4.13 **rise time**: The interval of time between the instants at which the instantaneous value of a pulse first reaches 10 % value and then the 90 % value. [IEV 161-02-05, modified]

4.14 **burst**: A sequence of a limited number of distinct pulses or an oscillation of limited duration. [IEV 161-02-07]

## 5 Test levels

The preferential range of test levels for the electrical fast transient test, applicable to power supply, protective earth (PE), signal and control ports of the equipment is given in table 1.

**Table 1 – Test levels**

| Open-circuit output test voltage (±10 %) and repetition rate of the impulses (±20 %) | | | | |
|---|---|---|---|---|
| Level | On power supply port, PE | | On I/O (Input/Output) signal, data and control ports | |
| | Voltage peak kV | Repetition rate kHz | Voltage peak kV | Repetition rate kHz |
| 1 | 0,5 | 5 | 0,25 | 5 |
| 2 | 1 | 5 | 0,5 | 5 |
| 3 | 2 | 5 | 1 | 5 |
| 4 | 4 | 2,5 | 2 | 5 |
| x[1)] | Special | Special | Special | Special |

[1)] "x" is an open level. The level has to be specified in the dedicated equipment specification.

These open-circuit output voltages will be displayed on the EFT/B generator. For selection of levels, see annex A.

## 6 Test equipment

### 6.1 *Test generator*

The simplified circuit diagram of the generator is given in figure 1.

The major elements of the test generator are:

- high-voltage source;
- charging resistor;
- energy storage capacitor;
- spark gap;
- impulse duration shaping resistor;
- impedance matching resistor;
- d.c. blocking capacitor.

6.1.1 *Characteristics and performance of the fast transient/burst generator*

- Open circuit output voltage range (voltage at the terminals of the energy storage capacitor): 0,25 kV –10 % to 4 kV +10 %

The generator shall be capable of operating under short-circuit conditions.

*Characteristics for operation into 50 Ω load conditions:*

| | |
|---|---|
| – maximum energy: | 4 mJ/pulse at 2 kV into 50 Ω load |
| – polarity: | positive/negative |
| – output type: | coaxial |
| – dynamic source impedance (see note) | 50 Ω ± 20 % between 1 MHz and 100 MHz |
| – D.C.-blocking capacitor inside the generator: | 10 nF |
| – repetition frequency of the impulses: | function of the selected test level (see 6.1.2) |
| – rise time of one pulse: | 5 ns ± 30 % (see 6.1.2 and figure 3) |
| – impulse duration (50 % value): | 50 ns ± 30 % (see 6.1.2 and figure 3) |
| – waveshape of the pulse output into 50 Ω load: | see 6.1.2 and figure 3 |
| – relation to power supply: | asynchronous |
| – burst duration: | 15 ms ± 20 % (see 6.1.2 and figure 2) |
| – burst period: | 300 ms ± 20 % (see 6.1.2 and figure 2) |

NOTE – The source impedance may be verified by the measurement of the peak values of the output impulse at no load and 50 Ω load conditions respectively (ratio 2:1).

6.1.2 *Verification of the characteristics of the fast transient/burst generator*

In order to make it possible to compare the test results from different test generators, the test generator characteristics shall be verified. For this purpose the following procedure is necessary. The test generator output is to be connected to an oscilloscope through a 50 Ω coaxial attenuator. The bandwidth of the measuring equipment shall be at least 400 MHz. The rise time, impulse duration and repetition rate of the impulses within one burst shall be monitored.

*Characteristics to be verified with a 50 Ω termination of the EFT/B generator (see figure 3):*

- Rise time of the pulses: 5 ns ± 30 %
- Impulse duration (50 % value): 50 ns ± 30 %

Repetition rate of the impulses and peak values of the output voltage:

5 kHz ± 20 % at 0,125 kV;
5 kHz ± 20 % at 0,25 kV;
5 kHz ± 20 % at 0,5 kV;
5 kHz ± 20 % at 1,0 kV;
2,5 kHz ± 20 % at 2,0 kV.

6.2 *Coupling/decoupling network for a.c./d.c. mains supply port*

This network provides the ability to apply the test voltage in a non-symmetrical condition to the power supply port of the EUT.

The circuit diagram (example for a three-phase power mains supply) is given in figure 4.

