

DM-31

Single Board Differential, 3½ Digit, LED Panel Meter

FEATURES

- Ultra-low cost yet retains outstanding performance
- Miniature 2" x 3.5" single board 3½ digit meter uses large 0.56" high red LED displays. Rear panel depth only 5/8"
- True balanced noise-rejecting differential inputs
- Tiny 5 pA bias current and very high 1000 Megohm input impedance won't load down sensitive input circuits
- Accepts external ratiometric reference and is autozeroing to correct drifts
- Hold function to freeze last reading
- Accepts user-supplied components for higher voltage ranges, current ranges, and digital ohmmeter (to ± 20 M Ω)
- 5 Vdc powered at 280 mA
- \$38.50, single quantity with generous OEM quantity discounts.

APPLICATIONS*

- Digital Thermometer, Digital Ohmmeter
- Audio dB sound level meter
- Digital Pressure Meter, Tachometer
- Flow Rate Meter, Bridge Nulling Meter
- Digital Scale or Strain Gauge Meter
- Laboratory and Analytical Instruments
- R&D and Test Instrumentation
- Industrial Process Indicators
- Data Loggers and Data Acquisition Systems

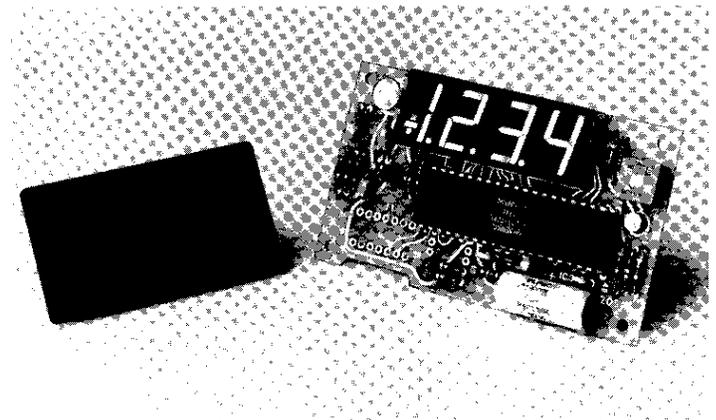
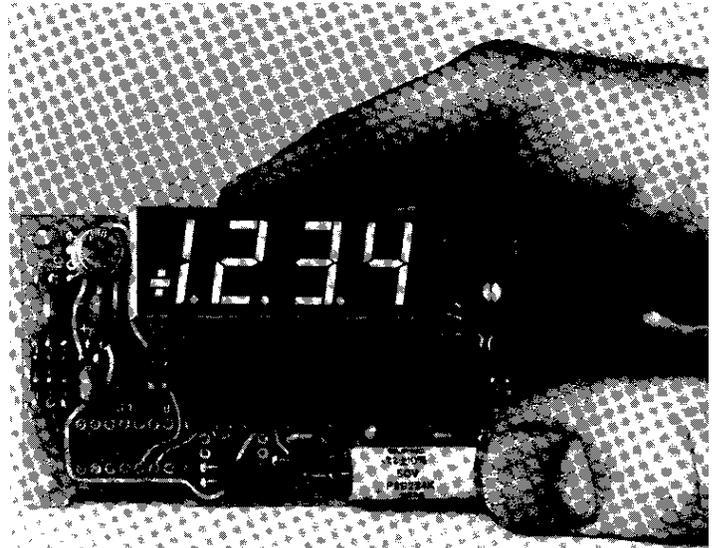
*Each application requires external circuits supplied by the user.

DESCRIPTION

The DM-31 is a digital panel meter (DPM) with 3½ digits of resolution (the maximum full scale count is plus or minus 1999). It employs red self-illuminated solid-state Light Emitting Diode (LED) displays which measure 0.56 inches (14,2 mm) high. The DM-31 is constructed on a single printed circuit board measuring 2"H x 3.5"W x 0.5" Thk (88,9 x 50,8 x 12,7 mm). The DM-31 accepts DC or slowly-varying electrical inputs and converts them to displayed decimal values on its LED digits. The basic fixed input range of the DM-31 is -1.999 Volts dc to +1.999 Vdc. However, the user may add internal or external components to change the voltage range from ± 2 V up to ± 300 Vdc. or to current ranges from ± 20 microamps, dc up to ± 2 Amps, dc or to resistance ranges of 0 to 2 Kiloohms up to 0 to 20 megohms.

APPLICATIONS

The DM-31 may be used for any application where a physical or electrical parameter needs to be measured and can be converted with user-supplied external circuits into the basic dc voltage, current or resistance ranges which the DM-31 will accept and display. Such parameters include temperature, pressure, flow rate, RPM, noise, weight, velocity, frequency and many



others. The DM-31 is intended for applications in analytical instruments, test and measurement equipment, data acquisition systems, research and development instrumentation, laboratory analyzers and other devices. Industries served by the DM-31 include petrochemical, power utilities, batch and continuous processing, telecommunications, paper, glass, metals and chemical manufacturing, photographic, automotive and medical services and much else.

