IEC/PAS 61076-3-110

Edition 1.0
2002-01

Connectors for electronic equipment –

Part 3-110: Detail specification for 8 way connectors for frequencies up to 600 MHz

PUBLICLY AVAILABLE SPECIFICATION

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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Part 3-110: Detail specification for 8 way connectors for frequencies up to 600 MHz

FOREWORD

A PAS is a technical specification not fulfilling the requirements for a standard, but made available to the public.

IEC-PAS 61076-3-110 has been processed by subcommittee 48B: Connectors, of IEC technical committee 48: Electromechanical components and mechanical structures for electronic equipment.

The text of this PAS is based on the following document:	This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document:
Draft PAS	**Report on voting**
48B/1115/PAS	48B/1153/RVD

Following publication of this PAS, the technical committee or subcommittee concerned will investigate the possibility of transforming the PAS into an International Standard.

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CONNECTORS FOR ELECTRONIC EQUIPMENT –

Part 3-110: Detail specification for 8 way connectors for frequencies up to 600 MHz

1 Scope

This part of IEC 61076-3 covers 8-way connectors up to 4 pairs to be used up to 600 MHz, when used with an appropriate cable. These cables are specified in the IEC 61156 series and used in cabling systems specified in ISO/IEC 11801.

The connectors are compatible with the already defined IEC 60603-7-7 connectors.[1]

The connectors are interoperable with the already defined IEC 60603-7-7 connectors.[2]

1.1 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61076-3. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 61076-3 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-14, *Environmental testing – Part 2: Tests. Test N: Change of temperature*

IEC 60068-2-38, *Environmental testing – Part 2: Tests. Test Z/AD: Composite temperature/humidity cyclic test*

IEC 60169-16, *Radio-frequency connectors – Part 16: R.F. coaxial connectors with inner diameter of outer conductor 7 mm (0.276 in) with screw coupling – Characteristic impedance 50 ohms (75 ohms) (Type N)*

IEC 60352-2:1990, *Solderless connections – Part 2: Solderless crimped connections – General requirements, test methods and practical guidance*

IEC 60352-3:1993, *Solderless connections – Part 3: Solderless accessible insulation displacement connections – General requirements, test methods and practical guidance*

IEC 60352-4:1994, *Solderless connections – Part 4: Solderless non-accessible insulation displacement connections – General requirements, test methods and practical guidance*

IEC 60352-6:1994, *Solderless connections – Part 6: Insulation piercing connections – General requirements, test methods and practical guidance*

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1 Backward compatibility definition and requirements are given in 2.5.2.

2 Interoperability definition and requirements are given in 2.5.3.

IEC 60512-1, *Connectors for electronic equipment – Tests and measurements – Part 1: General*

IEC 60512-2, *Electromechanical components for electronic equipment, basic testing procedures and measuring methods – Part 2: General examination, electrical continuity and contact resistance tests, insulation tests and voltage stress tests*

IEC 60512-3, *Electromechanical components for electronic equipment; basic testing procedures and measuring methods – Part 3: Current-carrying capacity tests*

IEC 60512-4, *Electromechanical components for electronic equipment; basic testing procedures and measuring methods – Part 4: Dynamic stress tests*

IEC 60512-5, *Electromechanical components for electronic equipment; basic testing procedures and measuring methods – Part 5: Impact tests (free components), static load tests (fixed components), endurance tests and overload tests*

IEC 60512-6, *Electromechanical components for electronic equipment; basic testing procedures and measuring methods – Part 6: Climatic tests and soldering tests*

IEC 60512-7, *Electromechanical components for electronic equipment; basic testing procedures and measuring methods – Part 7: Mechanical operating tests and sealing tests*

IEC 60512-8, *Electromechanical components for electronic equipment; basic testing procedures and measuring methods – Part 8: Connector tests (mechanical) and mechanical tests on contacts and terminations*

IEC 60603-7, *Connectors for frequencies below 3 MHz for use with printed boards – Part 7: Detail specification for connectors, 8-way, including fixed and free connectors with common mating features, with assessed quality*

IEC 60603-7-1, *Detail specification for connectors, 8-way, including fixed and free connectors with common mating features,with assessed quality – Shield mating*

IEC 60603-7-7, *Detail specification for connectors, 8-way, including fixed and free connectors with common mating features,with assessed quality – Shield mating*

IEC 61076-1:1995, *Connectors with assessed quality, for use in d.c., low frequency analogue applications and in digital high speed data applications – Part 1: Generic specification*

IEC 61156 (all parts), *Multicore and symmetrical pair/quad cables for digital communications*

IEC 61196-1 (all parts), *Radio-frequency cables*

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

ISO 1302, *Technical drawings – Method of indicating surface texture*

ITU-T G.117, *Transmission aspects of unbalance about earth*

ITU-T K.20, *Resistibility of telecommunication equipment installed in a telecommunications centre to overvoltages and overcurrents*

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

CENELEC PREN 50289-1-6, *Communication Cables – Specifications for Test Methods Part 1-6: Electrical Test Methods – Electromagnetic Performance*

2 IEC type designation

Connectors, connector bodies and connectors with pre-inserted contacts according to this standard shall be designated by the following system (see IEC 61076).

IEC 61076-3-110 — L N N L L L — L N N N — N L

IEC 61076-3-110: Reference to this standard

Letters denoting connector type	
Fixed panel mounted version	A
Fixed board mounted version	B
Free version	C
Free coupler version	D

Number of contacts
08
12

Contact position	
Standard	A
Variant	B

Letter denoting type of contact	
Female	F
Male	M

Letter denoting type of termination	
Screw terminal	A
Crimp	C
Insulation displacement	D
Insulation piercing	P
Solder	S
Compliant pin	T

Letter denoting type of conductor accommodation, or cable	
A	Tinsel wire
B	Stranded wire
C	Solid wire
D	Tinsel or stranded wire
E	Stranded or solid wire
F	Tinsel, stranded or solid wire
G	Board-mounted
X	Customer specific cable requirements

Number denoting contact finish	
1	Gold, gold-alloy
2	Palladium/nickel

Number denoting variant	
01	For details see clause 4
02	
03	
04	
05	
06	
07	

Number denoting performance level (PL)	
1	750 operations
2	2 500 operations

Letter denoting assessment level
A
G

NOTE "L" stands for letter
"N" stands for number

Example:

IEC 61076-3-110 C08AFD-C101-2G: Free shielded connector, IDC-contact, non-keyed having 8 female contacts in standard contact positions, gold plated to be used with solid wires, meeting performance level 2, assessment level G.

2.1 Terminology

The terminology used in and applicable to this specification is stated in 2.1 of IEC 61076-1. Some applicable terms are also covered in IEC 60512-1.

2.2 Marking

Each connector and/or its associated package shall be marked in accordance with the requirements specified in 2.6 of IEC 61076-1.

2.3 Main functions

These connectors are compatible with IEC 60603-7-7 series connectors insofar as described in 2.5.

The IEC 60603-7-7 fixed connector switch is actuated by a protrusion added onto the end of a standard shaped IEC 60603-7 series free connector (type C) (plug). An IEC 61076-3-110 free connector includes a similar protrusion.

The IEC 61076-3-110 free connector includes two protrusions added onto each side of a standard shaped IEC 60603-7 series free connector (type C) (plug). (An IEC 60603-7-7 free connector includes similar movable protrusions, which function as free connector switch actuators.)

2.4 Interchangeability

These connectors are intermateable, interoperable with all IEC 60603-7-7 connectors.

The original 4 pairs of contacts and the shield contacts specified for lower level IEC 60603-7 series connectors are given for reference and their specifications given in this standard conform to the specifications for IEC 60603-7 series connectors.

2.4.1 Intermateability

Intermateability with other IEC 60603-7 series connectors is ensured herein by applying the same “GO” and “NO-GO”, free and fixed connector gauge requirements as specified for all lower level IEC 60603-7 series connectors.

2.4.2 Interoperability

2.4.2.1 General

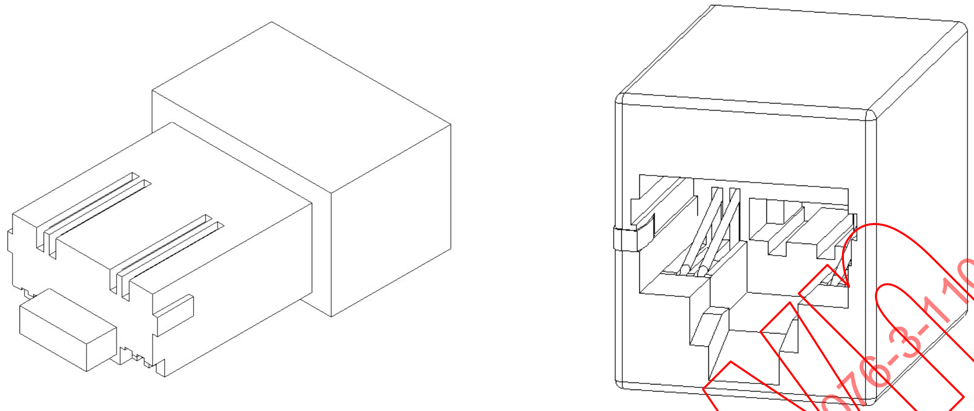
Interoperability ensures that the resulting mated connection of any connector from any source and complying with IEC 60603-7-7 with another such connector shall comply with the mechanical, electrical and transmission requirements of IEC 60603-7-7.

2.4.2.2 Requirements

Specific interoperability requirements and test procedures for applications up to 600 MHz are given herein.

