Lascar digital panel meter modules application notes

Data Sheet

The Lascar DPM range of panel voltmeters uses monolithic dual-slope A/D converters to create accurate and adaptable instruments which have many uses. This data sheet shows various possible applications, full technical data is supplied on instruction sheets with each module.

Operation

The meters have a resolution of either 3½ (±1999) or 4½ (±19999) digits. This will usually correspond to a full scale reading (FSR) of ±199.9mV. (V_{REF} = 100mV) or ±1.9999V (V_{REF} = 1.00V). All feature Autozero operation and have built in reference voltages (V_{REF}).

Their output is determined as follows:

$$3½: \text{Reading} = 1000 \times \frac{V_{IN}}{V_{REF}} \quad (1.1)$$

$$4½: \text{Reading} = 10000 \times \frac{V_{IN}}{V_{REF}} \quad (1.2)$$

The DPM 300S (260-038) sets either 200MV or 2V FSR (V_{REF} = 1V) digitally. Thus for 200mV FSR:

$$\text{Reading} = 10000 \times \frac{V_{IN}}{V_{REF}} \quad (1.3)$$

With V_{REF} fixed and V_{IN} varied, the meter will multiply (see eqn 1.1-1.3). However, if V_{IN} is fixed and V_{REF} is the input, the meter will divide. This can be used with effect in systems measuring period from the output of a F-V converter for example or any other application requiring a reciprocal function eg. velocity.

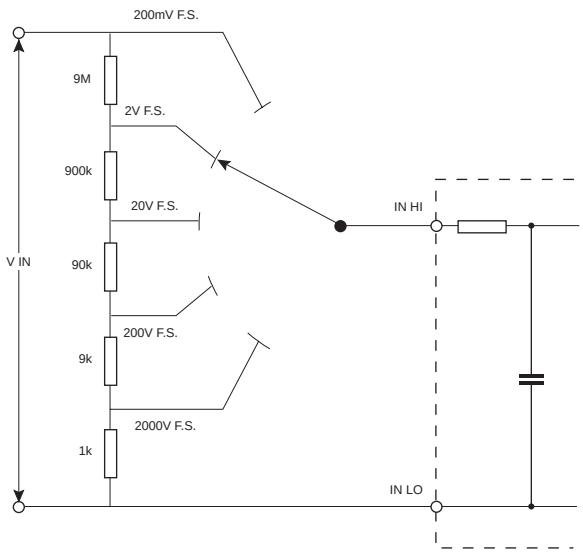
Note: If you provide your own reference, you will need to disconnect the reference fitted; check the meter instruction sheet.

Adjusting the calibration control varies V_{REF} but not the zero point. To add a zero (tare) offset see below 'adding an offset'.

Measuring voltage

Because all meters measure voltage, this is the simplest parameter to measure. The most common interface circuit is a voltage attenuator. Figure 1 gives an example of a multi-range attenuator.

Figure 1 **Multi-range voltmeter**

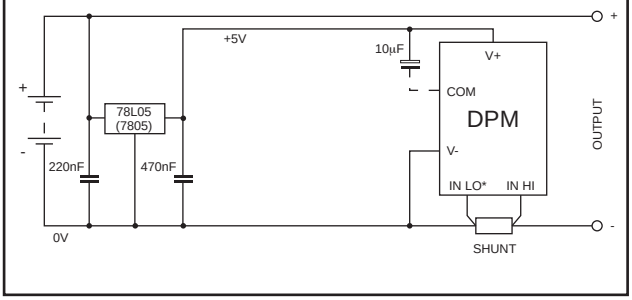


Measuring current

Although measuring current simply means measuring the voltage across a low value resistor, which has been placed in series with the current, there are some potential pitfalls. Ensure that the signal to the meter is within its common mode range. (See below: 'common mode range'.) The commonest mistake is to place the shunt in the positive supply with the meter referred to ground. If it is possible, place the shunt in the ground line but be careful not to superimpose the meter supply current in the reading.

