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SERIES L: CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Test suites for assessment of the universal charger solution

Recommendation ITU-T L.1005

International Telecommunication Union

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Test suites for assessment of the universal charger solution

Summary

Recommendation ITU-T L.1005 considers the creation of specific test suites to assess certain functional aspects of the: energy efficiency, interworking, safety and electromagnetic compatibility (EMC) of the universal charger solution (UCS). Such testing is required to guarantee a minimum quality level of the UCS in conformance with the target basic configuration of the UCS and charger described in Recommendation ITU-T L.1000.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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Conformance, EMC, safety, UCS.

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Test suites for assessment of the universal charger solution

1 Scope

This Recommendation describes the general test suites applicable to the universal charger solution (UCS) defined in [ITU-T L.1000].

It establishes a test list necessary to assess the UCS with respect to the requirements described in [ITU-T L.1000].

With regard to electromagnetic compatibility (EMC) and safety aspects, additional requirements to those listed in [ITU-T L.1000] shall necessary for a product to be available for use by the general public.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

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[ITU-T K.44] Recommendation ITU-T K.44 (2012), *Resistibility tests for telecommunication equipment exposed to overvoltages and overcurrents – Basic Recommendation*.

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[IEC 61000-3-3] IEC 61000-3-3 (2013), *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current up to and including 16 A per phase and not subject to conditional connection.*

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[IEC 61000-4-3] IEC 61000-4-3 (2010), *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*.

[IEC 61000-4-4] IEC 61000-4-4 (2012), *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test.*

[IEC 61000-4-5] IEC 61000-4-5 (2005), *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*.

[IEC 61000-4-6] IEC 61000-4-6 (2013), *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*.

[IEC 61000-4-11] IEC 61000-4-11 (2004), *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*.

[IEC 62430] IEC 62430 (2009), *Environmentally conscious design for electrical and electronic products*.

[IEC 62684] IEC 62684 (2011), *Interoperability specifications of common external power supply (EPS) for use with data-enabled mobile telephones.*

[IEC CISPR 22] IEC CISPR 22 (2008): *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 charger [ITU-T L.1000]: A common term used to describe the power adapter for the mobile terminal or other hand-held ICT devices used to apply power to the battery.

3.1.2 detachable cable [ITU-T L.1000]: A detachable cable connects the power adapter to the mobile terminal or other hand-held ICT device for powering through two connectors, one on the charger side and one on the side of the mobile terminal or other hand-held ICT device.

3.1.3 power adapter [ITU-T L.1000]: The equipment that converts mains AC power voltage at the input to low DC power voltage at the output, or the equipment which transfers DC power supply, e.g., car voltage to another low voltage of DC power output.

3.1.4 universal charger solution [ITU-T L.1000]: Overall initiative that defines the charger solution for different mobile terminals and other hand-held ICT devices.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 test suite: A list of tests necessary to validate a universal charger solution.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AC Alternating Current

DC Direct Current

EMC Electromagnetic Compatibility

ESD Electrostatic Discharge

LISN Line Impedance Stabilization Network

MOU Mutual of understanding

RF Radio Frequency

UCS Universal Charger Solution

USB Universal Serial Bus

5 ITU-T L.1000 conformance testing

This part of the Recommendation defines the test to determine whether a universal charger solution (UCS) meets the conformance requirements described in [ITU-T L.1000].

The need to establish a common test suite for the UCS is derived from the necessity to establish a common modality to assess product quality and to provide a regulatory guide on which product testing could be based for market surveillance purposes.

- Table 5-1 provides a list of tests on energy efficiency that are necessary to check conformance of the UCS with requirements described in [ITU-T L.1000].
- Table 5-2 provides a list of DC tests that are necessary to check conformance of the UCS with requirements described in [ITU-T L.1000].

