IEC 62153-4-17

Edition 1.0 2018-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Metallic cables and other passive components – Test methods –
Part 4-17: Electromagnetic compatibility (EMC) – Reduction Factor**

**Câbles métalliques et autres composants passifs – Méthodes d'essai –
Partie 4-17: Compatibilité électromagnétique (CEM) – Facteur de réduction**

IEC 62153-4-17:2018-08(en-fr)

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METALLIC CABLES AND OTHER PASSIVE COMPONENTS – TEST METHODS –

Part 4-17: Electromagnetic compatibility (EMC) – Reduction Factor

FOREWORD

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International Standard IEC 62153-4-17 has been prepared by technical committee 46: Cables, wires, waveguides, RF connectors, RF and microwave passive components and accessories.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
46/689/FDIS	46/694/RVD

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

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62153 series, published under the general title *Metallic cables and other passive components test methods*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://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- withdrawn,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.

METALLIC CABLES AND OTHER PASSIVE COMPONENTS – TEST METHODS –

Part 4-17: Electromagnetic compatibility (EMC) – Reduction Factor

1 Scope

Multi-element metallic communication and control cables are often designed with metallic screen against harmful effects of electromagnetic fields e.g. generated in the environment of electric power and electrified railway lines [1][1].

This part of IEC 62153 applies to the testing of the reduction factor of multi-element metallic cables used in analogue and digital communication and control. The described method is generally applicable to all screened metallic cables.

The reduction factor describes the screening effectiveness of a cable screen at frequencies below 1 kHz with a ratio of voltages describing the screened and unscreened situation. During the measurement, the cable under test is connected to a specific current loop arrangement.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
reduction factor
voltage ratio describing the effectiveness of a screen by relating the screened and unscreened situation using a specific current loop

3.2
metallic screen
interconnection of all electric and magnetic screens, where applicable

4 Test procedure

4.1 General

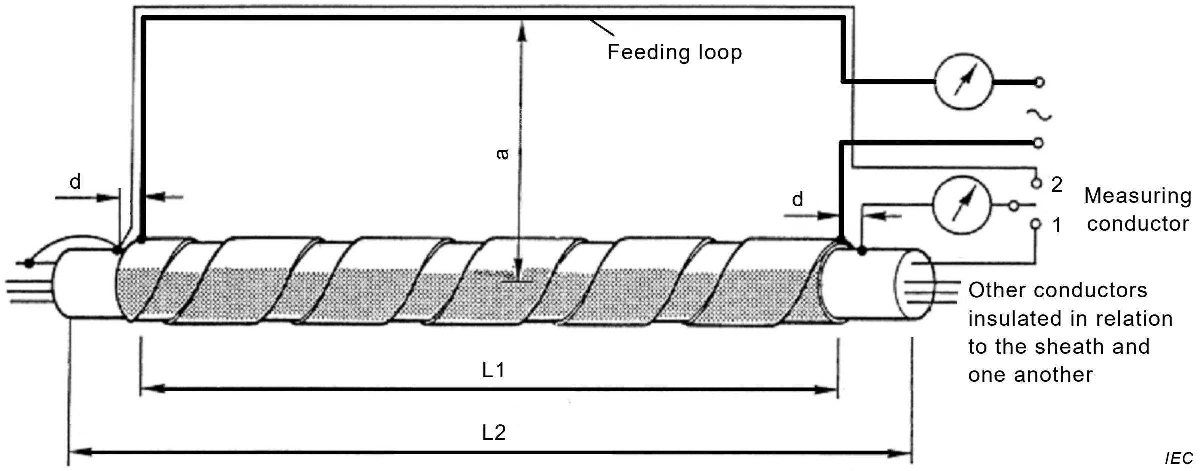
The general test set-up is shown in Figure 1. Test is performed under following conditions:

Temp = 20 °C ± 10 °C, RH = 55 % ± 25 %

[1] Figures in square brackets refer to the Bibliography.

The cable is set up on a non-conductive and non-metallic table and at least 1 m away from any metallic part. The cable shall be demagnetised. The test method described in this document is intended, in the first instance, to be used as type test.

