Application Note: Surge Testing according to IEC 61000-4-5 Edition 2 (2005)

Introduction

There has been a great deal of change recently to the IEC 61000-4-5 standard for surge testing. In November 2005 the latest version, IEC 61000-4-5 edition 2 (2005) was approved by the IEC.

The new EN 61000-4-5:200X which is derived from the IEC 61000-4-5 Edition 2:2005 can be used from the * on and must be used from * on. This is also the withdrawal date of the current EN 61000-4-5:1995.

Edition 2 incorporates earlier Amendment 1 (2000), and also includes additional requirements:

- Definition of the open circuit voltage and the short circuit current for the 10/700µs impulse shape
- Impulse shapes at the output of the power line CDN are clearly defined with tolerances
- Synchronization angles are defined more clearly and have a tolerance to meet
- Different coupling elements for data and control line testing are specified to meet a broad range of requirements
- Shorter time interval allowed between the impulses in order to speed up the test time

The new edition includes better defined test equipment to increase the reproducibility. It also deals with the problems of EUTs with higher power mains current as well as the complex issue of testing data and control lines.

The intention of this application note is to describe the various changes, to discuss current products offered by Haefely for complying with the new requirements, and to review existing Haefely products for conformity with the current standard.

What is really new in IEC 61000-4-5 Edition 2?

Definition of the Impulse Shapes at the Generator Output

Up to now the telecom impulse known as 10/700µs impulse was defined by the circuit with the component values and the open circuit impulse shape. In edition 2 there are no component values given any more. But both the open circuit and the short circuit impulse shape is given. This change makes it easier for the user to verify the impulse generator. The 10/700µs is now also called combination wave impulse. There are now two combination wave impulses defined in the IEC 61000-4-5:

- 1.2/50µs combination wave (1.2/50µs into open circuit and 8/20µs into short circuit)
- 10/700µs combination wave (10/700µs into open circuit and 5/320µs into short circuit). This is the same impulse generator as used in ITU K series.

Thus when referring to a combination wave impulse it is important so specify which one!

These new definitions have no influence on any Haefely product.

*** These dates are not yet fixed by CENELEC**

Power Line Testing

Synchronization for Power Line Testing

The synchronization angle is given as 0°, 90°, 180° and 270°. What is new is that there is a tolerance of ±10° for the synchronization angle. *This relative narrow tolerance means that the older generators with mechanical high voltage switches are no longer according to the IEC 61000-4-5 Edition 2 because of their jitter*. From the Haefely product range only the PC6-288 with HV module PHV 1 is affected by the changes.

Selection of a suitable Coupling/Decoupling Network

In edition 2 there is a very helpful flow chart at the end of chapter 6.3. It gives an overview of the coupling methods and their use. Table A.1 in annex A defines when the different impulse shapes must be used.

Coupling and Decoupling Networks for Power Line Testing

Edition 2 contains a similar coupling/decoupling network as the edition 1. A new requirement is that the impulse shape is also defined at the CDN output for differential mode and common mode coupling.

The coupling part remains the same as in edition 1. The decoupling part changes as described below.

The decoupling inductance should not exceed 1.5mH. For higher currents the decoupling inductivity must be reduced significantly. In this case, the "time to half value" of the open-circuit voltage may be reduced as shown in table 6 and 7.

There is a big advantage of reducing the decoupling inductors for higher currents. With decoupling inductors of 1.5mH some EUT with higher currents either do not start or do not work properly because of the voltage drop at the EUT terminal. When reducing the decoupling inductivity many more EUTs will start and work properly.

The definition of the residual voltage at the line input is slightly changed. This change has no influence on any Haefely product.

Our PCD 100 and PCD 130 are fully compatible to edition 2. This also applies for our older products FP-SURGE 16.1, FP-SURGE 32.1 and PSURGE 4.1. Our FP-SURGE 100M and FP-SURGE 100DC are no longer compatible with edition 2. There is a new coupling/decoupling network available named FP-SURGE 100M2 for 100A per phase according to edition 2. The existing FP-SURGE 100M can be upgraded to fulfill edition 2. The FP-SURGE 100DC cannot be upgraded.