Table 5-1 – Test suites for energy efficiency assessment

Test #	Test type	Description	Requirement	Test reference
1.	**Energy efficiency requirement**			
1.1.	No load	No-load power consumption test	See clause B.2.1 of [ITU-T L.1000]	[EN 50563]
1.2.	Energy Efficiency	Energy efficiency conversion	See clause B.2.3 of [ITU-T L.1000]	[EN 50563]

Table 5-2 – Test suites for DC output characteristic evaluation

Test #	Test type	Description	Requirement	Test reference
2.	**DC output**			
2.1.	Voltage	DC output voltage	5.0 V ±5% – See clause B.2.3 of [ITU-T L.1000]	
2.2.	Current	DC output current	750 mA to 1500 – See clause B.2.3 of [ITU-T L.1000]	
2.3.	USB	USB interface conformance	USB Specification V2.0 [b-USB Spec] USB Battery Charging Specification V1.1 [b-USB Battery] (minimum output current of 500 mA and maximum output current of 1500 mA)	[IEC 62684]
2.4.	Common mode noise	Limitation of common mode noise on DC port	See section 5.4 of [IEC 62684]	[IEC 62684]
2.5.	Ripple	Limitation of ripple DC port	80 mV peak-to-peak measured at 20 MHz bandwidth	[IEC 62684]

6 Conformance testing for safety

This part of the Recommendation defines the test to determine whether a UCS is in conformance with safety requirements.

Table 6-1 does not provide an exhaustive list of applicable tests.

The UCS shall be designed in line with [IEC 60950-1].

Table 6-1 – Test suites for assessment of safety conformance

Test #	Test type	Description	Requirement	Test reference
3.	**Safety**			
3.1.	General	General – Safety requirement	The power adapter must be a limited power source in accordance with section 2.5 of [IEC 60950-1]	[IEC 60950-1]
3.2.	Fire resistance	Risk – Ignition reduction and fire propagation of UCS	The power adapter construction and functionality shall be in accordance with section 4.7 of [IEC 60950-1]	[IEC 60950-1]
3.3.	Fire resistance	Fire propagation of detachable cable	Plastic material V1 No fire propagation in accordance with [IEC 60332-1-1] Fire resistance: see [IEC 60331-23]	[IEC 60332-1]
3.4.	Fire resistance	Fumes – Emanation	[IEC 60754-1] (amount of halogen acid gas) and [IEC 60754-2] (acidity of gases evolved during combustion)	[IEC 60754-1] [IEC 60754-2]

7 Conformance testing for EMC

This part of the Recommendation defines the test for a UCS to be in conformance with EMC requirements.

Table 7-1 reports the DC test list necessary to check UCS conformance with EMC requirements.

Table 7-1 – EMC test suites

Test #	Test type	Description	Requirement	Test reference
4.	**Electromagnetic compatibility (EMC)**			
4.1.	Radiated emission	Radiated emission from UCS enclosure	[IEC CISPR 22] class B	[ETSI EN 301 489-34] [IEC CISPR 22]
4.2.	DC conducted emission	Conducted emission on UCS DC line	[IEC CISPR 22] class B	[ETSI EN 301 489-34] [IEC CISPR 22]
4.3.	AC conducted emission	Conducted emission on UCS AC line	[IEC CISPR 22] class B	[ETSI EN 301 489-34] [IEC CISPR 22]
4.4.	Harmonic	Limitation of harmonics current	The requirements contained in [IEC 61000-3-2/A1] relevant to harmonic current emission apply for equipment.	[IEC 61000-3-2]/A1 [ETSI EN 301 489-34]
4.5.	Voltage fluctuations and flicker	Voltage fluctuations and flicker	The requirements contained in [IEC 61000-3-3] relevant to voltage fluctuations and flicker apply.	[IEC 61000-3-3] [ETSI EN 301 489-34]
4.6.	Radiated immunity	RF electromagnetic field (80 MHz to 1 000 MHz and 1 400 MHz to 2 700 MHz)	3 V/m For some specific frequency the test level is 10 V/m, see [ETSI EN 301 489-34]	[ETSI EN 301 489-34] [IEC 61000-4-3]
4.7.	ESD	Electrostatic discharge enclosure and DC power output port	4 kV contact discharge 8 kV air discharge.	[ETSI EN 301 489-34] [IEC 61000-4-2]
4.8.	Fast transients	Fast transients common mode DC and AC power ports applicable	DC port 0.5 kV open circuit voltage AC port 1 kV open circuit voltage	[ETSI EN 301 489-34] [IEC 61000-4-4]
4.9.	Radio frequency (RF) common	RF common mode 0.15 MHz to 80 MHz DC and AC power port	Level 2 3 Vrms	[ETSI EN 301 489-34] [IEC 61000-4-6]