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MOUNTING

The DM-31 is designed as a very general purpose panel-mounting component which may be stocked in one version to be used in multiple applications. Normal mounting techniques include four half-inch standoffs, either behind a front panel display cutout or on the front of a panel. An alternate method is to directly mount the DM-31 on a full-size board cutout using the four mounting holes punched in the corner of the DM-31's PC board.

PERFORMANCE

Despite its low cost, the DM-31 has excellent performance specifications which are normally seen only in more expensive instruments. The DM-31 requires regulated +5 Vdc input power (@ .28 Amp), which is commonly used by digital logic circuits. A low-cost optional accessory AC power adapter is available in case the user's equipment has no regulated 5 Vdc power. Input signals may be bipolar and the DM-31 will automatically switch its polarity display (autopolarity) to indicate whether signals are positive or negative. Three LED decimal points are included in the display and may be selected on the 14-pin input/output connector either by a jumper, a user-supplied external relay or logic control. These programmable decimal points are to display input scale multipliers or conversion to units other than the electrical range of the input. For example, the user may add external circuits to accept a ± 2 Vdc input but display 0 to +150.0 PSI.

Analog input specifications are outstanding. The basic input configuration is true balanced differential, non-isolated, for high noise rejection and for connections to bridge-type inputs found in many industrial transducers such as strain gauges. The common mode rejection is 80 dB (dc to 60 Hz) and the common mode voltage range is approximately ± 2 V to Power Common. By using a transformer input power supply such as the optional UPA-5/500 AC Power Adapter, DC isolation will be achieved.

By using CMOS electronic technology, input impedance is extraordinarily high, typically 1000 Megohms. Input bias currents are very small, typically 5 picoamps, many orders of magnitude below older DPM's. These two features mean that the DM-31 may be safely connected to high source resistance inputs (up to 100 K Ω) and will not cause errors by loading down sensitive circuits. Yet the DM-31's inputs are fully protected against normal overloads (± 250 Vdc or 155 VAC).

Displayed accuracy is adjustable to $\pm 0.1\%$ of reading, ± 1 count and temperature drift is typically within ± 50 ppm of reading/ $^{\circ}$ C over the 0 $^{\circ}$ C to +50 $^{\circ}$ C operating range (+32 $^{\circ}$ F. to +122 $^{\circ}$ F.).

APPLICATION FEATURES

The DM-31 includes autozeroing circuits to correct zero drift. A ratiometric input accepts external dc voltages for limited gain change. These two features correct drift and reference errors in measurement circuits. An external +1 Volt dc reference may be substituted for the internal reference.

The basic ± 1.999 Vdc input range may be altered very easily. PC board pads have been left for the user to add attenuator resistors (for higher voltage ranges) or a shunt resistor for current ranges. Resistance ranges require a few more components external to the board. A simple digital thermometer may also be made using a few user-supplied external components. These inexpensive components are not supplied by Datel-Intersil but are readily available from electronic parts distributors.

The DM-31 includes a HOLD input which will latch the last A/D sample and freeze the display. This input may be connected to a switch for an operator to momentarily copy down a reading.

A DISPLAY ENABLE input may be used to blank the display and save power but keep the A/D converter sampling to reduce turn-on drift in portable applications. An automatic overscale indication is also included. All segments of the display may be checked by using the DISPLAY TEST input which displays "1888". The polarity sign may be blanked using the POLARITY ENABLE Input for non-polarized applications. This pin may also be controlled by an external relay, transistor or digital logic. Flashing the polarity sign may be used to indicate special conditions such as exceeding an alarm limit (this would require external, user-supplied circuits). Finally, an ANALOG RETURN output is provided as an optional bias return for differential inputs and for use as reference common when an external reference is employed or for digital ohmmeter circuits.

A single-turn adjustment pot is included on the front of the DM-31 PC board to calibrate full scale gain. Many users will mount the DM-31 behind their own front panel filter which may have legends screened on it as well as other indicators behind the panel filter besides the DM-31. If preferred, users may separately purchase a snap-in bezel/filter as part of an optional accessory kit which includes a solder-tab DIP-plug connector, 4 standoffs and mounting hardware. Some type of red filter is recommended to improve viewing contrast of the display and for aesthetics to conceal the components on the PC board. For users who prefer a fully cased DPM, refer to Datel-Intersil's DM-3100 and DM-4100 series at additional cost.

If you are unfamiliar with DPM's but feel that a low-cost DM-31 would be an important asset to your product, we have a few suggestions. Many manufacturers with limited electronics experience have recognized the important sales appeal to their customers of a modern DPM on the front panel of their product.

While the DM-31 is not at all difficult to use, those who are unfamiliar with electronics may wish to seek the assistance of a staff electronics engineer or a consultant or contracting engineer. If such a person is not available at your facility, your local Datel Sales Office will be happy to discuss your requirement and may be able to direct you to such assistance. More comprehensive technical assistance is available from Datel's Applications Engineering Department at the Mansfield, Mass. home office and from Datel's direct sales people.

The DM-31 is a very versatile, general purpose instrument with a wealth of operating features to be used in a large range of applications. However, no one universal connection scheme can be recommended to serve all requirements. Each user will obtain the best performance from the DM-31 by designing the unique right connections for his application.

