WHITEPAPER

VXI Instruments
the test solutions provider

This is how to select oscilloscope, digitizer, and DMM

Once the appropriate measurement procedure has been selected and the test setup is determined, it is to select the instrument: oscilloscope, digitizer or DMM. We give tips on the selection of devices.

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The tasks of testing electronic assemblies are becoming more and more complex. After selecting the suitable measuring methods and the test set-up, the selection of a proper measurement device is one of the most important tasks of the test engineer. In this context, the requirements for devices used in test systems are also increasing. This applies to use in the laboratory as well as in production test systems. Reliability in continuous operating production test systems and test speed also play a decisive role here. The core components of a test system can be divided into two basic types. Stimuli devices generate signals for the device under test (DUT) and electrical measuring instruments detect the signals supplied by the DUT. Digital multimeters (DMMs) and oscilloscopes are by far the most widely used measuring instruments. So-called digitizers are frequently found in the production test, and they are becoming increasingly important due to the increasing requirements for testing. Other articles in this series are dedicated specifically to these three types of meters. They give the user assistance in the selection of the optimal device for him and show possible measures to avoid measurement errors.

1. THE PROBLEM OF DIFFERENT SPECIFICATIONS

The user is often faced with the problem that even in seemingly simple devices such as a DMM, the specifications of the individual manufacturers are so differently structured that a comparison is possible only with relatively great effort. When selecting meters which can fulfil the requirements of the test specification, both the measurement uncertainties must be taken from the instrument specification as well as the fact how a meter itself influences the signal to be measured.

Relevant effects include, for example, the input impedance whose ohmic component with DC components is usually 10 MOhm and often only 1 MOhm with AC components. Likewise, the input capacities must be considered, which can vary from 10 pF to 300 pF, depending on the device type.

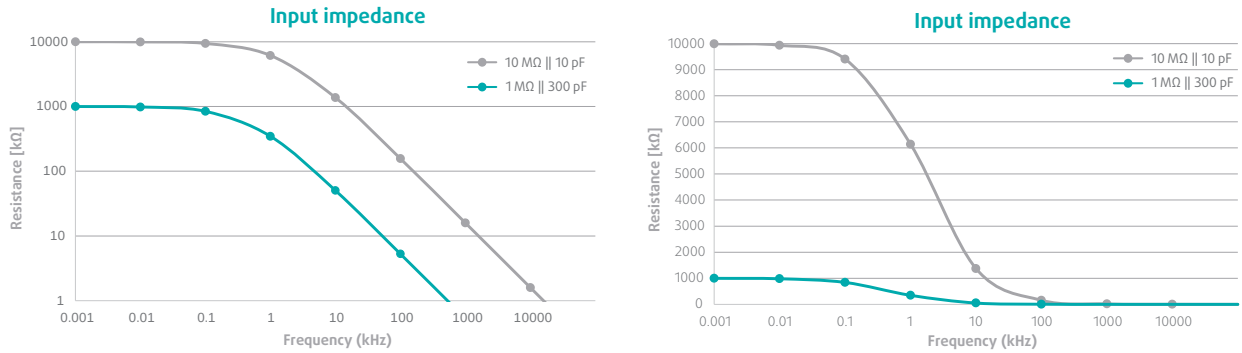

Image 1: Input impedance in double logarithmic representation with clearly recognizable 3 dB cutoff frequency (left) and input impedance in simple logarithmic representation for the representation of different frequency responses.

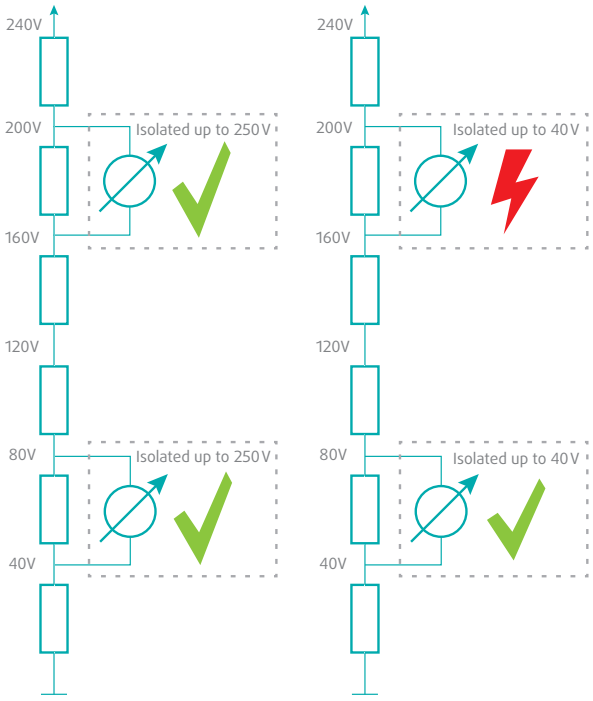

Image 2: Presentation of the possible danger of using insufficiently isolated measuring instruments.

