



DM-4105

4½-Digit, Differential LCD Display with Data Outputs

FEATURES

- Low Cost, 4½ Digit DPM with LCD Display
- Balanced Differential Inputs
- .5" high Liquid Crystal Display (LCD)
- 1000 Megohm CMOS Input with 5 pA input bias currents
- Battery-portable circuitry requires only 15 milliwatts power (5 Vdc @ 3 mA)
- Autozeroing with ratiometric reference for drift correction
- Digit Serial BCD outputs — can drive DM-4106 remote slave display
- + 5 Vdc Power — provides — 5 Vdc at 15 mA output to power user circuits.
- Right digit programmable as °C or °F for digital thermometer

DESCRIPTION

The DM-4105 is a 4½-digit DPM (Digital Panel Meter) with balanced differential analog inputs, a .5" high Liquid Crystal Display (LCD) and low power circuitry which requires only 15 milliwatts of power (+ 5 Vdc at 3 mA, typical). The meter converts analog voltages from -1.9999V to +1.9999 Vdc to be displayed as decimal digits. Digit-serial BCD data outputs and digit drives are available on the meter's rear-panel connector where they can be used to drive remote displays, or (in conjunction with an interface demultiplexer) as A/D inputs to a microcomputer, data logger, or printer.

The DM-4105 provides excellent electrical performance in a compact panel-mounting package. Analog inputs have a very high input impedance (1000 Megohm typical) with very low bias currents of 5 pA (typical). Common Mode Rejection Ratio (CMRR) is 86 dB. The meter is autozeroed on each conversion cycle to minimize drift of zero. A Reference In-Out loop can be used to correct drift in externally excited ratiometric circuits.