Always use the 'four terminal' technique to avoid errors due to terminal resistance etc. If it is essential to have the shunt in the positive supply, use an isolated meter supply.

Figure 2 **LED and S type LCD current monitoring**

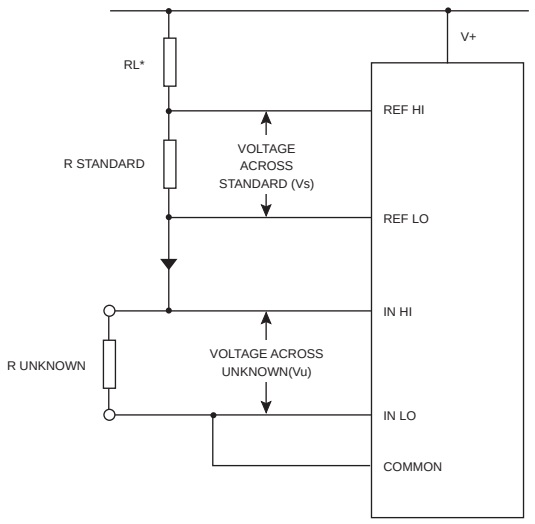


*Always ensure that INLO is not connected to COM.

Measuring resistance

The method of measuring the value of a resistor requires very few external components and, provided the reference resistor used is accurate, needs no calibration. Known as the ratiometric method, it uses a known resistor to generate a reference voltage and the unknown resistor to supply the input.

Figure 3.1 **Ratiometric resistance measurement**



*RL should be chosen to set the value of Vs in the range 50-200mV

$$\text{Reading} = 1000 \times \frac{R_U}{R_S} \qquad (3.1)$$

The following meters are suitable for this application:

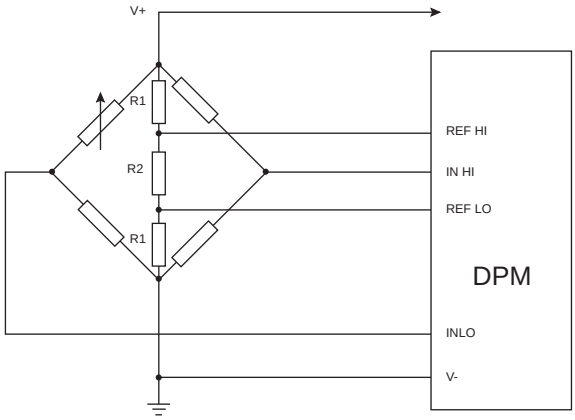
Meter	**RS** stock no.
DPM 125*	257-212*
DPM 200(S)	260-050/260-044
DPM 300S	260-038
DPM 400*	260-274*
DPM 500S	255-985/260-252
DPM 700 (S)	255-979/260-246
DPM 2000(S)	255-963/260-280

* Some modification to PCB required

Using strain gauges

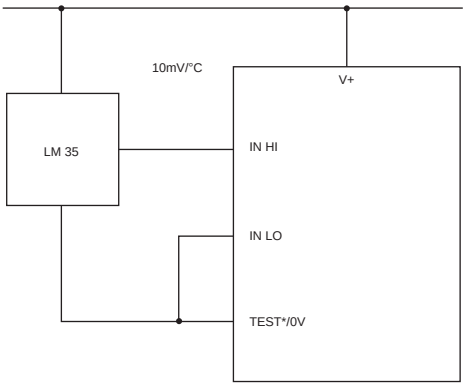
The strain gauge circuit is a variation of the resistance circuit as seen above in Figure 3.1. It gives a reading of bridge imbalance as a ratio of the applied voltage and is thus independent of supply voltage. As with the resistance circuit, ensure you choose a meter with separate input and reference connections and which can have the meter reference disconnected. See list above.