The DM-31 does not directly measure temperatures, pressures, RPM, frequencies and many other physical parameters. External devices supplied by the user are required to convert such parameters into electrical inputs usable by the DM-31. A competent engineer will be able to specify and fabricate a complete system to your needs.

PRELIMINARY SPECIFICATIONS (Typical at +25° C and +5 Vdc power unless noted)

ANALOG INPUT

| | |
|---|---|
| Configuration | True, balanced differential bipolar inputs |
| Full Scale Input Range | -1.999 Vdc to +1.999 Vdc |
| Optional Ranges | Up to ±300 Vdc, or ±19.99 μ A to ±1.999 Amps or 0 to 1.999 K Ω up to 0 to 19.99 megohms. These optional ranges require connection of external components supplied by the user. |
| Displayed | |
| Accuracy at +25° C | Adjustable to within ±0.1% of reading, ±1 count |
| Resolution | 1 mV |
| Input Bias Current | 5 pA typical, 50 pA maximum |
| Temperature Drift of Gain | Within ±50 ppm of Reading/°C typical Within ±100 ppm of Reading/°C max. |
| Temperature Drift of Zero | |
| | Autozeroed, ±1 count max over 0° C to +50° C |
| Input Impedance | 100 Megohms, min., 1000 Megohms, typical to Analog Return or Power Common |
| Input Overvoltage | ±250 Vdc or 155 VRMS, continuous max. ±300V intermittent max. |
| Common Mode Rejection | |
| | 80dB to Analog Return, DC to 60 Hz, 1 Kilohm unbalance |
| Common Mode Voltage Range | |
| | Both inputs must remain within +4.5V and -4V of Power Common |
| Warm-Up Time | 1 minute to rated accuracy |
| Reference | Choice of internal or user-supplied external reference. The internal reference is referred to Analog Return (pin 10). The DPM is calibrated when a one volt dc drop exists from pin 11 (+) to pin 10 (-). |
| External Ratiometric Reference Range | |
| | Pin 11 +2V to +.5V (Relative to pin 10) |
| Ratiometric Gain Equation | |
| | Display = $1000 \times V_{IN} / V_{REF}$ (no decimal points) |
| Calibration | Front panel single-turn screwdriver pot adjusts full scale gain. Zeroing is automatic. Suggested recalibration in stable conditions is 90 days |

DISPLAY

| | |
|---|--|
| Number of Digits | 3 decimal digits and most significant "1" digit (3½ digits) |
| Decimal Points | 3 Selectable decimal points are included for scale multipliers |
| Luminous Intensity per Average Digit | |
| | 125 microcandelas, typical |
| Display Type | Red, light-emitting diode (LED) self-illuminated |
| Display Height | 0.56 inches (14.2 mm) |

| | |
|----------------------------|---|
| Overscale | Inputs exceeding full scale blank the 3 least significant digits leaving a "1" MSD and sign displayed |
| Autopolarity | + & - sign are automatically displayed if pin 5 is grounded. Disconnecting pin 5 will blank sign display for non-polarized applications |
| Sampling Rate | 3 samples per second |

INPUT/OUTPUT CONNECTIONS

| | |
|--|--|
| Analog HI Input (pin 8) Analog LO Input (pin 9) | Differential input signals are connected between these pins. A bias current path to either Analog Return or Power Common must be externally provided by the user to constrain these inputs not to exceed the common mode voltage range. |
| Analog Return Input (pin 10) | This pin may be used as a low-noise bias current return path for certain types of isolated inputs. If preferred, Analog Return may be left disconnected and Power Common may be used as a bias return. Analog Return is approximately -2.8 Vdc below +5V Power (pin 7) and can sink approximately 5 mA. Analog Return may be connected to Power Common if required. <i>Do not connect Analog Return to +5V (pin 7). Will destroy DPM.</i> Analog Return is also used as Reference Common when an external ratiometric reference is used in place of the internal reference. |
| Reference Out (pin 12) Reference In (pin 11) | Normally Ref. In and Ref. Out should be jumpered together. Ref. Out is approximately +1 Volt above Analog Return. Output impedance (pin 12) is approx. 3 K Ω . Recommended external reference source resistance should be less than 10 K Ω into pin 11. Ref. Out adjustment range is approx. ±5%. For ratiometric operation, where DPM gain is changed inversely to an external user-supplied reference, Ref. Out is not used and the external reference is connected to Ref. In + (pin 11) and biased against Analog Return (pin 10). If the external reference is single-ended, connect Analog Return to Power Common. The DPM is calibrated when a one volt dc drop exists between pin 11 (+) and pin 10 (-). |