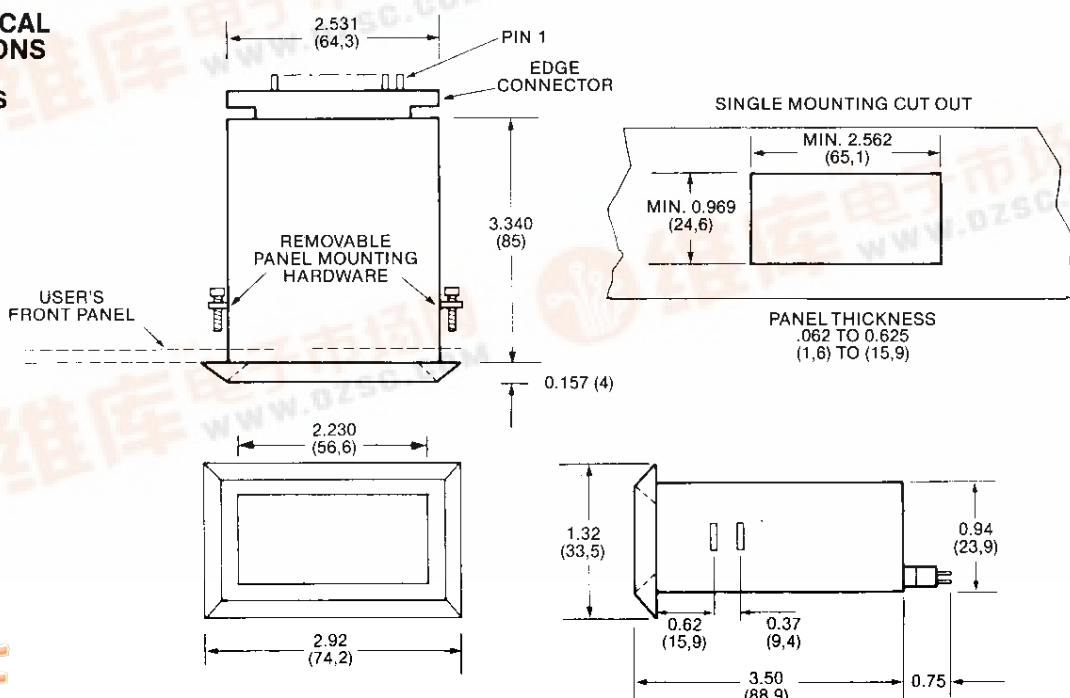


A variety of designed-in features make it easy to use the DM-4105 in many applications. Blank circuit pads will accept user-supplied current shunts, voltage dividers, and ohmmeter components. Overrange and Underrange outputs can be used to trigger external autoranging circuitry (the DM-4105 display has Overrange and Underrange descriptors which may be set by the user). In 3½ digit thermometer applications, a degree sign can be enabled on the display, while the right Digit (LSD) can be solder-gap-programmed as "C" for Celsius readings or "F" for Fahrenheit readings.

The DM-4105 is powered from + 5 Vdc at 3 mA typical (5 mA max.). It may be powered from 4 "AA" alkaline cells. A - 5V output (at up to 15 mA output) is provided to power external circuits. The meter's Low Profile polycarbonate case is 2.53"W x 3.25"D x 0.94"H (64,3 x 82,5 x 23,8 mm).

MECHANICAL DIMENSIONS

INCHES
(MM)



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

ANALOG INPUT

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

Full Scale Input Range
-1.9999 Vdc to +1.9999 Vdc

Input Bias Current
5 pA typical, 50 pA maximum

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

Resolution
100 μ V in last digit

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

Temperature Drift of Gain
 ± 50 ppm of Reading/°C typ.
 ± 100 ppm of Reading/°C max.

Input Impedance
100 Megohms, minimum, 1000 Megohms,
typ.

Input Overvoltage
 ± 250 Volts dc, 175 VRMS continuous
max.
 ± 300 Volts intermittent max.

Reference
Internal, referred to Analog Return. An Ex-
ternal, user-supplied referenced biased
against pin B3 is optional for ratiometric
operation.

External Ref. Range
 ± 100 mV to ± 2 V, referred to Analog Re-
turn (pin B3)

Common Mode Rejection
86 dB typical to Analog Return

Common Mode Voltage Range
Both inputs must remain within ± 4 Vdc to
Power Common. The user must provide
external circuitry to keep the inputs within
the common mode range (call Datal-
Intersil if engineering assistance is
needed)

DISPLAY

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

Display Type
Black-digits-on-white Liquid Crystal Dis-
play (LCD); requiring external illumination

Display Height
0.5 inches (12.7 mm)

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

Autopolarity
A plus or minus sign is automatically dis-
played for positive or negative voltage in-
puts, and may also be blanked. The
polarity display may be disabled by open-
ing Solder Gaps 6 and 7. This would be
used for unsigned reverse sensing (im-
plied positive) applications with negative
inputs.

Sampling Rate
Approximately 3 conversions per second

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

INPUT/OUTPUT CONNECTIONS

Analog HI Input (Pin A7)
Analog LO Input (Pin A8)
Differential input signals are applied to
pins A7, A8. The input may be made
single-ended to Analog Return (Pin B3) by
closing solder gap SG5. Analog HI In is
connected to the A/D input through solder
gap SG4 (supplied closed). Users may in-
stall internal attenuator or current shunt

resistors (see the block diagram) for
higher voltage or current ranges. Open
SG4 for voltage attenuators; leave SG4
closed for a current shunt installed at R2.
Custom voltage or current ranges are
available from Datal-Intersil in OEM quan-
tities. A bias current path to Power Com-
mon or Analog Return must be provided in
the user's external circuits.

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

Reference In/Out (Pin B4)
Normally, pin B4 is not used. The instru-
ment is calibrated when a +1.0 Vdc drop
exists between pins B4 (+) and B3 (-). In-
ternally, this is supplied from a reference
diode, the full scale adjustment poten-
tiometer wiper connected through solder
gap SG3. An external ratiometric refer-
ence may be substituted by opening SG3
and biasing the external source against
pin B3. External reference range: +0.1
Vdc to +2.0 Vdc. Refer to the ratiometric
diagram.