3 Common features and isometric view

3.1 Isometric view



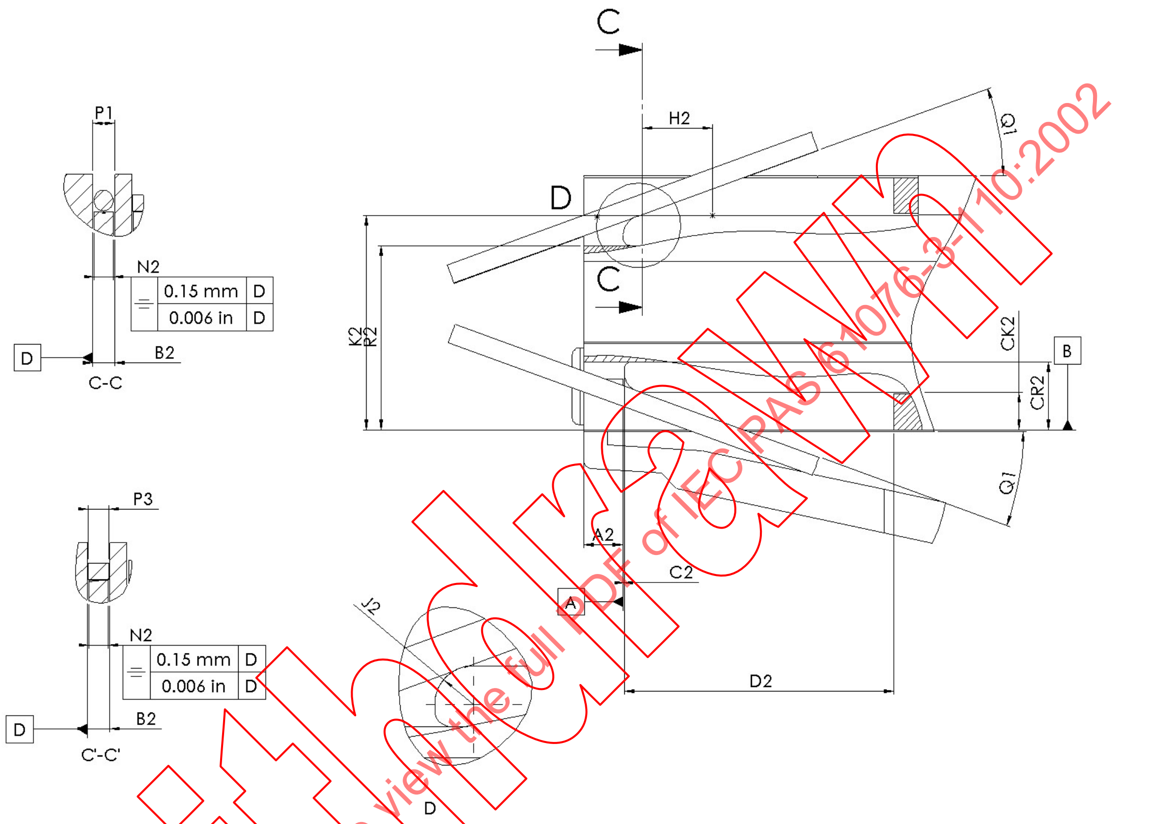
IEC 118/02

Figure 1 - Examples free and fixed connectors

3.2 Mating information

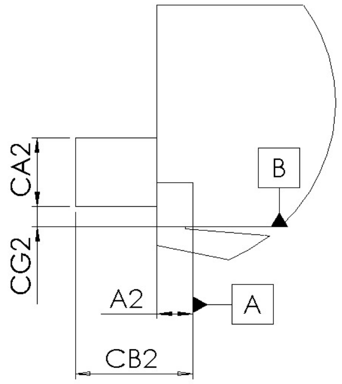
For the purpose of this specification, dimensional information equivalent of that specified in IEC 60603-1 is detailed.

3.2.1 Contacts interface

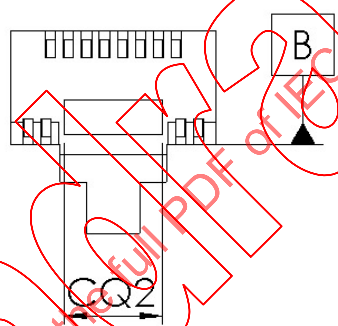


IEC 119/02

Figure 2 - Physical interface, contacts interface, see table 1



Switch actuator in extended position



IEC 120/02

Switch actuator, front

Figure 3 - Physical interface, switch actuator, see table 1

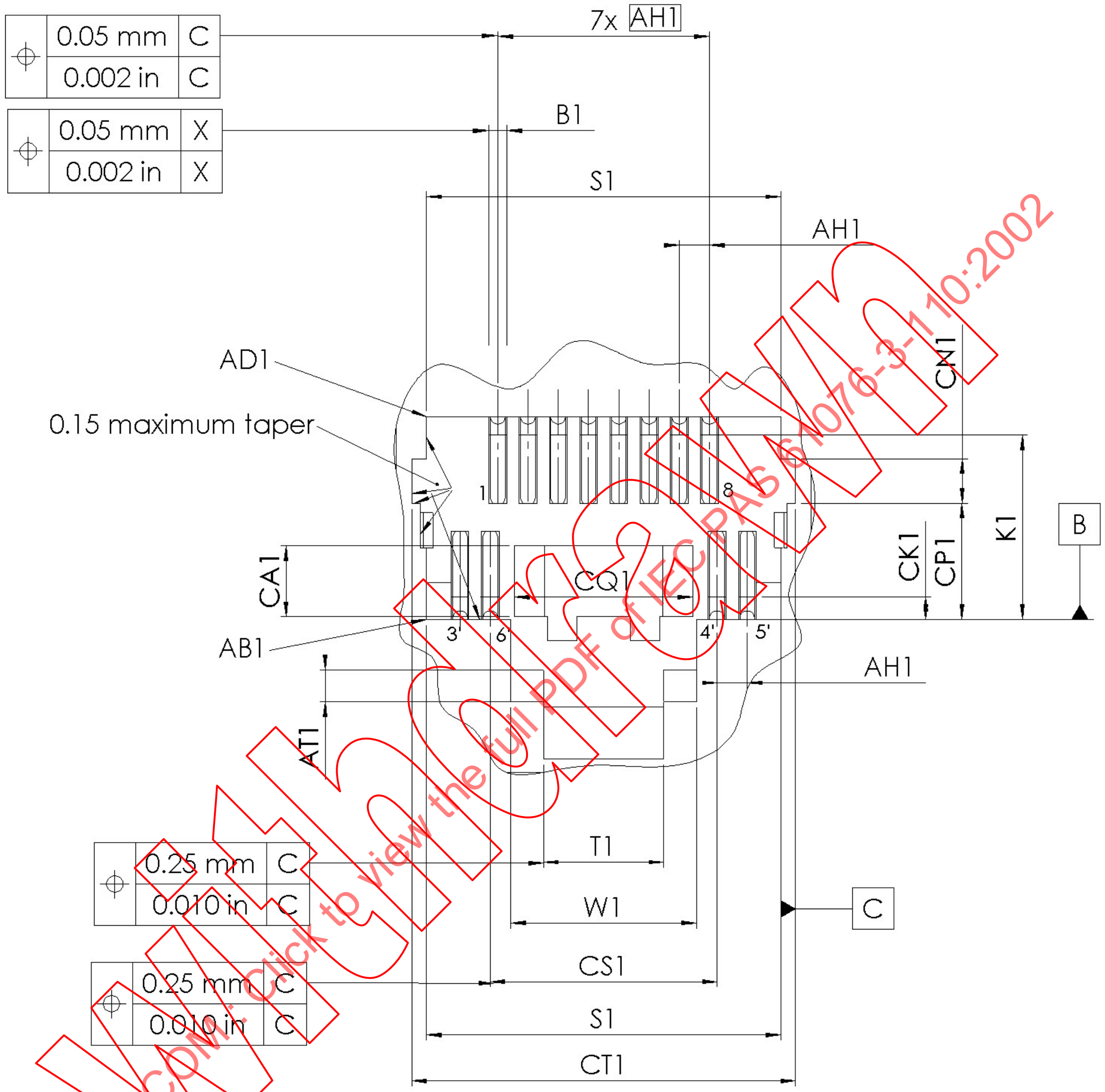
NOTE Switch actuator extension dimensions are given for the free connector

Table 1 – Physical interface contacts interface and switch actuator dimensions

Letter	Maximum		Minimum	
	mm	in	mm	in
A2	1,45	0,057	0,89	0,035
B2	0,61	0,024	0,51	0,020
C2	0,46	0,018	0,03	0,001
D2			2,79	0,110
H2			0,38	0,015
J2	0,64	0,025	0,38	0,015
K2	6,15	0,242	5,89	0,232
CK2	0,60	0,024	0,50	0,020
N2			0,28	0,011
P1	0,50	0,0195	0,45	0,0177
P3	0,50	0,0195	0,36	0,014
R2	4,83	0,190		
CR2			1,70	0,067
CA2	2,20	0,087	2,00	0,079
CB2	3,95	0,155	3,75	0,148
CC2	0,20	0,008	0,00	0,00
CG2	0,22	0,009	0,12	0,005
CQ2	5,50	0,217	5,70	0,224

Letter	Maximum	Minimum
Q_1	24°	11°

3.2.2 Fixed connector contacts



IEC 121/02

Figure 4 - Physical interface, fixed connector contacts, front view, see table 2

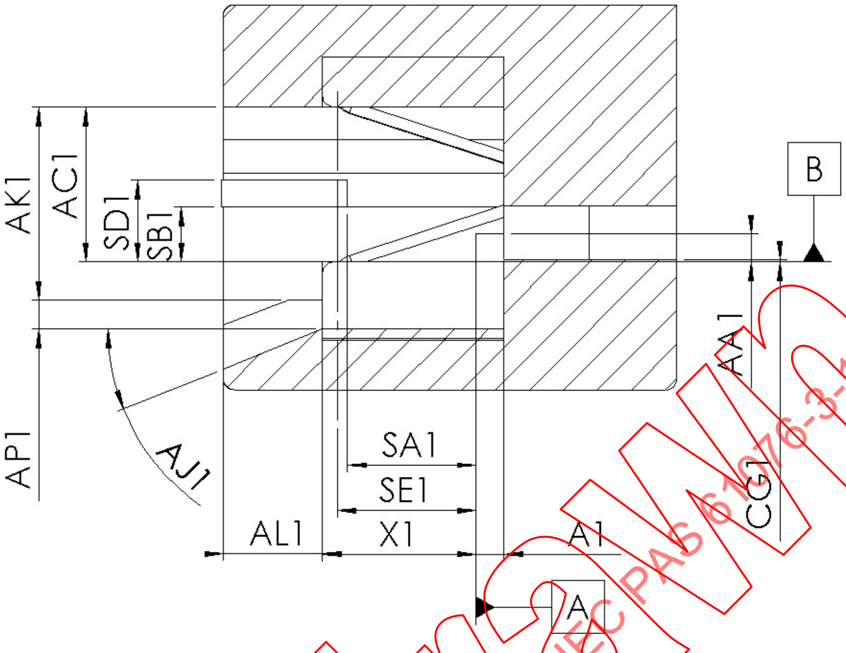


Figure 5 - Physical interface, fixed connector contacts, side view, see table 2

NOTE The fixed connector switch is actuated by the extension of the switch actuator protrusion located on the free connector. The fixed connector switch is located accordingly.

