIMAL POINT 1.2345		2	2	DECIMAL POINT 123.45	
POLARITY OUT[3]		3	3	ANALOG RETURN	
RUN/HOLD IN		4	4	REF IN/OUT (SG2)[1]	
BUSY/DONE OUT		5	5	DISPLAY TEST IN	
STROBE OUT		6	6	B1 (LSB)	BCD
ANALOG HI IN		7	7	B2	OUTPUTS[3]
ANALOG LO IN		8	8	B4	
DIGIT DRIVE OUTPUTS[3]	D1 (LSD)	9	9	B8 (MSB)	
	D2	10	10	DISPLAY ENABLE IN	
	D3	11	11	DECIMAL POINT COMMON	
	D4	12	12	UNDERSCALE OUT	
	D5 (MSD)	13	13	OVERSCALE OUT	
POWER COMMON		14	14	+ 5V POWER IN	
− 5V POWER OUT (SG3)[2]		15	15	+ 5V POWER OUT (SG4)[2]	

SIGNAL INPUT

5V RETURN

+ 5VDC POWER

This connector rear view shows the DPM tilted on its side.

NOTES:
1 SG2 is supplied closed for REF OUT; Open SG-2 for REF IN.
2 Digit drive and BCD outputs are used in conjunction with the DM-4102 slave display.
3 Pins A14 and B3 *must* be externally connected together.

INTERNAL MODIFICATIONS

Attenuator and shunt resistor pads are supplied on the bottom DPM printed circuit board to allow the user to program higher current or voltage ranges. DATEL will also modify these meters on special order in OEM quantities only.

CAUTION: Such modification 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.

Input attenuator resistors and shunt (R1, R2), solder gaps and jumpers are located by removing the DPM circuit board from its housing.

<u>For the Low Profile miniature models</u>, remove the rear connector and remove the rear cover by inserting a small screwdriver between the cover and the case. Bow the cover backward to release the 2 catches in the side of the case. Slide the circuit board out backwards. After modification, be sure the front filter is in place, then slide the bottom board between the guide rails molded into the case. The rear cover will need to be compressed slightly to fit back into the slots in the case.