Digital Connections are MOS and will
drive TTL, or LS or CMOS. Outputs will
drive 1 TTL load (1.6 mA sink min.).
Outputs: +2.4V $\leq$ "1" = HI $\leq$ +5.0V
0V $\leq$ "0" = LO $\leq$ +0.4V
Inputs should be driven from open collec-
tor TTL outputs (10 K Ω pullup or less) or
CMOS buffers (4049, 4050, etc.) or hard
wire connection to ground or +5V. Totem
pole drivers should use pullups.
Caution: MOS inputs may be damaged
by static discharge voltage spikes.
Use ground protection when wiring or
handling.

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 milli-
seconds. The HI Busy level may be used
by automatic equipment to prevent chang-
ing the input voltage during conversion.
See the timing diagram.

Strobe Out (Pin A6)
Strobe consists of 5 negative pulses per
conversion of approximately 6.7 micro-
seconds width and approximately 1.3 mil-
liseconds apart issued after an A/D
conversion. They indicate that valid multi-
plexed data is available on the BCD data
output lines, starting with the Most Signif-
icant Digit (MSD). Note that the Polarity
Output is not mux'd out with the unsigned
BCD data. A fifth line (Polarity Out, Pin A3)
must be polled to determine the sign. Re-
fer to the timing diagram.

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

Underscale Out (Pin B12)
Underscale is HI if the previous input dis-
plays ± 1800 counts or less. Underscale
must be sampled after the Busy falling
edge. Underscale and Overscale are nor-
mally used as up/downranging gain selec-
tion controls for an autoranging input
section.

Backplane Out (Display On, pin B11)
Backplane Out (Display Off, pin B10)

All decimal points and the degree symbol
must be wired to either pin B10 or B11 to
blank or display the selected item.

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

Polarity Out (Pin A3)
HI indicates a positive input; LO indicates
a negative input. Polarity must be sam-
pled after the Busy falling edge. See tim-
ing diagram.

Degree Symbol (°) In (Pin B5)
The temperature degree symbol may be
displayed between the 1's and 10's digit by
tying pin B5 to B11. To blank the degree
symbol, tie B5 to B10. The 1's digit may be
dedicated as an F (Fahrenheit) or C (Cel-
sius) unit abbreviation by modifying inter-
nal solder gaps (see table and diagram).
Also available preconfigured under spe-
cial order. This modification provides a
3½ digit (1.9.9.9.°□) instrument.

Note: The DM-4105 does not directly mea-
sure temperature. External user-supplied
probes are required since the DM-4105 re-
mains a ± 2 Vdc input instrument.

-5V Power Out (Pin A15)
Up to 15 mA of -5 Vdc power may be
taken to power external user-supplied cir-
cuits such as signal conditioners.
Caution: Pin A15 is not short circuit pro-
tected. The -5V output is loosely regula-
ted and may require an external
user-supplied filter for DC/DC converter
ripple depending on the application.

+5V Power Out (Pin B15)
Pin B15 is connected by solder gap SG1
(supplied closed for an additional +5V
power pin).

POWER REQUIREMENTS

External +5 to 6 Vdc regulated required at
3 mA typical, 5 mA max. Logic spikes
must not exceed 50 mV. (Note: Any current
taken at -5V Out must be added to +5V
power to yield total meter power.)