Table 2 – Physical interface, fixed connector contacts dimensions

Letter	Maximum		Minimum		Nominal	
	mm	in	mm	in	mm	in
A1			1,47	0,058		
B1	0,71	0,028				
K1	5,84	0,230				
S1	12,04	0,474	11,84	0,466	11,94	0,470
T1	4,19	0,165	3,94	0,155		
W1	6,38	0,251	6,22	0,245		
X1	6,86	0,270	6,68	0,263		
AA1	1,24	0,049				
AB1	0,38	0,015				
AC1	6,96	0,274	6,76	0,266	6,86	0,270
AD1	0,13	0,005				
AH1					1.02	0,040
AK1	8,66	0,341	8,38	0,330		
AL1			1,40	0,055		
AM1			1,52	0,060		
AP1			1,27	0,050		
CA1	2,30	0,091	2,20	0,087		
CK1			0,65	0,026		
CN1	1,40	0,055	1,30	0,051		
CP1	5,05	0,199	4,95	0,195		
CQ1	6,00	0,236	5,80	0,228		
CS1					7,66	0,3016
CT1	13,0	0,512	12,9	0,508		
SA1			5,31	0,209		
SB1	2,16	0,085				
SD1			4,90	0,193		
SE1	5,80	0,288				
Letter						
AJ1					15°	

3.2.3 Free connector contacts

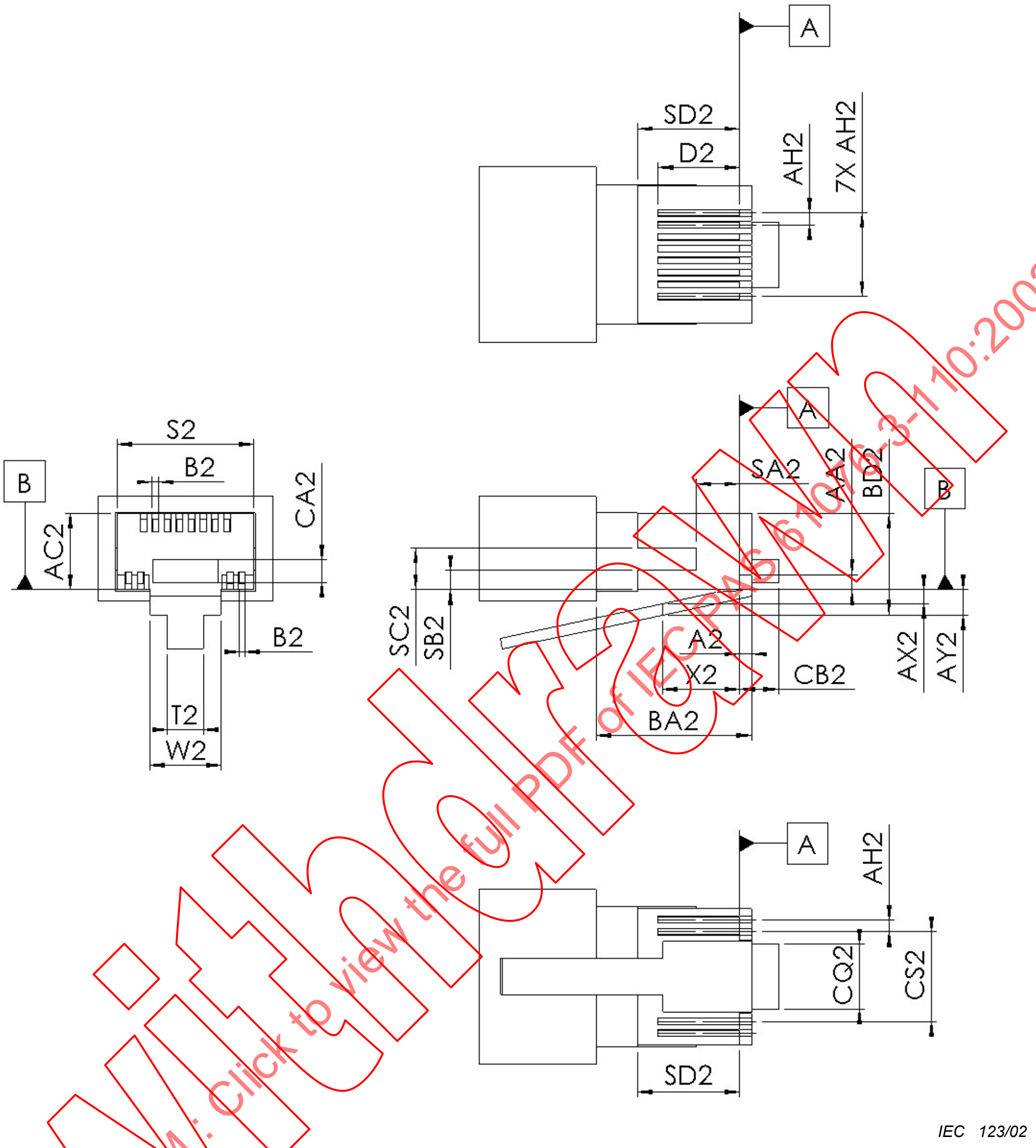


Figure 6 - Physical interface, free connector contacts, see table 3

Table 3 – Physical interface, free connector contact dimensions

Letter	Maximum		Minimum		Nominal	
	mm	in	mm	in	mm	in
A2	1,45	0,057	0,89	0,035	1,17	0,046
B2	0,61	0,024	0,51	0,020	0,56	0,022
S2	11,79	0,464	11,58	0,456	11,68	0,460
T2	3,38	0,133	3,12	0,123		
W2	6,17	0,243	6,02	0,237		
X2	6,02	0,237	5,77	0,227		
AA2			1,24	0,049		
AC2	6,71	0,264	6,50	0,256	6,60	0,260
AH2					1,02	0,040
AX2	1,32	0,052				
AY2	2,87	0,113	2,67	0,105		
BD2			8,38	0,330		
CA2	2,20	0,087	2,00	0,079		
CB2	3,95	0,155	3,75	0,148		
CQ2	5,70	0,224	5,50	0,216		
BA2			12,32	0,485		
CS2					7,66	0,3016
SA2	4,22	0,166				
SB2	2,11	0,083				
SC2			4,95	0,195		
SD2			6,85	0,270		

4 Dimensions

4.1 General

Dimensions are given in millimetres, with inch equivalents. The original dimensions are in inches.

The basic type A, type B, and type C connector dimensions are similar to those given for the same types specified for IEC 60603-7 series connectors. Specific dimensions given herein are limited to the free connector switch actuator dimensions, which should be used to implement this standard.

4.2 Type C free connectors

4.2.1 Free connector, side protrusions dimensions

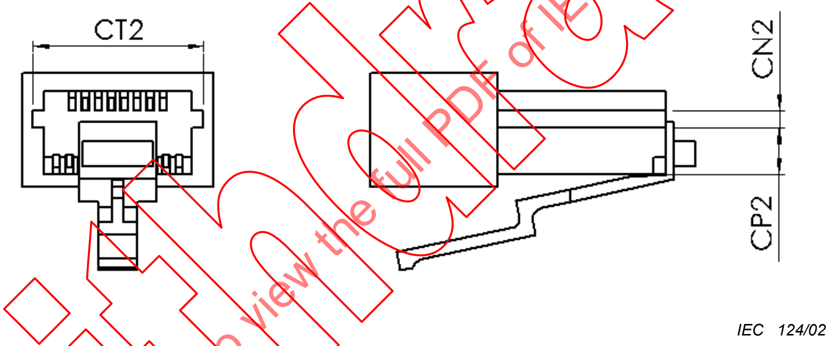


Figure 7 - Free connector, switch actuator dimensions, see table 4

Table 4 –Free connector, switch actuator dimensions

Letter	Maximum		Minimum	
	mm	in	mm	in
CN2	1,3		1,2	
CP2	5,05		4,95	
CT2	12,85		12,75	

4.3 Terminations

Free connectors are terminated to cordage or cable to provide connector cord and cable assemblies. The connector type designation provides basic terminations concerning the type of conductor (stranded or solid) to which the conductor may be applied, and the type of connection used (solder, insulation displacement, etc.). Specific details concerning wire gauge size, type and thickness of conductor insulation, size and shape of cordage or cable jacket, etc., are not part of this specification. Cable shield construction and method of cable shield termination are not part of this specification. These shall be as agreed between purchaser and supplier. Minor variations in a free connector's interior details to accommodate differing wire gauge sizes, outer jackets, etc., do not require the generation of new free connector variants.

5 Gauges

See annex A for additional gage information.

5.1 Fixed connectors

Gauges shall be made according to the following requirements:
Material: tool steel, hardened.
√ = Surface roughness, according to ISO 1302
Ra = 0,25 µm maximum. (10 µin maximum.)
A 0,01 mm (0,0004 in) wear tolerance shall be applied.
Clearance shall be provided for connector contacts.