Solder Gap 5 (which single-ended-grounds Analog LO In) is located on the bottom (non-component) side of the lower board, in parallel with R1. R1 and R2 are found on the top of the lower board by tracing the Analog HI Input pin etch.
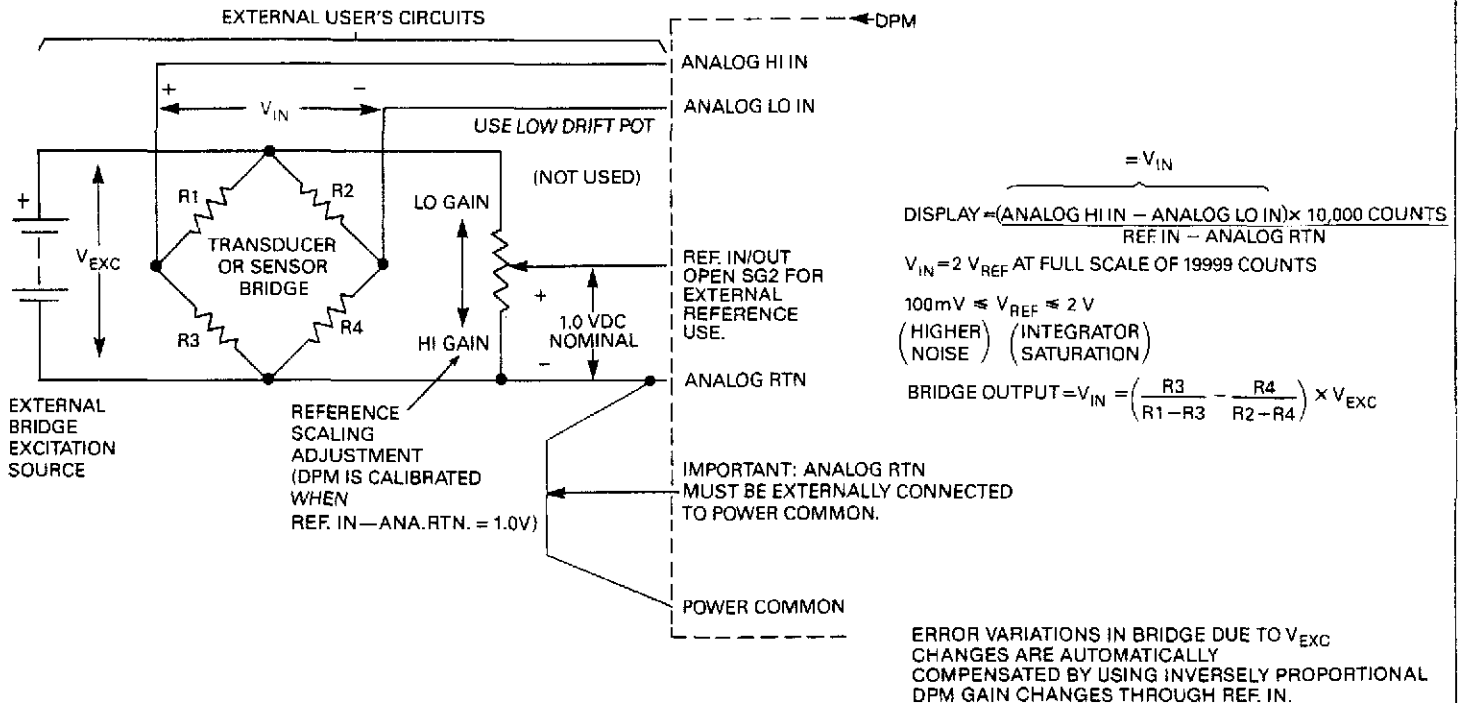
INTERNAL COMPONENT LOCATIONS
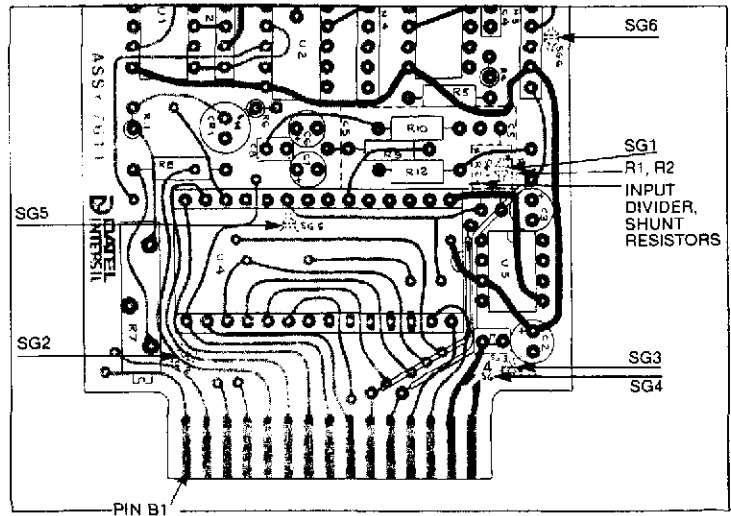
RATIOMETRIC OPERATION

Ratiometric operation is used with bridge-type differential inputs to reduce system errors when two or more reference voltages are otherwise used. By using a single reference to operate the entire measurement circuit, accuracy depends only on the tracking ratio of the resistors rather than the magnitude of the reference voltage.