In the case of AC measurements, these form a low-pass filter together with the measurement object and can thus significantly falsify the measurement result.

2. BENEFITS AND BOUNDARIES OF ISOLATION

With the terms 'not grounded', 'isolated' or 'floating', however, be careful in several respects. When using such a device it is essential to check the voltage up to which the measuring inputs are isolated to the protective conductor. If you want to measure a single cell in a stack on a high-voltage battery, the meter must also be isolated to the protective conductor up to the maximum voltage. In order to rule out a malfunction and thus a hazard, it is recommended that the selected meter is also isolated to the protective conductor in the entire available measuring range. For example, if a device is isolated to the protective conductor only up to 40 V, cells above a voltage of 40 V can no longer be individually measured. A device with a maximum input voltage of 250 V should be isolated to the protective conductor with this value in order to be able to use it without restriction.

With DMMs, many users automatically assume that the devices are not grounded, i.e. isolated from the protective conductor. This is usually the case when you look purely at the ohmic resistance between the measuring ground connection and the protective conductor. The ohmic isolation is several gigaohms and can therefore be disregarded. Some DMMs show a considerable capacity between the measuring ground connection and the protective conductor, which can achieve several nanofarads (parasitic coupling). Although nanofarad capacitances appear small, it must be checked whether the test object is too heavily influenced thereby causing another relevant measuring error. This happens due to the load of the measuring signal due to the input impedance of the meter.

3. DIFFERENT PARAMETERS IN THE DEVICE SELECTION

Also parameters such as the duration of measurement are of increasing importance as they significantly influence the throughput in test systems and therefore in the production line. It should be noted here that the measurement inaccuracy occurring during the measurement increases strongly with increasing measuring speed.

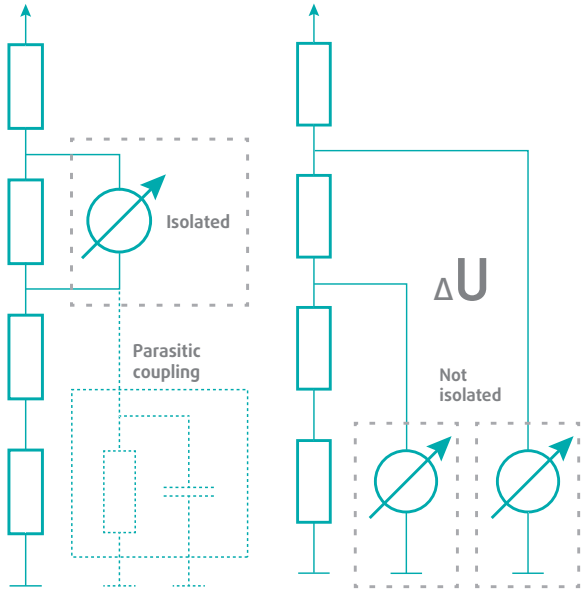

Image 3: Schematic representation of isolated measuring technology with indicated parasitic coupling.

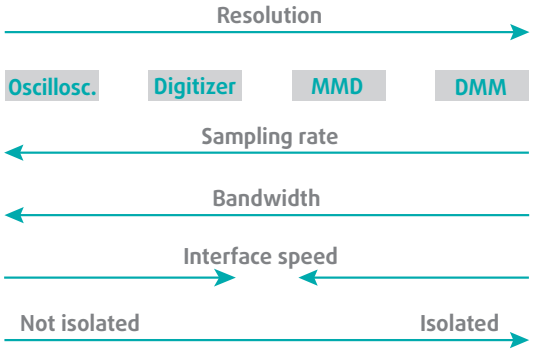

Image 4: Schematic representation of the properties of measuring device groups.