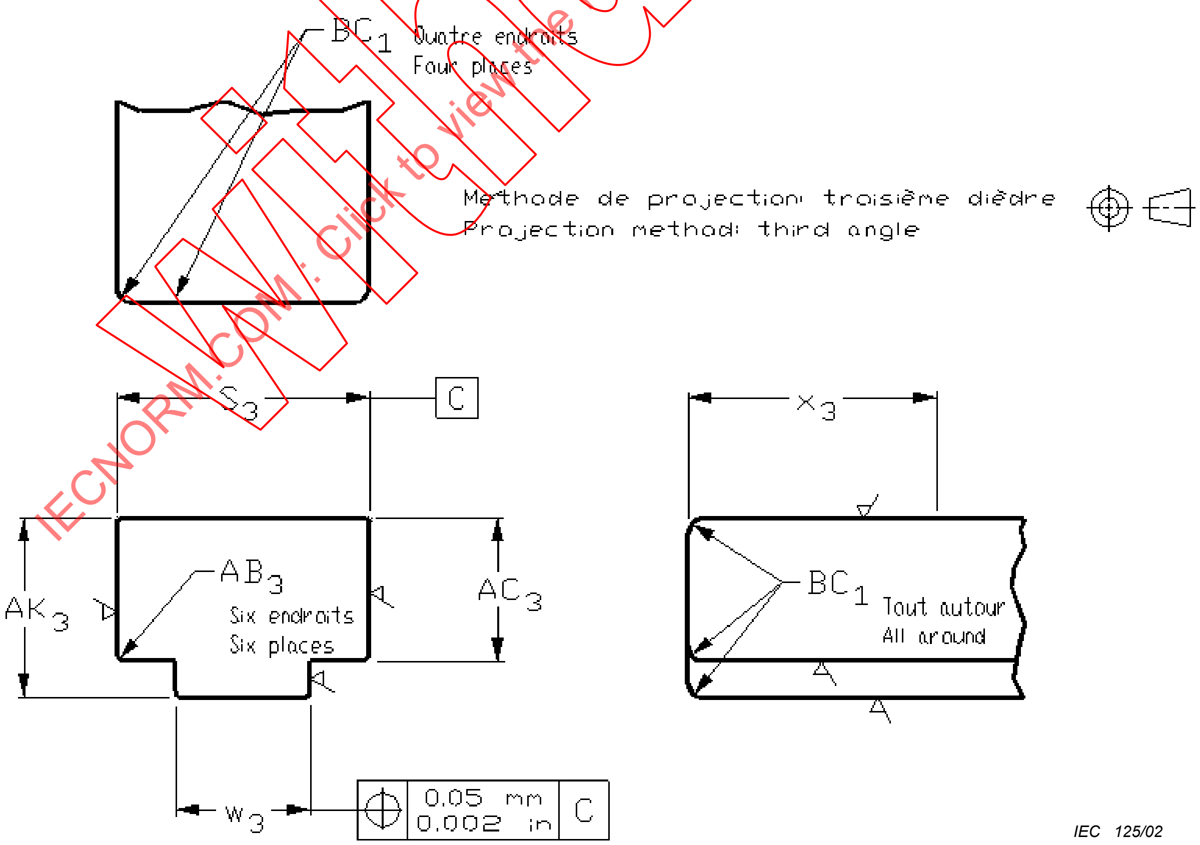


Figure 8 - Fixed connector GO gauge

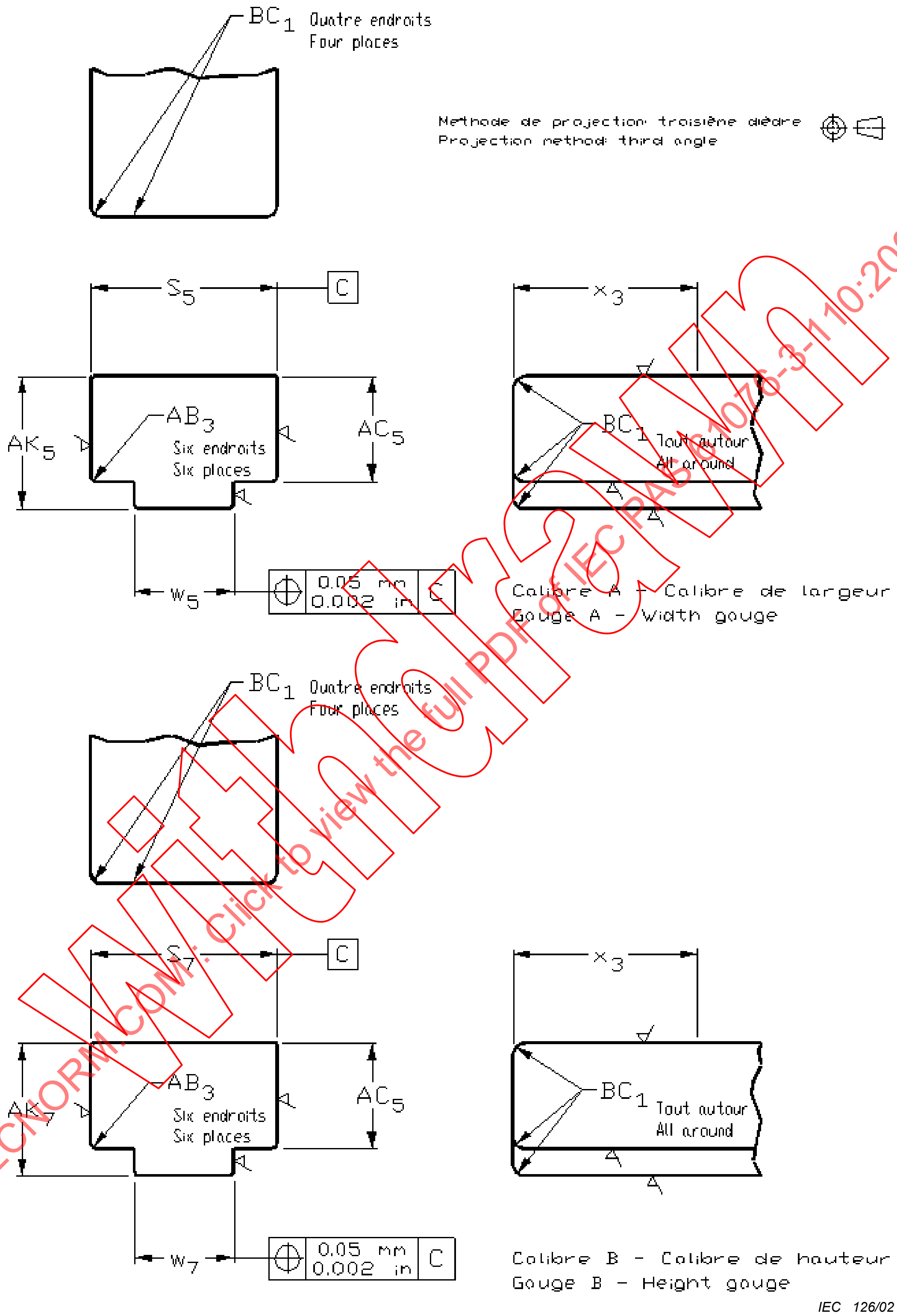


Figure 9 - Fixed connector NO-GO gauges

Table 5 – Fixed connector gauge dimensions

Letter	Maximum		Minimum		Nominal (ref)	
	mm	in	mm	in	mm	in
S_3	11,796	0,4644	11,786	0,4640		
S_5	12,050	0,4744	12,040	0,4740		
S_7	11,68	0,460	11,58	0,456		
X_3			10,16	0,400		
AB_3	0,51	0,020	0,389	0,0153	0,450	0,0177
AC_3	6,716	0,2644	6,706	0,2640		
AC_5	6,45	0,254	6,35	0,250		
AC_7	6,970	0,2744	6,96	0,274		
BC_1	0,89	0,035	0,64	0,025	0,76	0,030
W_3	6,12	0,241	6,109	0,2405		
W_5	6,38	0,251	6,365	0,2506		
W_7	5,97	0,235	5,89	0,232		
AK_3	8,357	0,3290	8,346	0,3286		
AK_5	8,13	0,320	8,05	0,317		
AK_7	8,672	0,3414	8,66	0,341		

5.2 Free connectors

Material: tool steel, hardened.

∇ = Surface roughness, according to ISO 1302.

Ra = 0,25 μm maximum (10 μin maximum).

A 0,01 mm (0,0004 in) wear tolerance shall be applied.