It is possible to use a sample length different from 1 m as described in DIN VDE 0472-507 [2], e.g. 2 m as described in NF F07-024 [3]. In this case, the inductance of the feeding loop shall be verified according to the method described in Annex A.



Key

L1 magnetic screen (armouring) of the cable under test of 1,00 m or 2,00 m length

L2 electric screen (screen) of the cable under test of approximately 1,2 m or 2,2 m length

a distance to the feeding loop to the centre of the cable under test of 0,40 m

d distance between the test points of the metallic screen and the centre of the ring electrode of 0,02 m

Figure 1 – Test configuration for reduction factor

4.2 Test samples

A cable sample of about 1,5 m or 2,5 m length shall be taken from the cable under test.

4.3 Test sample preparation

The test current is injected into the metallic screen via two ring electrodes at a centre distance of 1,0 m or 2,0 m. Flexible copper conductor strands of at least 25 mm^2 cross-sections circular enclosing the metallic screen or equivalent ring electrodes concepts may be used for that. The ring electrode shall be connected in such a way that the contact resistance between the ring electrode and the electric screen, as well as to the armouring if any, is negligible compared to the test result.

Metal sheath applied as electric screen (or aluminium tape in case of aluminium laminated polyethylene sheath construction) shall protrude approximately 0,10 m over the ring electrodes resulting in a total length of 1,20 m or 2,20 m. Screening wires or tapes applied as electric screen or to improve the reduction factor of a metal sheath shall be also well conducting connected to the ring electrodes in such a way that the contact resistance is negligible compared to the test result.

All other parts protruding over the ring electrodes shall be kept as short as possible.

4.4 Test equipment

The test equipment consists of:

- adjustable AC power source for the specified frequency (e.g. 16,7 Hz, 50 Hz, 60 Hz, 400 Hz or 800 Hz),
- current transformer (optional),
- voltmeter with RMS display,
- amperemeter with RMS display (optional).

It is important to ensure that a sinusoidal voltage is effective in the feeding loop under all current load conditions, whereas a voltage curve is considered sufficient sinusoidal if no instantaneous value deviates more than 10 % from the instantaneous value of the same phase of the fundamental wave (1st harmonic).

The test equipment shall be such that the reduction factor can be determined with a tolerance of 5 % of the measured value + 0,01.

4.5 Test setup

The test setup consists of the feeding loop and the prepared cable sample, where they shall be laid together with the measuring conductor as close as possible such that they form a nearly closed rectangle as shown in Figure 1.

An appropriate feeding loop conductor for currents up to 250 A may be a 19 strand, 50 mm² copper conductor, with one wire of the outer layer replaced by an insulated measuring conductor.

For currents up and above 250 A, the feeding loop conductor may consist of two parallel flat copper bars whose mutual distance equals the thickness of the bars and with a measuring conductor (2) lying centrally in-between.

With a centre distance of 0,40 m between the cable sample and the long side of the feeding loop the test setup emulates the mean value of the inductivity of the external earth return current of the cable, which is assumed to be 2 mH/km.

In case of other conductor designs for the feeding loop, the centre distance 0,40 m may be adjusted accordingly to obtain the same value for the external inductance of the metallic sheath to earth loop of 2 mH/km. In case of doubt and for initial calibration purposes, it is recommended to perform an inductance measurement of the feeding loop as per test method described in Annex A.

The distance between the test points of the metallic screen and the centre of the ring electrode shall be 0,02 m on both sides of the test sample to enable the measurement of the metallic sheath voltage $U_{(2)}$ representing the unscreened situation.

An arbitrary core of the cable may be selected as measuring conductor (1) to measure the voltage $U_{(1)}$ representing the screened situation. One end of the conductor shall be connected with low contact resistance to the nearest test point of the metallic screen and the other end shall be connected to the voltmeter on the shortest possible path. All other conductors of the cable shall be isolated against each other and the metallic screen.

4.6 Testing

The test sample shall be measured at ambient temperature, which shall be kept largely stable throughout the test. A speedy measurement progression is recommended to limit heating of the circuit.

With measuring conductor (2) connected to the voltmeter, the AC power generator shall be adjusted to the required test voltages $U_{(2)}$. Afterwards the measuring conductor (1) shall be connected to the voltmeter to measure the corresponding voltage $U_{(1)}$ of the screened conductor.

