

# Keeping Your Cool

Modern measuring instruments can give you accurate results in a wide range of environments, their use being limited as much by operator comfort as engineering design.

Starting work on a nice icy winter morning, you might turn on the heater, pick up your hand-held meter from the bottom shelf in the workshop, and then wonder why that ac signal is low by 4%. You were sure it was set up well inside 2% the night before, but a quick adjustment is easy. Coming back that afternoon after a call-out, you realise that you left the meter on the seat in the van in full sun. On retrieving the meter, you check that signal again to find it's now high by a few percent. What's going on?

Most things change with temperature. Instrument designers often use components with intrinsically low temperature coefficients and they sometimes use software correction to cope with changing temperature. With a modern multimeter you should start thinking about what is happening once you move outside the comfort zone of  $23\text{ °C} \pm 5\text{ °C}$ . You can typically assume that the basic accuracy of the meter applies over this range. Outside that range there will be a specification of something like  $0.2 \times (\text{specified accuracy})/\text{°C}$ . This begins to matter if you leave the meter on a  $5\text{ °C}$  shelf or inside a  $40\text{ °C}$  van. Given a 2% ac voltage accuracy at  $23\text{ °C}$ , then at  $40\text{ °C}$  the specification indicates that the meter might be wrong by as much as  $0.2 \times 2\% \times (40\text{ °C} - 23\text{ °C}) / \text{°C} = 6.8\%$ .

At least with a handheld instrument you get some clue about its temperature just by picking it up (see Figure 1). With rack- or bench-mounted instruments temperature shifts can be less obvious. As the instruments are likely to be used for more demanding measurements, the impact of these temperature shifts may be critical. It is common for internal temperatures to be  $10\text{ °C}$  to  $15\text{ °C}$  higher than ambient.

Minor alterations to airflow around an

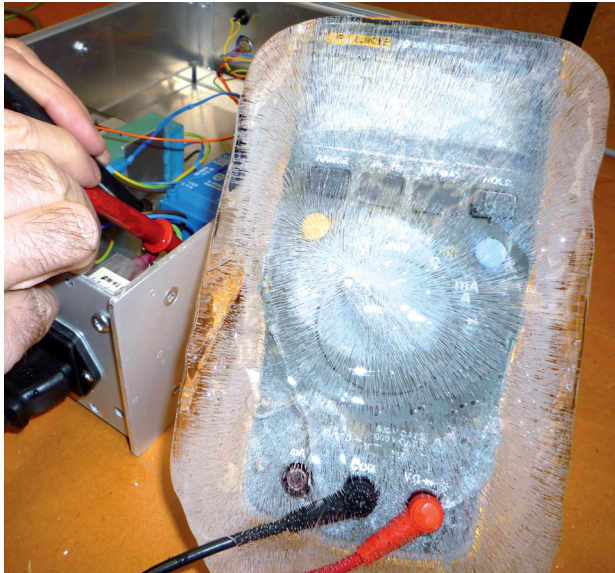


Figure 1 A cold start to the day.

instrument, such as moving it closer to the edge of a bench or under a shelf, can affect the internal temperature difference from ambient by  $2\text{ °C}$  or more (see Figure 2). It is important to understand the airflow around and through an instrument and to ensure that any fan filters are kept clean. The problems get worse when bringing together a number of instruments. Even side by side on a bench, the warm fan exhaust from one can feed into the cool air intake of the other. A well-designed rack with additional forced circulation might allow a  $15\text{ °C}$  rise in air temperature, sending internal temperatures up to  $30\text{ °C}$  above ambient. Direct heating by radiation from light sources (particularly the sun) and other equipment can also be a serious issue.

Assuming you have done everything

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practical to control the operating environment for your equipment, you then need to look through the instrument's calibration certificate and the manufacturer's table of specifications. Some high-accuracy instruments can report their internal temperature. If this is within  $5\text{ °C}$  of the internal temperature at the time of calibration, then the instrument can usually be assumed to be operating within specification. If the difference is higher, then it will be necessary to expand the accuracy limits using the specified temperature coefficient, as we did for the handheld example above.

In other cases, the best estimate of temperature is to measure the air temperature in the region of the cool air intake for the instrument with an electronic thermometer. Take care not to disturb airflows or to provide additional heat sources such as from your hand. The measured temperature needs to be close to the ambient temperature at which the instrument was calibrated if the accuracy limits are not to be extended based on the specification temperature coefficients.

The Electrical Standards group at the Measurement Standards Laboratory can offer more detailed advice, particularly if measurement uncertainties better than the nominal instrument specifications are needed.

Figure 2 Which temperature is right? Two fan-cooled multimeters reporting their internal temperature, while a thermometer measures the inlet air temperature.