In the circuit shown here, the DPM's input is the output of a sensor bridge (example: strain gauge or load cell). The bridge requires a source of excitation voltage which varies with the type of application. The DPM also requires a reference voltage. Both bridge excitation and the DPM reference input must be held stable to avoid errors. Bridge output is directly proportional to the bridge excitation. However, the DPM display is 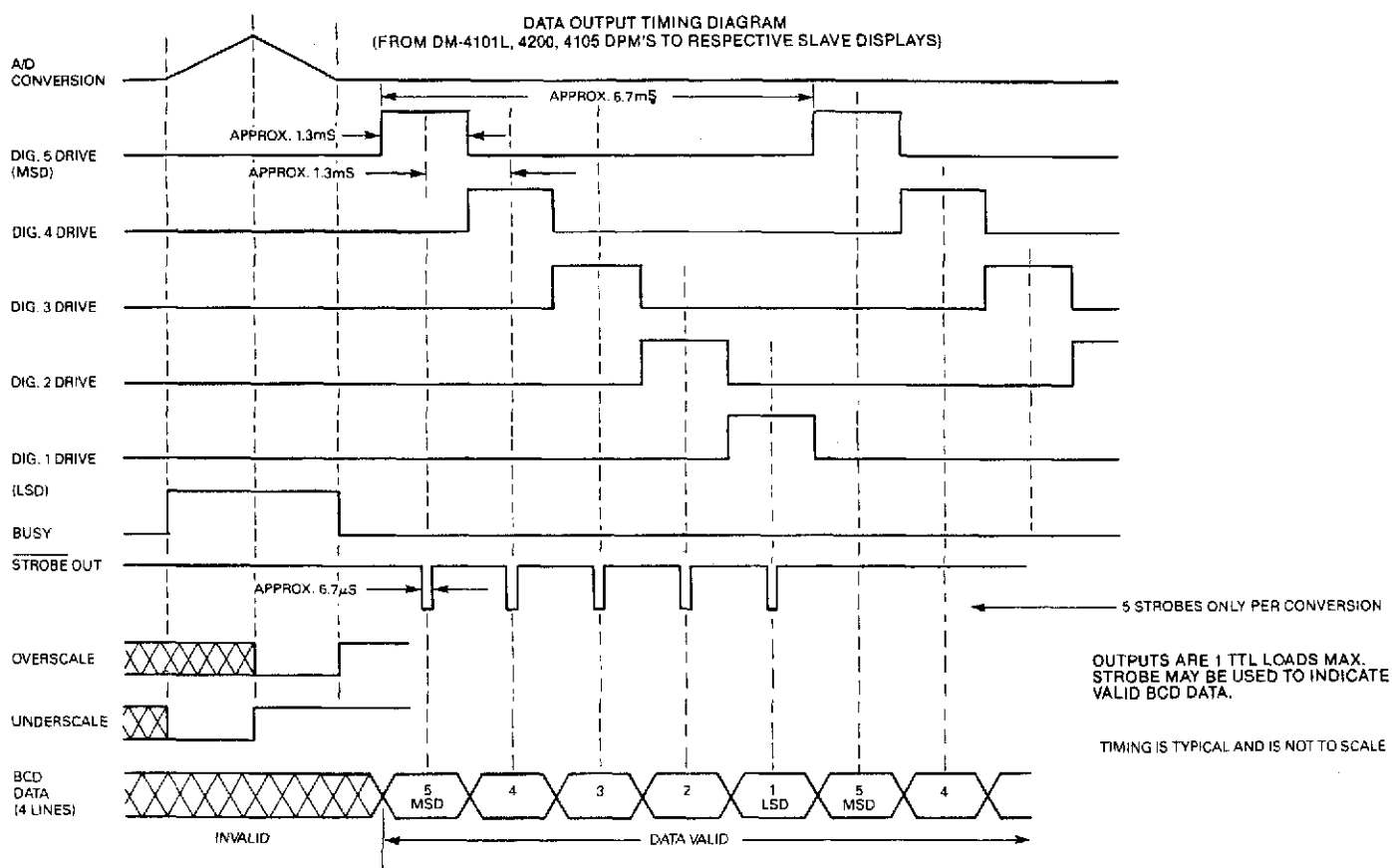*inversely* proportional to the reference input. That is, with a smaller reference input, larger values are displayed. By using a common voltage source to excite the bridge and DPM reference, the DPM will automatically compensate for small bridge output variations. Since the bridge excitation is usually larger than +1.0 Vdc used to reference the DPM, a precision pot on the voltage source supplies the DPM's reference as a proportion of the voltage source. Over a limited range (+0.1 to +2.0 Vdc), this pot may be used as the DPM's full scale adjustment. Since the DPM's internal reference is not used in this application, the DPM's gain pot will have no effect. The DPM's internal reference may be used for the entire circuit in place of the external voltage source, however an external user-supplied amplifier may be required to get adequate bridge excitation.

$$DISPLAY = \frac{(ANALOG\ HI\ IN - ANALOG\ LO\ IN) \times 10{,}000\ COUNTS}{REF\ IN - ANALOG\ RTN}$$

$V_{IN} = 2\ V_{REF}$ AT FULL SCALE OF 19999 COUNTS

$$100mV \leqslant V_{REF} \leqslant 2\ V$$

$$\left(\begin{array}{c}HIGHER \\ NOISE\end{array}\right) \quad \left(\begin{array}{c}INTEGRATOR \\ SATURATION\end{array}\right)$$

$$BRIDGE\ OUTPUT = V_{IN} = \left(\frac{R3}{R1-R3} - \frac{R4}{R2-R4}\right) \times V_{EXC}$$

IMPORTANT: ANALOG RTN MUST BE EXTERNALLY CONNECTED TO POWER COMMON.

ERROR VARIATIONS IN BRIDGE DUE TO V_{EXC} CHANGES ARE AUTOMATICALLY COMPENSATED BY USING INVERSELY PROPORTIONAL DPM GAIN CHANGES THROUGH REF. IN.

DATA OUTPUT TIMING DIAGRAM

To reduce the amount of wiring required to implement a slave display, 4-wire BCD data is multiplexed using 5 digit drive outputs which direct the BCD data to the proper digit. The DPM displays rely on the persistence of vision of the human eye to store an image of the displayed digit. This multiplexing technique is commonly used with DPM's and DVM's. Each digit drive has the effect of sequentially turning on its respective digit when the drive signal is Hi. The digit is blanked when the drive is low.

Digits are scanned in this manner in the DM-4101L, 4200, 4105 approximately 150 times per second. The BCD data is updated with every A/D conversion which is approximately 3 times per second. Only 5 strobe pulses are issued with each new conversion. These DPM's may be connected to popular microprocessors by using peripheral interface circuits and a suitable data transfer program. The strobe may be used to generate an interrupt which latches the DPM's output data, then transfers it to memory.

DATA OUTPUT TIMING DIAGRAM
(FROM DM-4101L, 4200, 4105 DPM'S TO RESPECTIVE SLAVE DISPLAYS)

5 STROBES ONLY PER CONVERSION

OUTPUTS ARE 1 TTL LOADS MAX. STROBE MAY BE USED TO INDICATE VALID BCD DATA.

TIMING IS TYPICAL AND IS NOT TO SCALE

OVERSCALE/UNDERSCALE AUTORANGING CONTROLS

DATEL'S new 4½ digit differential DPM's include Underscale and Overscale outputs. Overscale trips when the input exceeds 19999 counts. Underscale trips on 1800 counts. If an external circuit consisting of relays or FET switches can change an external *decade* programmable gain amplifier, the Underscale control should be used to decrement a PGA counter which downranges to higher gain. Overscale should increment the PGA counter to cause an uprange to lower gain or less attenuation. Underscale and Overscale are positive-true pulses. They both should be sampled after the Busy falling edge.

The decimal points can also be programmed by the autoranging circuits to indicate what the range is.

WARRANTY INFORMATION

NOTE: DATEL'S Digital Panel Meters are warranted to be free from defects in materials and workmanship when operated as described in this brochure for a period of one year from the date of shipment. This information is believed to be sufficient for the user to determine and be responsible for the selection, application and specification of this product for the user's intended usage. This warranty is expressed in lieu of all other warranties, expressed or implied, including the implied warranty of fitness for a particular purpose and of all other obligations or liabilities on the seller's part. The warranty neither assumes nor authorizes any other person to assume for the seller any other liabilities in connection with the sale of the said articles.

Suggested operating modes such as voltage attenuation or current shunt measurement may include components which are internally installed by the user. Since the selection of these components and the manner of installation is beyond DATEL'S control, the warranty extends only to products which operate as standard, unmodified units. This means that DATEL will honor warranties on products which have been restored to their original condition (that is, added or modified components will have been removed by the customer before returning the product for repair). Further, the customer must insure that the product was not damaged by the addition and removal of components. Such damage would void the original product warranty.

As a practical matter, users have several alternatives to insure warranty protection. Although this product is 100% functionally tested and inspected, a thorough incoming inspection by the customer should be considered before modification. Those original components of the DPM (displays, IC's, etc.) will be warranted if defective (and, in DATEL'S opinion, not subject to catastrophic user damage).

Users may also partially remove components (one lead of a shunt resistor, for example) to restore the DPM to original condition while expediting return to the user's modified condition, once DATEL has repaired the product.

The intent of this procedure is to allow rapid diagnosis and repair on DATEL's test fixtures. Because of the variety of possible DPM modifications, DATEL test fixtures can only test unmodified products.

DM-4102 SLAVE DISPLAY WIRING

SIG. IN

$\pm 1.9.9.9.9$

DM-4200

12 WIRES

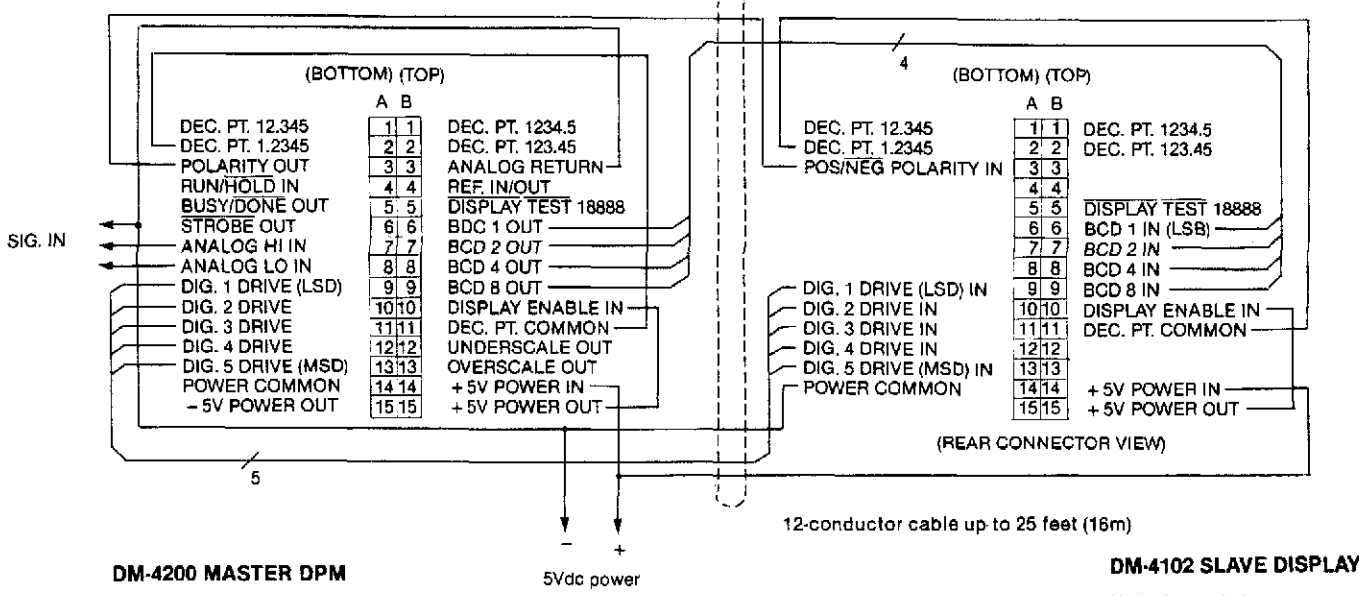UP TO 25 FEET

$\pm 1.9.9.9.9$

DM-4102

+5 VDC POWER
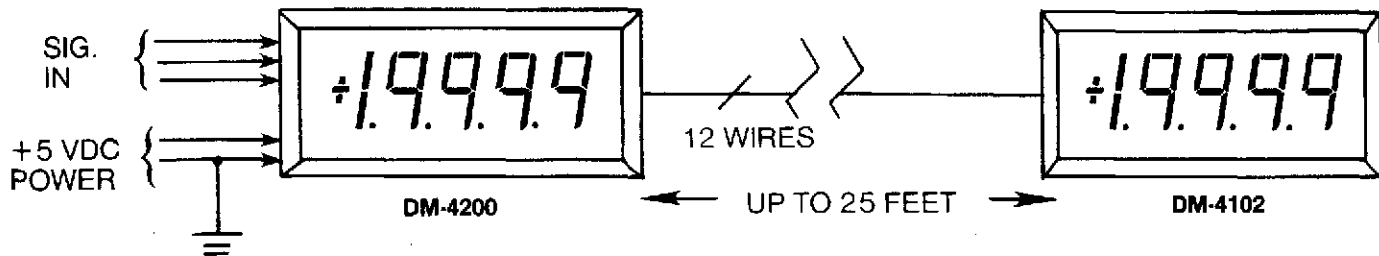
SLAVE DISPLAY

A companion low-cost slave display, Model DM-4102 is offered by DATEL for use with the DM-4200 Master DPM. The DM-4102 can be used as a remote data repeater up to 25 feet away. A simple 12-wire interface, suitable for ribbon cable connects as shown below. The Diagram shows both the DM-4200 and DM-4102 connectors vertically to illustrate their associated pin-out connections.
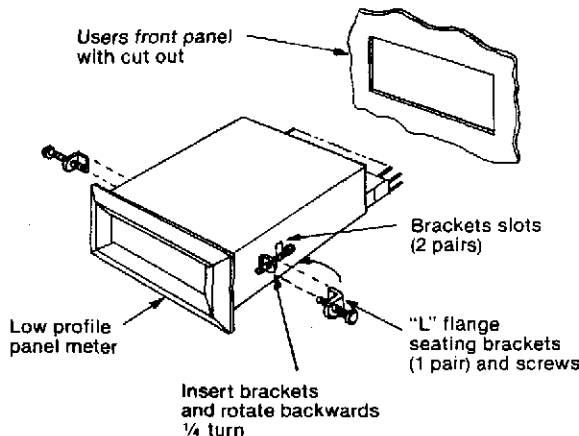
TYPICAL SLAVE CONNECTION DIAGRAM

