INTERNATIONAL ELECTROTECHNICAL COMMISSION

CISPR 15

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Amendment 1 2024-07

Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment

INTERPRETATION SHEET 1

This interpretation sheet has been prepared by subcommittee CISPR F: Interference relating to household appliances, electric tools, electrical lighting equipment, and similar apparatus, of IEC technical committee CISPR: International special committee on radio interference.

The text of this interpretation sheet is based on the following documents:

DISH	Report on voting
CIS/F/926/DISH	CIS/F/932/RVDISH

Full information on the voting for the approval of this interpretation sheet can be found in the report on voting indicated in the above table.

CISPR 15 interpretation sheet on the use of the current probe on wires with high differential currents

INTRODUCTION

This document is an interpretation sheet to CISPR 15:2018 and CISPR 15:2018/AMD1:2024. It answers the question how to avoid the measurement of false common mode disturbance currents in CISPR 15 with the current probe.

This interpretation sheet is an interim solution that will not automatically be included into future CISPR 15 amendments and editions. A permanent solution will be based on a future amendment of CISPR 16-2-1.

The proposed measurement procedure is based on investigations and measurements done in Japan (JLMA), Germany (Bundesnetzagentur BNetzA) and by Manufacturers of electronic LED drivers. Based on these investigations and discussions within CISPR/F the proposal for an interpretation sheet has been created.

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CISPR 15:2018-05/AMD1:2024-07ISH1:2026-05(en)

When measuring conducted disturbances according to Clause B.3 (local wired ports), it has been observed that reproducibility of common mode disturbance measurements performed with a current probe (see B.3.5 and Table 3, Table 6 for the limits) is under special circumstances low. This low reproducibility has been observed when measuring the common mode current with a current clamp on the wires from the electronic control gear or halogen converter (EuT = Equipment under Test) to the load (LED or halogen lamp).

Various measurements have been done to find out the reason for this low reproducibility.

As a result of these measurements, it has been found that there is a significant impact on the reading at the receiver depending on the spatial position and orientation of the local wired port cable within the current probe. The measurement results are showing that the variations in the readings are large if there are high differential mode currents flowing in these wires (several amperes).

The typical LED control-gear generates a high (pulse-width-modulated) differential mode output current.

The reason for this variation in the measurement results seems to be the non-ideal behaviour of the current probe. An ideal current probe will suppress the differential mode perfectly, no matter where the two wires of the cable – carrying the differential and common mode current – are located within the current probe.

However, even according to CISPR 16-1-2:2014, 5.1.3, a current probe is allowed to have an “influence of orientation” of up to 1 dB up to 30 MHz and 2,5 dB from 30 MHz to 1 000 MHz.

A calculation has been done showing that even this “low” value of 1 dB influence by the orientation of the wire within the probe hole can cause significant change of readings in a receiver if high differential mode currents are present (see Figure 1).

Calculation of the influence of orientation in case of strong differential currents in a CISPR current								
Differential current:	1,0	A		1,0	A		0,01	A
Differential current in dBµA:	120	dBµA		120,0	dBµA		80	dBµA
Influence of orientation Value (Difference between the two conductors)	1	dB		0,01	dB		0,1	dB
Conductor 1 Current reading:	120	dBµA		120,0	dBµA		80	dBµA
Conductor 2 Current reading:	119	dBµA		120,0	dBµA		79,9	dBµA
Conductor 1 Current reading:	1,000 0	A		1,000 0	A		0,010 0	A
Conductor 2 Current reading:	0,891 3	A		0,998 8	A		0,009 9	A
Delta (Conductor 1 minus Conductor 2)	0,108 7	A		0,001 2	A		0,000 1	A
Receiver reading ("Artificial" Signal/false common mode):	**100,7**	**dBµA**		**61,2**	**dBµA**		**41,2**	**dBµA**

IEC

Table 1 – Calculation of the false common mode current in case of high differential currents