PHYSICAL-ENVIRONMENTAL

Outline Dimensions
2.53"W $\times$ 3.34"D $\times$ 0.94"H
(64.3 $\times$ 85 $\times$ 23.8 mm)

Cutout Dimensions
2.562"W $\times$ 0.97"H min. (65.1 $\times$ 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

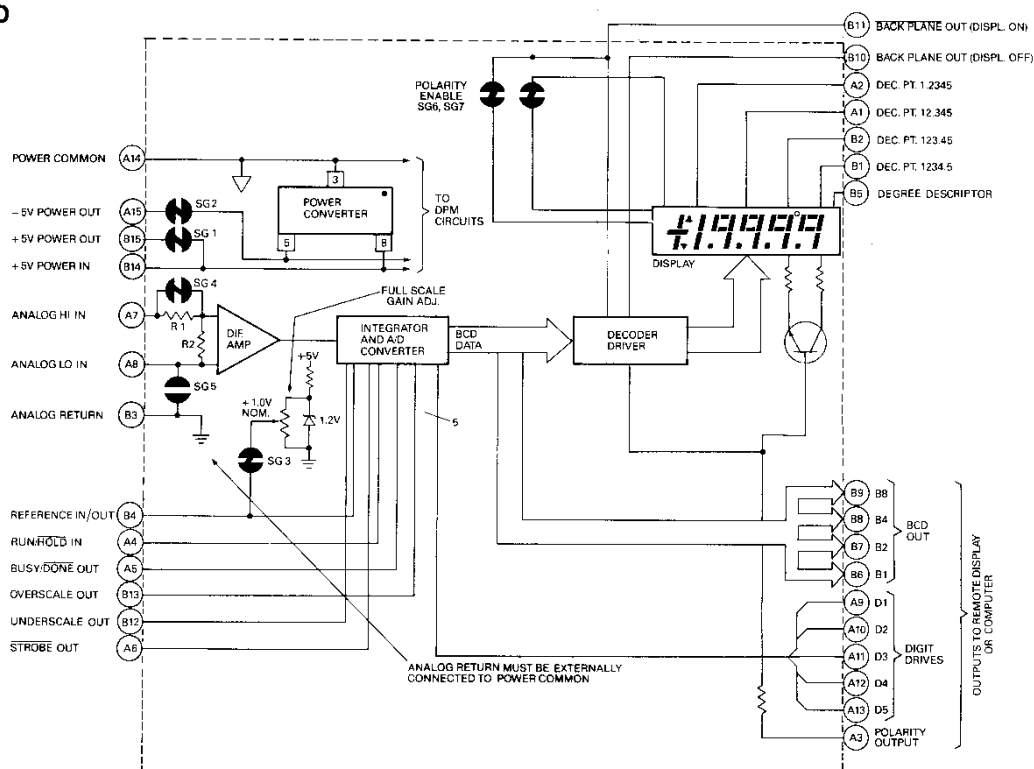
Mounting Position
Any

Operating and Storage Temperature Range
0 to +50°C (Caution: Avoid long exposure
to high temperature, direct sunlight
display overheating and high humidity.)

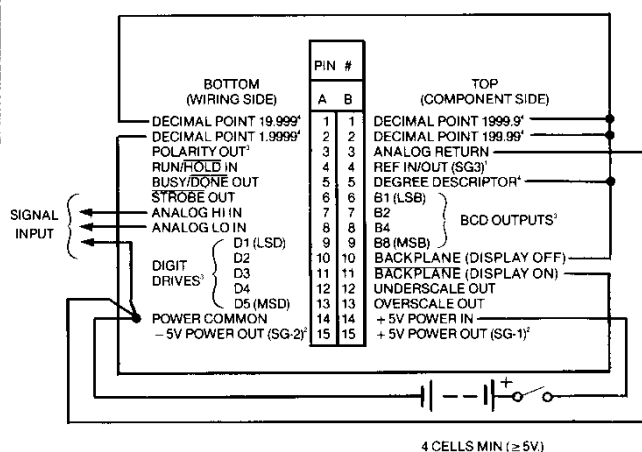
Ordering Information

DM-4105-1: ± 2 Vdc Input Range
(Supplied With Free Connector)

RN-3100/4100: Range-Change
Accessory Kit for DM-Series Meters

SIMPLIFIED
BLOCK
DIAGRAM

TYPICAL INPUT/OUTPUT CONNECTIONS



NOTES:

- 1 Close SG3 for REF OUT; open SG3 for REF IN.
- 2 Close SG2 for -5V OUT; close SG1 for +5V OUT.
- 3 Used in conjunction with slave display.
- 4 Tie Decimal Point or Descriptor to BACKPLANE (B11) to enable. Tie all unused Decimal Points and Descriptors to BACKPLANE (B10).
- 5 Analog Return (pin B3) must be externally connected to Power Common (pin A14).