Continued on page 4

PRELIMINARY SPECIFICATIONS Continued

| | |
|--|---|
| Decimal Point Inputs (Pins 2, 3, 4) | Ground the appropriate pin to display the selected decimal point. The decimal points may be externally controlled by an NPN transistor or open collector TTL gate. Sink 10mA |
| Display Test Input (pin 1) .. | Connect to +5V to display "1888". Make no connection when not in use. |
| Polarity Enable Input (pin 5) | Ground this pin for normal autopolarity operation. Leave this pin open to blank the +/- sign for unipolar applications. |
| Display Enable Input (pin 6) | Tie to +5V for normal operation. Disconnect to blank the display and save power but keep the A/D converter sampling to reduce turn-on drift in portable applications. May be wired as "press to read." |
| +5 VDC Power Input (pin 7) | Connect this pin to the positive leg of an external, user-supplied +5V regulated power source. |
| Hold Input (pin 13) | Ground this pin for normal use. Open this pin to latch the last A/D conversion and stop the display from changing. May be used by an operator to momentarily copy down the last reading. |
| Power Common (pin 14) .. | Connect the common of the external +5V power source to this pin. Power Common may also be used as a bias current return path for signal inputs. |
| Power Requirement | +5 Vdc nominal, -1, +2V regulated required. Logic spikes must not exceed 50 mV. Use an external bypass capacitor or other means to attenuate noise. Current @ 5V: 280 mA average, 450 mA max. Current varies rapidly as digits switch so that unregulated supplies cannot be used. Current is approximately 5 mA with displays blanked. |

PHYSICAL-ENVIRONMENTAL

| | |
|---------------------------------|--|
| Outline Dimensions | 3.5"W x 2"H x .5" Thk depth behind front panel (88,9 x 50,8 x 12,7 mm) Max. height on component side of board is 0.315" (8 mm) |
| Mounting Method | Using a front panel cutout, 4 holes for .5" mounting standoffs and 1 hole for the gain pot. |
| Mounting Kit | Optional, includes filter/bezel DIP connector, standoffs, and hardware; see ordering guide. |

Cutout Dimensions (For optional bezel/filter) ... 1.156"H x 2.375"W (29,36 x 60,33 mm) Bezel/filter panel thickness range: .040 to 0.062" (snug fit at 0.062") 1,0 to 1,6 mm.

Optional Snap-In Bezel/Filter Dimensions

Outside Dimensions:
1.343"H x 2.531"W (34,1 x 64,3 mm)
Display Opening:
0.812"H x 2.0"W (20,6 x 50,8 mm)

Front Panel Bezel Relief Height:
0.062" (1,6 mm)

Weight

Connector

14 pin sockets mounted on board for Dual-Inline Package (DIP-spaced) plugs. Consists of two rows, spaced 0.300" (7,62 mm) between rows and 0.100" (2,5 mm) between sockets. Accepts .020" dia. (0,5 mm) pins. Solder tab plug connector included in optional Model 39-7249-1 Accessory Kit.

