

**GigaDevice Semiconductor Inc.**

**IEC61000-4-4 System-Level EFT Test**

**Application Notes**

**AN128**

Revision 1.0

(Jul. 2023)

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## 1. Transient pulse interference in a circuit system

The operation of circuit system needs to consider the influence of electromagnetic interference on the system. Transient pulse interference is a common type of electromagnetic interference. Usually the circuit system will be affected by the transient pulse of the power system as well as the system itself. In the power system, the substation is the place where the electromagnetic environment is relatively harsh, and a large part of the primary and secondary equipment is concentrated in the substation. The switching on and off operation of relays, circuit breakers and high-voltage isolation switches will produce rapid interference pulses. These disturbances will exist in the power grid and cause interference to the electronic and electrical equipment connected to the power grid. Secondly, there are interference pulses in electronic and electrical equipment, such as cutting off the inductive load, the bouncing of relay contacts and other device working state transient switching process will produce transient pulse interference. The transient pulse interference of electronic and electrical equipment may lead to the reset of the control module in the system and the start and stop of the high-power load, affecting the normal work of the whole control system. Therefore, it is necessary to evaluate the anti-jamming ability of electronic and electrical equipment to withstand transient pulse in order to design a system that meets the application requirements. IEC61000-4-4 is the international unified electrical fast pulse group immunity evaluation standard. The standard provides the standard test method, the voltage of the electrical fast pulse group, pulse waveform details and the grade evaluation method of the immunity, etc., for the design and test personnel to provide a unified measurement standard.

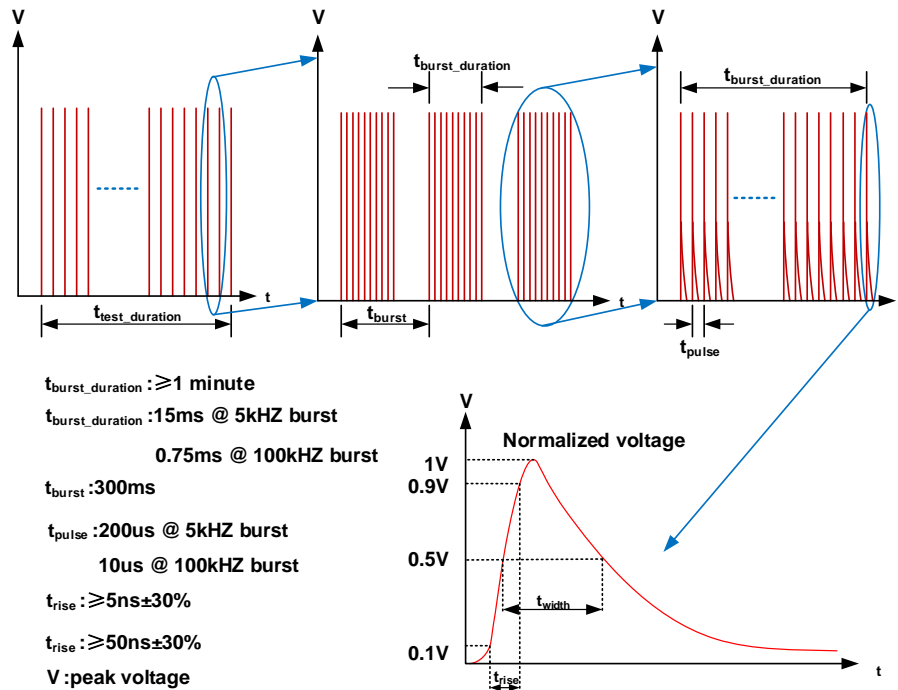
## 2. Overview of IEC61000-4-4

The Electrical Fast Transient Pulse Group (EFT) immunity test provided in IEC61000-4-4 can be used to evaluate the immunity of the supply power port, signal&control port and ground port of an electrical or electronic device when subjected to electrical fast transient pulse group interference. The test process needs to be configured in accordance with different ports of the test environment, the power port and the ground port need to directly coupling the interference to the power supply and ground path of the device under test to test the immunity of system to the inference from the power supply. The signal and control ports coupling the interference to the signal and control connection lines by means of capacitive coupling clamp to test the system's immunity to the interference of the signal and control connection lines. In addition, the interference of different port coupling of electronic and electrical equipment is not independent of each other. EFT in the system circuit has two transmission paths, including conduction interference and radiation interference. In the process of transmission, common mode interference may become differential mode interference after transmission through the circuit, and part of the energy of common mode interference will be manifested as space radiation interference.