SOLDER GAPS AND JUMPER

SOLDER GAP/ JUMPER	FUNCTION	
	OPEN	CLOSED
SG 1 (N.C.)	No Connection to Pin B15	+5V IN connected to Pin B15
SG 2 (N.C.)	No connection to Pin A15	-5V from DC-DC converter on Pin A15
SG3 (N.C.)	Ref. IN on Pin B4	Ref. IN connected to Ref. OUT, Ref. OUT (1.0 Vdc) on B4
SG4 (N.C.)	R1 in circuit	R1 position shorted
SG 5 (N.O.)	Differential Input	Single-Ended Input (ANA LO connected to ANA RTN)
SG6 (N.C.)	Polarity Sign Disabled	Polarity Sign Enabled
SG7 (N.C.)		
SG8 (N.C.) ³	Disable LSD Seg. E	Enable LSD Seg. E
SG9 (N.C.) ³	Disable LSD Seg. D	Enable LSD Seg. D
SG10 (N.C.) ³	Disable LSD Seg. C	Enable LSD Seg. C
SG11 (N.C.) ³	Disable LSD Seg. G	Enable LSD Seg. G
SG12 (N.C.) ³	Disable LSD Seg. F	Enable LSD Seg. F
SG13 (N.C.) ³	Disable LSD Seg. A	Enable LSD Seg. A
SG14 (N.C.) ³	Disable LSD Seg. E	Enable LSD Seg. E
SG15 (N.C.) ³	Disable ▽ (Underrange Descriptor) ²	Enable ▽ (Underrange Descriptor) ²
J1 (N.O.)		

NOTES:

- 1 N.O. = Normally Open
N.C. = Normally Closed
- 2 The Underrange Descriptor is displayed whenever input is less than or equal to 9% of input range ($-0.18V \leq \text{input} \leq +0.18V$ on $\pm 2V$ input range) to track the underrange output (Pin B12).
- 3 To use LSD (Least Significant Digit) as temperature abbreviation open SG's 8 through 14 to disable LSD. Tie side of Solder Gap connected to display to the following locations to yield "C" or "F". Tie pin B5 to pin B11.

TEMPERATURE ABBREVIATION	TIE TO BACKPLANE (B10)	TIE TO BACKPLANE (B11)
"F" (Fahrenheit)	SG9, SG10, SG14	SG8, SG11, SG12, SG13, Pin B5
"C" (Celsius)	SG10, SG11, SG14	SG8, SG9, SG12, SG13, Pin B5