Figure 4 **Strain gauge application**



Thermometer circuits

Figure 5 **Using the LM35 temperature sensor**



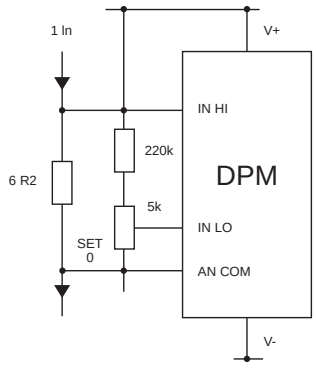
*Use TEST on normal LCD meters and 0V on LED and S-type LCD meters.

Adding an offset

Some applications need the meter to have an offset (eg. tare). The basic method is to apply the signal between INHI and COM and apply the offset between COM and INLO.

Figure 6 gives an example of a tare application. Note that it gives a negative offset. For a positive offset, INLO must be set below the signal ground.

Figure 6 **4-20mA reading 0-1000 (200mV FSR meter)**



ac-dc converters

Two basic techniques for ac-dc conversion exist. The simplest is the 'precision rectifier' whose output is the average of the ac input. Provided that the waveform of the input is constant, the meter can be calibrated to read RMS values.

The second is the true RMS converter. This can give the true RMS value of the input and is recommended for such applications as monitoring the current in SCR controlled loads.

Figure 6a **Averaging ac-dc converter**

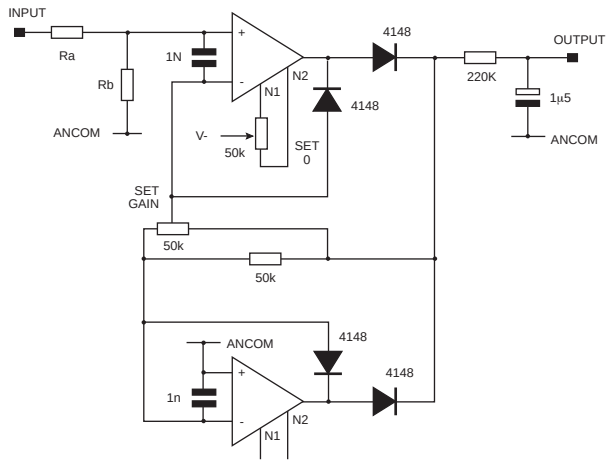
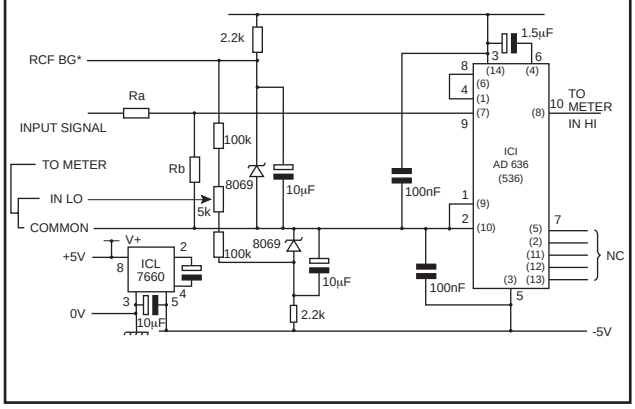


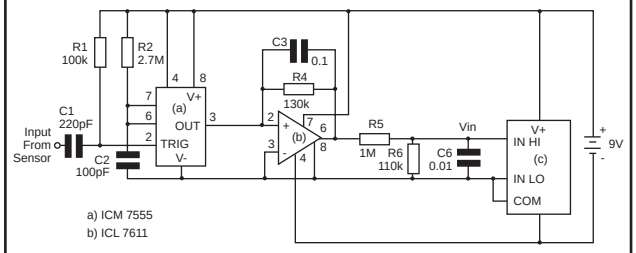
Figure 6b **Using the AD636/536 RMS-D converter IC**



Measuring frequency

To do this you will need a frequency to voltage converter. One advantage of the F/V converter over the more conventional digital frequency meter is that it has a faster response to low frequencies.