Mounting Position

Operating Temperature

Range

Storage Temperature

Range

Altitude

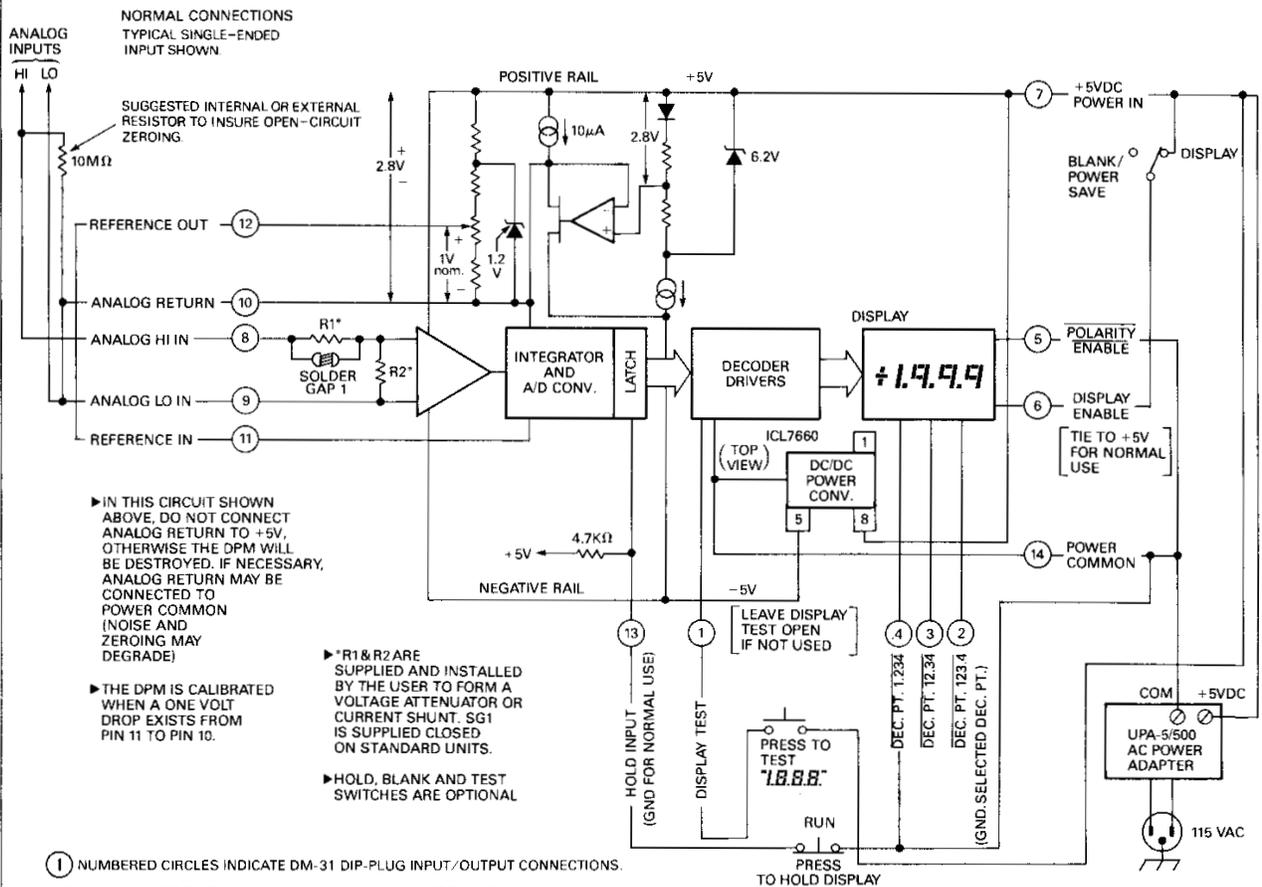
Relative Humidity

Ordering Information

DM-31-1: ± 2Vdc Input Range
(Supplied With Free Connector)

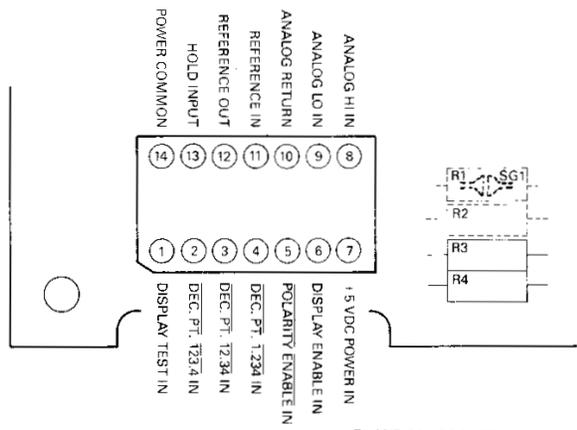
RN-3100/4100: Range-Change
Accessory Kit for DM-Series Meters

BLOCK DIAGRAM WITH TYPICAL EXTERNAL CONNECTIONS



① NUMBERED CIRCLES INDICATE DM-31 DIP-PLUG INPUT/OUTPUT CONNECTIONS. CIRCUITS INTERIOR TO THE NUMBERED CIRCLES ARE INTERNAL DM-31 COMPONENTS. EXTERNAL CONNECTIONS SHOWN ARE FOR EXAMPLE ONLY. SPECIFIC APPLICATIONS MAY REQUIRE DIFFERENT EXTERNAL CONNECTIONS.

INPUT/OUTPUT CONNECTIONS



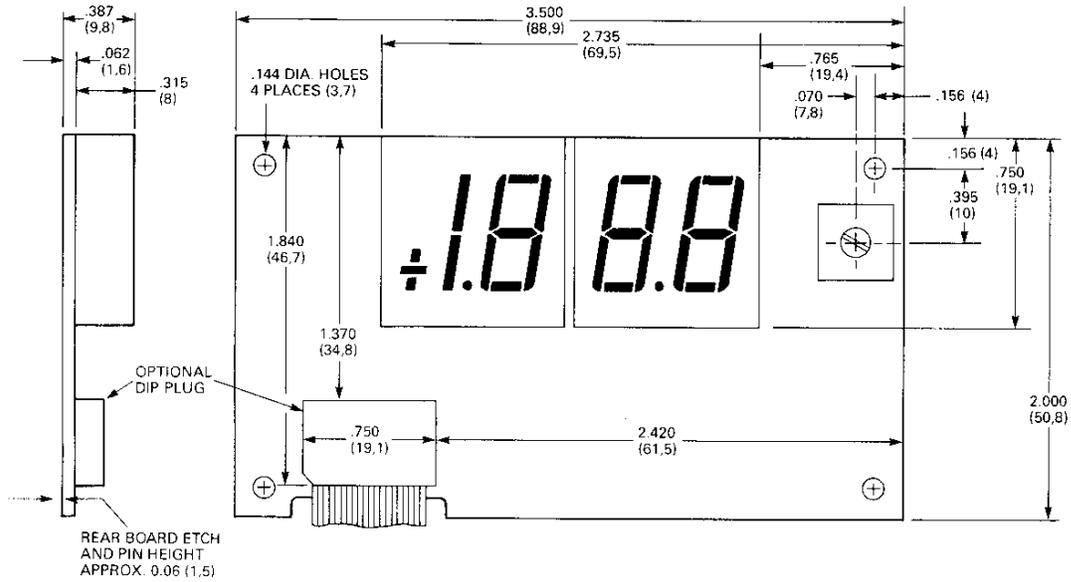
R1 AND R2 ARE SUPPLIED AND INSTALLED BY THE USER. REFER TO BLOCK DIAGRAM. SOLDER GAP 1 APPEARS ON THE FAR (ETCH SIDE) OF THE BOARD. SG1 IS SUPPLIED CLOSED AND MUST BE OPENED IF R1 IS USED.