Coupling and Decoupling Networks for Unshielded Data and Control Lines

For this type of CDN no impulse shape at the EUT output is given. Nonlinear components such as gas arrestors and breakdown avalanche diodes can be used as coupling elements. With such components it is not possible to define any impulse parameter and tolerances.

There are several types of coupling elements used for coupling the surge impulses onto data and control lines:

- capacitor 0.5μF (preferred for asymmetrical operated lines)
- clamping devices such as gas arrestors (preferred for symmetrical operated lines, no 100nF capacitor in parallel any more)
- avalanche devices such as avalanche breakdown diodes or varistors

Which one is used for a specific application should be defined in the product standard. If no information is given and the preferred type of coupling elements does not work the user has to decide which one he should use. This has to be documented in the test protocol because different types of coupling elements can produce different test results.

For symmetrical lines current compensated inductors are used to decouple the auxiliary equipment. In the edition 2 there are two current compensated inductors with two coils each as standard. The compensated inductor, over all four lines according to edition 1, can also be used although the test results can be different. But with two separate inductors the communication on the EUT lines often works better than with one inductor with four coils.

The products PCD 120, IP6.2 and DEC1A can be used without changes. If a breakdown avalanche diode is required as coupling element in the PCD 120 please call Haefely for this modification. The new products PCD 121, PCD 122, PCD 126, DEC 5, DEC 6 and DEC 7 are fully compatible to edition 2 and give the user flexibility in selecting a suitable coupling or protection device.

For I/O and communication lines, the series impedance of the decoupling network will limit the available bandwidth for data transmission. Subclause 6.3.4 of edition 2 describes a procedure of how to test when the communication does not work when a decoupling network is used.

More information about this complex topic is given in our application note "Surge Testing of unshielded Control and Data Lines".

Test Procedures

A change was made in order to speed up the tests. The repetition rate is now 1 per minute or faster. In edition 1 it was 1 per minute or slower. If testing done at rates faster than 1/min cause failures and tests done at 1/min do not, the test done at 1/min prevails. This change has no influence on any Haefely equipment.

Ordering Information for Haefely Equipment according to IEC / EN 61000-4-5 Edition 2

Type	Article No.	Short description
PSURGE 4010	249600	Combination wave 1.2/50µs - 8/20µs generator with single phase coupling decoupling network
PSURGE 8000	249900	Surge Platform Controller and high voltage source
PIM 100	249902	Combination wave 1.2/50µs - 8/20µs impulse module up to 7.4kV
PIM 120	249940	Combination wave 10/700µs - 5/320µs impulse module up to 7.4kV
PCD 100	249904	Automatic coupling and decoupling network, single phase up to 264V 16A
PCD 120	249941	Automatic coupling network for symmetrical data lines according ITU-T K.44 and IEC 61000-4-5
PCD 121	249801	Manually operated coupling network for symmetrical data lines according IEC 61000-4-5
PCD 122	249802	Manually operated coupling network for symmetrical data lines according IEC 61000-4-5 and ITU-T K.44
PCD 126	249803	Manually operated coupling network for asymmetrical data and control lines according to IEC 61000-4-5 and IEC 61000-4-12
PCD 130	249964	Automatic Coupling and Decoupling network, three phases, up to 690/400V, 32A per phase
DEC 5	249014	Decoupling network for symmetrical data lines according IEC 61000-4-5 and ITU K.44
DEC 6	249015	Decoupling network for symmetrical data lines according ITU K.44
DEC 7	249016	Decoupling network for asymmetrical data and control lines according IEC 61000-4-5 and IEC 61000-4-12.
FP-SURGE 100M upgrade	249018	Upgrade for the FP-SURGE 100M to edition 2 (must be done in our factory)
FP-SURGE 100M2	249019	Manually operated coupling and decoupling network, three phases, up to 690/400V, 100A per phase
ECOMPACT4	249100	Compact Tester for burst, surge and line testing.
ECOUPLER 4	249101	Automatic coupling and decoupling network for SURGE and EFT, up to 400/230V, 16A. Works with ECOMPACT 4 only!

Note: The coupling networks PCD 121, PCD 126 and FP-SURGE 100M2 can be used together with either PSURGE 4010 and PSURGE 8000 with PIM 100 as well as with the ECOMPACT 4.

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