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Responsible committee: EPL/46 Cables, wires and waveguides, radio frequency connectors and accessories for communication and signalling

Interested committees:

Title: Draft BS EN 61935-4 Ed.1.0 SPECIFICATION FOR THE TESTING OF BALANCED AND COAXIAL INFORMATION TECHNOLOGY CABLING

Part 4: Installed balanced single pair cabling as specified in ISO/IEC 1801-1 and related standards

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard

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- iii) requires additional national guidance or information

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



46/895/CD

COMMITTEE DRAFT (CD)

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IEC TC 46 : CABLES, WIRES, WAVEGUIDES, RF CONNECTORS, RF AND MICROWAVE PASSIVE COMPONENTS AND ACCESSORIES

SECRETARIAT:

United States of America

SECRETARY:

Mr David Wilson

OF INTEREST TO THE FOLLOWING COMMITTEES:

SC 46A, SC 46C

PROPOSED HORIZONTAL STANDARD:



Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

☐ EMC

☐ ENVIRONMENT

☒ QUALITY ASSURANCE

☐ SAFETY

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

TITLE:

SPECIFICATION FOR THE TESTING OF BALANCED AND COAXIAL INFORMATION TECHNOLOGY CABLING - Part 4: Installed balanced single pair cabling as specified in ISO/IEC 1801-1 and related standards

NOTE FROM TC/SC OFFICERS:

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SPECIFICATION FOR THE TESTING OF BALANCED AND
COAXIAL INFORMATION TECHNOLOGY CABLING –**Part 4: Installed balanced single-pair cabling as specified in ISO/IEC
11801-1 and related standards**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61935-4 has been prepared by IEC technical committee 46: Cables, wires, waveguides, RF connectors, RF and microwave passive components and accessories.

FDIS	Report on voting
46/XX/FDIS	46/XX/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.

235 A list of all parts in the IEC 61935 series, published under the general title *Specification for the*
236 *testing of balanced and coaxial information technology cabling*, can be found on the IEC
237 website.

238 The committee has decided that the contents of this document will remain unchanged until the
239 stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to
240 the specific document. At this date, the document will be

- 241 • reconfirmed,
- 242 • withdrawn,
- 243 • replaced by a revised edition, or
- 244 • amended.

245 A bilingual version of this publication may be issued at a later date.

246

IMPORTANT – The 'colour inside' logo on the cover page of this publication 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.

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249

INTRODUCTION

250 Telecommunication cabling, once specified uniquely by each telecommunications application,
251 has evolved into a generic cabling system. Telecommunications applications now use the
252 ISO/IEC 11801-1 cabling standard to meet their cabling requirements. Formerly, connectivity
253 tests and visual inspection were deemed sufficient to verify a cabling installation. Now users
254 need more comprehensive testing in order to ensure that the link will support
255 telecommunications applications that are designed to operate on the generic cabling system.
256 This part of IEC 61935 addresses reference laboratory and field test methods and provides a
257 comparison of these methods.

258 Transmission performance depends on cable characteristics, connecting hardware, patch cords
259 and cross-connect cabling, the total number of connections and the care with which they are
260 installed and maintained. IEC 61935 (all parts) provides test methods for installed cabling and
261 pre-fabricated cable assemblies. These test methods, where appropriate, are based on those
262 used for components of the cable assembly.

263 This Part 4 contains the test methods required for laboratory testing and testing of installed
264 single twisted pair cabling.

265 Since part 4 often refers back to IEC 61935-1 for further details, the document structure of part
266 4 has been kept the same as IEC61935-1 to make the document easier to understand and
267 follow.

268

SPECIFICATION FOR THE TESTING OF BALANCED AND COAXIAL INFORMATION TECHNOLOGY CABLING –

Part 4: Installed balanced single-pair cabling as specified in ISO/IEC 11801-1 and related standards

1. Scope

This part of IEC 61935 specifies reference measurement procedures for balanced-single-pair cabling parameters and the requirements for field tester accuracy to measure cabling parameters identified in ISO/IEC 11801-1 AMD1. References in this standard to ISO/IEC 11801-1 AMD1 mean ISO/IEC 11801-1 AMD1 or equivalent cabling standards.

