DMS-20LCD Series, 3½ Digit, LCD Display, Digital Voltmeters represent the ultimate combination of low price, low power, small size and high performance in digital meters. Epoxy encapsulated in a subminiature (1.38” x 0.88” x 0.43”), 12-pin DIP package, these completely self-contained, fully operational meters offer a combination of ruggedness, long-term reliability and component-like ease-of-use simply not available in any other meters.

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### FEATURES
- Lowest cost
- Lowest power, 2mW
- Subminiature size: 1.38” x 0.88” x 0.43”
- Large (0.37”/9.4mm), enhanced-contrast LCD display
- Epoxy-encapsulated, 12-pin DIP
- Panel or pc-board mountable
- 4 differential input voltage ranges
- High accuracy, ±1 count (±0.05%)
- Single +5V supply or 9V battery
- Low-battery annunciator
- User-selectable decimal point placement
- 0 to +60°C temperature range

### SIMPLIFIED SCHEMATIC DIAGRAM

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Performance/Functional Specifications

Typical at \( T_a = +25^\circ C \) and supply voltage = +5V (using the single-ended input circuit) or +9V (using the differential input circuit), unless otherwise noted.

### Analog Inputs

<table>
<thead>
<tr>
<th>Input Range</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMS-20LCD-0</td>
<td>±200</td>
<td>±2</td>
<td>±2</td>
<td>Volts</td>
</tr>
<tr>
<td>DMS-20LCD-1</td>
<td>±2</td>
<td>±2</td>
<td>±2</td>
<td>Volts</td>
</tr>
<tr>
<td>DMS-20LCD-2</td>
<td>±20</td>
<td>±20</td>
<td>±20</td>
<td>Volts</td>
</tr>
<tr>
<td>DMS-20LCD-3</td>
<td>±200</td>
<td>±200</td>
<td>±200</td>
<td>Volts</td>
</tr>
</tbody>
</table>

### Input Impedance

- DMS-20LCD-0, -1: 100 MΩ
- DMS-20LCD-2, -3: 0.8 kΩ

### Overvoltage Protection

- DMS-20LCD-0, -1, -2: ±100 Volts
- DMS-20LCD-3: ±250 Volts

### Common Mode Voltage Range

- ±2 Volts

### CMRR (dc to 60Hz)

- 86 dB

### Control Inputs

- Decimal Pt. Placement (Pins 4-6): Tie to pin 3 to activate
- Functionality: Tie to pin 3 to activate
- Logic Compatibility: TTL (on 5V-powered models)
- Backlight (Pin 9): Tie to pin 3 to turn on backlight

### Performance

- **Sampling Rate**: 2.5 reading per second
- **Accuracy (1 minute warm-up)**:
  - DMS-20PC-0 (Vin = +0.19V): ±1 ±2 Counts
  - DMS-20PC-1 (Vin = +1.9V): ±1 ±2 Counts
  - DMS-20PC-2 (Vin = +19V): ±2 ±3 Counts
  - DMS-20PC-3 (Vin = +190V): ±2 ±3 Counts
- **Zero Reading (Vin = 0 Volts)**:
  - “-001”
  - “000”
  - “001”
- **Temperature Drift (0 = +60°C)**:
  - ±0.2 ±0.4 Counts/°C

### Power Supply Requirements

#### 5V Models

- **Supply Voltage**: +4.75 +5.00 +5.25 Volts
- **Supply Current**: Standard Models: +400 +650 μA
  - Backlight Models: +35 +50 mA

#### 9V Models

- **Supply Voltage**: +7.5 +9.0 +14.0 Volts
- **Supply Current**: Standard Models: +230 +350 μA
  - Backlight Models: +35 +50 mA

### Display

- **Display Type and Size**: 3½ digit, 0.37”/9.4mm high LCD
- **Polarity Indication**: Autopolarity (“-” for negative Vin)
- **Overrange Indication**: “-1...” for negative Vin
  - “1...” for positive Vin

### Physical/Environmental

- **Operating Temperature**: 0 – +60 °C
- **Storage Temperature**: –20 – +75 °C
- **Humidity (non-condensing)**: 0 – 95 %
- **Case Material**: Polycarbonate
- **Weight**: 0.4 ounces (11 grams)

### Ordering Information

- **DMS-20LCD - 1 - 5 - C**
  - Add -C for RoHS
  - Power Source:
    - 5 = +5V
    - 9 = +9V
  - Accessories:
    - DMS-20-CP: Panel cutout punch
    - DMS-BZL3-C: DMS-20 bezel assembly
    - DMS-BZL4-C: DMS-20 bezel assembly with sealing gasket
    - DMS-EB2-C: Application/evaluation board with standard MOLEX connector, decimal point solder pads and attenuation resistor pads.

#### TECHNICAL NOTES

1. **REFERENCE OUTPUT (Pin 8) and INPUT (Pin 7)**: Pin 8 is a precision reference actively trimmed at the factory. In normal operation, pin 8 must be tied to pin 7 to achieve all listed accuracy and drift specifications.

2. **ANALOG COMMON (Pin 10)**: This pin is connected to an internal, low-noise, “relative” ground. It is used in certain differential and “floating” measurements as described in the Applications section of this data sheet and Ap Note 3 of the DATEL Panel Meter Catalog. Pin 10 should not be connected to pin 3 (5V RETURN/-BATTERY) or to your system’s analog ground.

3. **Decimal Point Placement**: The location of the decimal point is user-selectable, and the decimal point control pins (DP1-DP3) are active low functions. Select the appropriate decimal point by tying the appropriate pin (pin 4, 5 or 6) to pin 3 (5V RETURN/-BATTERY). Unused decimal
8. Suggested Mating Connectors:

Panel mounted:
- Connector housing: DATEL P/N 4320-01069-0
- Terminal type: DATEL P/N 4400-01032-0
- Crimping tool: DATEL P/N 39-2099000
- Wire size: 22 to 26 AWG
- Insulation diameter: 0.062” (1.57mm) maximum
- Stripping length: 0.100 to 0.125” (2.54 to 3.17mm)

Board mounted:
- Socket: DATEL P/N 4320-01074-0

APPLICATIONS

DMS-20LCD meters are available in either 5V-powered or 9V-powered models. 9V devices operate directly from 7.5V to 14V supplies (usually batteries) without the need for external voltage regulators. 9V devices, however, cannot be used to measure voltages referenced to the negative battery terminal (pin 3) because the minus input to the meter (pin 12, (–) INPUT LO) must always be at least 1.5V above pin 3. 9V-powered meters can only be used to make differential and not single-ended measurements.

5V-powered devices operate from any well-regulated +5V supply and will accurately measure voltages both above and below pin 3 (5V RETURN) in either single-ended or differential configurations.

1. Single-Ended Input Configurations: True single-ended measurements can only be made with 5V-powered meters. The circuit of Figure 2 avoids problems normally associated with ground-loop currents. Separate ground runs should be used for 5V RETURN (pin 3) and (–) INPUT LO (pin 12).
2. **Differential Input Configurations:** Differential measurements can be made with either 5V-powered or 9V-powered meters. Figure 3, though not a practical real-world application, uses a voltage divider to demonstrate the concept of a differential input signal. Be careful not to exceed the ±2V common mode voltage limitation for 5V powered meters.

3. **Engineering Scaling:** For measuring voltages greater than the full scale input range of a given meter, the input signal must be attenuated. A simple voltage divider (similar to that shown in Figure 4) will scale the input to within the range of the selected meter. R1 and R2 should be precision, ±1%, metal-film resistors with absolute TCR’s less than 50ppm/°C. See Ap Note 4 for more information on engineering scaling.

\[
\frac{50k\Omega < R1 + R2 < 10M\Omega}{R2} \times \frac{V_{IN}}{R1 + R2} = \text{Reading}
\]

4. **Floating Signal Source Measurements:** Floating signals can be measured using the circuits shown in Figures 5 and 6. Figure 5 uses a 5V-powered meter. Figure 6 uses a 9V-powered meter. Connecting pin 10 (ANALOG COMMON) to (-) INPUT LO (pin 12) provides the reference point for the meter’s input.

A “floating” input is a signal that has no galvanic connection to the meter’s power supply. In the figures below, the 1.5V battery illustrates a true floating input.

5. **Process Control (4-to-20mA) Measurements:** In many common process-control applications, a 4-to-20mA current loop is used to transmit information. Because DMS-20LCD meters have such high input impedance, a simple shunt resistor across the meter’s input can be used to convert the loop current to a voltage. See Figure 7. The value of the shunt resistor is a function of the scaling requirements of the particular application and can be calculated using the following equation:
APPLICATIONS

\[
R_{\text{shunt}} = R_1 = \frac{V_{\text{fsr}}}{I_{\text{fsr}}}
\]

Where: \(V_{\text{fsr}}\) = Full scale reading (in Volts)
\(I_{\text{fsr}}\) = Relative full scale current (in Amps)

Example: For a meter with a 2V full scale input (1.999 full scale reading) and a desired full scale display reading of 1000 (with an input of 20mA), \(V_{\text{fsr}} = 1.000\) Volts
\(R_{\text{shunt}} = 1.000\text{V}/(0.020 - 0.004)\text{A}
\(R_{\text{shunt}} = 1.000\text{V}/0.016\text{A} = 62.5\text{ Ohms}

To calibrate the circuit of Figure 7, perform the following:

1. With 4mA applied, adjust the 50kΩ potentiometer (R2) to display a reading of "000" (assuming that is the desired reading).
2. With 20mA applied, adjust the gain-adjust potentiometer on the back of the meter to display a reading of "1999". For different full scale readings, alter the value of \(R_{\text{shunt}}\) accordingly.

\[
R_\text{Shunt} = \frac{V_{\text{fsr}}}{I_{\text{fsr}}}
\]

Where:

- \(V_{\text{fsr}}\) = Full scale reading (in Volts)
- \(I_{\text{fsr}}\) = Relative full scale current (in Amps)

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\(R_{\text{shunt}} = \frac{1.000\text{V}}{0.016\text{A}} = 62.5\text{ Ohms}

Therefore, the 9V battery voltage appears to the meter inputs as 0.9V. With the decimal point moved to its DP2 position (pin 5 tied to pin 3), the meter reads 9.00 Volts.

The circuit can be calibrated by first measuring the actual battery voltage with another meter and then adjusting the gain-adjust potentiometer on the back of the DMS-20LCD until a similar reading is obtained. If possible, the resistors in the divider should be ±1% metal-film types with TCR’s less than 50ppm/°C.

Figure 7. 4-to-20mA Current Loop Operation (5V-Powered Models)

6. Power Supply Monitoring: A popular application for DATEL’s low-power LCD meters is monitoring the supply voltage in battery-operated portable equipment. Figure 8 demonstrates how a 9V-powered DMS-20LCD can be used to monitor its own supply. The meter used is the DMS-20LCD-1-9. A three-resistor voltage divider is used to attenuate the battery voltage and also to satisfy the requirement that the input voltages applied to pins 12 and 11 be at least 1.5 Volts above and below the battery voltage applied to pins 1 (+BATTERY) and 3 (–BATTERY). The divider should be designed so that 1/10th the battery voltage falls across the inputs to the meter:

\[
\frac{R_2}{R_1 + R_2 + R_3} < 0.1
\]

Figure 8. Power Supply Monitor (9V-Powered Models)

7. External Gain Adjustment: Connect REFERENCE OUT (pin 8) to REFERENCE IN (pin 7) for normal, factory calibrated, operation. Use the circuit shown in Figure 9 for applications needing external gain adjustment. Calibration is performed with a precise, near-full-scale, input voltage.

Figure 9. External Gain Adjustment
MECHANICAL SPECIFICATIONS

MECHANICAL DIMENSIONS: Inches (mm)
TOLERANCES: 2 PL DEC ±0.02 (±0.51)
3 PL DEC ±0.010 (±0.254)
LEAD DIMENSIONS: 0.025 (0.635) x 0.025 (0.635) NOMINAL
RECOMMENDED PCB FINISHED HOLE DIAMETER: 0.042 ±0.003 (1.067 ±0.076)

TYPICAL POTENTIOMETER HOLES LOCATION

CALIBRATION POTENTIOMETER HOLE LOCATION

RECOMMENDED DRILL AND PANEL CUTOUT DIMENSIONS

BEZEL INSTALLATION AND RECOMMENDED DRILL AND PANEL CUTOUT

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ISO 9001 and 14001 REGISTERED

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