### 2.1. Electric fast Transient pulse Group (EFT)

The EFT pulse group applied to the tested equipment in the test is generated by the EFT generator. The manufacturer of the EFT generator has designed and manufactured according to the standard to output the EFT pulse group in line with the specification. It should be noted that the equipment in the test needs to be calibrated regularly to make the test results acceptable. As shown in [Figure 2-1. EFT pulse waveform parameters](#), the main feature of the EFT pulse group is that 75 identical pulses will be output at a fixed interval, with a frequency of 5kHz & 100kHz. The pulse intervals in the 5kHz & 100kHz EFT pulse group are different, and the waveform of each pulse must meet the definition in the standard. The amplitude of the electric rapid pulse rises from 10% to 90% of the rise time is 5ns, and the pulse duration is 50ns.

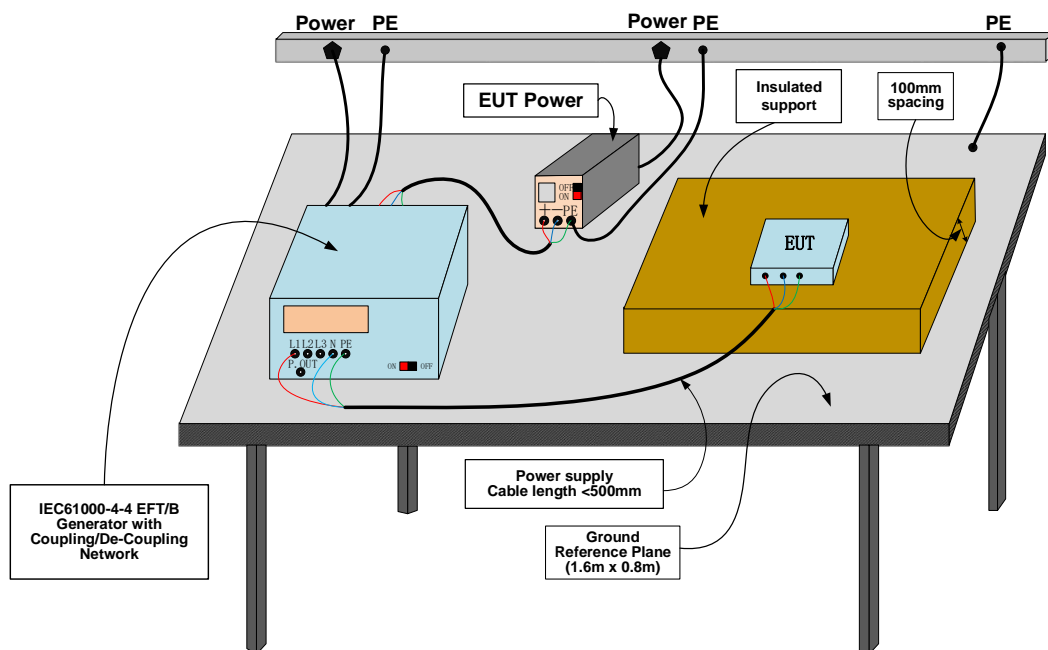
Figure 2-1. EFT pulse waveform parameters



## 2.2. Power port test

During the EFT experiment on the power port, the coupling and decoupling network that interferes with the power port is included in the EFT generator. The interference is coupled to the test power supply through the coupling network and connected to the power cable with the coupling interference to the test device through the output of the EFT generator. The test device needs to be placed on an insulated base with a thickness of  $(0.1\text{m} \pm 0.01\text{m})$ , which is placed on the reference plane of the test stand. The ground plane should extend at least 0.1m beyond the four sides of the test equipment. The parameters that can be set in EFT generator include test class, pulse polarity, coupling mode, pulse group length, pulse frequency, pulse phase, pulse group period and test time. As shown in [Figure 2-2. EFT experiment of power port](#), the test can be carried out after the establishment of test platform and parameter setting.