In order to test efficiently and fast, in addition to the pure measurement time, the time for instrument setup, the measurement range change required during the test procedure and the data transmission time from the instrument to the PC must also be taken into account. To make it even more difficult to plan the test procedure, these times are generally not specified in data sheets and must therefore be determined experimentally for each device. This shows that even choosing a seemingly simple device like a DMM can already raise a lot of questions. For oscilloscopes and digitizers, the parameters are even more diverse.
Conversely, DC mean values and AC RMS values can be measured with an oscilloscope. However, the results are of lower accuracy as these instruments are mostly equipped with 8 to 12 Bit A/D converters. In addition, the measuring ground connection of an oscilloscope is not isolated but connected directly to the protective conductor. As a result, the use for many types of measurements, for example in the case of in-circuit tests, is significantly restricted or causes further measurement errors due to ground loops. A list of important additional parameters and their typical values for the device groups shown is given in the table on the last page of this whitepaper.

Meanwhile, high-resolution digitizers, which are isolated at the same time, with a resolution of up to 20 Bit are available. Depending on the measurement task, they represent an alternative to DMMs and oscilloscopes. The fact that the boundaries between these devices will continue to blur is shown by a new device that will soon be launched.

The Multi Measurement Device (MMD) by VX Instruments combines the following functions:

- Digitizer 40 MS/s, 16 Bit, ±250 V
- 24 Bit-DMM for DC-voltage and current, AC voltage and current, resistance and LCR
- Timer/counter with various measuring functions with a resolution of 25 ns and voltages up to 250 V
- High configurable FPGA trigger matrix and
- fully isolated up to ±250 V

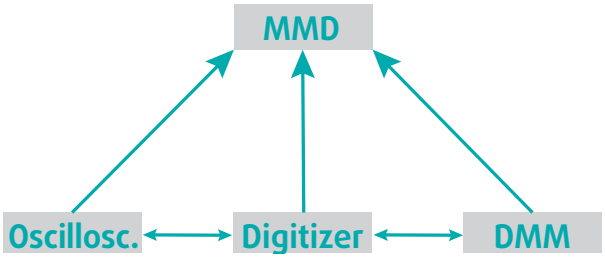

Image 5: Schematic relationship of the measuring device groups.

4. SUMMARY

It is still important for the user to know his test case and the requirements, as well as the effects of the measurement device itself to the DUT, in order to select the right instrument. Furthermore, the structure and integration of the test system into production must be taken into account. The developer should keep an eye on the parasitic capacitances and inductances as well as coupled-in interferences, which are caused by long cabling, for example.
In the next two editions, on the one hand, a comparison between isolated and ground based measurement technology will be presented. On the other hand, possible reasons of the measured value influencing by the measuring device itself are represented and assistance for the evaluation and minimization is given.

	DMM	Digitizer	Oscilloscope	MMD
Resolution	<32 Bit	8 ... 20 Bit	8 ... 12 Bit	16 ... 24 Bit
Accuracy	<5 ppm/0,0005%	1.000 ppm/0,1%	20.000 ppm/2%	50 ppm/0,005%
Sample rate	100 kS/s	10 MS/s ... 2 GS/s	<10 GS/s	1 MS/s ... 40 MS/s
Input impedance	10 M || 300 pF	1 M || 20 pF	1 M || 20 pF	10 M || 20 pF
Isolated	>1 G || 1 nF	Not isolated until >1 G || 100 pF	Not isolated	>1 G || 100 pF
Number of channels	1	1 ... 16	1 ... 4	1
Trigger capability	Limited	Yes	Yes	Yes
Interfaces	GPIB, USB, LXI, PXI	PXI, PXIe, LXI	GPIB, LAN, USB	PXI, PXIe

Table: Properties and typical values of the represented measuring device groups.

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PXI System Alliance
VX Instruments is one of nine Executive Members (total over 60 members) in the PXI System Alliance, the consortium, which defines and develops the PXI standard. Here we enjoy voting privileges and have direct access to the technical committee.

LXI Consortium
The LXI Consortium is promoting the development and adoption of the LXI Standard, an open, accessible standard identifying specifications and solutions relating to the test and measurement industry.

PCI-SIG
The PCI-SIG is a community, which develops and maintains the standardized approach to PCI data transfers.

ISO 9001:2015
VX Instruments GmbH is certified by International Certification Management GmbH since February 2003.

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