Figure 7 **Measuring frequency**



Common mode range

Many application problems arise from a misunderstanding of the limits imposed by the common mode range of the analogue inputs. The analogue inputs for V_{IN} (IN HI and IN LO) respond to the voltage across them and not their voltages with respect to the analogue common[1]. But these inputs must be no higher than 0.5V below V+ and no lower than 1.0V above V–[2]. These limits define the common mode range.

The reference voltage V_{REF} (REF HI and REF LO) may be anywhere within the power supply voltage range of the converter. However, if there is a large voltage between the reference input and COM there is a risk that stray capacitance in the analogue switching circuitry will cause a noticeable roll-over error. Roll-over error is the difference in reading between identical positive and negative inputs.

Note[1]: Some meters have IN LO and/or REF LO linked to AN COM. The DPM 40 (**RS** stock no. 257-206), DPM 45 (**RS** stock no. 260-230) and DPM 116 (**RS** stock no. 260-268) meters have REF LO permanently connected to AN COM.

Note[2]: All LED and S version LCD instruments generate their own negative supply which is below the 0V power input.

Analogue common

This pin is included primarily to set the common mode voltage for battery operation (LCD), or for any system where the input signals are floating with respect to the power supply. The common pin sets a voltage that is approximately 3.0 volts more negative than the positive supply.

Within the IC, analogue common is tied to a N channel FET that can sink 300µA (100µA on 7136) or more of the current to hold the voltage 3.0 volts below the positive supply (when a load is trying to pull the common line positive). Sinking excessive current into COM can seriously damage the unit[3]. However, there is only 10µA of source current, so common may easily be tied to a more negative voltage thus over-riding the internal reference.

Note[3]: The DPM 45 (**RS** stock no. 260-230) uses the ICL 7135 and this has an uncommitted COM which must be tied to 0V.

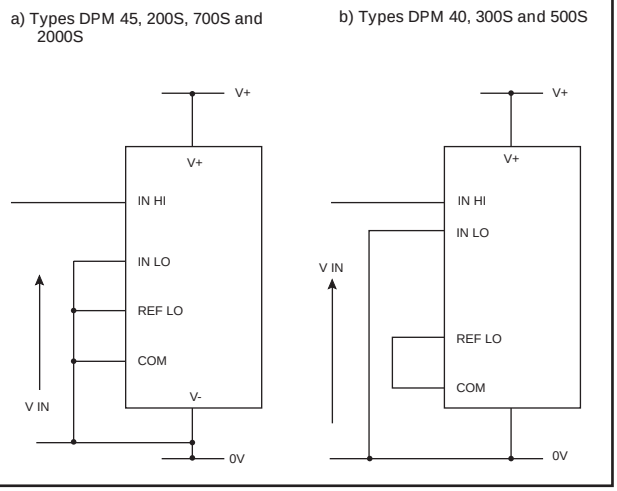
Referring inputs to supply 0V

In many applications the meter will need to be powered from the same supply as the circuit under test. There are two pitfalls to be avoided:

1. Excessive common mode voltage (see above).
2. Ground loop errors and noise.

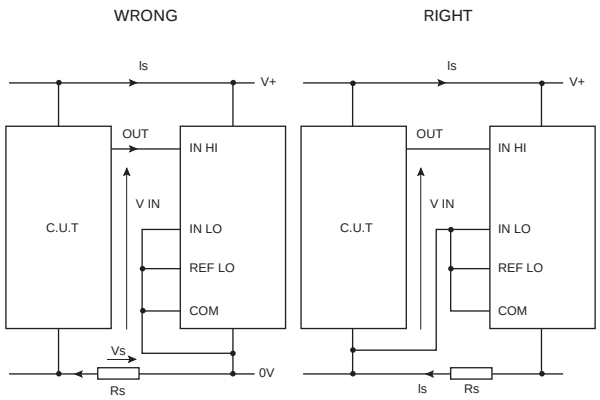
We also know that V– must be at least 1.0V below the analogue inputs so we must provide a negative supply. All LED and S-type LCD meters have their own built in. If a suitable negative supply is not available, one must be provided or a different meter chosen for the application.