This standard is organized as follows:

- reference laboratory measurement procedures on cabling topologies are specified in Clause n. In some cases, these procedures may be used in the field, see IEC/TR 61156-1-2;
- descriptions and requirements for measurements in the field are specified in Clause m;
- performance requirements for field testers and procedures to verify performance are specified in Clause p

NOTE 1 This standard does not include tests that are normally performed on the cables and connectors separately. Tests performed on the cables and connectors are described in 61156-1., respectively.

NOTE 2 Wherever possible, cables and connectors used in cable assemblies, even if they are not described in IEC 61156, IEC 63171 series, shall be tested separately according to the tests given in ISO/IEC 11801 series. In this case most of the environmental and mechanical tests described in this standard may be omitted.

NOTE 3 Users of this standard are advised to consult with applications standards, equipment manufacturers and system integrators to determine the suitability of these requirements for specific networking applications.

This standard relates to performance with respect to 100 Ω cabling. For cabling with another characteristic impedance, the same principles apply but the measurement system should correspond to the nominal characteristic impedance level.

Field tester types include certification, qualification and verification test equipment.

- Certification testing is performed to the requirements of this standard.
- Qualification testing is described in IEC 61935-3. Qualification testing determines whether the cabling will support certain network technologies (e.g. 1000BASE-T, 100BASE-TX, 10G Base-T, FireWire). Qualification testers do not have traceable accuracy to national standards and only provide confidence that specific applications will work.
- Verification testers only verify connectivity.

2. Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60169-15, *Radio-frequency connectors – Part 15: R.F. coaxial connectors with inner diameter of outer conductor 4.13 mm (0.163 in) with screw coupling – Characteristic impedance 50 ohms (Type SMA)*

IEC 60169-22, *Radio-frequency connectors – Part 22: R.F. two-pole bayonet coupled connectors for use with shielded balanced cables having twin inner conductors (Type BNC)*

- 315 IEC 60512-25-9, *Connectors for electronic equipment – Tests and measurements – Part 25-9:*
316 *Signal integrity tests – Test 25i: Alien crosstalk*
- 317 IEC 60512-28-100, *Connectors for electronic equipment – Tests and measurements – Part 28-*
318 *100: Signal integrity tests up to 1 000 MHz on IEC 60603-7 and IEC 61076-3 series connectors*
319 *- Tests 28a to 28g*
- 320 IEC 60603-7 (all parts), *Connectors for electronic equipment – Part 7: Detail specification for*
321 *8-way, unshielded, free and fixed connectors*
- 322 IEC 63171 Series *Connectors for electrical and electronic equipment - Shielded or unshielded*
323 *free and fixed connectors for balanced single-pair data transmission with current-carrying*
324 *capacity - General requirements and tests*
- 325 IEC 60603-7-81, *Connectors for electronic equipment – Part 7-81: Detail specification for*
326 *8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to*
327 *2 000 MHz*
- 328 IEC 60603-7-82, *Connectors for electronic equipment – Part 7-82: Detail specification for*
329 *8-way, 12 contacts, shielded, free and fixed connectors, for data transmission with frequencies*
330 *up to 2 000 MHz*
- 331 IEC 61076-3-104, *Connectors for electrical and electronic equipment – Product requirements –*
332 *Part 3-104: Detail specification for 8-way, shielded free and fixed connectors for data*
333 *transmissions with frequencies up to 2 000 MHz*
- 334 IEC 61076-3-110, *Connectors for electronic equipment – Product requirements – Part 3-110:*
335 *Detail specification for free and fixed connectors for data transmission with frequencies up to 3*
336 *000 MHz*
- 337
- 338 IEC 61156-1, *Multicore and symmetrical pair/quad cables for digital communications – Part 1:*
339 *Generic specification*
- 340
- 341 IEC TR 61156-1-2, *Multicore and symmetrical pair/quad cables for digital communications –*
342 *Part 1-2: Electrical transmission characteristics and test method of symmetrical pair/quad*
343 *cables*
- 344 IEC 61156-11 *Multicore and symmetrical pair/quad cables for digital communications - Part 11:*
345 *Symmetrical single pair cables with transmission characteristics up to 600 MHz - Horizontal*
346 *floor wiring - Sectional specification*
- 347 IEC 61156-12 *Multicore and symmetrical pair/quad cables for digital communications - Part 12:*
348 *Symmetrical single pair cables with transmission characteristics up to 600 MHz - Work area*
349 *wiring - Sectional specification*
- 350 IEC 61156-13
- 351
- 352 IEC 61156-14