INTERNAL MODIFICATIONS

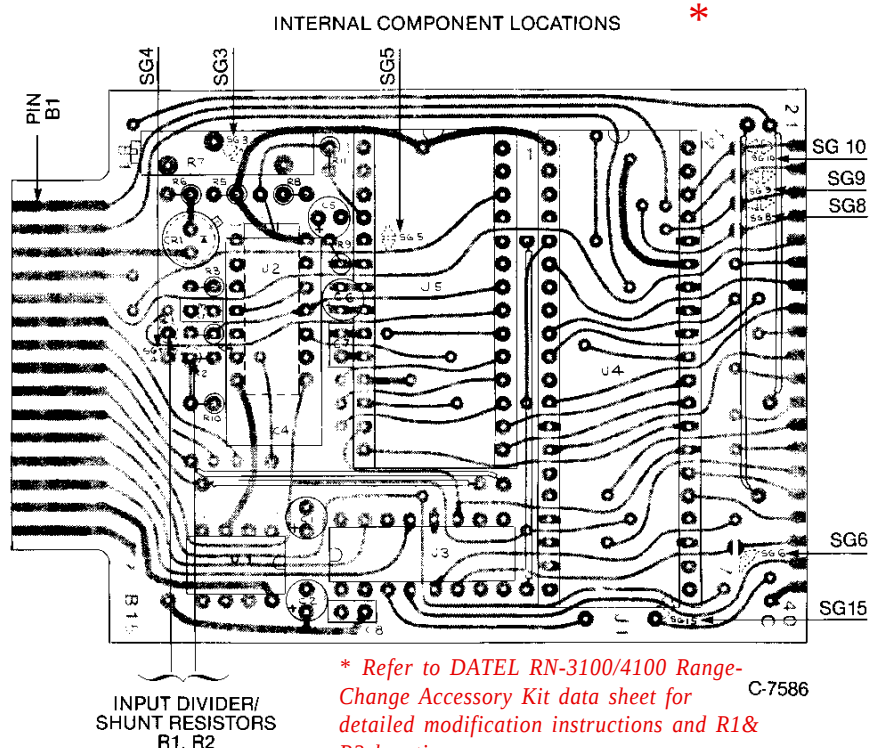
Attenuator and shunt resistor pads are supplied on the bottom DPM printed circuit board to allow the user to program higher current or voltage ranges. Datel will also modify these meters on special order in OEM quantities only.

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.

For access to internal components, 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.

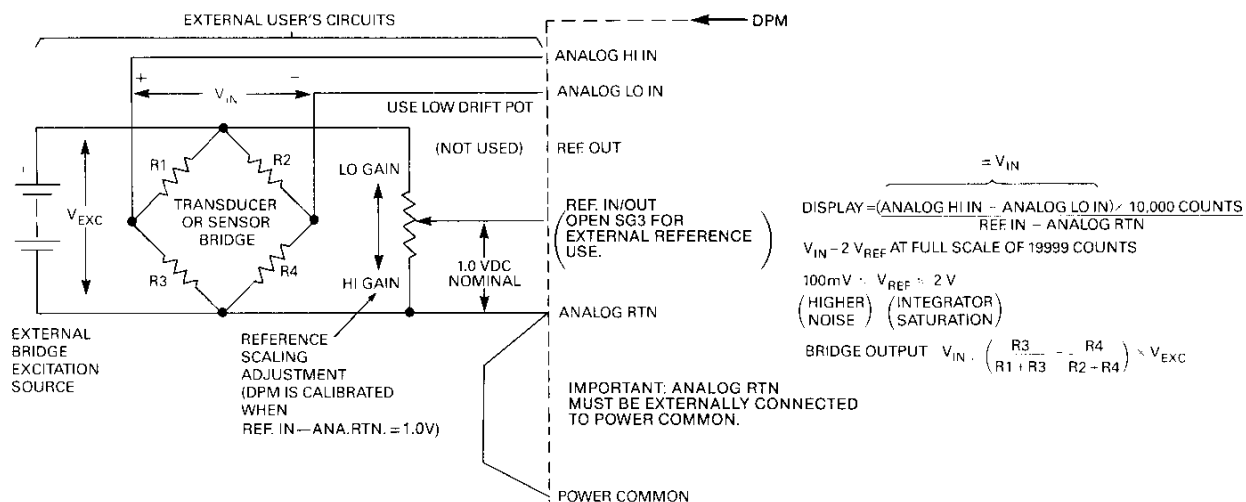


RATIOMETRIC OPERATION

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.