Figure 8 **Ideal circuit connections**



Reducing ground loop errors

Figure 9 **Errors due to supply impedances**



If we re-draw Figure 8(a) we will see that small impedances (Rs) in power supply lines will cause a volt drop (Vs) which will be subtracted from the reading, causing an offset. Furthermore, with LED meters not only do they have a much higher current consumption (causing significant offsets), but each reading results in a different current consumption. If there is a change in current consumption there is a change in the reading which causes a change in current consumption, etc., etc. A good example would be a DPM 40 reading – say 1001. A drop of one count gives 1000, a difference of 4 segments in the least significant digit. Each segment consumes 8mA. Thus the total change in current is 4 3 8 = 32mA. Under these conditions it only needs Rs to be 6mΩ to cause a 2 count offset.

Noise

Electrical noise can be generated from stray electric, magnetic and electromagnetic fields as well as from supply and signal borne interference. Although meters have very good line regulation and CMRR, they will be affected by excessive amounts of noise. Remember that meter signals are referred to V+ and any suppression capacitors should be fitted between COM and V+.

Each case of noise problems will have its own solution. Below is a list (in order of importance) of possible remedies.

Ground noise

Check that there are no signal errors due to ground impedances. See above.

Power supplies

Supplies that are likely to generate noise, such as those with noisy loads or switching converters, need to be suppressed. Decouple the meter supply at the meter and if necessary place a choke in the positive supply. Remember that electrolytic capacitors can be inductive and it is better to decouple with solid tantalum capacitors.

Signals

All meters have input filters which reduce noise, however, where the signal leads to the meter are long, use twisted pair wires and place any attenuator networks at or near the meter. In extreme cases, use screened leads but be careful not to connect the screen to any noisy signal or power line. Only screen the lead to COM at the meter.

Stray fields

If stray electrical or magnetic fields are suspected of causing noise, physical screening of the meter may be necessary. Other measures include placing the meter away from cables that are likely to have large and noisy currents in them. Another source of magnetic interference will be any transformer especially one operating at high frequency.

Parallel operation

Some applications will have more than one meter measuring in a circuit. It is very easy in these circumstances to have erroneous readings or worse. Figure 10a shows an example of how, even with an isolated supply, it is possible to destroy at least one meter. With shunts in each of the ±24V supplies, there will be 48V between the meter INLO inputs. Figure 10b shows a better arrangement. The general rule is don't use the same supply if you cannot use the same signal ground.

Figure 10a **How not to use common supplies**

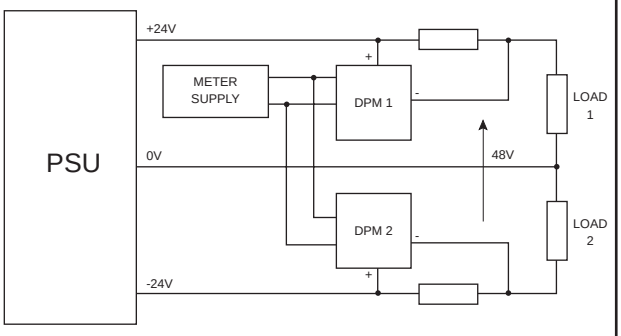
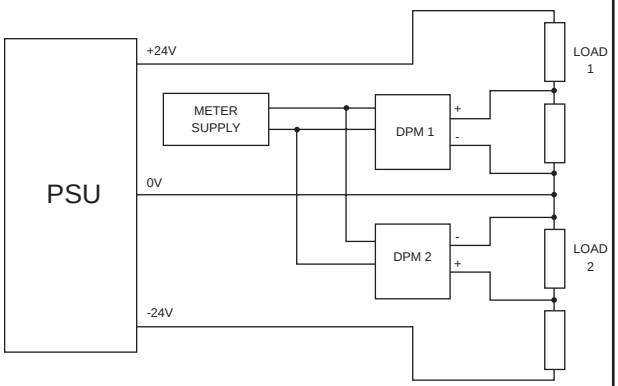


Figure 10b **How to use common supplies**



Ensure that when meters with internal references are paralleled and COM is used as the ground (eg. in battery powered equipment) the references do not 'fight' each other: The meter with the highest COM–V+ voltage will pull all the other COM voltages lower and only one meter will be accurate. In these cases use one meter to define the ground and leave the others with their COM pins unconnected. Check that programming links do not connect COM to INLO inside the meter.