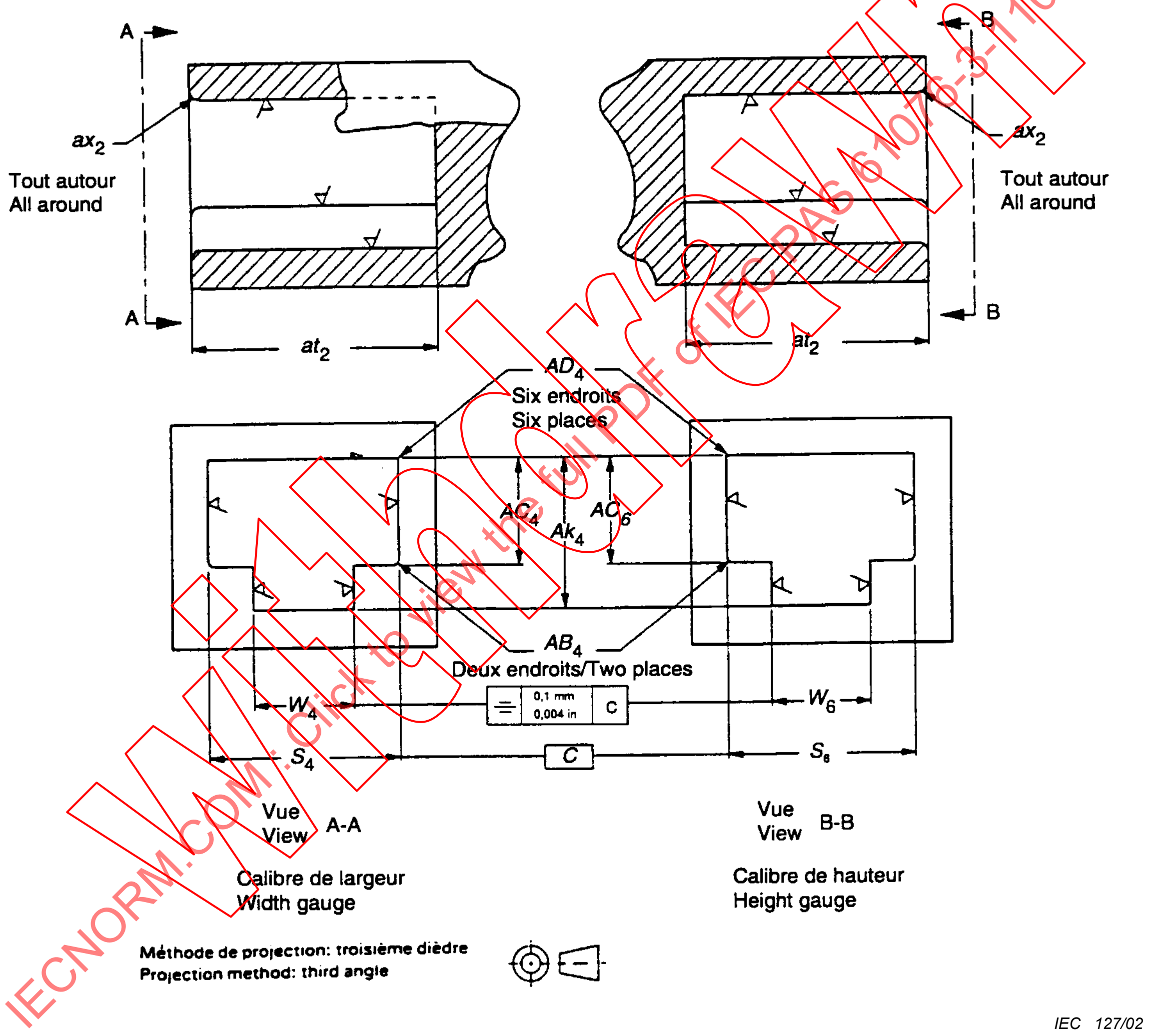


Figure 10 - Free connector NO-GO gauges

Table 6 – Free connector NO-GO gauges dimensions

Letter	Maximum		Minimum	
	mm	in	mm	in
S_4	11,593	0,4564	11,582	0,4560
S_6	11,989	0,472	11,887	0,468
W_4	6,02	0,237	6,010	0,2366
W_6	6,40	0,252	6,30	0,248
AB_4	0,38	0,015	0,0	0,0
AC_4	6,91	0,272	6,81	0,268
AC_6	6,512	0,2564	6,502	0,2560
AD_4	0,127	0,0050	0,0	0,0
AK_4	9,42	0,371	9,32	0,367
at_2	15,29	0,602	15,19	0,598
AX_2	0,635	0,0250	0,38	0,015

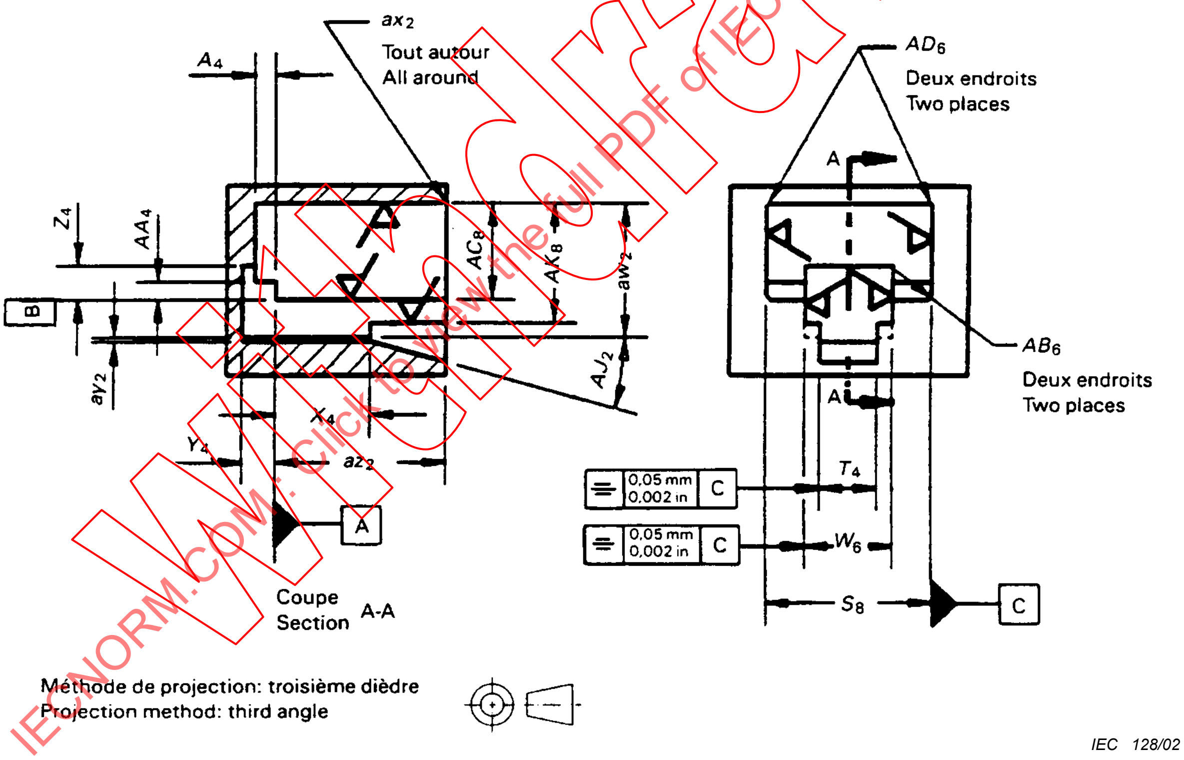


Figure 11 - Free connector GO gauges

Table 7 – Free connector GO gauges dimensions

Letter	Maximum		Minimum	
	mm	in	mm	in
A_4	1,448	0,0570	1,438	0,0566
S_8	11,847	0,4664	11,836	0,4660
T_4	4,115	0,1620	4,013	0,1580
W_6	6,198	0,2440	6,187	0,2436
X_4	6,604	0,2600	6,594	0,2596
Y_4	2,39	0,094	2,34	0,092
Z_4	2,39	0,094	2,29	0,090
AA_4	1,255	0,0494	1,245	0,0490
AB_6	0,38	0,015	0,0	0,0
AC_8	6,767	0,2664	6,756	0,2660
AD_6	0,13	0,005	0,0	0,0
AK_8	8,357	0,329	8,346	0,3286
aw_2	9,42	0,371	9,32	0,367
ax_2	0,64	0,025	0,38	0,015
ay_2	0,305	0,0120	0,295	0,0116
az_2	11,91	0,469	11,81	0,465

Letter	Maximum	Minimum
AJ_2	16°	14°

5.3 Switch actuator gauges

Switch actuator and protrusions gauge supplements and dimensions for use with the standard IEC 60603-7 series connector gauges are given in annex M.

6 Characteristics

6.1 General

The characteristics given within this specification are those that are specific to IEC 60603-7-7. The other relevant characteristics are given in IEC 60603-7-1. It is assumed that any connector complying with IEC 60603-7-7 also complies with IEC 60603-7-1 and with the other lower levels of IEC 60603-7-X performance requirements.

All the requirements and test schedules apply to the entire mated connectors including the switch unless otherwise specified.

6.2 Classification into climatic categories

The lowest and highest temperatures and the duration of the damp heat, steady state test should, unless otherwise impractical, be selected from the preferred values stated in 2.2 of IEC 61076-1. The connectors are classified into climatic categories in accordance with the general rules given in IEC 60068-1. The following preferred temperature range and severity of the damp heat steady state test have been selected to comply with IEC 61156.

Table 8 – Climatic categories – selected values

Climatic category	Temperature range °C	Damp heat steady state days
40/070/21	–40 to +70	21

6.3 Creepage and clearance distance

The permissible operating voltages depend on the application and on the applicable or specified safety requirements.

Insulation co-ordination is not required for this connector; therefore, the creepage and clearance distances in IEC 60664-1 are reduced and covered by overall performance requirements.

Therefore, the creepage and clearance distances are given as operating characteristics of mated connectors.

In practice, reductions in creepage or clearance distances may occur due to the conductive pattern of the printed board or the wiring used, and shall duly be taken into account.

Table 9 – Minimum distances

Type	Minimum distance between contacts and chassis				Minimum distance between adjacent contacts			
	Creepage		Clearance		Creepage		Clearance	
	mm	in	mm	in	mm	in	mm	in
A, B, C	1,40	0,055	0,51	0,020	0,36	0,014	0,36	0,014

6.4 Electrical characteristics

6.4.1 Voltage proof

Conditions: IEC 60512-2, test 4a.

Method A.

Mated connectors all variants:

1 000 V d.c. or a.c. peak, contact-to-contact,

1 500 V d.c. or a.c. peak, contact-to-test panel or contact-to-shield.

6.4.2 Current-carrying capacity

Conditions:

IEC 60512-3, test 5b.
All contacts, connected in series.

The current carrying capacity of connectors in accordance with the requirements of 2.4 of IEC 61076-1 shall comply with the derating curve given in figure 12.

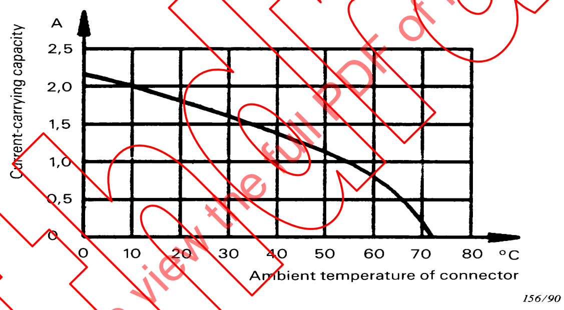


Figure 12 - Connector derating curve

6.4.3 Initial contact resistance

Conditions:

IEC 60512-2, test 2a, fixture according to 7.4.3.
Mated connectors.

Signal contacts: 20 mΩ max.

Screen contact: 20 mΩ max.
Switch contact: 20 mΩ max.

6.4.4 Input to output resistance

Conditions:

IEC 60512-2, test 2a.
Mated connectors.
Signal contacts: 200 mΩ maximum

Screen: 100 mΩ maximum

6.4.5 Input to output resistance unbalance

Conditions:

IEC 60512-2 test 2a

Mated connectors

Among all signal and switch conductors, maximum difference between maximum and minimum

100 mΩ maximum

6.4.6 Initial insulation resistance

Conditions:

IEC 60512-2, test 3a.
Method A.
Mated connectors
Test voltage: 100 V d.c.
All types: 500 MΩ minimum.

6.5 Transmission characteristics, category 7

Category 7 performance level, respective to transmission characteristics, is determined according to specific test methods described in annexes C to L. Category 7 level interoperability transmission performance of independent fixed or free connectors is determined by tests conducted when they are mated with precision test fixtures given in annex C.