Figure 2-2. EFT experiment of power port

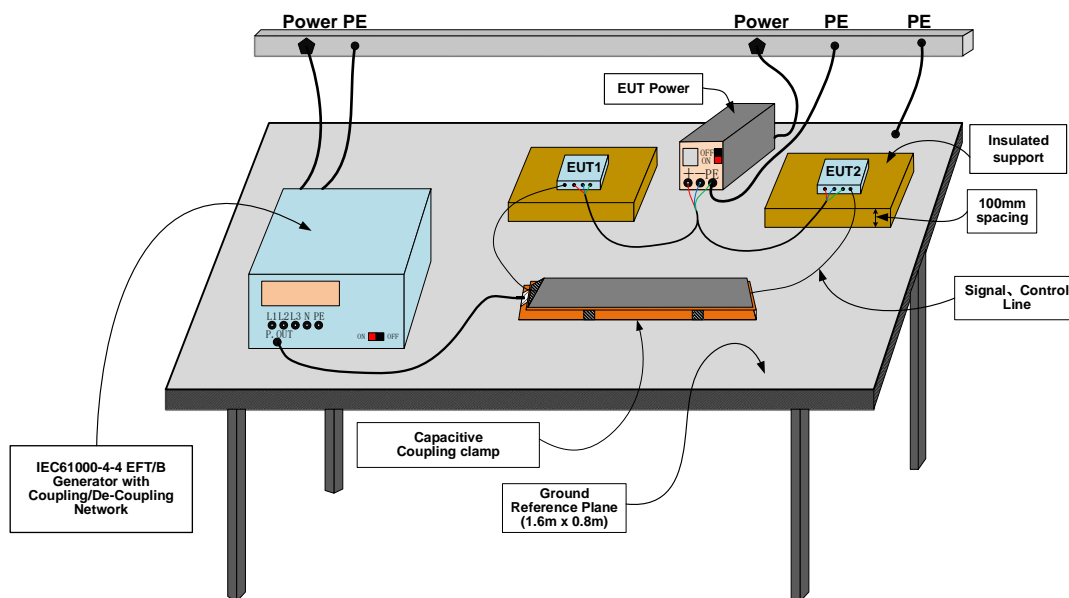


### 2.3. Test of signal&control ports

The EFT of the signal&control ports is tested by coupling interference to the port connector of the EUT via capacitive coupling clamp. The capacitive coupling clamp is placed on the ground reference board with the perimeter of the ground reference board at least 0.1m beyond the coupling clamp. The coupling clamp has a high voltage copper shaft interface at both ends. The interface near the generator is selected to be connected to the pulse output port of the EFT generator through the coaxial line. The EUT is placed on an insulated base of  $(0.1\text{m} \pm 0.01\text{m})$  thickness, which is placed on the reference plane of the test stand. The ground plane should extend at least 0.1m above the perimeter of the EUT. The cable to be tested should be put into the coupling clamp, and the coupling clamp should be pressed as tightly as possible to increase the coupling effect between the cable and the coupling clamp. The size of the coupling capacitance is related to the material and diameter of the tested cable. The parameters that can be set in EFT generator include test grade, pulse polarity, coupling mode, pulse group length, pulse frequency, pulse phase, pulse group period and test time. As shown in the EFT experiment of signal&control port in [Figure 2-3. EFT experiment of signal&control port](#), the test can be carried out after the establishment of the test platform and the setting of parameters.



Figure 2-3. EFT experiment of signal&control port



## 2.4. Evaluation of immunity level

In the test process, the test grade is selected according to the standard, as shown in [Table 2-1. EFT test grade](#). For some special application requirements, the test voltage value other than the given value can be selected to pulse the group frequency.

Table 2-1. EFT test grade

Open output test voltage and pulse repetition rate				
Level	Power ports and ground ports		Signal ports and control ports	
	Peak voltage kV	Repetition rate kHz	Peak voltage kV	Repetition rate kHz
1	0.5	5 or 100	0.25	5 or 100
2	1	5 or 100	0.5	5 or 100
3	2	5 or 100	1	5 or 100
4	4	5 or 100	2	5 or 100
X	specific	specific	specific	specific

A repetition frequency of 5kHz is traditionally used; However, 100kHz is closer to the reality.

For some products, there is no clear distinction between the power port and the signal port, in which case it is up to the Product Standardization Technical Committee to determine how to proceed according to the purpose of the test.

The "X" may be any grade and this level should be specified in the technical specification for professional equipment.

At the end of the test, the EUT shall be recorded separately according to its operating conditions and functional requirements. The results of the test shall classify the EUT's functional loss or performance degradation relative to the functional or performance level defined by the EUT. The evaluation criteria specified in the standards are shown in [Table 2-2](#).

[Failure mode levels of IEC62132-1 of MCU.](#)

**Table 2-2. Failure mode levels of IEC62132-1 of MCU**

Level	Describe
A	Unaffected: EFT interference did not have any effect on the chip before and after injection of the pulse.
B	Automatic recovery: During the pulse injection process, the chip operation becomes abnormal, but after the end of the pulse injection, the chip can return to the original normal stat.
C	Manual recovery: In the process of pulse injection, the chip operation becomes abnormal. After the end of pulse injection, the chip cannot automatically return to the original normal state, but after manual intervention (reset), the chip will return to the original normal state.
D	Re-power on: The chip will not function properly after pulse injection and injection (reset does not work) and will only return to normal state after re-power on the chip, usually due to the latch-up phenomenon.
E	Hard failure: EFT pulse injection has caused physical damage to the chip.

### 3. Revision History

Table 3-1. Revision history

Revision No.	Description	Date
1.0	Initial release	Jul.1, 2023

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