Editors Note: IEC 61156-13 and -14 are at the time of editing not published – reference needs to be updated for CDV or FDIS of this document

IEC 61169-16, *Radio-frequency connectors – Sectional specification – RF coaxial connectors with inner diameter of outer conductor 7 mm (0,276 in) with screw coupling – Characteristics impedance 50 Ω (75 Ω) (type N)*

IEC 61935-1-2 *Specification for the testing of balanced communication cabling in accordance with ISO/IEC 11801-1 – Part 1-2: additional requirements for measurement of resistance unbalance with field test instrumentation*

IEC 62153-4-9, *Metallic communication cable test methods – Part 4-9: Electromagnetic compatibility (EMC) – Coupling attenuation of screened balanced cables, triaxial method*

IEC 62153-4-11, *Metallic communication cable test methods – Part 4-11: Electromagnetic compatibility (EMC) – Coupling attenuation or screening attenuation of patch cords, coaxial cable assemblies, pre-connectorized cables – Absorbing clamp method*

IEC 62153-4-14, *Metallic communication cable test methods – Part 4-14: Electromagnetic compatibility (EMC) – Coupling attenuation of cable assemblies (Field conditions) absorbing clamp method*

ISO/IEC 11801-1, *Information technology – Generic cabling for customer premises*

ISO/IEC 14763-1, *Information technology – Implementation and operation of customer premises cabling – Part 1: Administration*

ISO/IEC 14763-2, *Information technology – Implementation and operation of customer premises cabling – Part 2: Planning and installation*

ITU-T Recommendation G.117:1996 *Transmission aspects of unbalance about earth*

ITU-T Recommendation O.9:1999, *Measuring arrangements to assess the degree of unbalance about earth*

Editors Note: Need to revise and complete references, suggest to clean up this section before the document goes to CD status

3. Terms, definitions and abbreviations

For the purposes of this document, the terms and definitions given in ISO/IEC 11801-1 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 Acronyms

SP Single Pair

4. Reference measurement procedures for electrical properties

4.1 General

Clause 4 describes reference measurement procedures for electrical parameters. The measurement procedures are intended to be used in a laboratory environment using laboratory equipment. In some cases, a measurement procedure may also be applicable for field testing. If this is the case, the procedure shall be specifically identified as being suitable for installed cabling testing and appropriate precautions shall be described.

Unless otherwise specified all measurement considerations shall be according to IEC 61935-1.

Table 1 - Accuracy levels and frequency ranges

Level	Frequency range [MHz]
SP-I	0,1 – 20
SP-II	0,1 – 600
SP-III	1 - 1250

4.2 Common measurement considerations

4.2.1 Test equipment consideration

For test equipment considerations refer to IEC 61935-1

4.2.2 Network analyser test requirements

Usually the input and output terminals of a network analyser are unbalanced. RF transformers with balanced outputs (baluns) can be used with unbalanced signal connections to the network analyser. For balunless test adapters, refer to IEC TR 61156-1-2. Balunless test adapters are particularly suitable for mixed mode measurements.

4.2.3 Test set-up

For test setups refer to IEC 61935-1

4.2.4 Termination of conductor pairs

During measurement, all conductor pairs of the cabling under test shall be terminated at both ends with impedance matching loads. For pairs under test, this is provided by the test instrumentation at one or both ends. For pairs not under test or not connected to test instrumentation, resistor loads or terminated baluns shall be applied.

Unless otherwise specified, the nominal differential mode impedance of the termination shall be 100 Ω for 100 Ω cabling. The nominal common mode impedance shall be 50 $\Omega \pm 25 \Omega$, unless otherwise specified in the measurement procedure.

Resistor loads shall use resistors specified for $\pm 0,1$ % accuracy at DC and have a return loss of 46 dB up to 100 MHz and 40 dB up to maximum frequency. For pairs connected to a balun, common mode load is implemented by applying a load at the centre tap of the balun. The impedance of the load is equal to the common mode impedance. For pairs connected to other kinds of balancing devices (180° power splitters), common mode load is implemented by use of an attenuator at each of the balanced terminals of the balancing device. This method is also

used if the centre tap is not available at the balun used. The attenuation provided by the attenuators shall be ≥ 6 dB (see Figure 3). The common mode impedance is approximately one fourth of the differential mode impedance for this implementation. For pairs connected to resistor loads, common mode load is implemented by the Y configuration shown in Figure 1.