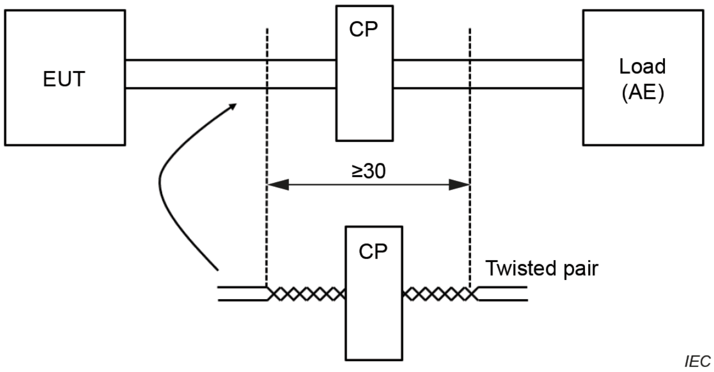
For the common mode current measured, the 1 dB influence of the orientation is not critical because the maximum change in the reading at the receiver is only 1 dB. But for the differential mode current the 1 dB will lead to significant changes in the reading. The calculations in Figure 1 are showing that even with a 0,01 dB influence of variation, which is very low compared to 1 dB, which is currently allowed by CISPR 16-1-2, a reading of 61 dBµA false common mode current at the receiver input will come up. This is much higher than the limit (Table 3 of CISPR 15:2018) of 40 dBµA at 150 kHz! Thus, a very limited differential mode rejection of the typical current probes becomes obvious. Also, one can see that a “better” current probe (e.g., having only 0,01 dB influence of orientation) would not solve the problem.

The various measurements which have been done by Japan, Germany and various manufacturers of LED drivers are showing that significant improvements can be achieved when a twisted pair cable or a coaxial cable are used as local wired port cable at the position where the load cable goes through the current probe. It is the assumption that the twisting or the coaxial current distribution through the current probe will lead to a much better suppression of the differential current, thus improving the stability of the readings performed with the current probe.

The reason to choose the twisted pair cable instead or beside of the coaxial cable in this interpretation sheet is, that the coaxial cable has an unsymmetrical behaviour in the high frequency range. As a result of the asymmetric transition between a two wire cable and a coaxial cable, the potential for a “differential to common mode conversion” is much higher when a coaxial cable segment is used.

Additionally, there is no extra benefit of using a coaxial cable compared to the twisted pair solution.

Dimensions in centimetres



CP = current probe

Figure 1 – Replacing the typical cable between EUT and load by twisted pair through the current probe

The effect of cancellation is due to a spatial averaging of the magnetic field, which is quickly reduced to small values when considering the field at a certain distance from the wires.

Clearly, a consistent number of turns shall fall within the thickness of the CP core, and the wires shall be torqued to have a small gap compared with the size of the core.

Thus, from a theoretical point of view, the twisted pair is not an ideal solution, but its effectiveness is related to the size of the conductors, their spacing and the turn density compared with the size of the CP. The advantage is of being a balanced line (symmetrical).

Figure 3 and Figure 4 are showing examples of a test set-up and of twisted cables.

