

# Application Note: EFT / Burst Testing according to IEC 61000-4-4 Edition 2 (2004)

## Introduction

There has been a great deal of change recently to the IEC 61000-4-4 standard for Electrical Fast Transient (burst) testing. In July 2004, IEC 61000-4-4:1995 amendment 2 (2001) became mandatory for CE mark testing. And in June 2004 the latest version, IEC 61000-4-4 edition 2 (2004) was approved by the IEC.

The new EN 61000-4-4:2004 which is derived from the IEC 61000-4-4 Edition 2:2004 can be used from the first of July 2005 on and must be used from first of October 2007 on. This is also the withdrawal date of the current EN 61000-4-4:2001.

Edition 2 incorporates earlier Amendment 1 (2000) and Amendment 2 (2001), and also includes additional requirements. 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.

## Waveform verification

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

Haefely now offers an EFT VERIFICATION KIT (part no. 249995) which includes the 50 $\Omega$  and 1000 $\Omega$  attenuators, plus cabling and documentation, all in a foam padded carry case.

Note also that the 50 $\Omega$  and 1000 $\Omega$  measuring attenuators are now held to a very tight tolerance (50 $\Omega$   $\pm$ 2%, 1000 $\Omega$   $\pm$ 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 now offers high frequency common mode verification adapters (single phase and three phase) to connect your attenuators to the outputs on the PEFT and FP-EFT series couplers. A common mode adapter has all lines short circuited and connected to one SHV socket to measure on it. These specially designed adapters are essential to accurately measuring the EFT waveform at the output of the CDN. Single phase adapters are included in the UPGRADE KITS part no. 249527 and 249528.

## 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  $\pm 20\%$  of the set voltage, compared to  $\pm 10\%$  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 now 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 new standard 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.

A firmware upgrade is included in the UPGRDE KIT PEFT 4010 (part no. 249528). With this firmware upgrade the correction factors in multi-line coupling mode for single and three phase coupling are included. With the release 1.70 or later of the WinFEAT&R software the correction factors are also included.

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 100M (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:  $U_{nominal} = \text{factor} * U_{test} = 1.09 * 2kV = 2.18kV$

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

### Test Set Ups

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.

## Summary

There are a number of new requirements in the Edition 2 and we encourage you to read this new Edition 2 very carefully to ensure proper verification and testing.

All Haefely burst generators manufactured since 1992 are in full compliance with Edition 2. This includes Haefely model PEFT 4010, PEFT 8010, PEFT-Junior, and PEFT.1 with either PHV 41.2 or PHV 42.1 plug-in modules.

- 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.

Haefely's FP-EFT 32.1 and FP-EFT 100M coupling decoupling networks are also in full compliance as well as our new products ECOMPACT 4 with ECOUPLER 4.

It has always been Haefely's policy to build instruments that have a long service life and can be easily adapted to meet any future standards changes. This policy is designed to secure the investment in test instrumentation made by our customers. The recent changes to the IEC standard have been under discussion in the responsible IEC technical committee working group for approximately 15 years. Haefely's participation in this working group has allowed us to anticipate these changes by more than a decade and incorporate the appropriate features and specifications into the last 3 generations of our EFT test equipment.

Generators, accessories and upgrade kits are available from Haefely for testing according to Edition 2. Please feel free to contact us to discuss your specific needs.

## Ordering Information

Article No.	Short description
249601	PEFT 4010 EFT generator (firmware version 1.40 or later)
249180	PEFT 8010 EFT generator
249995	EFT VERIFICATION SET (PAT 50A and PAT 1000, coaxial cable, user manual)
249603	Single phase verification adapter (Schuko to SHV) for PEFT 4010
249528	UPGRADE KIT PEFT 4010 (single phase verification adapter, firmware upgrade, application note)
249527	UPGRADE KIT PEFT.1 and PEFT JUNIOR (single phase verification adapter, application note)
249130	IP4A capacitive coupling clamp
249017	FP-EFT 32M manually operated three phase CDN, 690/400V, 32A
249010	VERIFICATION ADAPTER (Banana to SHV) for FP-EFT 32M
249586	FP-EFT 100M manually operated three phase CDN, 690/400V, 100A
249011	VERIFICATION ADAPTER (Banana to SHV) for FP-EFT 100M
249970	WinFEAT&R control and reporting software

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