Note: f is the frequency expressed in MHz.

6.5.1 Insertion loss

Conditions:Annex E, insertion loss.
Mated connectors, all pairs of contacts.
All types: $\leq 0{,}02 \times \sqrt{f}$ rounded to superior 0,1 dB.

6.5.2 Return loss

Conditions:

Annex F, return loss.
Mated connectors, all pairs of contacts.
All types: 64 – 20log (f) dB up to 600 MHz not ≥ 30 dB.

6.5.3 Propagation delay

Conditions:

Mated connectors, all pairs of contacts.
All types: ≤ 2,5 ns.

NOTE This characteristic does not need to be measured since it is achieved by design.

6.5.4 Delay skew

Conditions:

Mated connectors, all pairs of contacts.
All types: < 1,25 ns.

NOTE This characteristic does not need to be measured since it is achieved by design.

6.5.5 NEXT loss

Conditions:

Annex G, NEXT loss.
Mated connectors, between all combinations of 2 pairs of contacts.
All types: 102,4 – 15log (*f*) up to 600 MHz not ≥ 80 dB.

6.5.6 FEXT loss

Conditions:

Annex H, FEXT pr to pr.
Mated connectors, between all combinations of 2 pairs of contacts.
All types: 90 – 15log (*f*) up to 600 MHz not ≥65 dB.

6.5.7 Longitudinal conversion loss

Conditions:

Annex I, longitudinal conversion loss.
Mated connectors, all pairs of contacts.
All types: 66 – 20log (*f*) up to 80 MHz (ffs).

6.5.8 Coupling attenuation

Conditions:

Annex K, coupling attenuation test method under development.
Mated connectors, all pairs of contacts.
All types ≥ 80 dB, 30 MHz ≤ f ≤ 100 MHz f.f.s.
≥ 80 – 20 log (*f*/100) dB, 100 < f ≤ 1 000 MHz f.f.s

NOTE The coupling attenuation requirement is assumed to be fulfilled when the transfer impedance requirement is met on the full bandwidth. Coupling attenuation should only be performed on cable assemblies.

6.5.9 Transfer impedance

Conditions:

Annex J, transfer impedance test method under development.
Mated connectors.
All types: under study.
0,5 Ω from 1 to 10 MHz ffs.
0,01*f Ω from 10 to 80 MHz.*

NOTE There is no requirement from 80 MHz to 600 MHz because coupling attenuation covers the need.

6.6 Mechanical characteristics

6.6.1 Mechanical operation including switch

Conditions:

IEC 60512-5, test 9a and annex B.
Speed: 10 mm/s (0,4 in/s) maximum.
Rest: 5 s minimum (unmated).
PL1: 750 operations.

6.6.2 Effectiveness of connector coupling devices

Conditions:

IEC 60512-8, test 15f.
Mated connectors.
All types: 50 N for 60 s ± 5s.

6.6.3 Insertion and withdrawal forces

Conditions:

IEC 60512-13-2, test 13b.
Speed: 10 mm/s maximum.
All types, insertion and withdrawal: 20 N maximum.

7 Tests and test schedule

7.1 General

See clause 4 of IEC 61076-1.

All the requirements and test schedules apply to the entire mated connectors including the switch unless otherwise specified.

The detail specification shall state the test sequence (in accordance with this standard), and the number of specimens for each test sequence (not less than four mated pairs).

Individual variants may be submitted to type tests for approval of those particular variants.

It is permissible to limit the number of variants tested to a selection representative of the whole range for which approval is required (which may be less than the range covered by the detail specification), but each feature and characteristic shall be proved.

The connectors shall have been processed in a careful and workmanlike manner, in accordance with good current practice.

7.2 Test procedures and measuring methods

The test methods specified and given in the relevant standards are the preferred methods but are not necessarily the only ones that can be used. In case of dispute, however, the specified method shall be the reference method.

Unless otherwise specified, all tests shall be carried out under standard atmospheric conditions for testing as specified in IEC 60068-1.

Where approval procedures are involved and alternative methods are employed it is the responsibility of the manufacturer to satisfy the authority granting approval that any alternative methods which he may use give results equivalent to those obtained by the methods specified.

7.3 Preconditioning

Before the tests are made, the connectors shall be preconditioned under standard atmospheric conditions for testing as specified in IEC 60068-1 for a period of 24 hours unless otherwise specified by the detail specification.

7.4 Wiring and mounting of specimens

7.4.1 Wiring

Wiring of these connectors shall take into account wire diameter of the cables defined in IEC 61156 parts 2, 3 and 4 as applicable. Where wiring and/or shielding of test specimens is required, the detail specification shall contain information suitable to comply with the selected methods of test.

7.4.2 Mounting

When mounting is required in a test, unless otherwise specified, the connectors shall be rigidly mounted on a metal plate or to specified accessories, whichever is applicable, using the specified connection methods, fixing devices and panel cut-outs as laid down in the detail specification.

7.4.3 Arrangement for contact resistance measurement

For the measurement of contact resistance, the points of connection shall be as shown in figure 13.

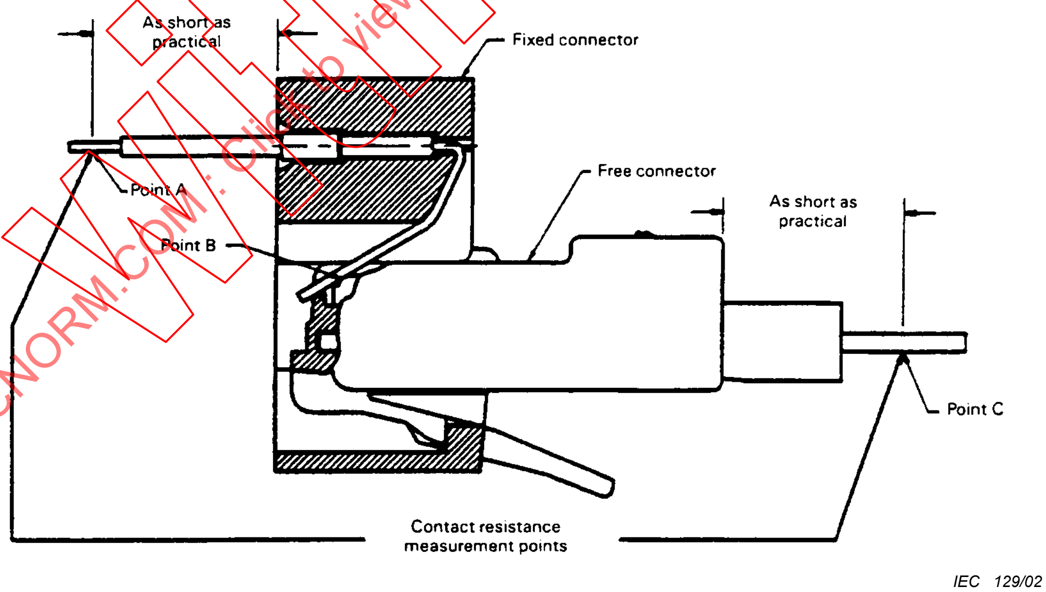


Figure 13 - Contact resistance measurement

7.4.4 Test procedure

a) Determine the bulk resistance of the fixed connector between points A and B of figure 13 by calculation or by measurement.

b) Determine the bulk resistance of the free connector between points B and C of figure 13 by calculation or by measurement.

c) Measure the total mated connector resistance between points A and C, following the requirements and procedures of IEC 60512-2, test 2a.

d) Calculate the contact resistance by subtracting the sum of the bulk resistance of the fixed and free connectors from the total mated connector resistance.

$$\text{Contact resistance} = R_{AC} - (R_{ABI} + R_{BCI})$$

where I indicates initial value.

7.4.5 Arrangement for dynamic stress tests (test phases AP6, AP7)

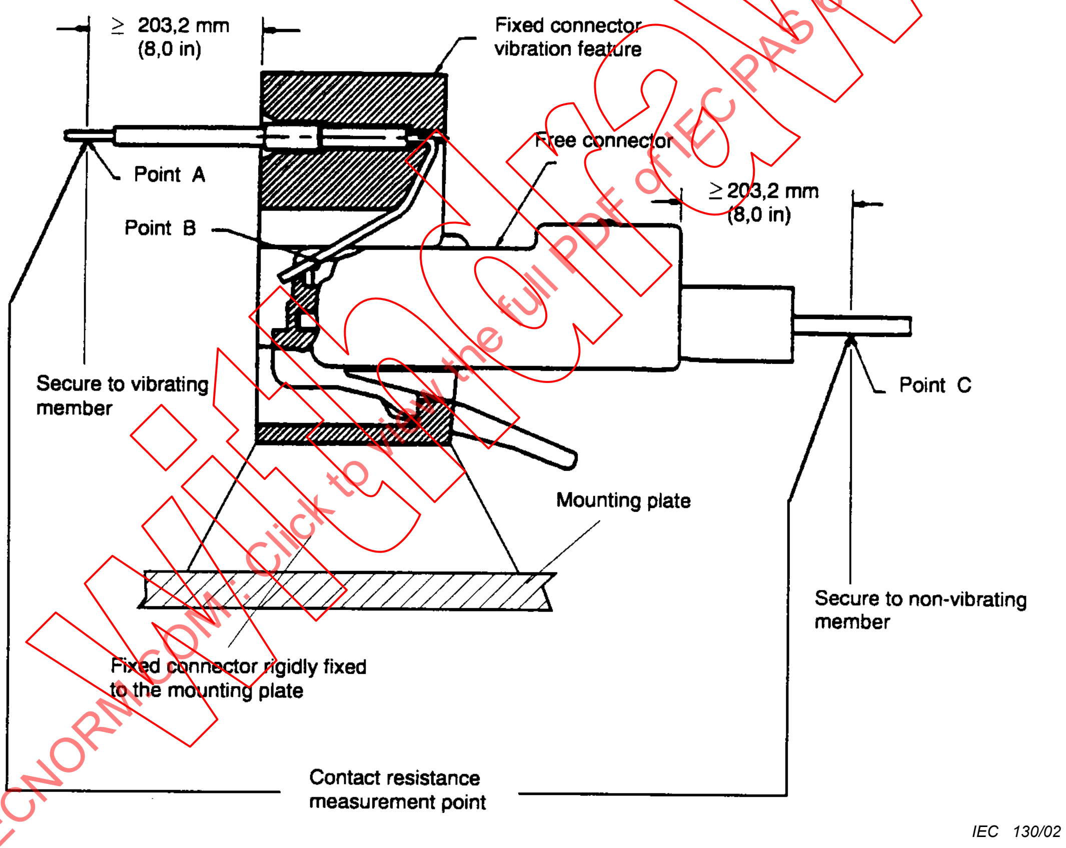


Figure 14 - Contact resistance measurement

7.5 Test schedules

The test parameters required shall not be less than those listed in 7.5.2. Unless otherwise specified, the requirements included in the following tables should be viewed as target values.