This procedure shall be repeated for all test voltages $U_{(2)}$ defined by the cable specification.

NOTE 1 To eliminate remanent magnetism, an initial ramp-up to the maximum current followed by a decrease to the lowest needed for measurement can be considered.

4.7 Expression of test results

The reduction factor r_k of the cable is given by the ratio of the associated voltage values $U_{(1)}$ and $U_{(2)}$ measured at the specified frequency

$$r_k = \frac{U_{(1)}}{U_{(2)}} = \frac{U_I}{U_E} \qquad (1)$$

where U_I refers to the internal (screened) voltage and U_E to the external EMF in the external (unscreened) circuit of the cable.

Depending on the requirements of the cable specification, it might be expedient to plot a Reduction factor-Field strength-diagram where the field strength is calculated from $U_{(2)}$ normalized to V/km and a logarithmic scale is used.

5 Requirement

The value of the reduction factor shall comply with the value indicated in the relevant cable specification.

Annex A
(normative)

Verification of feeding loop inductance

In some cases, it is necessary to verify the feeding loop inductance of 2 µH/m with a relative tolerance of ± 10 %. Examples for this are an extended test setup for 2 m sample length, deviating feeding loop conductor geometry or for general calibration purposes. A set-up as shown in Figure A.1 for a sample length of 1 m or 2 m is to be used. The feeding loop (2) is bridged by a copper rail (3') instead of the test sample. Along the centre of the copper rail, a sensing conductor (3) is positioned which encloses the entire area of the feeding loop. The voltage induced in the measuring conductor V_4 is then measured via an isolating transformer.

Dimensions in millimetres

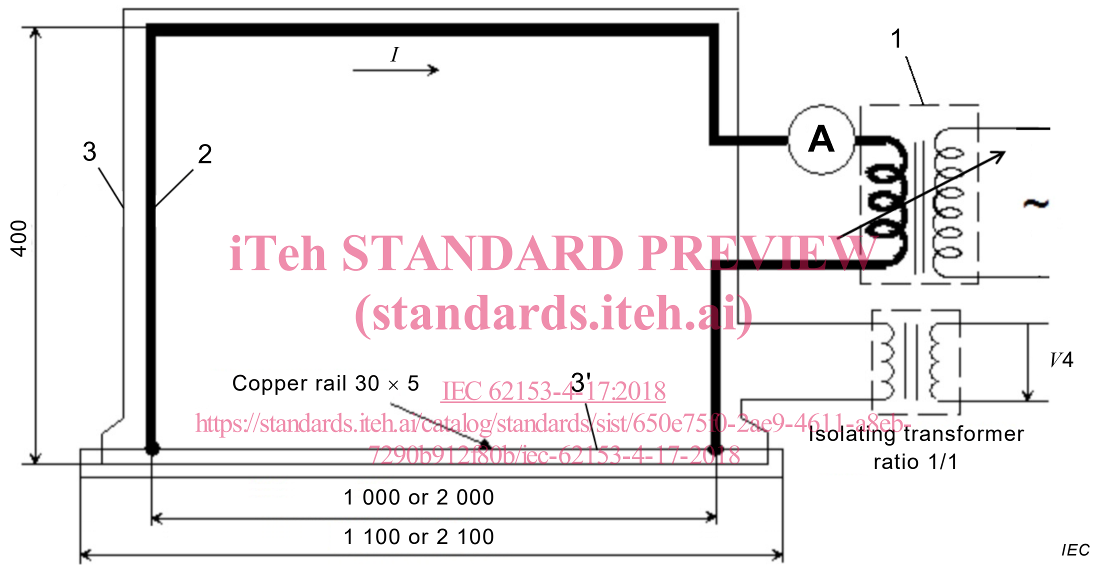


Figure A.1 – Set-up for inductance measurement of feeding loop

A current of about 10 A shall be set with the feeding transformer (1). The inductance L_0 can then be calculated as follows:

$$L_0 = \frac{V_4}{\omega l I} \tag{A.1}$$

where

l is the length of the copper rail;

I is the feeding current;

ω is the angular frequency of the used mains supply;

V_4 is the voltage induced in the measuring conductor.