IEC 61000-4-24

Edition 2.0 2023-08

INTERNATIONAL STANDARD

colour inside

AMENDMENT 1

Electromagnetic compatibility (EMC) –
Part 4-24: Testing and measurement techniques – Test methods for protective devices for HEMP conducted disturbance

IEC 61000-4-24:2015-11/AMD1:2023-08(en)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC 61000-4-24

Edition 2.0 2023-08

INTERNATIONAL STANDARD

colour inside

AMENDMENT 1

Electromagnetic compatibility (EMC) –
Part 4-24: Testing and measurement techniques – Test methods for protective devices for HEMP conducted disturbance

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.100.01 ISBN 978-2-8322-7395-1

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-24: Testing and measurement techniques – Test methods for protective devices for HEMP conducted disturbance

AMENDMENT 1

FOREWORD

Amendment 1 to IEC 61000-4-24:2015 has been prepared by subcommittee 77C: High power transient phenomena, of IEC technical committee 77: Electromagnetic compatibility.

The text of this Amendment is based on the following documents:

Draft	Report on voting
77C/330/FDIS	77C/331/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Amendment is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications/.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

2 Normative references

Replace the reference with the following new reference:

IEC 61000-2-10:2021, *Electromagnetic compatibility (EMC) – Part 2-10: Environment – Description of HEMP environment – Conducted disturbance*

3 Terms, definitions and abbreviated terms

Replace the definition of 3.1.2 with the following new definition:

3.1.2
gas discharge tube
GDT
device with two or three metal electrodes hermetically sealed so that gas mixture and pressure are under control and designed to protect apparatus or personnel from high transient voltages

Add, after Clause 5, the following new Clause 6:

6 Measurement method of HEMP protectors for RF antenna ports

6.1 General

For the early-time HEMP, the high-amplitude electric field couples efficiently to antennas which are used within the frequency spectrum of HEMP. The HEMP coupling into the antenna is called front-door coupling. The antenna coupling mechanism is extremely variable and dependent on the details of the antenna design. The near worst-case peak response of a vertical electric monopole to the HEMP early-time waveform is considered for the test level for RF antenna ports. The waveforms for the conducted environments at antenna ports are damped sinusoids with a frequency approximately equal to the designed dominant response frequency f_c of the antenna.

6.2 Test level and injection waveform specification

Table 7 – Pulsed current injection test level for RF antenna ports

Type of Injection	**Dominant response frequency** f_c, MHz	**Peak current injection [a] test level**, A	**Injection waveform**	**Rise time** ns	**FWHM** ns
Inner conductor to outer shield	≤ 30	1 200	[b] Double exponential	Refer to Table 1	Refer to Table 1
	[c] 30 < f_c ≤ 1 000	36 000/f_c, in MHz	Damped sinusoidal	3 ± 2	30 ± 20

[a] The test level in the current is measured with the condition of short-circuit of the output of the generator.

[b] Double exponential waveform of conducted early-time HEMP shown in Table 1.

[c] Above 1 GHz, the HEMP requirement is under consideration.

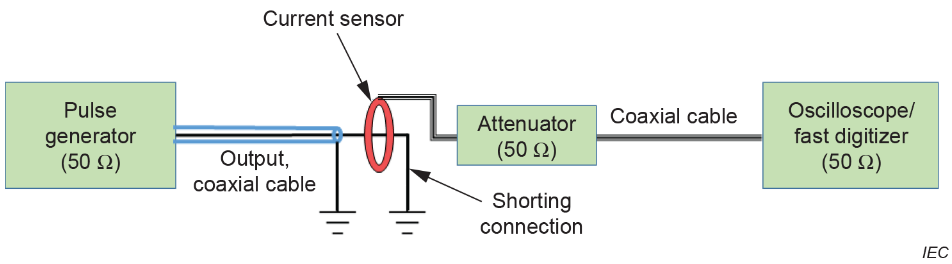
The early-time HEMP double exponential waveform shall be used for antenna port testing at a dominant response frequency ≤ 30 MHz. The double exponential generator is used because most of the energy content of early time HEMP is below 30 MHz. The double exponential generator specified in Table 1 is needed to reach the peak test level.

A damped sinusoidal waveform shall be used for antenna port testing when its dominant response frequency is 30 MHz ≤ f ≤ 1 000 MHz. A recommended waveform is provided in IEC 61000-2-10:2021, Annex E. If the required current injection level exceeds the damped sinusoidal pulse generator capability, an early-time HEMP double exponential waveform shall be used.

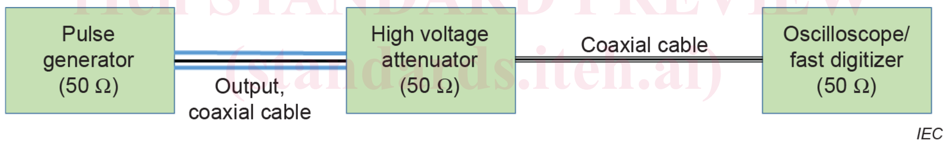
If the output voltage of a damped sinusoidal pulse generator is measured instead of short-circuit current, the test level voltage shall be determined by multiplying the required current test level, specified in Table 7, with the antenna load impedance (usually 50 Ω).

6.3 Verification of test level

The configuration for test level verification is shown in Figure 9.