*Characteristics*

- frequency range: 1 MHz to 100 MHz;
- coupling capacitors: 33 nF;
- coupling attenuation: < 2 dB;
- decoupling attenuation in non-symmetrical condition: > 20 dB
- cross-talk attenuation in the network between each line to the other: > 30 dB;
- insulation withstand capability of the coupling capacitors: 5 kV (test-pulse: 1,2/50 µs).

6.3 *Capacitive coupling clamp*

The clamp provides the ability of coupling the fast transients/bursts to the circuit under test without any galvanic connection to the terminals of the EUT's ports, shielding of the cables or any other part of the EUT.

The coupling capacitance of the clamp depends on the diameter, material of the cables, and shielding (if any).

The device is composed of a clamp unit (made of galvanized steel, brass, copper or aluminium) for housing the cables (flat or round) of the circuits under test and shall be placed on a ground plane of minimum area of 1 $m^2$. The reference ground plane shall extend beyond the clamp by a least 0,1 m on all sides.

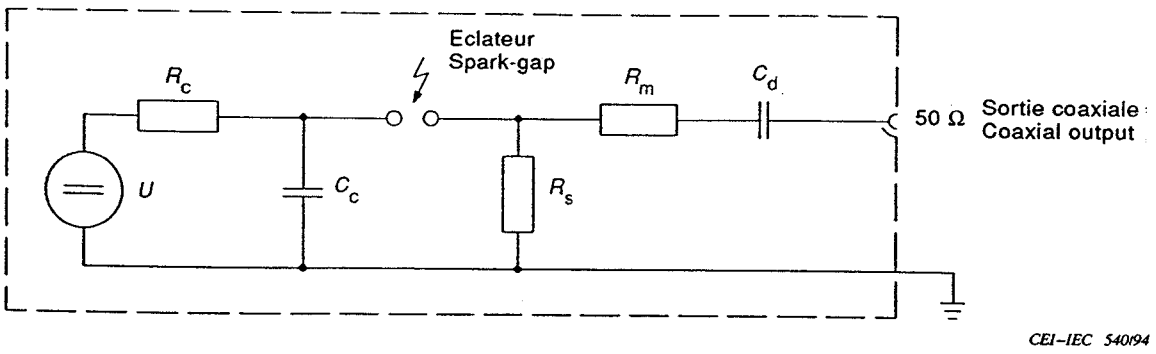
The line shall be provided at both ends with a high-voltage coaxial connector for the connection of the test generator at either end. The generator shall be connected to that end of the clamp which is nearest to the EUT.

The clamp itself shall be closed as much as possible to provide maximum coupling capacitance between the cable and the clamp.

The recommended mechanical arrangement of the coupling clamp is given in figure 5 and determines its characteristics, such as frequency response, impedance, etc.

*Characteristics*

- typical coupling capacitance between cable and clamp: 50 pF to 200 pF;
- usable diameter range of round cables: 4 mm to 40 mm;
- insulation withstand capability: 5 kV (test-pulse: 1,2/50 µs).




$U$ = source à haute tension
$R_c$ = résistance de charge
$C_c$ = condensateur de stockage d'énergie
$R_s$ = résistance de dimensionnement de la durée de l'impulsion
$R_m$ = résistance d'adaptation d'impédance
$C_d$ = condensateur de blocage du courant continu

$U$ = high-voltage source
$R_c$ = charging resistor
$C_c$ = energy storage capacitor
$R_s$ = pulse duration shaping resistor
$R_m$ = impedance matching resistor
$C_d$ = d.c. blocking capacitor

**Figure 1 – Schéma simplifié d'un générateur de transitoires rapides en salves**
**Simplified circuit diagram of a fast transient/burst generator**