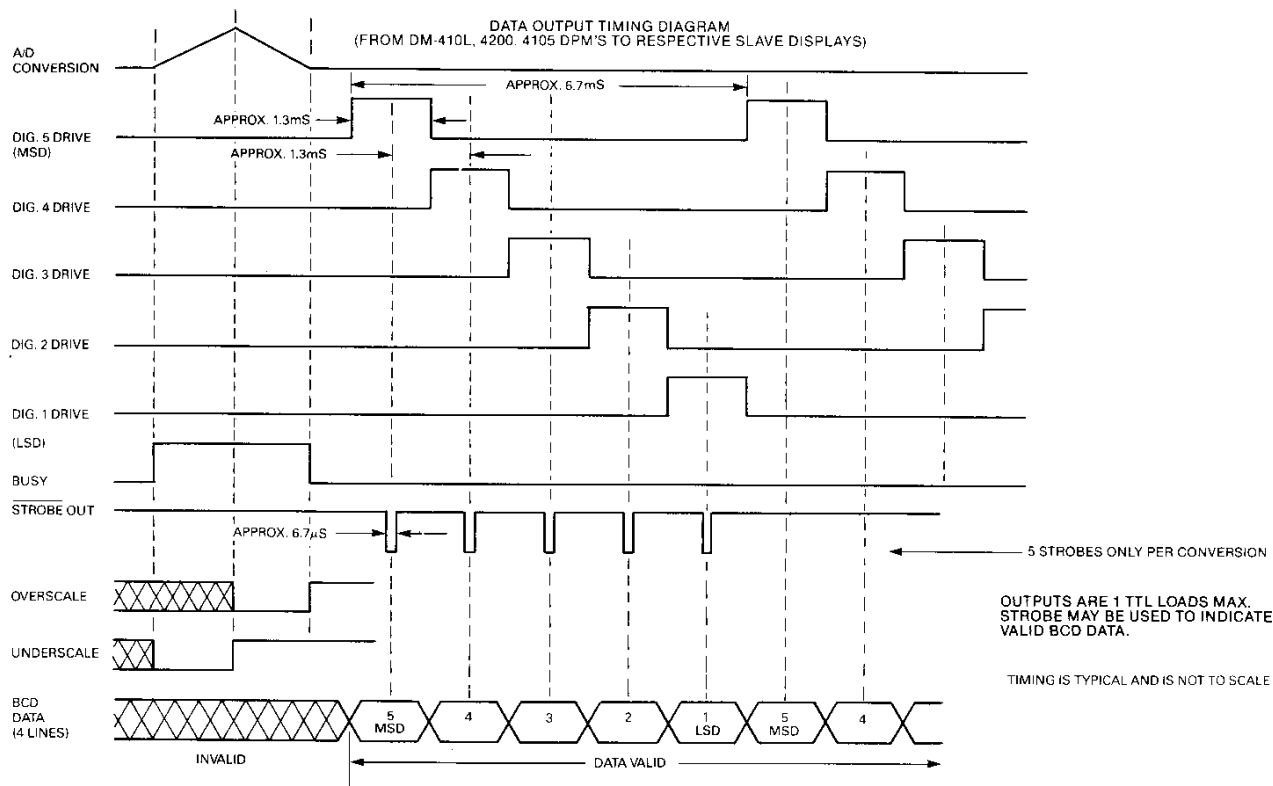


ERROR VARIATIONS IN BRIDGE DUE TO V_{EXC} CHANGES ARE AUTOMATICALLY COMPENSATED BY USING INVERSELY PROPORTIONAL DPM GAIN CHANGES THROUGH REF. IN.