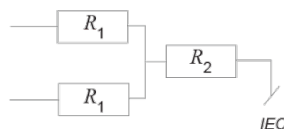


Figure 1 – Resistor load

where

$$R_1 = \frac{R_{\text{dif}}}{2} \quad (1)$$

$$R_1 = 50 \, \Omega \pm 0,1 \, \%$$

and

$$R_2 = R_{\text{com}} - \frac{R_{\text{dif}}}{4} \quad (2)$$

$$R_2 = 25 \, \Omega \pm 1 \, \%$$

where

R_{dif} is the differential mode resistance (Ω);

R_{com} is the common mode resistance (Ω).

For unscreened cabling, the common mode termination points for all pairs are connected together at either end of the cabling. For screened cabling, the common mode termination points are connected to the cable screen or screens at each end of the cabling.

NOTE Accuracy is dependent on the uses of equivalent calibration techniques.

4.2.5 Reference loads for calibration

To perform a one or two-port calibration of the test equipment, a short-circuit, an open circuit and an impedance matching termination are required. These devices shall be used to obtain a calibration at the reference plane.

The impedance matching termination shall be calibrated against a calibration reference, which shall be a $50 \, \Omega$ load, traceable to a national reference standard. If the value of the reference load for calibration is $100 \, \Omega$, two loads in parallel shall be calibrated against the calibration reference. The reference loads for calibration shall be placed in an N type connector according to IEC 61169-16 or SMA type according to IEC 60169-15, meant for panel mounting, which is machined flat on the back side. The loads shall be fixed to the flat side of the connector, distributed evenly around the center conductor. A network analyzer shall be calibrated, one port full calibration, with the calibration reference. Thereafter, the return loss of the reference loads for calibration shall be measured. The verified return loss shall be 46 dB up to 100 MHz and 40 dB up to maximum frequency.

4.2.6 Test configurations

Balanced single pair cabling configurations as per ISO/IEC 11801-1 shall be supported.

4.2.7 Coaxial cables and test leads for network analysers

For coaxial cables and test leads for network analysers refer to IEC 61935-1.

EDITORS NOTE: check and harmonize with frequency ranges of 11801-1

4.2.8 Balanced test leads

Balanced test leads and associated connecting hardware to connect between the test equipment and the cable assembly under test shall be taken from components that meet or exceed the requirements for the category of the cable assembly under test. Balanced test leads shall be limited to a length of 50 mm between any test fixtures and the reference plane of the cabling under test. Pairs shall remain twisted between any test fixtures to where connections are made to the DUT to where connections are made, and unscreened balanced test leads shall be separated by 5 mm from any ground plane.

The S-parameters of a mixed mode measurement consist of 16 terms for a single measurement path, providing the full matrix of common and differential parameters. The nomenclature is given by Table 1.

Table 1 – Mixed mode S-parameter nomenclature

		Differential mode stimulus		Common mode stimulus	
		Port 1	Port 2	Port 1	Port 2
Differential mode response	Port 1	S_{DD11}	S_{DD12}	S_{DC11}	S_{DC12}
	Port 2	S_{DD21}	S_{DD22}	S_{DC21}	S_{DC22}
Common mode response	Port 1	S_{CD11}	S_{CD12}	S_{CC11}	S_{CD12}
	Port 2	S_{CD21}	S_{CD22}	S_{CC21}	S_{CC22}

4.2.9 Balun requirements

Depending on the test set-up, baluns are an optional element that may be required for measurements. In case baluns are used, the following applies:

A balun is designated class A in the frequency range for which the class A requirements are met. A balun is designated class B in the frequency range for which the class B requirements are met. A balun may be class A in one frequency range and class B in another extended frequency range.

Class A baluns are preferred for verification of performance characteristics of all classes of cabling.

Class B baluns (see Annex D) may be used to verify performance of all classes of cabling, provided that the lower performance of the balun is taken into account in the measurement error calculation.

Baluns shall be RFI shielded and shall comply with the requirements given in Table 2.

EDITORS NOTE: specified frequency ranges:

Harmonize balun classes with SP classes

3 SP classes:

- 484 “20”: 0.1 to 20 MHz
- 485 “600”: 0.1 to 600 MHz
- 486 “1250”: 0.1 to 1250 MHz
- 487 Table 2 to be filled for 3 columns per 3 classes.