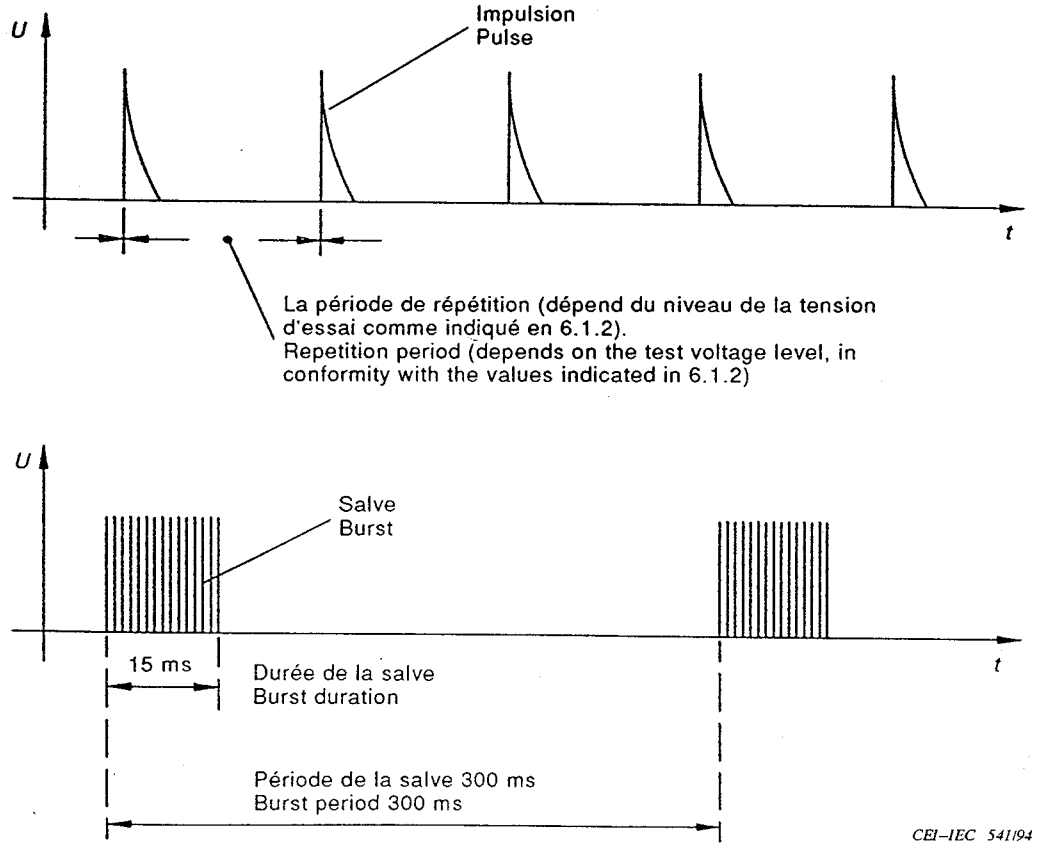



**Figure 2 – Allure générale d'un transitoire rapide en salve**
**General graph of a fast transient/burst**

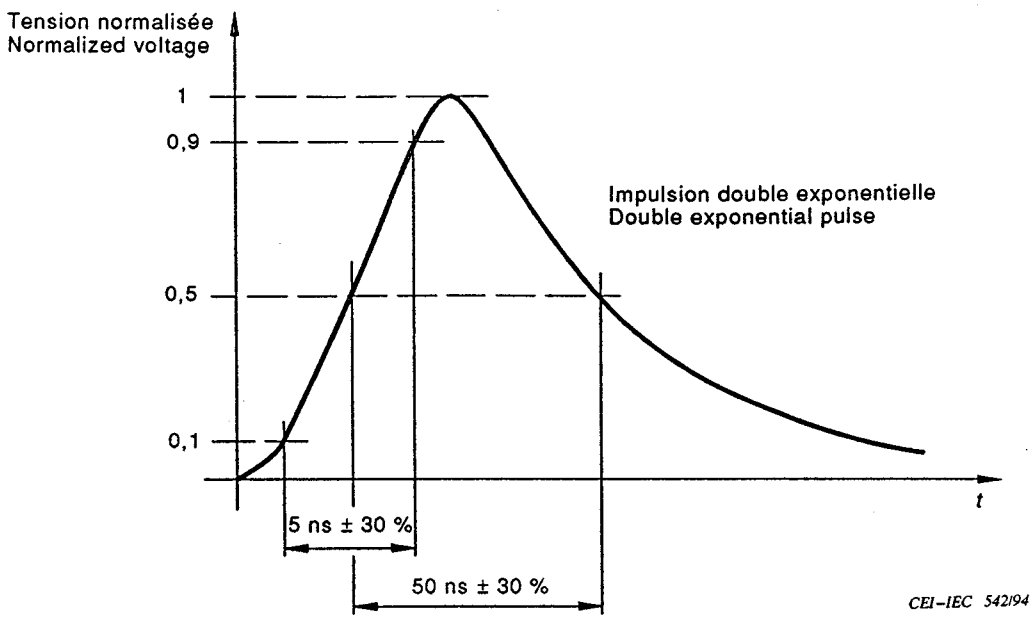



**Figure 3 – Forme d'onde d'une impulsion unique sur une charge de 50 Ω**
**Waveshape of a single pulse into a 50 Ω load**