	(BOTTOM) (TOP) A B			(BOTTOM) (TOP) A B	
DEC. PT. 12.345	1 1	DEC. PT. 1234.5	DEC. PT. 12.345	1 1	DEC. PT. 1234.5
DEC. PT. 1.2345	2 2	DEC. PT. 123.45	DEC. PT. 1.2345	2 2	DEC. PT. 123.45
POLARITY OUT	3 3	ANALOG RETURN	POS/NEG POLARITY IN	3 3	
RUN/HOLD IN	4 4	REF. IN/OUT		4 4	
BUSY/DONE OUT	5 5	DISPLAY TEST 18888		5 5	DISPLAY TEST 18888
STROBE OUT	6 6	BDC 1 OUT		6 6	BCD 1 IN (LSB)
ANALOG HI IN	7 7	BCD 2 OUT		7 7	BCD 2 IN
ANALOG LO IN	8 8	BCD 4 OUT		8 8	BCD 4 IN
DIG. 1 DRIVE (LSD)	9 9	BCD 8 OUT		9 9	BCD 8 IN
DIG. 2 DRIVE	10 10	DISPLAY ENABLE IN	DIG. 1 DRIVE (LSD) IN	10 10	DISPLAY ENABLE IN
DIG. 3 DRIVE	11 11	DEC. PT. COMMON	DIG. 2 DRIVE IN	11 11	DEC. PT. COMMON
DIG. 4 DRIVE	12 12	UNDERSCALE OUT	DIG. 3 DRIVE IN	12 12	
DIG. 5 DRIVE (MSD)	13 13	OVERSCALE OUT	DIG. 4 DRIVE IN	13 13	
POWER COMMON	14 14	+5V POWER IN	DIG. 5 DRIVE (MSD) IN	14 14	+5V POWER IN
–5V POWER OUT	15 15	+5V POWER OUT	POWER COMMON	15 15	+5V POWER OUT

SIG. IN

(REAR CONNECTOR VIEW)

12-conductor cable up to 25 feet (16m)

DM-4200 MASTER DPM

5Vdc power

DM-4102 SLAVE DISPLAY

Undesignated pins are no connection

PANEL INSTALLATION INSTRUCTIONS

The low profile case is retained in a front panel cutout by sliding the DPM housing in through the cutout opening and securing the housing from the rear using 2 "L" brackets and screws. Proceed as follows.

1. After determining the correct position, form a cutout in the mounting panel. Refer to the cut-out drawing for proper dimensions.
2. Install the panel meter from the front (display) side of the mounting panel as shown.
3. There are two pairs of slots in the side of the case to receive the L-brackets and retaining screws. Most applications will use the front pair of slots. For panels thicker than about 0.25 inches (6 mm), use the rear slot pair.
4. A thin plastic molding may cover the selected slots. This can be broken through with the L brackets in the next step or can be removed using a screwdriver or knife before panel mounting.
5. Assemble the supplied 4-40 screws into the L brackets as shown, turning the screw until several threads are engaged.
6. Using the screw as a lever, push the short side of the bracket into the slot as shown and rotate the screw backwards ¼ turn until the screw is parallel to the case side and the L bracket is fully captured in the case.
7. Lightly tighten the screws against the front panel.

Users front panel with cut out

Brackets slots (2 pairs)

Low profile panel meter

"L" flange seating brackets (1 pair) and screws

Insert brackets and rotate backwards ¼ turn

CIRCUIT BOARD ACCESS

If access to the internal circuit board is required, bow the rear cover plate backward by prying up in the center with a small screwdriver or knife blade, to release the two catches in the side of the case. When reinstalling the circuit board, first be sure the front filter is flush against the inside of the housing. The circuit board engages a pair of guide tracks which are molded inside the case.

When reinstalling the rear cover plate, be sure the trim pot access hole is to the lower left when facing the rear. Compress the cover plate slightly so that it snaps into the two retaining slot catches at the rear sides.

If a second user-fabricated circuit board is installed in the upper pair of board guide tracks, the upper connector slot (if used) in the rear cover plate may be opened by using a knife from inside the cover.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE   4/87