Table 7-1 – EMC test suites

Test #	Test type	Description	Requirement	Test reference
	mode			
4.10.	Voltage dips and interruptions	Voltage dips and interruptions AC mains power input	voltage dip: 0% residual voltage for 0.5 cycle; voltage dip: 0% residual voltage for 1 cycle; voltage dip: 70% residual voltage for 25 cycles (at 50 Hz); voltage interruption: 0% residual voltage for 250 cycles (at 50 Hz).	[ETSI EN 301 489-34] [IEC 61000-4-11]
4.11.	Surges	Surges, line-to-line and line-to-ground AC mains power input	2 kV line to ground, and 1 kV line to line	[ETSI EN 301 489-34] [IEC 61000-4-5]

8 Conformance testing for resistibility

This part of the Recommendation defines the test for a UCS to be in conformance with resistibility requirements.

Table 8-1 reports the resistibility test list necessary to check UCS conformance.

Table 8-1 – Resistibility test suites

Test #	Test type	Description	Requirement	Test reference
5.	**Electromagnetic compatibility**			
5.1.	Lightning	Inherent, transverse and port-to-earth	[ITU-T K.21] Table 5 basic test level Uc(max) = 2.5 kV R = 0 Ω	[ITU-T K.44]

Appendix I

Guidance on application of some requirement to UCS

(This appendix does not form an integral part of this Recommendation.)

This appendix reports guidance on the application of some requirement of UCS.

The text of this appendix is based on the applicable points of [b-MOU Annex III].

I.1 Clarification of voltage drop caused by the detachable cable

The requirement allows for standard USB cable assemblies to be used and is identical to the requirements of the cable assembly voltage drop specified in Table 3-1 of [b-USB Connect].

I.2 Guidance on common mode noise and switching frequency components

This part of the appendix reports guidance on the application of the requirement on common mode noise contained in section 6.2 of [IEC 62684].

These requirements are exempted as the MoU signatories have not identified a testing method giving repeatable and reproducible results across test facilities for these common mode noise requirements.

Based on the outcome of the work and the requirements of the touch screen technology used by the mobile industry, it is expected that a proposal to revise the common mode noise specification will be submitted in future.

To avoid interoperability problems with the common chargers in the market, the following assessment for common mode noise is recommended:

1) Common mode noise is assessed based on pulses longer than 250 ns and by visual inspection of the whole AC period (see clause I.7).
2) The visual inspection may be aided by applying additional filtering (see clause I.7 for details).
3) A LISN may be used as impedance stabilizer and to filter noise from the AC main voltage source.

Based on the requirements of the touch screen display technology used in mobile devices, uninterrupted function of the touch screen during charging can be expected for chargers where the above measured levels are below 2 Vpp. Chargers with levels up to 3 Vpp can cause interruption in the function of touch screen on certain manufacturer devices.

I.3 AC voltage frequency component

The requirement contained in [IEC 62684] bullet d of point 5.4 "switching frequency component" can be exempted.

I.4 Occupied bandwidth

The requirement contained in [IEC 62684] bullet e of point 5.4 "switching frequency component" can be exempted.

I.5 Maximum amount of slew

The requirement contained in [IEC 62684] bullet f of point 5.4 "switching frequency component" can be exempted.

I.6 Required reliability of receptacles and plugs contained in [IEC 62684]

Implementation of the USB Standard-A and Micro-B connectors may be subject to market availability of connectors classified as ruggedized.

I.7 Assessment of common mode noise pulses

The measurement is subdivided in different points depending on noise pulse duration. Figures I.1 and I.2 report examples of the measurement.