7.5.1 Basic (minimum) test schedule

Not applicable.

7.5.2 Full test schedule

The following tests specify the characteristics to be checked and the requirements to be fulfilled.

For a complete test sequence, 52 specimens are needed (5 groups of 10 and 1 group of 2. The group of 2 shall be for transmission testing, group E).

7.5.2.1 Test group P preliminary

All specimens shall be subjected to the following tests. All the test group specimens shall be subjected to the preliminary group P tests in the following sequence.

The specimens shall then be divided into the appropriate number of groups. All connectors in each group shall undergo the following tests as described in the sequence given, required alteration of the sequence of tests or adding of new tests to verify additional connector characteristics.

Table 10 – Test group P

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 test No.	Severity or condition of test	Title	IEC 60512 test No.	Requirements
P 1	General examination	1		Visual examination	1a	There shall be no defects that would impair normal operation
				Examination of dimensions and mass	1b	The dimensions shall comply with those specified in the detail specification.
P 2	Polarization					
P 3	Contact resistance		Measurement points as in figure 13 All contacts/specimens	Millivolt level method or contact resistance – specified test current method	2a	Contact resistance = 20 mΩ max.
P 4			Test voltage 100 V ± 15 V d.c. Method A Mated connectors	Insulation resistance	3a	500 MΩ minimum
P 5			Contact/contact Method A Mated connectors	Voltage proof	4a	1 000 V d.c. or a.c. peak
			All contacts to test panel Method A Mated C			1 500 V d.c. or a.c. peak.

7.5.2.2 Test group AP

Table 11 – Test group AP

Test phase	Test			Measurement to be performed		
	Title	**Test No.**	**Severity or condition of test**	**Title**	**IEC 60512 Test No.**	**Requirements**
AP 1	Insertion and withdrawal forces	IEC 60512-7, test 13b	Connector locking device depressed			Insertion force 20 N max. Withdrawal force 20 N max.
AP 2	Effectiveness of connector coupling device	IEC 60512-8, test 15f	Rate of load application 44,5 N/s max.			50 N for 60 s ± 5 s
AP 3	Rapid change of temperature	11d	–40 °C to 70 °C Mated connectors 25 cycles ι = 30 min Recovery time 2 h			
AP 4			Test voltage 100 V ±15 V d.c. Method A Mated connectors	Insulation resistance	3a	500 MΩ min.
AP 5			Measurement points as in figure 13 All contacts/specimens	Contact resistance	2a	20 mΩ max. change from initial
AP 6			Contact/contact: Method A Mated connectors	Voltage proof	4a	1 000 V d.c. or a.c. peak
			All contacts to test panel: Method A Mated connectors			1 500 V d.c. or a.c. peak
AP 7			Unmated connectors	Visual examination	1a	There shall be no defects that would impair normal operation
AP 8	Cyclic damp heat	60068-2-38	21 cycles low temperature 25 °C High temperature 65 °C cold subcycle –10 °C Humidity 93 % Half of the samples in mated state Half of the samples in unmated state			
AP 9			Measurement points as in figure 13 All contacts/specimens	Contact resistance	2a	20 mΩ max. change from initial
AP 10	Insertion and withdrawal forces	IEC 60512-7, test 13b	Connector locking device depressed			Insertion force 20 N max. Withdrawal force 20 N max.
AP 11	Effectiveness of connector coupling device	IEC 60512-8, test 15f	Rate of load application 44,5 N/s max.			50 N for 60 s ± 5 s
AP 12			Unmated connectors	Visual examination	1a	There shall be not defects that would impair normal operation
AP 13	Solderability		As applicable			
AP 14	Resistance to soldering heat		As applicable			

Test phase	Test			Measurement to be performed		
	Title	**Test No.**	**Severity or condition of test**	**Title**	**IEC 60512 Test No.**	**Requirements**
AP 15			See Note Contact/contact: Method A Mated connectors	Voltage proof	4a	1 000 V d.c. or a.c. peak
			All contacts to test panel: Method A Mated connectors			1 500 V d.c. or a.c. peak
NOTE Do not perform step AP 15 if solderability and resistance to soldering heat were not performed.						

7.5.2.3 Test group BP

Table 12 – Test Group BP

Test phase	Test			Measurement to be performed		
	Title	**IEC 60512 test No.**	**Severity or condition of test**	**Title**	**IEC 60512 test No.**	**Requirements**
BP 1	Locking device mechanical operations		2 N operations – see mechanical operations			See annex B
BP 2	Mechanical operations	9a	N/2 operations – see mechanical operations Speed 10 mm/s (0,4 in/s) Rest 5 s (when unmated) Locking device inoperative			(N) = 750
BP 3	Flowing mixed gas corrosion	11g	4 days Half of the samples in mated state Half of the samples in unmated state		11-7	
BP 4			Measurement points as in figure 13 All contacts/specimen	Contact resistance	2a	20 mΩ maximum change from initial
BP 5	Mechanical operations	9a	N/2 operations – see mechanical operations Speed 10 mm/s (0,4 in/s) Rest 5 s (when unmated) Locking device inoperative			
BP 6			Measurement points as in figure 13 All contacts/specimen	Contact resistance	2a	20 mΩ max. change from initial
BP 7			100 V ± 15 V d.c. Method A Mated connectors	Insulation resistance	3a	500 MΩ Min.
BP 8			Contact/contact: Method A Mated connectors	Voltage proof	4a	1 000 V d.c. or a.c. peak
			All contacts to test panel: Method A Mated connectors			1 500 V d.c. or a.c. peak
BP 9				Visual examination	1a	There shall be no defects that would impair normal operation

7.5.2.4 Test group CP

Table 13 – Test group CP

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 test No.	Severity or condition of test	Title	IEC 60512 test No.	Requirements
CP 1	Vibration	11c	6d 60068-2-6	Contact disturbance	2e	10 μs max.
CP 2			Test voltage 100 V d.c. Method A Mated connectors	Insulation resistance	3a	500 MΩ min.
CP 3			Measurement points as in figure 13 All contacts/specimens	Contact resistance	2a	20 mΩ max. change from initial
CP 4			Unmated connectors	Visual examination	1a	There shall be no defects that would impair normal operation

7.5.2.5 Test group DP

Table 14– Test Group DP

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 test No.	Severity or condition of test	Title	IEC 60512 test No.	Requirements
DP 1	Electrical load and temperature	9b	5 connectors 500 h 70 °C Recovery period 2 h			0,5 A, 5 connectors No current: 5 connectors
DP 2			Test voltage: 100 V d.c. Method A Mated connectors	Insulation resistance	3a	500 MΩ min.
DP 3			Contact/contact: Method A Mated connectors	Voltage proof	4a	1 000 V d.c. or a.c. peak
			All contacts to test panel: Method A Mated connectors			1 500 V d.c. or a.c. peak
DP 4			Unmated connectors	Visual examination	1a	There shall be no defects that would impair normal operation
DP 5			Measurement points as in figure 13 All contacts/specimens	Contact resistance	1a	20 mΩ max. change from initial

7.5.2.6 Test group EP

Table 15 – Test Group EP

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 test No.	Severity or condition of test	Title	Test	Requirements
EP1				Insertion loss	Annex E	< 0,02 √(f) rounded to superior 0,1 dB See notes 4, 6, 7
EP 2			All pairs, both directions, (pair to pair)	NEXT loss	25-1; Annex G	102,4 – 15log(f) See notes 1, 6, 7
EP 3			All pairs, both directions	Return loss	Annex F	64 – 20log(f) See notes 2, 6, 7
EP 4			All pairs, both directions, (pair to pair)	FEXT loss	Annex H	90 – 15log(f) See notes 3, 6, 7
EP 5				Longitudinal conversion loss	Annex I	66 – 20log(f) See notes 5, 6, 7
EP 6				Transfer impedance	Annex J	$0,5f^{0.301}$ Ω from 1 to 10 MHz 0,01f Ω from 10 to 80 MHz
EP 7				Coupling attenuation	Annex K	[≥ 80 – 20log(f/100)] dB from > 100 to 1 000 MHz ffs See notes 6,7
EP 8	Input to output resistance		Measurement points as in figure 13 All signal contacts switch contacts and screen / specimens	Millivolt level method	2a	Signal contact resistance = 200 mΩ maximum. Screen resistance = 100 mΩ maximum
EP 9	Resistance unbalance		Measurement points as in figure 13 All signal contacts and switch contacts specimens	Millivolt level method	2a	Unbalance resistance = 100 mΩ maximum

NOTE 1 NEXT loss at frequencies that correspond to calculated values of greater then 80 dB shall revert to a minimum requirement of 80 dB.

NOTE 2 Return loss at frequencies that correspond to calculated values of greater then 30 dB shall revert to a minimum requirement of 30 dB.

NOTE 3 FEXT loss at frequencies that correspond to calculated values of greater then 65 dB shall revert to a minimum requirement of 65 dB.

NOTE 4 Attenuation at frequencies that correspond to calculated values of less than 0,1 dB shall revert to a requirement of 0,1 dB maximum.

NOTE 5 Balance at frequencies that correspond to calculated values of greater then 60 dB shall revert to a minimum requirement of 60 dB.

NOTE 6 All transmission results shall report the overall worst case for the corresponding pair or pair combination after testing the ten samples.

NOTE 7 All measurements to be performed on mated connectors.