488

Table 2 – Test balun performance characteristics (TBD)

Parameter	Class A 20 0.1 to 20 MHz	Class A 600 0.1 to 600 MHz	Class A 1250 1 to 1250 MHz	
Impedance, primary ^a	50 Ω unbalanced	50 Ω unbalanced	50 Ω unbalanced	
Impedance, secondary	Matched balanced	Matched balanced	Matched balanced	
Insertion loss ^d	3 dB maximum	2 dB maximum	3 dB maximum	
Return loss secondary, minimum	20 dB	12 dB, 1 MHz to 15 MHz 20 dB, 15 MHz to 500 MHz	12 dB, 4 MHz to 15 MHz 20 dB, 15 MHz to 550 MHz 17,5 dB, 550 MHz to 600 MHz 10 dB, 600 MHz to 1 000 MHz	
Return loss, common mode ^b , minimum	10 dB	15 dB, 1 MHz to 15 MHz 20 dB, 15 MHz to 400 MHz 15 dB, 400 MHz to 500 MHz	15 dB, 4 MHz to 15 MHz 20 dB, 15 MHz to 400 MHz 15 dB, 400 MHz to 600 MHz 10 dB, 600 MHz to 1 000 MHz	
Power rating	0,1 Watt minimum	0,1 Watt minimum	0,1 Watt minimum	
Longitudinal balance ^c , minimum	60 dB	60 dB, 1 MHz to 100 MHz 50 dB, 100 MHz to 500 MHz	60 dB, 4 MHz to 350 MHz 50 dB, 350 MHz to 600 MHz 40 dB, 600 MHz to 1 000 MHz	
Output signal balance ^c , minimum	50 dB	50 dB	60 dB, 4 MHz to 350 MHz 50 dB, 350 MHz to 600 MHz 40 dB, 600 MHz to 1 000 MHz	.
Common mode rejection ^c , minimum	50 dB	50 dB	50 dB, 4 MHz to 600 MHz 40 dB, 600 MHz to 1 000 MHz	
^a Primary impedance may differ, if necessary to accommodate analyser outputs other than 50 Ω . ^b Measured either by connecting the balanced output terminals together and measuring the return loss. The unbalanced balun input terminal shall be terminated by a 50 Ω load. Or measured at the common-mode port – if available – while terminating the balanced port for differential and common mode. ^c Measured per ITU-T Recommendations G.117 and O.9. ^d In case separate attenuators are used, they shall be excluded from the insertion loss measurement.				

489

EDITORS NOTE: Need to clean up table.

490

1) Remove Column 4

2) Update values**3) Update Class names**

NOTE Proper test for configurations for qualifying tests baluns to the requirements are given in Annex D.

4.2.10 Balunless

Where balunless techniques are used for measurement, the requirements are provided by IEC TR 61156-1-2.

4.2.11 Network analyser measurement precautions

For network analysers measurement precautions refer to IEC 61935-1

4.2.12 Data reporting and accuracy

The measurement uncertainty shall be determined for each test. This shall be calculated by determining the uncertainty from each error source expressed as the resulting spread in the result. The values of the different error sources are based on instrumentation specifications, calculated errors from imperfect calibration loads and measurement experience. The overall estimated measurement uncertainty is calculated as two times the resulting spread coming from the different error sources. The resulting spread is calculated as:

$$\sigma_{\text{res}} = \sqrt{\sigma_1^2 + \sigma_2^2 + \dots + \sigma_n^2} \quad (3)$$

where σ_1 to σ_n is the spread of the different error sources.

The overall measurement uncertainty is defined as $2 \sigma_{\text{res}}$ which is approximately equivalent to a 95 % confidence level. A measurement uncertainty band is determined on both sides of the specified limit.

4.2.13 Frequency step size

Unless otherwise specified, if the test instrument measures at discrete frequencies, the frequency steps shall be no greater than:

- 100 kHz up to 1.0 MHz (TBD)
- 100 kHz up to 20 MHz (TBD)
- 150 kHz up to 31,25 MHz;
- 250 kHz from 31,25 MHz up to 100 MHz;
- 500 kHz from 100 MHz up to 250 MHz;
- 1 MHz from 250 MHz up to 6 00 MHz;
- 2 MHz from 600 MHz up to 1 250 MHz.

