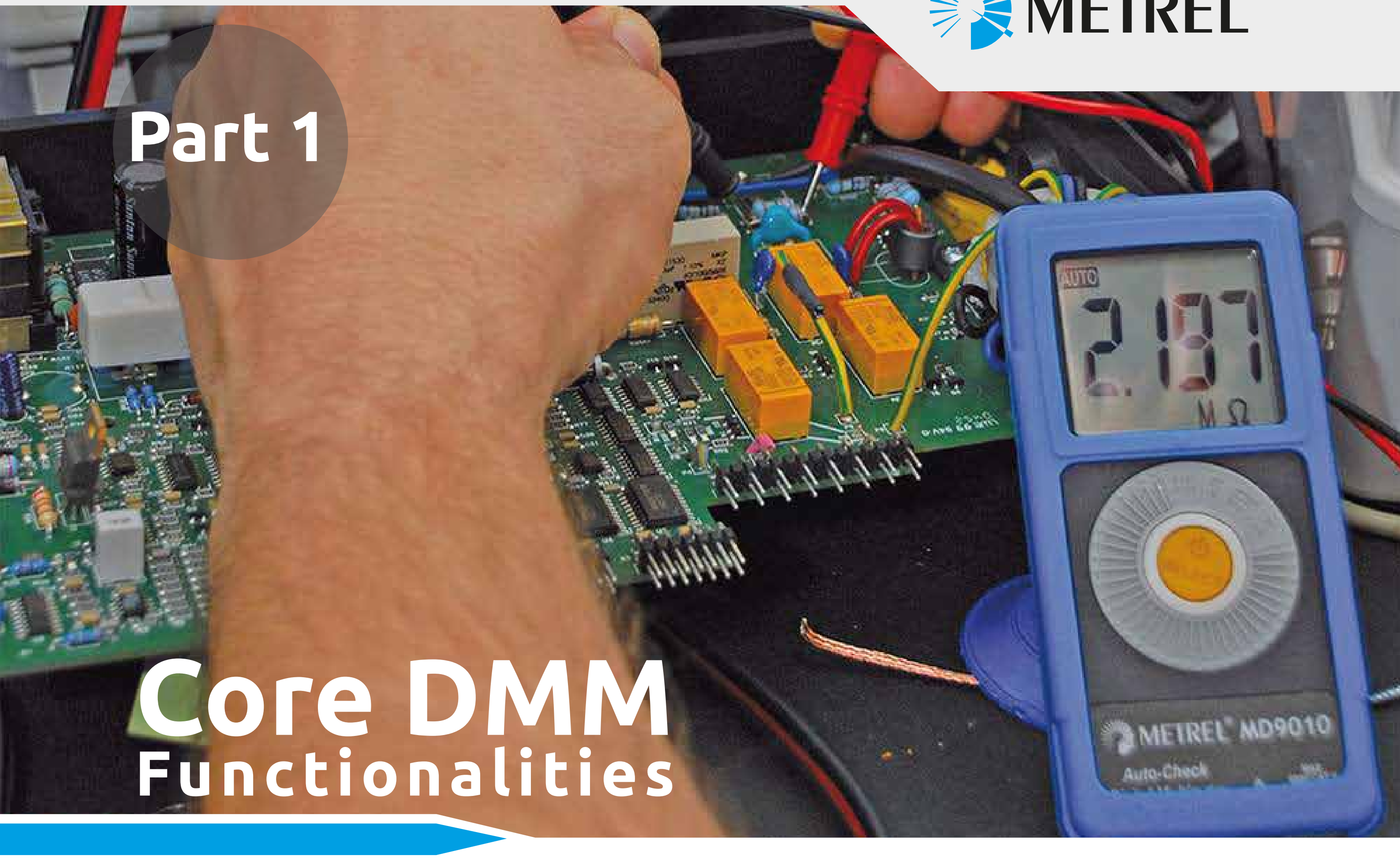

Part 1

Core DMM Functionalities

Digital Multimeter Functions & Properties 101

Handheld digital multimeters are one of the most widely used electrical instruments. Everyone, from field electricians, electrical engineers to service workers to a kid with his first broken toy, tests their devices, circuitry etc. with one of these. Modern multimeters are fully digital, taking measurements by sampling the data into a microcontroller, processing it and showing it on a display.

Usually, only the input stage is analogue, preparing the signal for digitalization. Also, keep in mind that ADCs tend towards slower, but high-resolution variants, as usually no more readings are needed than the naked eye can process. The digital platform itself, on the other hand, enables easy addition of various features, some of which will be presented in this and subsequent newsletters, while keeping the design sturdy and easy to use (even in on-handed manner). But, before delving into some of the features we should take a look at some basic properties of digital multimeters (also applicable to many other testing/measuring instruments).

Resolution, Counts, Digits

Being three ways to describe the same quality, these expressions only differ superficially. All three mean the smallest change that the instrument can show. Resolution is usually given in units per range, e.g. 1 mV at 1 V, which means that 1 mV is the smallest visible change when reading a 1 V value. Counts mean the largest number that can be displayed, which, combined with the chosen measuring range, means exactly the same as resolution. Digits are number of spaces for numbers on the screen. Most often it is decided that the first number or the most significant digit doesn't have a full 0-9 range, but a smaller one, like only 0-1. Typical notation for that is 3 ½ digits. It means that three digits are full-range and one can only show 0 or 1, giving the display 1999 counts. However, some manufacturers use the ½ fraction for any narrowed range, not only 0-1, so by knowing the number of digits, number of counts is not yet clear.

Accuracy

Accuracy is the biggest error the instrument by itself would make under certain controlled conditions, or a measure of how close the displayed value is to the actual. It does not take into account the impact (e.g. load) the instrument may make on the measured circuit. It is usually expressed as a percentage of the range and number of smallest digits. For example, if accuracy is ±1% at 100 V, it means that when the reading is 100 V, the actual value is between 99 V and 101 V. If the accuracy is ± (1% + 2d), the actual value is between 98.8 V and 101.2 V. Sometimes, the notation without the d is used, as in ± (1% + 2).

Effective or RMS Value

RMS value is thermally equivalent DC value to AC (or different) signal. For periodic signals, it is calculated as square root of integral over one period length, of squared signal, divided by length of period. Modern multimeters usually give a reading by definition and can show true value regardless of waveform shape. Some cheaper variants, however, use rectifiers and calibration by fixed factor, and only give accurate reading for sine wave. The error can be given with crest factor – ratio between the largest and RMS values of the signal. For pure sine, it is 1.414. For some distorted signals, it may even be in multiple digits. For very high values, even TRMS meters might start giving bad readings. The range of crest factors with specified accuracy should be noted in the data sheet. Another part of TRMS measurement is consideration of the DC component. The multimeter might filter it out, only giving TRMS of the alternating part of the signal, or it might use it in measurement. On the other side of the spectrum, there are higher harmonic components. If left unfiltered (and many multimeters can "see" them at least partially), they become a part of the TRMS calculation and can make RMS value seem higher. Accuracy needs a frequency specification as well.