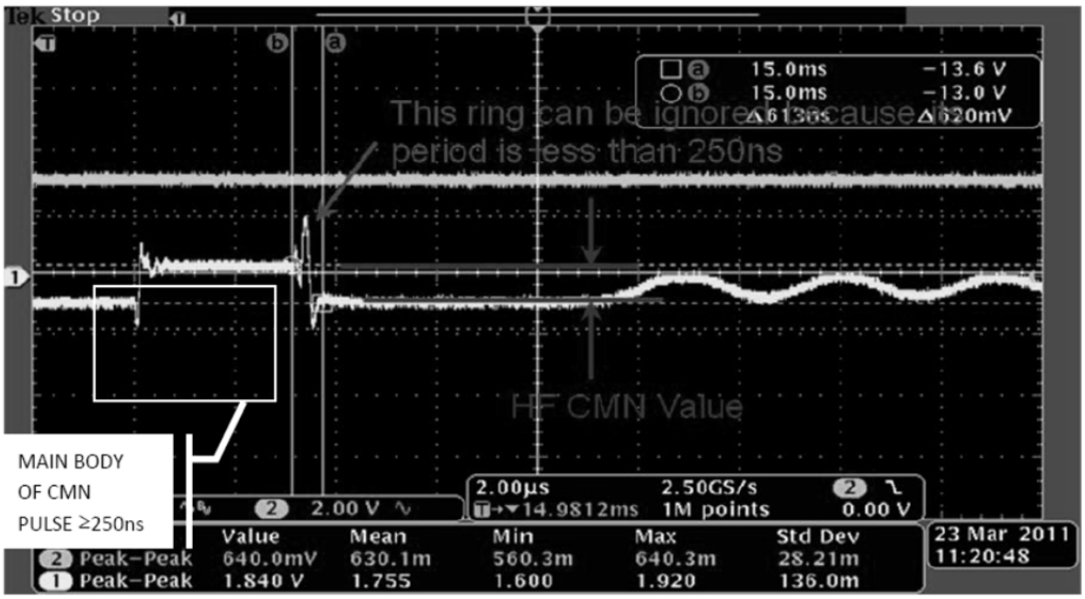

Figure I.1 – Example of noise measurement in which ringing of less than 250 ns is ignored during the common mode noise measurement