Editors Note: Step sizes for 0.1 to 20MHz need to be revised. Current proposal is very high.

4.3 DC loop resistance

For DC loop resistance measurements refer to IEC 61935-1

526 Note that drawings in IEC61935-1 show a DC loop resistance measurements on a 4 pair cabling.
527 Same test setup is applicable for 1 pair cabling as well.

528 EDITORS NOTE: ADD DCR for shielded cables; check figure

529 4.4 Direct current (DC) resistance unbalance

530 EDITORS NOTE: this paragraph is FFS and is depending on superior standards

531 4.4.1 Objective

532 The objective of this test is to ensure the DC resistance unbalance meets the requirements.

533 This test is applicable for laboratory testing.

534 4.4.2 Test method

535 For test methods refer to IEC 61935-1-2

536 Note that drawings in IC61935-1 clause 4.4.2 show measurements on 4 pair cabling. Same test setup is applicable
537 for 1 pair cabling as well.

538 4.4.3 Test equipment and set-up

539 For test equipment and set-up refer to IEC 61935-1

540 4.4.4 Procedure

541 For test procedure refer to IEC 61935-1.

542 4.5 Direct current (DC) resistance unbalance between pairs

543 This test is not applicable for SP cabling.

544 4.6 Insertion loss

545 For DC insertion loss measurements refer to IEC 61935-1

546 For Objective, test method, test equipment and set-up, and procedure refer to IEC 61935-1.

547 Note that drawings in IEC 61935-1 show measurements on 4 pair cabling. Same test setup is
548 applicable for 1 pair cabling as well.

549 4.6.1 Temperature correction

550 Insertion loss measurements should be conducted at the expected highest operating
551 temperature of the cabling, which may be affected by DC power that is supplied over the cabling
552 system.

553 If it is not possible to conduct the measurements at the expected highest operating temperature
554 of the cabling, adjustments for insertion loss should be made based on the estimated difference
555 of the expected highest operating temperature of the installation and the actual temperature at
556 the time of measurement. This may be a critical issue when link lengths are near the maximum
557 value.

558 The temperature coefficient for screened cabling is 0,2 %/°C. For unscreened cabling, the
559 temperature coefficient is specified to be maximum 0,4 %/°C below between 20 °C and 40 °C
560 and 0,6 %/°C between 40 °C and 60 °C, see IEC 61156-5 , IEC 61156-6, IEC 61156-9 and
561 IEC 61156-10.

EDITORS NOTE: TO be verified if those temperature correction values are still applicable for SP cabling

4.6.2 Uncertainty

The uncertainty of reference insertion loss measurements for cabling shall be less than 0,5 dB.

EDITORS NOTE: to be verified if this is still achievable with SP cabling

4.7 Propagation delay

4.7.1 Objective

The objective of this test is to measure propagation delay of the cabling being tested.

The test method is applicable to cabling in a laboratory environment only. The reference test method cannot be used for installed cabling.

4.7.2 Test method

Propagation delay is measured by determining the phase delay of a signal transmitted through the cabling using Equation (9).

$$\delta = \frac{\phi}{2\pi f} \quad (4)$$

where

δ is the phase delay in seconds;

ϕ is the phase in radians;

f is the frequency in Hertz.

4.7.3 Test equipment and set-up

The set-up is the same as for insertion loss measurements (see 4.6.3). Insertion loss and delay can be measured in the same test with one sweep if the network analyser can measure the complex scattering parameter, S_{21} .

4.7.4 Procedure

4.7.4.1 Calibration

See 4.6.4.1.

4.7.4.2 Measurement

See 4.6.4.2, but note that for this measurement a linear frequency sweep shall be applied. The frequency steps shall be made small enough to ensure that the phase shift from one measurement frequency to the next measurement frequency is less than 2π . In order to assure an adequate margin, the frequency steps shall be no greater than 1 MHz.

4.7.4.3 Calculation

Some network analysers give a readout of the continuous phase trace of the tested item. This readout can be directly inserted in Equation (10). It is usual for the network analyser to measure the phase in an interval of $\pm\pi$. As the ratio of phase versus frequency is a continuously decreasing function, 2π shall be subtracted from the measured phase every time there is a positive step in the measured phase versus frequency trace, therefore: