



EN61000-4-11 AN-144



BACKGROUND

IEC 61000-4-11 is an EMC test standard titled 'Testing and measuring techniques – Voltage dips, short interruptions and voltage variations immunity tests'. It defines the setup, equipment requirements, and other conditions for testing systems to changes in the AC mains voltage. It is frequently used to show compliance.

DESCRIPTION OF TEST STANDARD

The standard describes three different tests:

1. **Voltage dips** are defined as sudden reduction in voltage to lower voltages for a short period of time, followed by recovery to the original voltage.
2. **Short interruptions** are defined as a disappearance of AC voltage for a short period of time, typically not exceeding 1 minute, followed by recovery to the original voltage. Short interruptions can be considered as voltage dips to zero volts.
3. **Voltage variations** are gradual changes of the supply voltage to a higher or lower value than the rated voltage. The duration can be short or long.

The standard also describes how the test results should be listed. Results of immunity tests are classified into four categories:

Performance Criteria A – 'Performance within specification limits'

- Performance Criteria B – 'Temporary degradation which is self-recoverable'
- Performance Criteria C – 'Temporary degradation which requires operator intervention'
- Performance Criteria D – 'Loss of function which is not recoverable'

Describing test results by performance criteria gives a clear idea of how the equipment responded. Criteria A ('Performance within specification limits') is clearer than 'Display flashed'. In addition, while no manufacturer would manufacture products only meeting Criteria D ('Loss of function'), this emphasizes that the test standard is focused on recording the results of the test, regardless of the result.

It's important to note that the test standard does not tell you the minimum performance criteria required for the product, what test level to use, or the duration of the test voltage. In fact, it allows you to document tests performed at levels & time durations not listed. This allows the standard to be used for future conditions not envisioned when it was written.

So if this test standard doesn't tell you what test levels to use, or the minimum performance criteria for compliance, where is that information listed? The system EMC standard.



SYSTEM EMC STANDARDS

System EMC standards pull together many different immunity and emission test standards and list the necessary test levels & criteria that must be met for that type of system.

Some system standards are referred to as 'Product Family' standards, and cover a wide range of systems. Examples are:

- IEC 60601-1-2: 'EMC For Medical Devices'
- CISPR 24: 'Immunity for ITE equipment'
- IEC 61326: 'Electrical equipment for measurement, control and laboratory use'

Some specialized systems require additional testing, different test parameters, or different performance criteria. These details are covered in 'Product Specific' standards. Examples are:

- IEC 60601-2-24: 'Particular requirements for the safety of infusion pumps'
- IEC 60601-2-12: 'Particular requirements for the safety of lung ventilators'
- IEC 61326-2-1: 'Test & operational conditions and performance criteria for sensitive test and measurement equipment'

For systems that do not have a product family or product-specific standard, there are generic system EMC standards, such as:

- IEC 61000-6-1, 'Immunity For Residential, Commercial and Light-Industrial Environments'
- IEC 61000-6-2, 'Immunity For Industrial Environments'

The system manufacturer is responsible for determining which product standard is appropriate for their system.

THE MANUFACTURER'S KNOWLEDGE OF HIS OWN PRODUCT

The performance criteria of some product standards are by necessity vague, due to the wide range of products they cover. This is when the manufacturer's knowledge of his system requirements is needed most.

An example is IEC 60601-1-2, 'EMC for Medical Devices'. The performance criteria listed for immunity tests are: 'The equipment or system shall be able to provide the essential performance and remain safe.'

For example, one customer manufactured a product incorporating a heater. Although the power supply output voltage dipped during the test, the thermal mass of the heater kept the temperature from changing during the test. The essential performance of the system was unaffected during the voltage dip testing.

Other systems will already have a backup power source, such as a high-energy rechargeable battery, or a small coin-cell battery used to maintain system memory during AC outages. These systems may meet the requirement of meeting essential performance during the test, regardless of momentary fluctuations in power supply DC output voltage.

CONCLUSION

IEC 61000-4-11 describes many details of testing equipment response to AC voltage changes.

However, more information from other standards is needed, along with the system manufacturer's intimate knowledge of his requirements. Correct testing can result in a system that is smaller, more cost effective, and is available to the marketplace in a timely fashion.



For very low leakage currents, the meter is replaced with a network consisting of either a resistor or a resistor and capacitor combination. The voltage drop across the network is then measured using a sensitive ac voltmeter. Ungrounded or double-insulated equipment is checked by connecting the meter between any touchable conductive part and ground. In the case of nonconductive housings, a copper foil of a specific size is placed on the housing, and the current flowing from it to ground is measured.

WHAT IS A SAFE LEVEL?

For non-medical equipment, the safe levels have been determined by an international organization and documented in the IEC 950 safety standard. Most countries around the world have adopted this standard. The limits are defined in Table 1.

Equipment	Type	Max. Leakage Current
Double Insulated	All	0.25 mA
Grounded	Hand Held	0.75 mA
	Movable (other than hand-held)	3.5 mA
	Stationary (Permanently connected)	3.5 mA (Note 1)

Notes : 1. Leakage currents greater than 3.5 mA are allowed under certain conditions.

Medical equipment leakage current limits are much lower. The requirements are summarized in Table 2. Because of the lower values of allowable leakage current in medical power supplies, it is important to substantially reduce the capacitances that cause leakage currents. This poses a special design problem for the power supply and especially EMI filters. For example, line-to-ground capacitors are an important part of the EMI filter's ability to perform properly reducing their value can severely reduce the filter's effectiveness. Condor's medical designs and patented EMI filtering techniques have overcome these problems.

Medical Device Category	Type B		Type BF		Type CF	
	N.C.	S.F.C.	N.C.	S.F.C.	N.C.	S.F.C.
Earth Leakage Current, Portable	0.5 ¹	1.0	0.5 ¹	1.0	0.5 ¹	1.0
Earth Leakage Current, Fixed	2.5	5.0	2.5	5.0	2.5	5.0
Enclosure Leakage Current	0.1	0.5	0.1	0.5	0.1	0.5
Patient Leakage Current	0.1	0.5	0.1	0.5	0.01	0.05

Notes : All leakage currents are in mA
 N.C. = Normal Condition
 S.F.C. = Single Fault Condition
 (1) 0.3 mA for UL 2601-1.



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