Insights and best practice

EMC COMPLIANCE KNOW-HOW

TECHNICAL NOTE 0117

INSULATION TESTS
WITH THE 1.2/50 PULSE

Overview

When designing electrical equipment, machines and systems, it is necessary to check the products from an EMC and safety point of view. These test are mandated by international standards and are designed to protect the user from potential harm and to ensure the performance of equipment is maintained in the event of electrical disturbances.

In addition to the classic EMC tests such as ESD (electrostatic discharge), Burst (fast transient) and Surge, there is also the area of insulation tests. Overvoltages are used to test an electrical products insulation without large currents flowing that occur during breakdowns and flashovers. This document discusses the various standards that address this issue and the implications for testing.

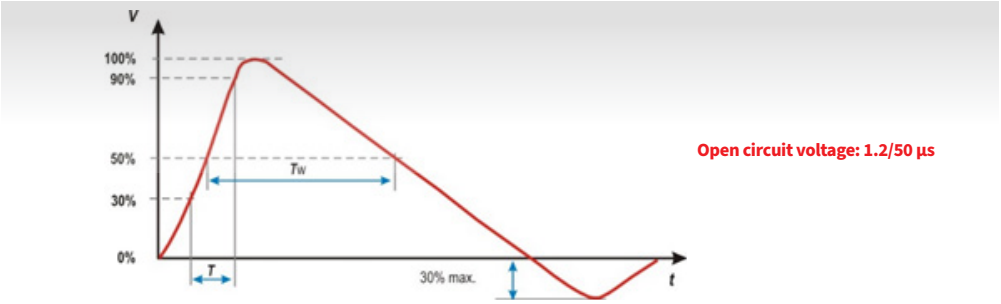
AMETEK CTS GmbH Sternenhofstrasse 15 4153 Reinach, Switzerland sales.cts.eu@ametek.com

AMETEK®
COMPLIANCE TEST SOLUTIONS

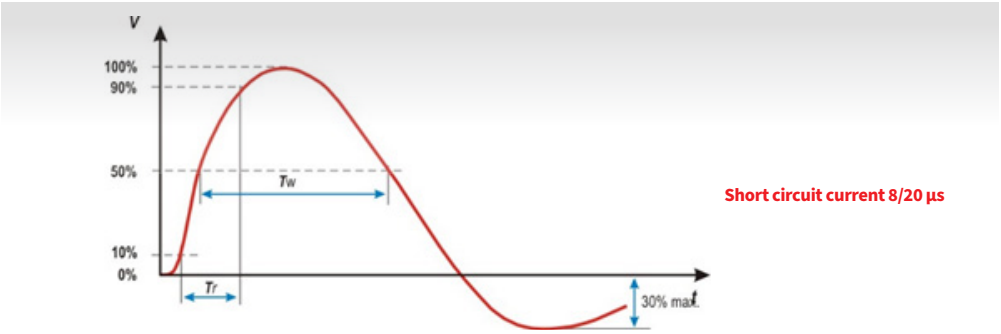
When does a so-called overvoltage event actually occur?
Within the European AC grid, the nominal voltage according to EN 60038 is 230V with a tolerance of +/-10% in single-phase systems. Thus, in our power grid, voltages of more than 253V are considered overvoltage by definition. Such overvoltages can occur either permanently, for example due to a faulty electrical installation, or for a short time, for example due to lightning strikes or switching operations.

IEC 61000-4-5
The phenomenon of surge voltage is regulated in IEC 61000-4-5. This standard describes the "testing of the immunity of electrical and electronic equipment, devices and installations to surge waves (surge voltages and currents)" and was adopted in its current version in March 2015. Short-term surge voltages are caused by a wide variety of events. A basic distinction is made here between surge voltages due to switching operations or system faults and overvoltage events caused by lightning. In the case of the latter, it is not only a matter of loads caused by a direct lightning strike in a power grid, but also by indirect lightning strikes and induced currents in the ground or earthing system of a system, which are caused by lightning strikes in the immediate vicinity.

A surge voltage is a short-term, very energetic impulse, which the device must survive undamaged. According to IEC 61000-4-5 the pulse has a front time of 1.2 µs with a pulse duration of 50 µs (1.2/50µs) for the open-circuit voltage and a front time of 8 µs with a pulse duration of 20 µs (8/20µs) for the short-circuit current.



Open circuit voltage: 1.2/50 µs



Short circuit current 8/20 µs

An impedance of 2 Ohm is used for symmetrical coupling (L-N, L-L) and an impedance of 12 Ohm for unsymmetrical coupling (L-PE, N-PE).
In addition to this classic surge test, there are also other pulse tests that have the same pulse shape of 1.2/50 µs (open circuit).

IEC 62052-11: Electricity metering equipment for indoor and outdoor applications
IEC 60255-27: Measuring relays and protection equipment

Both IEC 62052-11 and IEC 60255-27 standards specify a 1.2/50 µs high voltage transient with a source impedance of 500 Ohm. What is special about these standards is that they specify a constant output energy of 0.5 J at all test levels. Classically, in EMC pulse generators, a capacitor is charged and this is discharged via a pulse-shaping network. If a capacitor of capacity C is charged with a voltage U and carries the charge Q, then the following applies to the electrical energy stored in the capacitor:

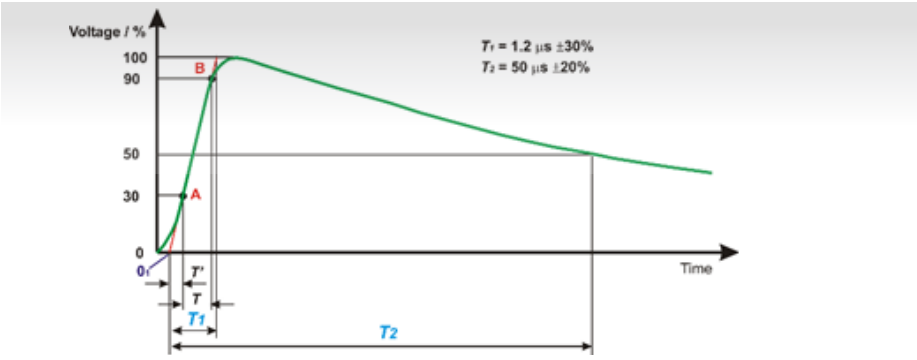
$$E_{el} = \frac{1}{2} * Q * U = \frac{1}{2} * C * U^2 = \frac{1}{2} * \frac{Q^2}{C}$$

Accordingly, the higher the amplitude, the higher the pulse energy. Generators such as the vsurge NX8.1 therefore have several pulse forming networks so that each test level is tested with the same energy of 0.5 J as required by the standard.

vsurge NX8.1 www.

IEC 60335-1 | IEC 60664-1 | IEC 60060-1

Another type of insulation test using the 1.2/50 µs pulse, but without the energy requirement of 0.5 J, is defined in the standards IEC 60335-1, IEC 60664-1 and IEC 60060-1. This is again a 1.2/50 µs pulse, but it is defined differently from IEC 61000-4-5:



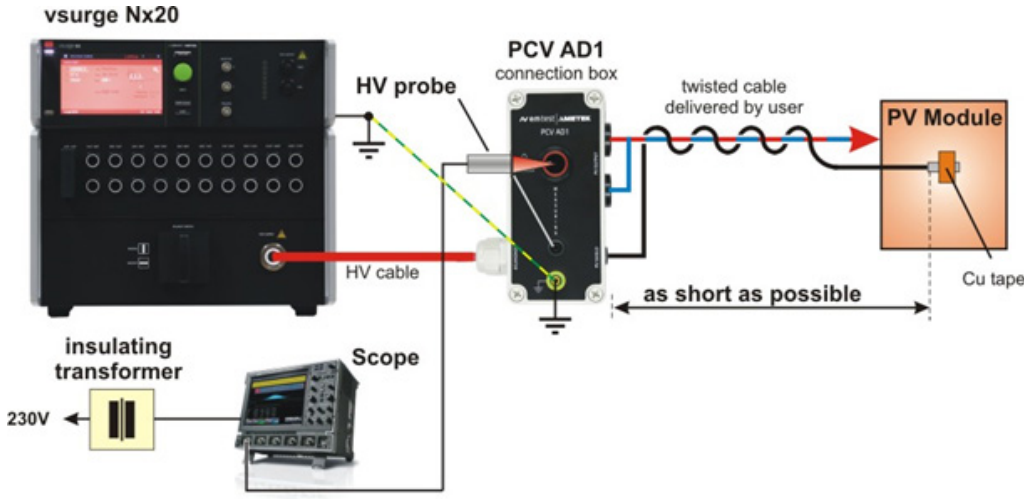
The purpose of these tests is to verify that clearances will withstand transient overvoltages. The requirements of the tests are satisfied if no indication of disruptive discharge or partial breakdown is obtained. In contrast to the surge test according to IEC 61000-4-5, the pulse is not coupled to the AC or DC voltage supply during the

insulation test, but, for example, contact pins, plugs or housing parts are directly exposed to the pulse. Therefore, these devices like the vsurge NX15 do not have an internal coupling network but only a pulse output.

vsurge NX15 www.

IEC 61730-1/-2

And then there are very special standards, including IEC 61730-1/-2, which deal with insulation tests of photovoltaic modules. The special thing about this is that the entire PV module is covered with a metal foil, the connection is short-circuited and the pulse is applied between the short-circuited connection and the covered metal foil. The IEC 61730 is special in that it is the only standard that requires compliance with the 1.2/50 µs waveform on the connected EUT.



Due to the many different designs and sizes, each PV module has a specific capacitance. The specified waveshape of 1.2/50us must be generated and maintained as specified across a broad range of capacitances that a PV represents. Normally, EMC pulse generators are calibrated in no-load operation or with a defined load. Such generator needs to be based on different pulse shaping networks to cope with the variable capacitive load of the panels. The vsurge NX20 covers a very wide range from 20 nF to 170 nF and divides this into 11 different capacitance ranges.

Insights and best practice

EMC COMPLIANCE KNOW-HOW

About AMETEK CTS

emtest | TESEQ | MILMEGA | IFI

AMETEK CTS is a global leader in EMC compliance testing and RF power amplifiers. AMETEK has been designing and manufacturing precision instruments for more than 30 years. Under the brand names of EM Test, Teseq, IFI and Milmega the company produce a wide range of specialist solutions aligned to the individual needs of equipment manufacturers across a variety of industries. These include:

Automotive
Aerospace and Defense
Consumer electronics
Household appliances
Medical devices
Renewable energy

From its design and manufacturing facilities in Switzerland, Germany, the United States and the UK, AMETEK CTS provides customers with innovative solutions to the complex requirements of EMC compliance standards.

KNOW-HOW - Learning hub and resources

KNOW-HOW is our online Learning Hub and Resource Centre. Here you will find EMC .and RF Amplifier education content and best practice information

Included is on the site is our series of 30 minute webinars. You can stream the full presentation content and download the accompanying

Best Practice Webinars

Technical Library

Video Content