(a) Configuration of verification for short-circuit current test level



(b) Configuration of verification for test level in voltage

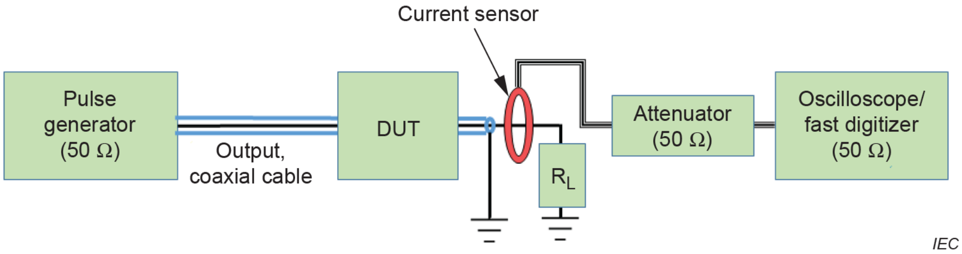
Figure 9 – Typical verification setup

Parasitic coupling between the pulse generator and the oscilloscope shall be avoided. It is recommended to use cables with multiple braided wire shields or solid shields. The cable and connectors shall be capable of withstanding the high voltage pulse without a breakdown. The shorting connection shall be as short as possible.

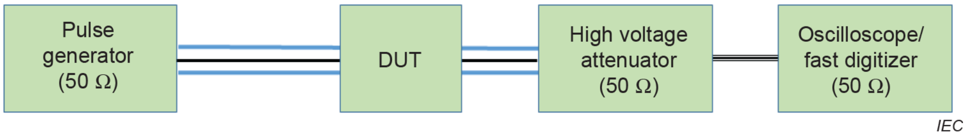
Perform the verification of the test level with 10 %, 25 %, 50 % and 100 % of the maximum test current and record the verified levels, the charging voltage and settings of the pulse generator required to achieve these test levels.

6.4 Measurement procedure

The measurement setup is shown in Figure 10.



(a) Setup for current measurement at DUT output with a 50 Ω resistive load (R_L)



(b) Setup for voltage measurement at DUT output

Figure 10 – Typical measurement setup

The measurement procedures shall be as follows:

a) Set up the DUT and measurement instruments as shown in Figure 10.

b) Inject a pulse three times into the DUT with the generator charging voltages verified in 6.3.

c) Record the measurement results of the DUT output waveform. Either the current waveform or voltage waveform shall be measured.

d) Compare the results to the performance criteria (see 6.5).

6.5 Evaluation of test results

The pass/fail results shall be classified in terms of the peak current or voltage at the output of a HEMP protector for an RF antenna. The required performance criteria are given in Table 8 for the early-time HEMP test.

Table 8 – Performance criteria of filters against early-time HEMP – RF antenna ports

RF antenna port mode	Peak residual norms	
	I_{Load}, A	U_{Load}, V
For receive only systems	< 0,5	$I_{Load} \times R_L$

The test shall be performed to ensure that the DUT is not damaged during the test. This shall be checked by ensuring that the DUT operates normally after the test.

In general, the manufacturer of the DUT shall specify the peak residual voltage and the residual energy into the nominal load. These values have to be compared with the immunity levels of the device to be protected (receiver, transmitter, antenna matching unit etc). Refer to Annex C.

6.6 Test report

For each step in the testing sequence, the following parameters should be included in the test report:

a) waveform, peak current and source impedance of verified pulses;

b) test mode;

c) test load resistance;

d) peak current or voltage of residual pulses;

e) measured waveforms of residual pulses;

f) comparison of results with immunity levels of equipment to be protected;

g) performance of additional tests with equipment to be protected as a load to verify proper protection.

Add the following new Annex C:

Annex C
(informative)

Residual measurements for antenna port protectors

C.1 Evaluating the required protection for RF antenna ports

When evaluating the effectiveness of conducted HEMP protection for any type of point of entry or point of egress (POE) it is typically the case that some type of residual current or voltage is measured. This is done quite effectively for conducted signal or power lines, which can use an electric surge arrestor (ESA) filter combination to reduce the residual currents or voltages into the device being protected. It is natural then to specify a similar method for evaluating the performance criteria of a HEMP protector for RF antenna ports against early-time HEMP. But there are a number of difficulties with this approach on RF antenna ports. This is especially the case for HF antennas where the early-time HEMP is in-band of both a transmitter and receiver RF port.

Most modern day HF antenna ports connect to equipment that uses the antenna as both a receiving antenna and a transmitter antenna.

This transmit/receive equipment is typically referred to as a transceiver and it is widely used in commercial and military applications.

Thus, the equipment antenna port has two functions; it serves as a receiver port and a transmitter port as shown in Figure C.1.

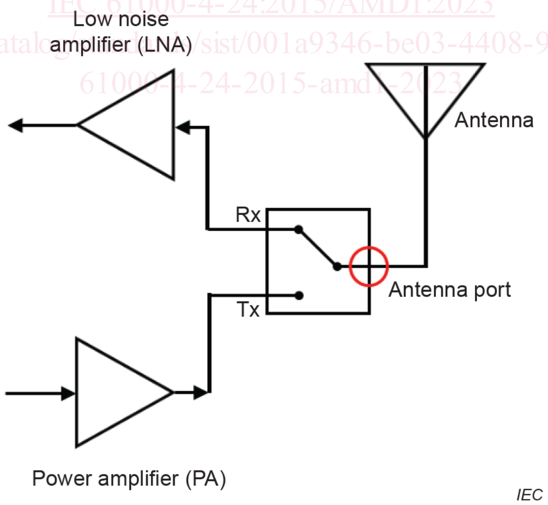


Figure C.1 – Transceiver with antenna port shown

While it can be fairly straightforward to select a protector with particular residuals for the transmitter side, on the receive mode the same protector could not work at protecting the receiver front end of the equipment.

The reason for this is that on transmit, much higher levels of current and voltage are present on the RF port than on the receive mode. Thus a protector external to the equipment's RF port for a transceiver would not protect the equipment when on receive mode operation.