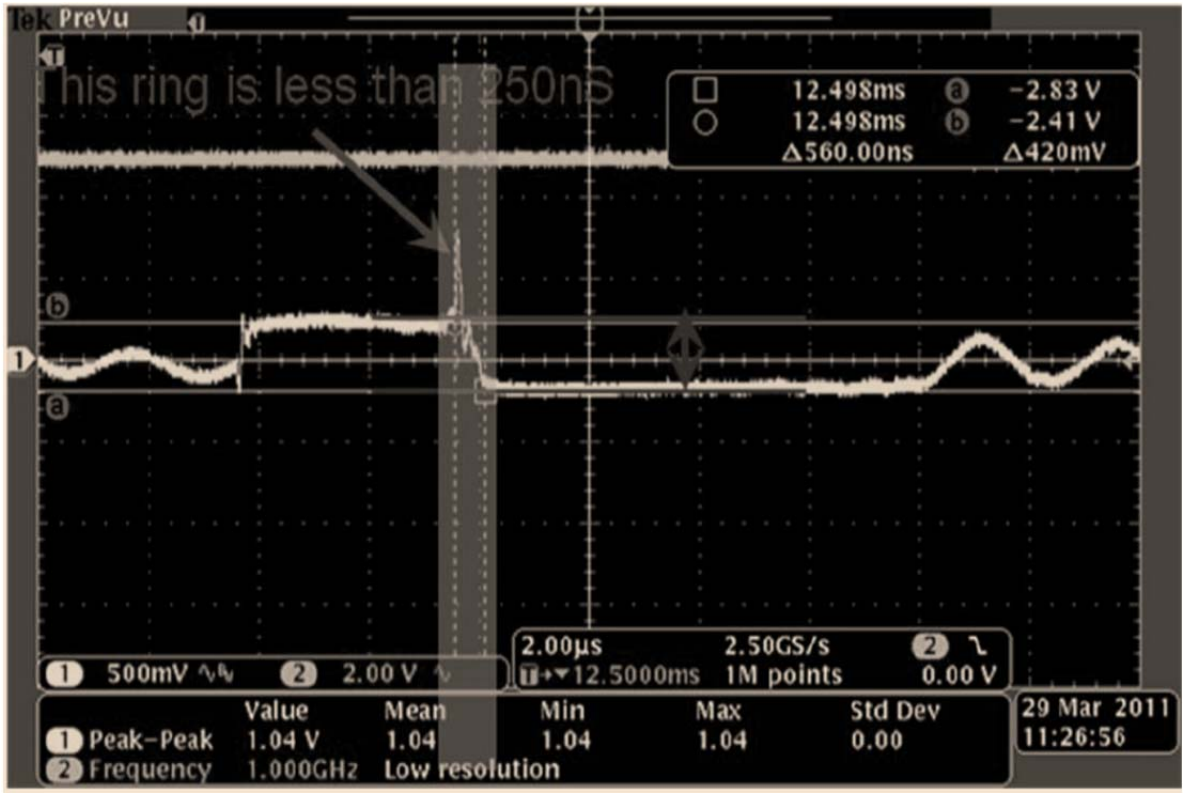

Figure I.2 – Example of noise measurement with transient

Figure I.2 reports a case in which the transient is part of the main body of the common mode noise pulse, its amplitude is disregarded in the over-all common mode noise pulse measurement since the transients width is less than 250 ns.

I.7.1 Noise pulse duration greater than 250 ms

If the main body of the common mode noise pulse or any part of its constituent noise (ring, transient over/undershoot, etc.) is greater than 250 ns, then its amplitude shall be considered, excluding any component of the waveform less than 250 ns (see Figure I.1).

I.7.2 Noise pulse duration shorter than 250 ms

If the main body of the common mode noise pulse or any part of its constituent noise is less than 250 ns, then no amplitude measurement is required.

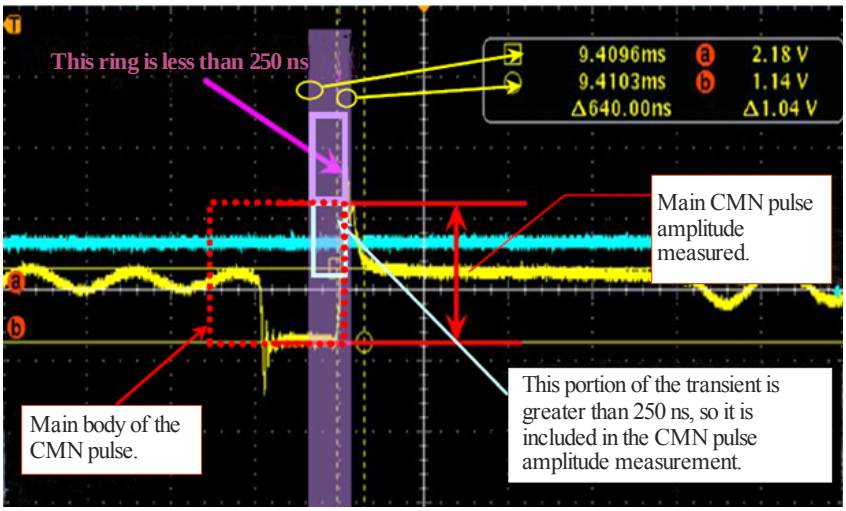

Figure I.3 – Common mode noise component

Figure I.3 dissects the waveform shown in the figure into its constituent components. The main body of the common mode noise pulse is highlighted with a dashed red line. It is this portion of the pulse that would be included in the common mode noise measurement.

Figure I.4 reports the low frequency AC noise and the common mode noise component (yellow plot). This waveform shows that the highest amplitude common mode noise pulse can be located anywhere between 0 and 360 degrees of the AC mains period.