Handling

Lascar meters do not normally need special handling precautions but static should be avoided. When soldering use irons with earthed tips and avoid applying excessive heat to the meter PCB. The recommended tip diameter should be between 1 and 2mm and flat not pointed.

If it is necessary to send a meter via the post etc, ensure that the unit is well packed, especially LCD panel meters. Keep bezel materials away from the glass and do not use padded bags. Firm cardboard boxes only should be used. Padded bags may protect against impact but not against crushing.

Circuit connection

Connections to the meter should be made with a socket. Meters such as the DPM 200(S) (**RS** stock nos. 260-050/183-357) and DPM 700(S) (**RS** stock nos. 255-979/260-246) can be soldered to. Do not solder to meters which have IC type pins on them. Always check that the power supply is correct and that the signals will not destroy the meter before connecting the unit.

Bezel fitting

Figure 11 **Snap-in bezel fitting**

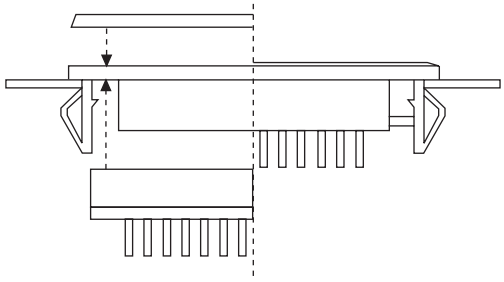


Figure 12 **Moulded window type fitting**

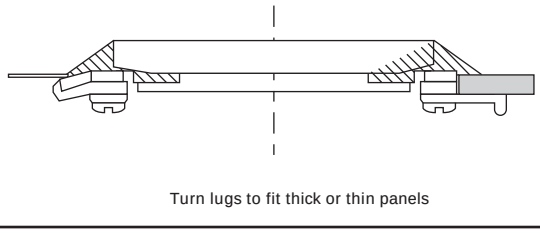
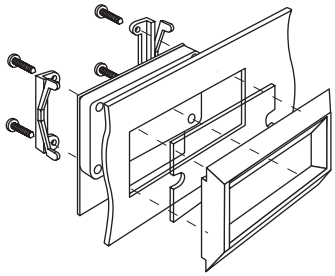


Figure 13 **Spring clip panel fitting**



Trouble shooting

The majority of difficulties stem from application problems. If a meter is suspected of malfunction, remove it from the circuit and connect it up on its own in the 'floating supply mode'. (See meter data sheet back page) and apply an isolated signal. If the meter works satisfactorily check the circuit.

Using PCB links

Lascar meters have programming pads to make circuit configuration quick and easy. Some pads will have a small PCB link across them. If you need to cut the link, use a sharp scalpel and be careful not to cut through adjacent tracks. Dig the link out rather than slice through it. See Figures 14a and 14b.

