

Application Note: EFT / Burst Testing according to IEC 61000-4-4 Edition 2 (2004-07) plus Amendment 1 (2010-01)

Introduction

In January 2010, IEC 61000-4-4-am1 ed. 2 was approved by the IEC.

The EN 61000-4-4:2004/A1:2010 which is derived from the IEC 61000-4-4-am1 ed.2 can be used from the first of December 2010 on and must be used from first of March 2013 on.

This amendment 1 defines the verification of the impulse shape at the CDN output. The intention of this application note is to describe the various changes between Edition 1 and 2 especially with amendment 1, 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.

Waveform verification

Edition 2 requires verification of the burst waveform into both a 50 Ω and a 1000 Ω load. Note that the tolerance on peak voltage measurement using the 1000 Ω load has been changed from +10%/-15% (Ed 1, Am 2) to \pm 20% (Ed 2).

Haefely offers an EFT VERIFICATION KIT (part no. 2499951) which includes the 50 Ω and 1000 Ω attenuators, plus cabling and documentation, all in a foam padded carry case.

Note also that the 50 Ω and 1000 Ω measuring attenuators are now held to a very tight tolerance (50 Ω \pm 2%, 1000 Ω \pm 2% // <6pF). All delivered attenuators PAT 50A and PAT 1000 are fully compliant to edition 2. The older equipment labeled with "ATTENUATOR 50R 54dB" or "ATTENUATOR 1k 60dB" are not compliant to edition 2!

Edition 2 also requires waveform verification at the output of the coupling / decoupling network (CDN). Haefely offers high frequency single pole verification adapters to connect your attenuators to the CDN outputs on the PEFT and FP-EFT series couplers. These specially designed adapters are essential to accurately measuring the EFT waveform at the output of the CDN.

Output voltage peak values

During verification of the waveform, it is important to consider both the attenuation of the load itself, and the interaction between the load and the 50Ω generator output impedance. For example:

Haefely model:	PAT 50A	PAT 1000
Impedance:	50Ω	1000Ω
Nominal attenuation:	54dB	60 dB
Nominal divider ratio:	500:1	1000:1
Interaction with 50Ω generator output:	$(50 + 50) / 50 = 2:1$	$(1000 + 50) / 1000 = 1.05:1$
Total measuring ratio:	1000:1	1050:1
Set voltage:	<i>measured voltage</i>	<i>measured voltage</i>
At 4kV	4V	3.81V
At 2kV	2V	1.90V
At 1kV	1V	0.95V
At 0.5kV	0.5V	0.48V
At 0.25kV	0.25V	0.24V

When using the 1000Ω load to measure the burst waveform, some overshoot is possible due to the impedance mismatch between the 50Ω generator output and the 1000Ω attenuator. For this reason, the tolerance on peak voltage measurements when using the PAT 1000 are ±20% of the set voltage, compared to ±10% for the PAT 50A.

It is very important that there is no mains voltage at the CDN output during the verification of the impulse shape because the attenuators would be damaged.

100kHz spike frequency

Edition 2 requires burst testing with either the traditional 5kHz spike frequency or the new 100kHz spike frequency. The traditional 2.5kHz spike frequency at 4kV amplitude is not required any more. The number of spike per burst remains constant at 75. That means that the energy transferred from the burst generator to the test object is independent of the selected spike frequency. It is left to individual product standard committees to determine which is the appropriate test for individual EUTs.

Multi-line common mode output

For mains coupling, the edition 2 requires that all lines be coupled simultaneously to ground for true common mode coupling. The generator/CDN must also be verified in this coupling mode and meet all waveform requirements. Haefely burst systems have the capability to select either single line or multi-line common mode coupling. When multi-line common mode for single or three phase coupling is selected, the added load of the CDN will reduce the burst amplitude. To ensure the proper voltage at the EUT a correction factor is used. Correction factors for various Haefely EFT systems are given in the table below.