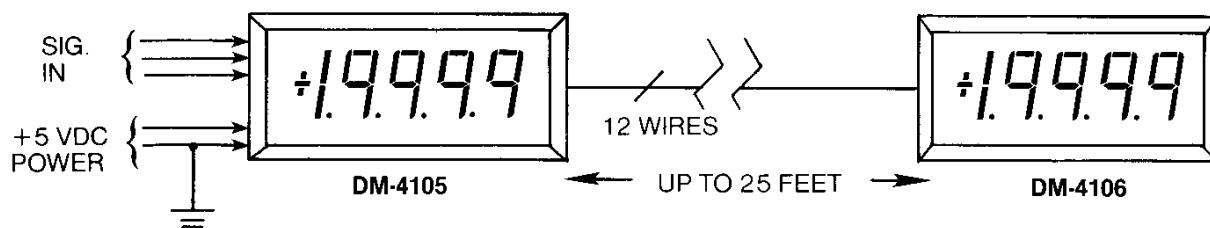
DATA OUTPUT TIMING DIAGRAM

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.



DM-4106 SLAVE DISPLAY WIRING



REAR CONNECTOR VIEW

WIRING SIDE BOTTOM (A)		COMPONENT SIDE TOP (B)	
	DEC PT 19.999	1	DEC PT 1999.9
	DEC PT 1.9999	2	DEC PT 199.99
A3	POLARITY INPUT	3	NO CONNECTION
	NO CONNECTION	4	NO CONNECTION
	NO CONNECTION	5	DEGREE SIGN IN
	NO CONNECTION	6	B1 LSB
	NO CONNECTION	7	B2
	NO CONNECTION	8	BCD INPUTS
	NO CONNECTION	9	B8 MSB
A9	D1 LSD	10	B.P. INPUT/OUTPUT
A10	D2	11	B.P. INPUT (DISP COM)
A11	D3	12	OVERSCALE INPUT
A12	D4	13	UNDERSCALE INPUT
A13	D5 MSD	14	+5VDC PWR IN
A14	PWR COMMON	15	+5VDC PWR OUT
	NO CONNECTION		

DM-4106 SLAVE DISPLAY

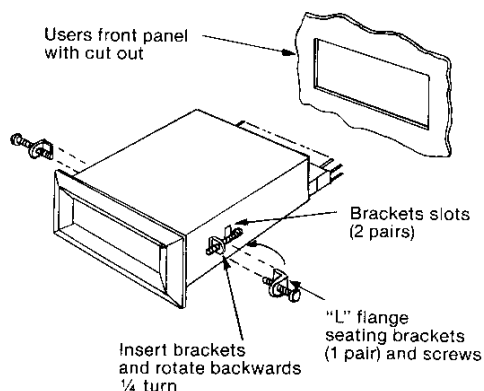
SLAVE DISPLAY

A companion low-cost slave display, Model DM-4106 is offered by Datel for use with the DM-4105 Master DPM. The DM-4106 can be used as a remote data repeater up to 25 feet away. A simple 12-wire interface, suitable for ribbon cable is shown. The diagram shows the DM-4106 rear view and the color connections show pin numbers to be connected on the DM-4105 Master DPM.

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 cutout 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.

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.

OVERSCALE/UNDERSCALE AUTORANGING CONTROLS

These 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.

CAUTION: The DM-4105 utilizes extremely high impedance, low bias current CMOS differential inputs. Both inputs must remain within the Common Mode Input Voltage Range (CMV) which is within ±4V of Power Common. There is no internal circuitry in the DM-4105 to insure that the CMV range will not be exceeded. To do so would compromise performance in high source resistance applications and with sensitive, high accuracy bridges. The user must provide external circuits to observe the CMV requirement and to supply the tiny but finite input bias currents which would otherwise force unterminated inputs into saturation outside the CMV range. Usually, bridge inputs or external high value input-zeroing load resistors will perform this function. Single-ended input sources under 10 megohms also do this. Call Datel-Intersil's application engineering department at the home office if you need technical assistance.

The inputs are protected from 115/230V AC power line voltage but not from high voltage static discharge. Use ground protection during handling and installation, especially in low humidity environments.

WARRANTY INFORMATION

NOTE: Datel-Intersil'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-Intersil's control, the warranty extends only to products which operate as standard, unmodified units. This means that Datel-Intersil 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.