

# Extended Temperature Operation of DMS-Series Meters

## Introduction

The question of how the performance of DMS-Series meters is affected when they are subjected to ambient temperatures outside their specified operating range is one we frequently encounter. The answer to this question depends on which display technology the meter employs: either LED (Light Emitting Diode) or LCD (Liquid Crystal Display). As shown in the table on page 2, within the limits specified later in this application note, the meter's A/D converter, reference circuit, and passive components are not adversely affected by temperature extremes. However, for reasons described below, LED display meters are better suited for extended temperature operation.

DMS-Series meters' operating temperature ranges of 0 to +60°C for 3½ digit meters and 0 to +50°C for 4½ digit meters are more than adequate for the majority of panel meter and process monitoring applications. (These two ranges are widely regarded as industry standards.) Unless otherwise noted on individual product data sheets, DATEL guarantees its panel meters and process monitors to meet all published specifications over the applicable 0 to +50°C or 0 to +60°C operating temperature range.

DATEL performs all standard production testing of its panel meters at 25°C room temperature. Our general purpose, 12-pin DIP, DMS-20PC/LCD and DMS-30PC/LCD meters receive sample-testing at +60°C, with accuracy, stability, and zero reading being the parameters of interest.

For purposes of specification guard-banding, DATEL also performs routine QA-qualification and engineering tests at temperatures well above and below the ranges specified on our data sheets. The table on page 2 shows actual display readings of nine LED display DMS-Series meters taken at eight different operating temperatures. Using a near full-scale positive input, each meter was initially calibrated at +25°C to an accuracy of ±1 count ("least significant digit"). All meters were subjected to a 30-minute soak time at each temperature before the readings were taken.

## LCD Display Meters

The displays used in DMS-20LCD, DMS-30LCD, and DMS-40LCD series meters, including all process monitors and 2-wire meters with 'LCD' in their part numbers, employ a liquid-crystal fluid sandwiched between two layers of glass, with the two layers of glass glued together. The liquid-crystal fluid physically moves as information to the display is updated.

At temperatures below 0°C, the fluid's movement becomes more sluggish. This sluggishness causes the interval required for the display to change from one reading to another to become progressively longer; from hundredths of a second at +25°C, to tenths of a second at 0°C. The end result is a difficult-to-read display that suffers from a phenomenon referred to as "ghosting," that is, old information and new information are simultaneously displayed.

At temperatures above +70°C, commercial LCD displays begin to turn black, a condition which renders them unreadable. Also, because of the

nature of the display's construction, LCD-based meters are not physically able to tolerate environmental extremes, and therefore are not recommended for operation outside their specified temperature ranges.

## LED Display Meters

Due to the fact that the light-emitting elements used in DATEL LED-display meters are solid-state semiconductors, they exhibit excellent electrical and mechanical characteristics over very wide temperature ranges. As such, their operational temperature limits are to a large extent dependent on the plastic packaging materials that house them. Therefore, DATEL's LED-display digital panel meters are the best choice when extended operating temperature, overall ruggedness, and long-term reliability are paramount concerns.

The most noticeable effect extended temperatures have on our LED meters' performance pertains to display brightness. At -40°C, the LED display becomes noticeably brighter, while above +60°C the display becomes noticeably dimmer, though still easily readable. This varying intensity is due to an electro-optical characteristic exhibited by practically all LEDs: conversion efficiencies increase as temperature is lowered, and decrease as temperature is raised from +25°C. However, because our segment drive-currents remain relatively constant with varying temperature, the meter's total power dissipation also stays constant.

## Conclusion

Results from qualification and engineering tests (see page 2) allow DATEL to conditionally state that LED display DMS-20PC, DMS-30PC, and DMS-40PC standard- and high-intensity models ('-RS' and '-RH' part number suffixes, respectively) will remain fully operational at operating temperatures of -40°C to +70°C. Low-power models ('-RL', and '-GL' suffixes) of these same three families can be briefly exposed to operating temperatures of up to +80°C. However, only the operating range specified on product data sheets — either 0 to +50°C for 4½ digit meters or +60°C for 3½ digit meters — is guaranteed. Also, keep in mind that continuous exposure to elevated temperatures will have a negative impact on any electronic device's long-term reliability.

The above information regarding extended temperature operation is intended to serve as a guide. Real-world applications often include issues that have not been considered or discussed in this application note. Please consult DATEL if you have any questions regarding your specific application.

## Related Documents

**DMS Application Note 1:** "The LED versus LCD Decision"

**DMS Application Note 19:** "Half-Digits, Resolution and Other DPM Display FAQ's"

**Quality Assurance Link:** [http://www.datel.com/qa\\_dpm.htm](http://www.datel.com/qa_dpm.htm)

**DMS APPLICATION NOTE 22**

The table below shows the actual display readings of nine LED-display DMS-Series meters when they were operated at the indicated temperatures. The models chosen are all +5V-powered and include the three most popular input ranges: ±200mV, ±2V, and ±20V. All meters were initially calibrated

at +25°C with a single-ended, near full-scale, positive input to an accuracy of ±1 count (shaded readings under the +25°C column). The readings were recorded after a 30 minute “soak” period to ensure uniform internal temperatures.