CDN type	Generator	Firmware Version	Coupling Mode	Correction Factor
Internal CDN (Single phase 16A automatic CDN)	PEFT 4010	1.22 or earlier	LNPE-GND	1.05
	PEFT.1	all		
	PEFT JUNIOR	all		
	PEFT 4010	1.30 or later	LNPE-GND	None required
	PEFT 8010	all		
FP-EFT 32.1 (Three phase 32A automatic CDN)	PEFT 4010	1.22 or earlier	L1NPE-GND L1L2L3NPE-GND	None required 1.09
	PEFT.1	all		
	PEFT JUNIOR	all		
	PEFT 4010	1.30 or later	L1NPE-GND L1L2L3NPE-GND	None required None required
	PEFT 8010	all		
FP-EFT 32M (Three phase 32A manual CDN)	PEFT 4010	1.30 or earlier	L1L2L3NPE-GND	1.12
	PEFT.1	all		
	PEFT JUNIOR	all		
	PEFT 4010	1.40 or later	L1L2L3NPE-GND	None required
	PEFT 8010	all		
FP-EFT 100M2 (Three phase 100A manual CDN)	PEFT 4010	1.30 or earlier	L1L2L3NPE-GND	1.25
	PEFT.1	all		
	PEFT JUNIOR	all		
	PEFT 4010	1.40 or later	L1L2L3NPE-GND	None required
	PEFT 8010	all		

Example of using the factors given in the table above:

Requirement: U_{test} (Test Voltage at the output of the CDN) = 2kV

Used equipment: FP-EFT 32.1 with PEFT JUNIOR

Calculation: $U_{nominal} = \text{factor} * U_{test} = 1.09 * 2\text{kV} = 2.18\text{kV}$

This voltage $U_{nominal}$ is to enter at the PEFT JUNIOR. This ensures to have the desired amplitude at the CDN output.

Test Setups

Another area of changes are the test set ups. For example, for laboratory type tests with table top equipment the burst generator is now placed on the table. There are also test set ups given to perform post installation tests. For more details see the current issue of the standard.

Amendment 1 (2010-01)

The following table shows the compliancy of the Haefely burst test equipment:

Equipment	Fully compliant with IEC 61000-4-4 (2004) ed.2 including cor.1 and cor.2	Fully compliant with IEC 61000-4-4 (2004) ed.2 including cor.1 and amendment 1
PEFT 4010	✓	needs to be upgraded when delivered before June 2007
PEFT 8010	✓	✓
PEFT.1 with PHV 41/42	✓	no upgrade possible
PEFT Junior	✓	no upgrade possible
FP-EFT32M	✓	✓
FP-EFT32.1	✓	no upgrade possible
FP-EFT100M	✓	needs to be upgraded when delivered before January 2010

Full compliance with Edition 2 includes:

- Fully compliant waveform into both 50Ω and 1000Ω.
- Fully selectable spike frequency from 1Hz to 1MHz, including 5kHz with 15ms burst duration OR 100kHz with 0.75ms burst duration.
- Selectable single or multiple line common mode coupling.

Full compliance with Amendment 1 Edition 2 includes additional:

- Fully compliant wave form at the CDN output when verified according the requirements of amendment 1.

Ordering Information

Article No.	Short description
2496010	PEFT 4010 EFT generator (firmware version 1.40 or later)
2491800	PEFT 8010 EFT generator
2499951	EFT VERIFICATION SET (PAT 50A and PAT 1000, coaxial cable, user manual)
2490040	Single pole verification adapter (banana to SHV) according amendment 1. Used for PEFT 4010/8010 and FP-EFT 32M
2495040	Upgrade PEFT 4010. Upgrades the PEFT 4010 instrument to the newest standard (IEC61000-4-4-am1 (2010-01) Ed. 2). It contains a firmware upgrade, a hardware modification and a calibration. This upgrade must be done in our factory or in one of our service centres. For equipment delivered after June 2007, no upgrade is necessary
2491300	IP4A capacitive coupling clamp
2490170	FP-EFT 32M manually operated three phase CDN, 690/400V, 32A
2495860	FP-EFT 100M2 manually operated three phase CDN, 690/400V, 100A
2495050	Upgrade FP-EFT100M. Upgrades the FP-EFT 100M instrument to the newest standard (IEC61000-4-4-am1 (2010-01) Ed. 2). It contains a hardware upgrade and a calibration. This upgrade must be done in our factory. For equipment delivered after January 2010, no upgrade is necessary
2490045	Single pole verification adapter (banana to SHV) according amendment 1. Used for FP-EFT 100M2
2499701	WinFEAT&R control and reporting software

Headquarters
Haefely Test AG
 Lehenmattstrasse 353
 CH-4052, Basel
 Switzerland

☎ + 41 61 373 41 11
 📠 + 41 61 373 45 99
 ✉ EMC-sales@haefely.com

Locate your local
 sales representative at
www.haefelyEMC.com



HAEFELY EMC
 TECHNOLOGY

North American Office
Hipotronics Inc.
Haefely EMC Division
 1650 Route 22
 Brewster, NY 10509

☎ ++1 845 279 3644 x262
 📠 ++1 845 279 2467
 ✉ EMCsales@hubbell-haefely.com