Figure 14 **How to cut PCB links**



14a WRONG 14b RIGHT

RS stock no.	257-206	260-230	257-212/ 260-268	260-050	260-038	260-274	255-985	260-252	255-979	260-246	255-963	260-280/ 183-357
Module type	DPM 40	DPM 45	DPM 125/116	DPM 200	DPM 300S	DPM 400	DPM 500	DPM 500S	DPM 700	DPM 700S	DPM 2000	DPM 2000S (DPM 200S)
Full scale deflection	200mV	2V	200mV	200mV	200mV or 2V logic selectable	200mV	200mV	200mV	200mV	200mV	200mV	200mV
Accuracy	±0.1% of reading ± 1 count	Better than ±0.01% ± 1 count	±0.1% of reading ± 1 count	±0.1% ± 1 count	Better than ±0.01% ± 1 count	±0.1% of reading ± 1 count	±0.1% of reading ± 1 count	±0.1% of reading ± 1 count	±0.1% ± 1 count	±0.1% ± 1 count	±0.1% ± 1 count	±0.1% ± 1 count
Linearity	± 1 count	± 1 count	± 1 count	± 1 count	± 1 count	± 1 count	± 1 count	± 1 count	± 1 count	± 1 count	± 1 count	± 1 count
Resolution	100µV	100µV	100µV	100µV	10µV/100µV	100µV	100µV	100µV	100µV	100µV	100µV	100µV
Input impedance	100MΩ on unscaled inputs	100MΩ	100MΩ	100MΩ	100MΩ	100MΩ	100MΩ	100MΩ	100MΩ	100MΩ	100MΩ	100MΩ
Sample rate	3 readings/ second	2.5 readings/ second	3 readings/ second	3 readings/ second	1.6 readings/ second	3 readings/ second	3 readings/ second	3 readings/ second	3 readings/ second	3 readings/ second	3 readings/ second	3 readings/ second
Temperature stability	150ppm/°C	30ppm/°C	100ppm/°C	30ppm/°C	30ppm/°C	100ppm/°C	100ppm/°C	100ppm/°C	30ppm/°C	30ppm/°C	30ppm/°C	30ppm/°C
Supply voltage dc	5V, 5.5V Max.	5V, 5.5V Max.	Min. 7,5V Max. 15V	5V to 15V	3.5V to 6V	7.5V to 15V	7.5V to 15V	3.5V to 6.5V	7.5V to 15V	3.5V to 6.5V	5V to 15V	3.5V to 6.5
Annunciators	—	—	—	pH,µ,%,g, °F,°C,A,m, Ω,M,k,~	µ,m,k,g, A,M,Ω,V, %,°C,°F,~,+ continuity symbol	K ,M,Ω,,V, m,A,°C, µ,~	Ω,Hz,V, m,A,°F,°C, µ,M,k,~	Ω,Hz,V, m,A,°F,°C, µ,M,k,~	V,m,A,°F,°C, µ,M,k,Ω, Hz,~	V,m,A,°F,°C, µ,M,k,Ω, Hz,~	pH,µ,%,g, °F,°C,A,m, Ω,M,k,~	pH,µ,%,g, °F,°C,A,m, Ω,M,k,~
LED back-light V/I	—	—	—	—	—	—	—	—	9V/25mA	5V/50mA	—	—
No of digits/display type	3½ LED	4½ LED	3½ LCD	3½ LCD	4½ LCD	3½ LCD	3½ LCD	3½ LCD	3½ LCD	3½ LCD	3½ LCD	3½ LCD
Operating temperature	0 to 50°C	0 to 50°C	0 to 50°C	0 to 50°C	0 to 50°C	0 to 50°C	—	0 to 50°C	—	0 to 50°C	0 to 50°C	0 to 50°C
Low battery threshold	—	—	7.5V	6.4V	Typ. 3.7V	7.5V	—	7.5V, 3.7V	6.4V*	3.2V*	6.4V*	3.2V*
Overall size excluding optional bezels	L.72 H.36 D.24.5	L.72 H.36 D.24.5	L.38.4 H.20.4 D.10.6	L.72 H.47 D.15	L.67.5 H.32.5 D.16.5	L.38.4 H.20.4 D.10.6	L.60 H.30 D.10.7	L.60 H.30 D.10.7	L.60 H.37 D.14.1	L.60 H.37 D.14.1	L.67.5 H.32.5 D.11.75	L.67.5 H.32.5 (45) D.11.75 (13.7)
Panel cut out	68×33	68×33	45×22.2	68×33	68×33	45×22.2	57×27	57×27	62×32	62×32	68×33	68×33
Digit height	11	10	12.5	15	12.5	10	12.5	12.5	12.7	12.7	15	15

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