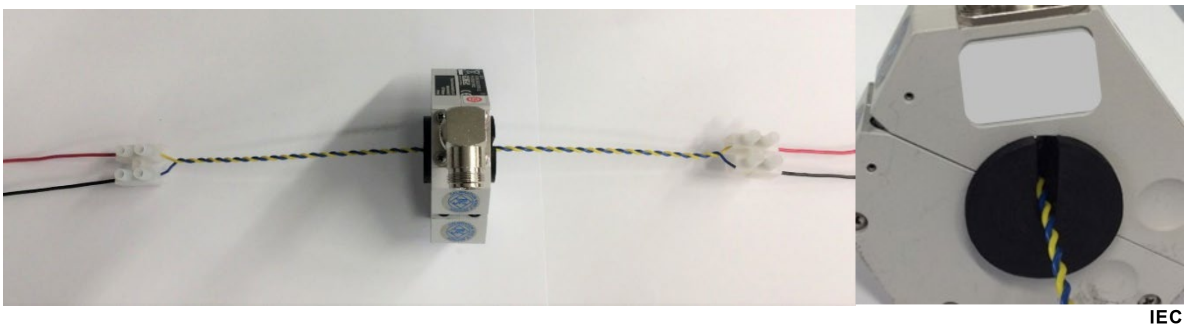


Figure 2 – Example of a measurement setup with a twisted pair

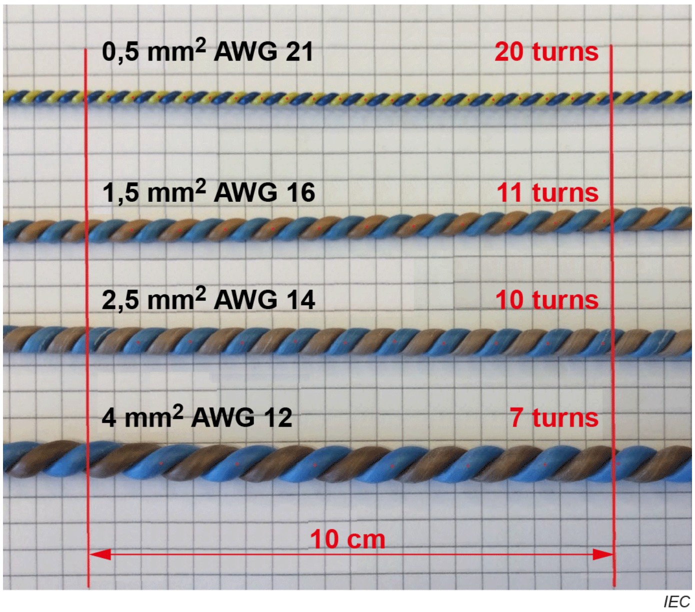


Figure 3 – Examples of twisted pair cables with different cable cross sections

END OF INTRODUCTION

Question:

How can the user of the standard avoid false common mode current indications when measuring with the current probe on wires carrying high differential currents?

Interpretation

When performing measurements with the current probe, the following procedure avoids the measurement of false common mode currents. This procedure can be seen as an explanation on how to interpret the requirements given in B.3.5 about the arrangement of measurement probes.

Before starting the measurement, the user shall verify if there is an impact on the disturbance current measured by performing the measurement on several spatial positions and orientations of the local wired port cable inside the current probe.

If the variability of the measured level of the disturbance current at any frequency with respect to the spatial position inside the current probe exceeds the combined CISPR measurement uncertainty (U_{CISPR} = 2,9 dB according to CISPR 16-4-2:2011, CISPR 16-4-2:2011/AMD1:2014 and CISPR 16-4-2:2011/AMD2:2018), the following two measures for the probe arrangement shall be applied to minimize the effect of large differential mode currents.

1) The wires in the local wired port cable carrying significant differential mode currents shall be fixed centrically in the clamp's aperture with a nonmetal fixture.
2) Additionally, the wires in the local wired port cable carrying significant differential mode currents shall be replaced for the measurement by a twisted pair cable with a length of at least 30 cm as a replacement of the existing local wired port cable.

   The twisted pair cable shall have at least or exactly the following number of twists:

Wire cross-section (w) in mm^2	**Minimum twists per 10 cm**
$w \leq 0{,}5$	20
$0{,}5 < w \leq 1{,}5$	11
$1{,}5 < w \leq 2{,}5$	10
$w > 2{,}5$	7

   The method of twisting the wires is not relevant in case of shielded cables or cable assemblies or in case of a single wire.