**Extended Temperature Performance Table**

Model Number	Input Voltage	-40°C	-25°C	0°C	+25°C	+50°C	+60°C	+70°C	+80°C
DMS-20PC-0-RS	-190.0mV	-189.7	-189.8	-189.8	-189.8	-190.1	-189.9	-189.9	-189.8
	-100.0mV	-99.8	-99.9	-99.9	-99.9	-100.1	-99.9	-100.0	-100.0
	0mV	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0
	+50.0mV	49.9	50.0	50.0	50.0	50.1	50.0	50.1	50.1
	+100.0mV	99.8	100.0	100.0	100.0	100.0	100.1	100.0	100.1
	+190.0mV	189.8	189.9	189.9	189.9	190.0	189.8	189.9	190.0
DMS-20PC-1-RL	-1.900V	-1.899	-1.900	-1.899	-1.899	-1.901	-1.900	-1.900	-1.900
	-1.000V	-1.000	-1.000	-1.000	-999	-1.001	-1.000	-1.000	-1.001
	0V	.000	.000	.000	.000	.000	.000	.000	.000
	+0.500V	.500	.500	.500	.500	.501	.500	.500	.501
	+1.000V	1.000	1.000	1.000	1.000	1.001	1.000	1.001	1.001
	+1.900V	1.900	1.900	1.900	1.899	1.901	1.900	1.901	1.901
DMS-20PC-2-GS	-19.00V	-19.03	-19.02	-19.01	-18.99	-19.01	-19.00	-19.00	-18.92
	-10.00V	-10.00	-10.01	-10.01	-9.99	-10.01	-10.00	-10.00	-9.96
	0V	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	+5.00V	5.01	5.01	5.00	5.00	5.00	5.00	5.00	4.98
	+10.00V	10.02	10.01	10.01	10.00	10.01	10.00	10.00	9.96
	+19.00V	19.04	19.02	19.01	18.99	19.01	19.00	19.00	18.93
DMS-30PC-0-RL	-190.0mV	-190.1	-190.0	-189.9	-189.9	-189.8	-189.6	-189.6	-189.5
	-100.0mV	-100.0	-100.0	-100.0	-99.9	-100.0	-99.8	-100.0	-99.8
	0mV	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0
	+50.0mV	50.0	50.0	50.0	50.0	50.0	49.9	50.0	50.0
	+100.0mV	100.0	100.0	100.0	100.0	99.9	99.8	100.1	99.9
	+190.0mV	190.2	190.0	190.0	190.0	189.8	189.6	189.6	189.6
DMS-30PC-1-RS	-1.900V	-1.899	-1.899	-1.899	-1.898	-1.901	-1.900	-1.900	-1.900
	-1.000V	-1.000	-1.000	-1.000	-999	-1.001	-1.000	-1.000	-1.000
	0V	.000	.000	.000	.000	.000	.000	.000	.000
	+0.500V	.500	.500	.500	.500	.500	.500	.500	.501
	+1.000V	1.000	1.000	1.000	1.000	1.001	1.000	1.000	1.002
	+1.900V	1.900	1.900	1.900	1.899	1.902	1.901	1.902	1.903
DMS-30PC-2-BS	-19.00V	-19.00	-18.99	-18.99	-18.99	-19.00	-19.00	-19.01	-19.01
	-10.00V	-10.01	-10.00	-10.00	-10.00	-10.01	-10.01	-10.01	-10.01
	0V	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	+5.00V	5.01	5.00	5.00	5.00	5.01	5.01	5.01	5.01
	+10.00V	10.01	10.00	10.00	10.00	10.01	10.01	10.01	10.02
	+19.00V	19.01	19.00	19.00	19.00	19.01	19.01	19.02	19.04
DMS-40PC-1-RL	-1.9000V	-1.8947	-1.8972	-1.8985	-1.8999	-1.9006	-1.9007	-1.9006	-1.9001
	-1.0000V	-.9974	-.9987	-.9994	-.9999	-1.0005	-1.0000	-1.0004	-1.0002
	0V	.0000	.0000	.0000	.0000	-.0001	-.0001	-.0001	-.0001
	+0.5000V	.4986	.4994	.4997	.5000	.5003	.5003	.5003	.5003
	+1.0000V	.9974	.9986	.9993	1.0000	1.0004	1.0001	1.0004	1.0003
	+1.9000V	1.8946	1.8973	1.8985	1.9000	1.9006	1.9007	1.9006	1.8976
DMS-40PC-1-RS	-1.9000V	-1.8962	-1.8983	-1.8991	-1.8999	-1.9000	-1.8997	-1.8992	-1.8976
	-1.0000V	-.9983	-.9992	-.9997	-.9999	-1.0002	-1.0000	-.9998	-.9992
	0V	.0000	.0000	.0000	.0000	-.0001	-.0001	-.0001	-.0001
	+0.5000V	.4990	.4996	.4999	.5000	.5001	.5000	.5000	.4998
	+1.0000V	.9982	.9992	.9996	1.0000	1.0001	1.0000	.9998	.9992
	+1.9000V	1.8962	1.8984	1.8992	1.9000	1.8999	1.8997	1.8992	1.8976
DMS-40PC-2-RS	-19.000V	-19.014	-19.009	-19.006	-18.999	-18.973	-18.963	-18.955	-18.943
	-10.000V	-10.012	-10.008	-10.005	-9.999	-9.987	-9.982	-9.977	-9.972
	0V	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	+5.000V	5.006	5.004	5.002	5.000	4.994	4.991	4.989	4.986
	+10.000V	10.012	10.008	10.005	10.000	9.987	9.982	9.977	9.972
	+19.000V	19.015	19.010	19.007	19.000	18.973	18.963	18.955	18.944

= Indicates initial calibration point of +25°C ±3°