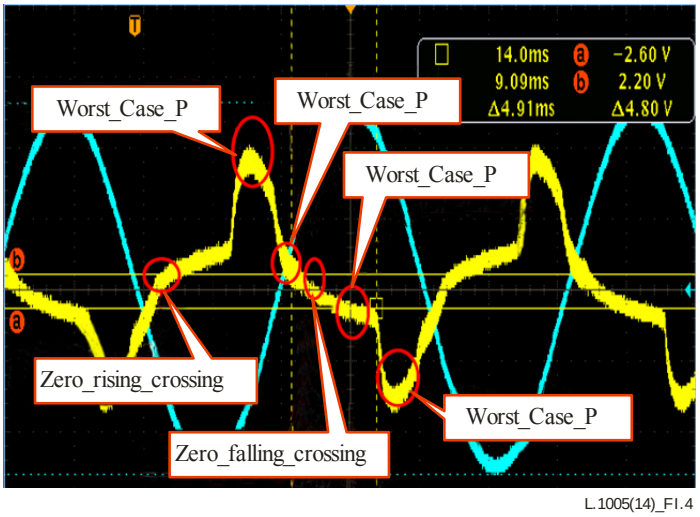

Figure I.4 – Detail of common mode noise

I.7.3 Connections of the LISN

A LISN is typically employed, *inter alia*, to measure conducted emissions from the AC input ports of electronic equipment. [b-CISPR 16-2-1] could be used for the test method for conducted emissions from the AC mains power input ports of ITU-T L.1000-compliant UCS. In turn, [b-CISPR 16-2-1] requires the use of artificial mains networks, also known as line impedance stabilization networks (LISNs), specified in [b-CISPR 16-1-2].

In this context, the LISN:

a) presents a defined impedance (typically 50 Ω), from live to earth and from neutral to earth, to the mains input port under test

b) removes incoming (high frequency) noise from the local mains environment using a low pass filter

c) provides signals for mains input port conducted emissions measurement from a high frequency output.

During the common mode measurement at the DC output of an UCS, it is recommended also to employ a [b-CISPR 16-1-2] compliant LISN (V-type). However its high frequency output is not used. The LISN simply prevents noise present on the mains network from appearing at the input of, and presents 50 Ω impedance to the charger. Because this 50 Ω resistance appears in series with the far larger 10 MΩ oscilloscope probe resistance, the LISN does not significantly reduce the measured common mode noise amplitude.

The LISN allows either the live or neutral charger input to be bonded to earth via a 50 Ω impedance, or to the terminated HF output, which normally presents a 50 Ω impedance via the measurement instrument. High frequency noise on the mains inputs is blocked by the HF filter. The unused HF output is terminated to 50 Ω. The charger input sees a 50 Hz AC voltage source having 50 Ω output impedance.

Upstream of the LISN an optional safety transformer – ideally shielded – provides extra attenuation of mains-borne high frequency noise.

The LISN causes a high current to flow in the earth connection. For safety and measurement accuracy reasons the LISN earth connection must be reliably bonded to the earth connection of the incoming mains supply.

The LISN, charger, test load and other components are arranged according to the principles of [b-CISPR 16-2-1], as amended by the requirements of section 6.2 of [IEC 62684].

[b-CISPR 16-2-1] requires a vertical and/or horizontal measurement ground reference plane measuring at least 2 m × 2 m. It is recommended to employ both of these planes, bonded together. The LISN is connected to either axis of the measurement ground reference plane, either directly to the LISN case, or with a conductor that is as short as possible. A shielded chamber is not required by [b-CISPR 16-2-1].

I.7.4 Filter details

The Guide on Implementation of Requirements of the Common EPS includes the recommendation to measure the common mode noise pulse generated by high frequency switching, whilst not considering any ring or component faster than 250 ns. The proposed method employs visual inspection and interpretation of ringing and other high frequency components.

Applying an appropriate band pass filter to the common-mode noise signal monitored by the sampling probe could be a more consistent way to select the signals of interest, and to reject these high frequency signals. For example, rejecting components faster than 250 ns might correspond to a filter having a high cut-off frequency of 4 MHz.

Such a band pass filter also allows an appropriate low cut-off frequency to be applied. An appropriate band pass filter may therefore be one having a lower cut-off frequency below the switching frequency and an upper cut-off frequency of 4 MHz. Cut-off frequencies are typically defined as those at which the output of the circuit is −3 dB of the nominal pass band value.

Such filter can be implemented equivalently in hardware, software or as a PC interfaced to the oscilloscope, offering a wide range of filter options.

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