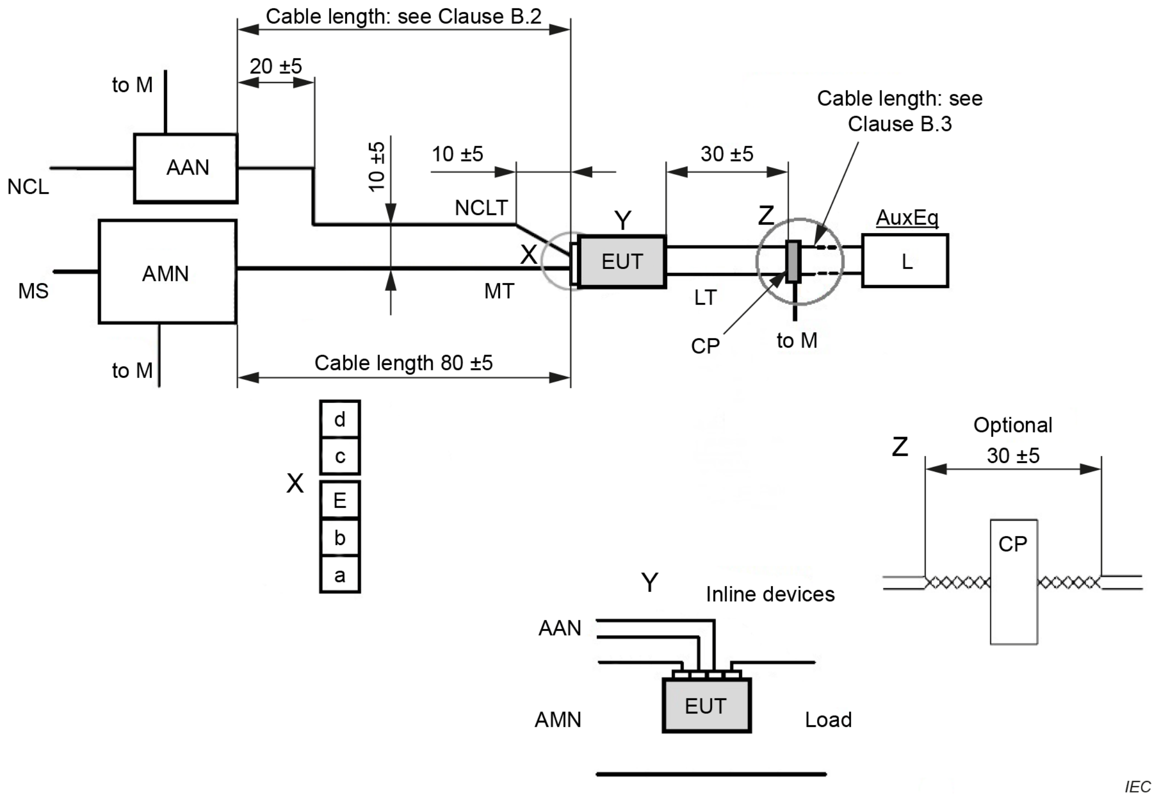
   Multi-wire cables shall be centred within the current probe and twisted in a similar way. The way the twisting is performed shall be noted in the test report.

NOTE 1 Other non-twisted cables have been observed to cause significant measurement artefacts (false common mode currents) due to non-ideal electromagnetic field patterns within the current probe and the influence of orientation (see CISPR 16-1-2:2014 + CISPR 16-1-2:2014/AMD1:2017, 5.1.3).

NOTE 2 If a twisted cable is very soft and untwists itself, a typical method to fix the twisting is to use non-conducting (plastic) cable ties or other non-conducting material. is used as a practical reference for deciding whether interim countermeasures should be taken.

Figure B.2 of CISPR 15:2018/AMD1:2024 can be interpreted as shown in Figure 5 below (adding the current probe position with a twisted pair cable):

Dimensions in centimetres



Key

a – b	Supply terminals	MS	Mains supply
c – d	Control terminals	MT	Mains terminals
AAN	Asymmetric artificial network	NCL	Network control line
AMN	Artificial mains network	NCLT	Network control line terminal
CP	Current probe		
E	Earth terminal		
L	Load		
LT	Load terminals		
M	CISPR measuring receiver (for AMN and AAN: replace by 50 Ω if not connected)		

The earth of the measuring receiver and the earth terminal of the EUT shall be connected to the AMN ground. Where an inline device is inserted in only one lead of the supply, measurements shall be made by connecting the second supply lead as indicated in the figure under inline devices. See CISPR 15:2018/AMD1:2024, Figure B.3 for details on the arrangement.

Figure 4 – Circuit for measuring conducted disturbances from an external module (with the option to apply the current probe position with twisted pair cable)