ARE YOU ALREADY A DM-3100 SERIES USER?

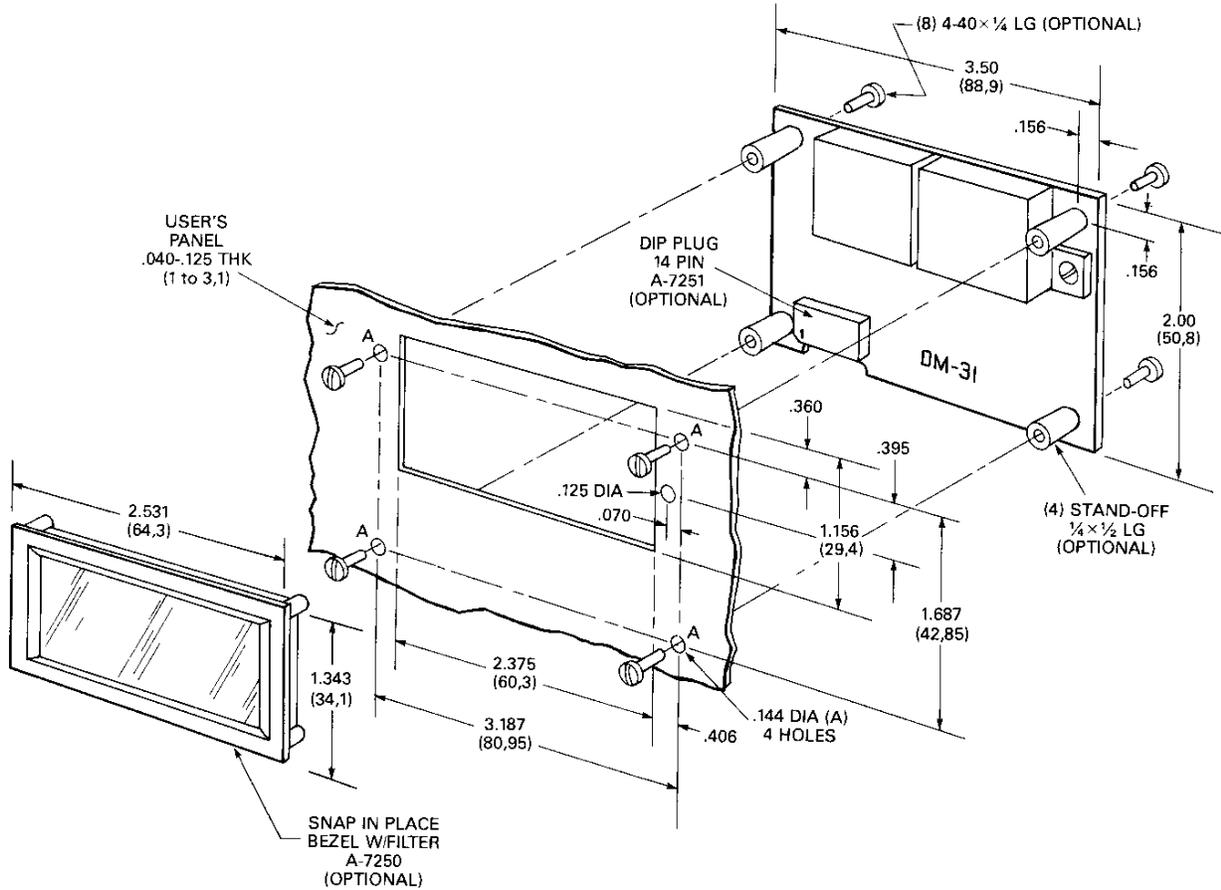
Note: For users familiar with Datel's DM-3100 series DPM's the DM-31 circuit is nearly identical to the DM-3100L or N except for the following:

1. The internal ICL8069 bandgap reference diode is biased against Analog Return, which is also internally connected (in the ICL7117 converter) to what was formerly Ohms LO, the cathode of the DM-3100 series reference. If desired, external ratiometric references can be single ended by connecting Analog Return to Power Common. Formerly, DM-3100 external references had to be biased against the negative rail.
2. A HOLD input (pin 13) is provided.
3. The -5V negative rail is not provided on the I/O DIP-plug connector (no room) but can be readily found on pin 5 of the ICL7660 voltage converter for users who wish to steal a few milliamps for external signal conditioners.

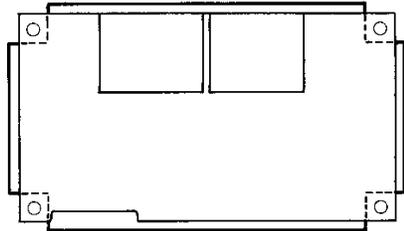
MECHANICAL DIMENSIONS
INCHES (MM)



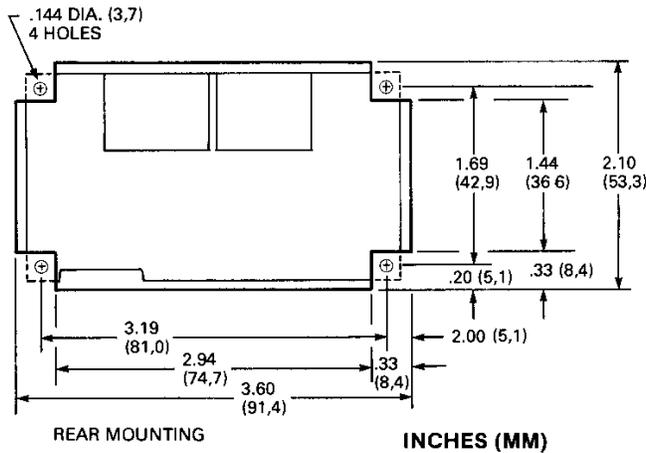
PANEL MOUNTING WITH OPTIONAL BEZEL/FILTER
INCHES (MM)



ALTERNATE FULL-BOARD-CUTOUT MOUNTING METHOD



FRONT MOUNTING



REAR MOUNTING

INCHES (MM)

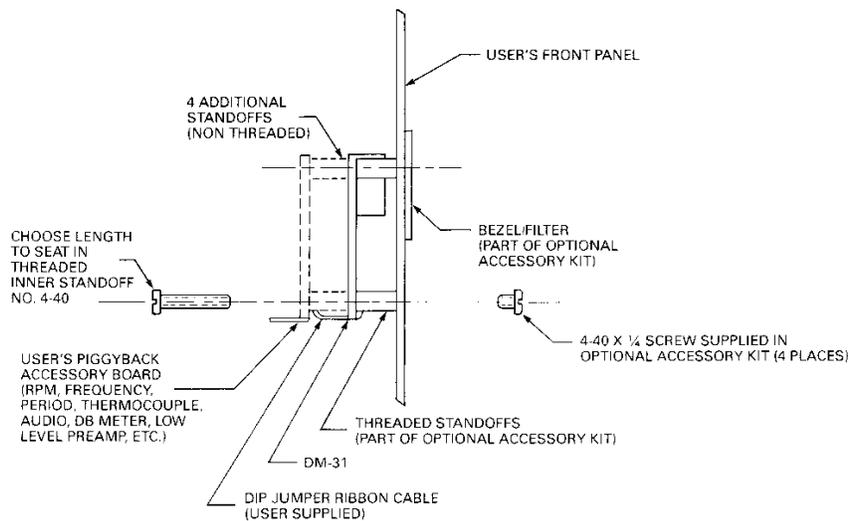
There are several suggested mounting methods for the DM-31. The standard method requires the optional accessory kit which includes a snap-in bezel/filter, DIP plug connector, 4 standoffs and mounting hardware. This method mounts the DM-31 PC board behind a front panel cutout sized for the optional bezel/filter. Four screw holes are required for the half-inch standoffs and a fifth hole provides screwdriver access to the full scale gain adjust pot.

In test and laboratory applications where aesthetics may have little importance, the DM-31 board can be mounted on the *outside front* of a test panel using only the four standoff holes. Some sort of red filter will enhance viewing contrast.

Many users will mount the DM-31 behind their own front panel filter which may have legends or units silkscreened on it. Other LED or incandescent indicators may be positioned to display through this filter as well as the DM-31. Several DM-31's for different functions may share a common large red front panel filter. For these applications, an alternate flush mounting is shown either in front of or behind the mounting surface. No standoffs are used but the cutout is slightly more complex.

- Appropriate filter materials would include: —
- Rohm & Haas Plexiglass #2423
 - Panelgraphic 60 or 65 (Red) or 90 (Purple)
 - 3M Panelfilm #6310
 - Homalite H100-LR72-1600
 - These can be supplied with anti-reflective/anti-scratch coatings

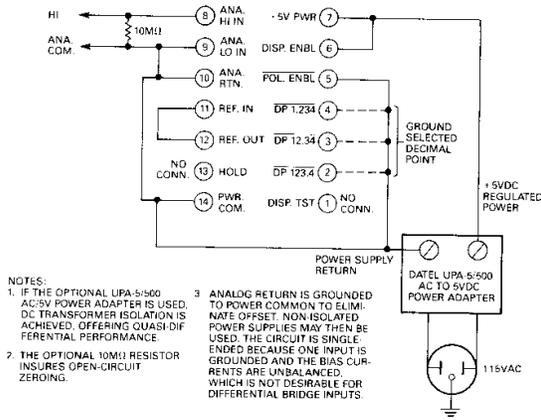
SUGGESTED ACCESSORY BOARD MOUNTING



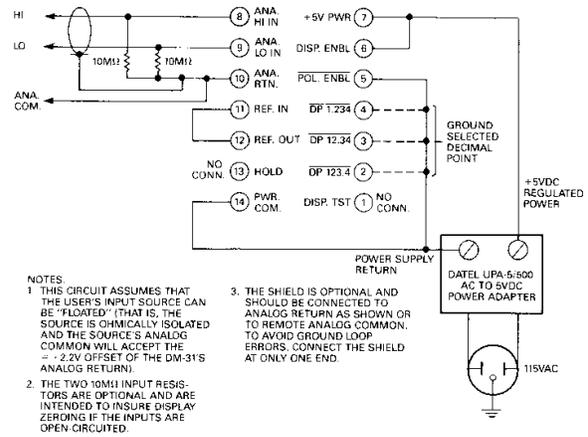
SUGGESTED ACCESSORY BOARD MOUNTING
(FOR USER-FABRICATED SIGNAL CONDITIONING ACCESSORY BOARDS PLUS THE OPTIONAL MOUNTING KIT AND BEZEL/FILTER.)

TYPICAL APPLICATIONS CIRCUITS

SINGLE-ENDED INPUT CONNECTION



ISOLATED DIFFERENTIAL INPUT CONNECTIONS



FOR OTHER INPUT RANGES, you may install resistors which you supply on the DM-31 PC board using the chart below. Refer to the I/O Connections diagram on page 5 to locate where the resistors are installed. The 2 Amp shunt must be remotely mounted.

| Full Scale Range, dc | R1 ⁽¹⁾ | R2 ⁽²⁾ |
|---------------------------|--------------------------------|-----------------------------|
| $\pm 1.999V$ (Std. range) | Short Solder Gap 1 | Omit |
| $\pm 19.99V^{(1)}$ | 10 MΩ ⁽²⁾ (1 MΩ) | 1.1 MΩ (110 KΩ) |
| $\pm 199.9V^{(1)}$ | 10 MΩ ⁽²⁾ (1 MΩ) | 100 KΩ (10 KΩ) |
| $\pm 300V^{(3)}$ | 10 MΩ ⁽²⁾⁽⁴⁾ (1 MΩ) | 10 KΩ (1 KΩ) |
| $\pm 19.99 \mu A$ | Short Solder Gap 1 | 100 KΩ |
| $\pm 199.9 \mu A$ | Short Solder Gap 1 | 10 KΩ |
| $\pm 1.999 mA$ | Short Solder Gap 1 | 1 KΩ |
| $\pm 19.99 mA$ | Short Solder Gap 1 | 100Ω |
| $\pm 199.9 mA$ | Short Solder Gap 1 | 10Ω ⁽⁵⁾ , 2W,W,W |
| $\pm 1.999 Amps$ | Short Solder Gap 1 | 1Ω ⁽⁶⁾ , 5W,W,W |

NOTES

- These ranges will require recalibration. There is sufficient range in the full scale gain pot for this.
- These ranges give 10 MΩ input impedance. If 10 MΩ resistors are unavailable, use 1 MΩ resistors with the same ratio shown for R2. Input impedance reduces to about 1 MΩ.
- The $\pm 300V$ range will display up to $\pm 1999V$ but the safe limit for the board and connector is $\pm 300V$.
- R1 for the $\pm 300V$ range is RN70C.
- R2 for the $\pm 200 mA$ range is 2 watts, wirewound and must be externally mounted (not on the board).
- R2 for the $\pm 2A$ range is 5 watts, wirewound and must be externally mounted (not on the board or connector.)
- Displayed accuracy is dependent on resistor quality. Economical metal film resistors $\pm 1\%$, $\pm 50 ppm/^{\circ}C$ are suggested except for 200 mA and 2A ranges (see notes 5 and 6).

CAUTION: If you are unfamiliar with electronic assembly, we recommend that you obtain competent assistance when installing any component internally on these DPM PC boards. This will prevent possible damage or loss of performance from improperly installed or incorrect types of components. Components may be mounted externally on the connector if board insertion is not preferred.

These additional components are generally readily available from most electronic distributors. However, Datel will preassemble components at extra cost for OEM quantity orders.

CAUTION: These DPM's employ high impedance CMOS inputs. Although internal protection is provided for several hundred volt overloads, these DPM's will be destroyed by kilovolts of static discharge which is especially prevalent in low humidity environments. Always handle these DPM's with ground protection.

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. A number of suggested operating modes shown in this brochure show components which must be installed by the user. Since the selection of these components and the manner of installation is beyond Datel's control, Datel's warranty extends only to standard unmodified products. 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 to Datel 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. A thorough incoming inspection by the customer is suggested before DPM's are modified. Those original components of the DPM (displays, IC's, etc.) will be honored under warranty if found to be defective (and 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 all these procedures is to allow rapid diagnosis and repair on Datel's test fixtures to return the product as soon as possible to the user. Because of the variety of possible DPM modifications, Datel test fixtures can only test unmodified products.

NOTICE

This applications information shows typical suggested circuits to illustrate design examples. Since Datel-Intersil has no control over the selection, mounting, interconnection, fabrication and environmental factors of external apparatus and components to this product, specific performance cannot be warranted. This information is believed to be accurate and reliable. No responsibility is assumed for any errors or omissions. Nor does Datel-Intersil, Inc. assume responsibility for the use of such information or for any infringement of present or future patents or other third party rights resulting from such use. No license is granted by implication or otherwise under any patent, patent rights, or otherwise of Datel-Intersil, Inc. Prices and specifications are subject to change without notice.