7.5.2.7 Test group FP

Table 16 – Test Group FP

Test phase	Test			Measurement to be performed		
	Title	Test	Severity or condition of test	Title	IEC 60512 Test No.	Requirements
FP 1	Surge test	ITU-T K.20	Mated connectors, Table 2a /2b, Basic test level Tests 2.1.1a, 2.1.1b, 2.1.3, 2.2.1a and 2.3.1a			Test 2.1 & 2.2: Acceptance criteria A per ITU-T K.44, clause 9, Test 2.3: Acceptance criteria B per ITU-T K.44, clause 9,
FP 2			100 V ± 15 V d.c. Method A Mated connectors	Insulation resistance	3a	500 MΩ min
FP 3			Unmated connectors	Visual examination	1a	There shall be no defects that would impair normal operation

Annex A
(normative)

Gauging requirements

A.1 Fixed connectors

The go gauge specified in 5.1 shall be capable of being inserted and removed with a force of 8,9 N (2 lbf) maximum.

The no-go gauges specified in 5.1 shall not be capable of entering the fixed connector more than 1,78 mm (0,070 in) with an 8,9 N (2,0 lbf) insertion force.

A.2 Free connectors

The connector shall be capable of insertion and latching into the go gauge specified in 5.2 with a 20 N (4,5 lbf) or less insertion force with the latch bar depressed.

After insertion and latching, the connector shall be capable of removal, with the latch depressed, with a removal force of 20 N (4,5 lbf) or less applied at an advantageous angle.

The free connectors shall not be capable of entering the no-go gauges specified in 5.2 more than 1,78 mm (0,070) with an 8,9 N (2,0 lbf) insertion force.

Annex B
(normative)

Locking device mechanical operation – test procedure and requirements

B.1 Object

The object of this mechanical endurance test is to assess the operational limits of the locking device on free connectors.

B.2 Preparation of the specimens

The specimen shall be prepared and mounted so that the locking device is readily accessible for application of the test. No other movement of the free connector shall be allowed.

B.3 Test method

The specimen shall be subjected to mechanical operational endurance tests of the number of cycles, as specified in test BP2 of table 12.

The speed of the operation of the applied force to the locking device shall not exceed 20 cycles per minute.

The specimen shall be operated in the normal manner, and the locking device shall be depressed until it contacts the body of the free connector.

Mechanical aids which simulate normal operations may be used, provided that they do not introduce abnormal stresses.

B.4 Final measurements

After the specified number of operations, the specimens shall show no visual indication of fatigue or stress cracking of the locking device.

Annex C
(normative)

High frequency (category 7) transmission interoperability testing

C.1 Object

Mated pairs of connectors are required to meet the transmission performance specifications of this annex. To evaluate the performance of individual connectors, a means is provided to connect the interface side of the connector directly to the port of the network analyser equipment. The termination side of the connector is connected to the other port of the network analyser equipment.

C.2 Test equipment

The equipment used shall be as described in annex D.

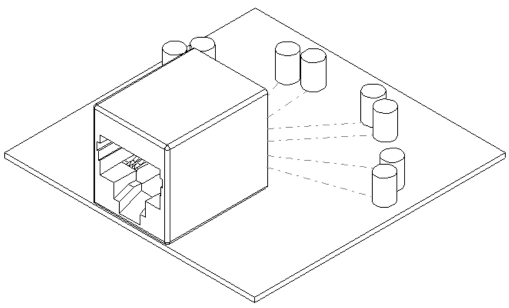
C.3 Free connector precision test fixture construction

Interoperability testing of free connectors is conducted by terminating the free connector interface to a precision test fixture.

There is no crosstalk compensation implementation within the test fixture.

A fixed board mount type connector is used with a board to make connections to the network analyser, see figure C.1. Only the 4 pairs (8 contacts) of connector used for high frequency transmission are terminated to leads on the board for connection to the network analyser interface. The other 2 pairs (4 contacts) of the connector are terminated to the measurement ground plane.

50 Ω strip line leads are used to facilitate either 100 Ω differential mode stimulus and detection using baluns or coupled transmission mode stimulus and detection using direct connections to network analyser equipment. Strip lines terminate each connector lead to female SMA terminations.



IEC 131/02

Figure C.1 – Free connector precision test fixture

C.4 Fixed connector precision test fixture construction

Interoperability testing of fixed connectors is conducted by terminating the fixed connector interface to a precision test fixture.

A free connector (variant 02) is used with a board to make connections to the network analyser, see figure C.2. Only the 4 pairs (8 contacts) of connector used for high frequency transmission are terminated to leads on the board for connection to the network analyser interface. The other 2 pairs (4 contacts) of the connector are terminated to the measurement ground plane.

50 Ω strip line leads are used to facilitate either 100 Ω differential mode stimulus and detection using baluns or coupled transmission mode stimulus and detection using direct connections to network analyser equipment. Strip lines terminate each connector lead to female SMA terminations.

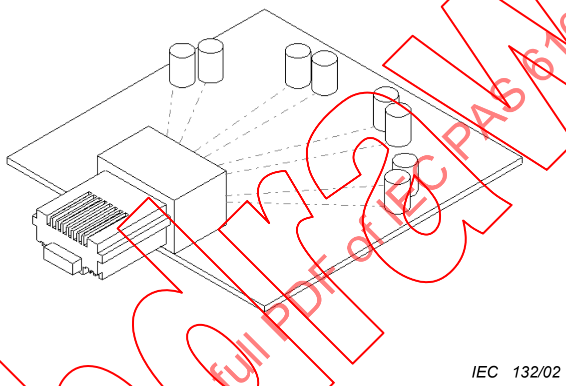


Figure C.2 – Fixed connector precision test fixture

C.5 Alternate fixed or free connector test fixture

The fixture consists of a fixed or free connector with a cover over the termination area that completely isolates the pairs. The cover portion may vary from manufacturer to manufacturer. The “cover” shall be used to shield the terminations on the far side of the connector under test.

C.6 Test fixture requirements

The performance of the precision test fixture, fixed and free, are verified together to have return loss, NEXT and FEXT performance that are a minimum of 6 dB superior to the standard category 7 requirements.

C.7 Test procedure

With the connector mated to the appropriate test fixture, measure the NEXT and FEXT performance for each pair combination as outlined in annexes G and H respectively.

Annex D
(normative)

General requirements for the measurement set-up

D.1 Test instrumentation

These electrical test procedures require the use of a vector network analyser. The analyser should be capable of full two port calibrations. The analyser shall cover the frequency range of 1 MHz to 1 GHz at least.

At least 2 test baluns are required in order to perform measurements with balanced symmetrical signals. The requirements for the baluns are given in clause D.4.

Reference loads and cables are needed for the calibration of the set-up. Requirements for the reference components are given in subclause D.5.1 and D.5.2 respectively.

Termination loads are needed for the termination of pairs, used and unused, which are not terminated by the test baluns. Requirements for the termination loads are given in clause D.6.

A test adapter (triaxial test set) is needed for the transfer impedance measurements. Reference to requirements for this set-up is given in annex J.

An absorbing clamp and ferrite absorbers are needed for the coupling attenuation measurements. The requirements for these items are given in annex K.

D.2 Coaxial cables and test leads for network analysers

Coaxial cable assemblies between network analyser and baluns should be as short as possible. (It is recommended that they do not exceed 60 cm each).

The baluns shall be electrically bonded to a common ground plane. For crosstalk measurements, a test fixture may be used, in order to reduce residual crosstalk (see annex L).

Balanced test leads and associated connecting hardware to connect between the test equipment and the connector under test shall be taken from components that meet or exceed the requirements for the relevant category. Balanced test leads shall be limited to a maximum of 7 cm between each balun and the reference plane of the connector under test. Pairs shall remain twisted from the baluns to where connections are made.

D.3 Measurement precautions

To assure a high degree of reliability for transmission measurements, the following precautions are required:

1) Consistent and stable balun and resistor loads shall be used for each pair throughout the test sequence.
2) Cable and adapter discontinuities, as introduced by physical flexing, sharp bends and restraints shall be avoided before, during and after the tests.
3) The relative spacing of conductors in the pairs shall be preserved throughout the tests to the greatest extent possible.

4) The balance of the cables is maintained to the greatest extent possible by consistent conductor lengths and pair twisting to the point of load.

5) The sensitivity to set-up variations for these measurements at high frequencies demands attention to detail for both the measurement equipment and the procedures.

D.4 Balun requirements

The baluns may be balun transformers or 180° hybrids with attenuators to improve matching if needed (see figure D.1).

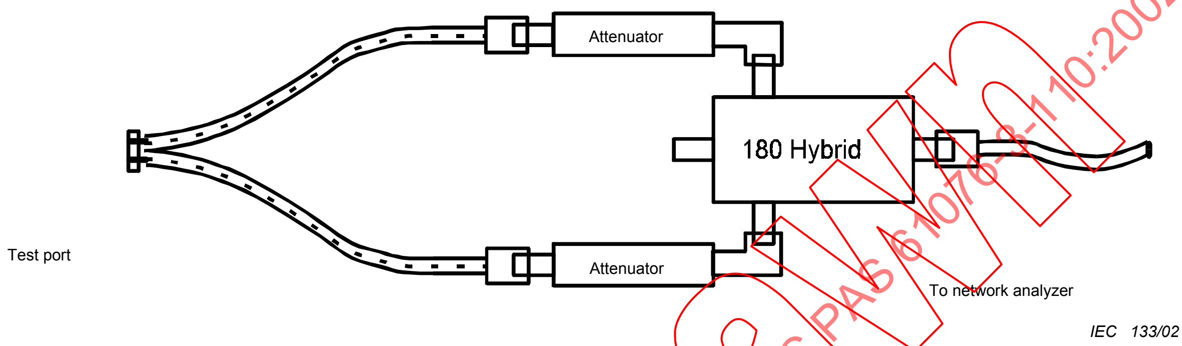


Figure D.1 – 180° hybrid used as a balun

The specifications for the baluns apply for the whole frequency range for which they are used. Baluns shall be RFI shielded and shall comply with the specifications listed in table D.1.

Table D.1 – Test balun performance characteristics

Parameter	Requirement at test frequencies up to 250 MHz	Requirement at test frequencies above 250 MHz
Impedance, primary	Matched to applied network analyser	
Impedance, secondary	100 Ω	
Insertion loss	10 dB max.	
Return loss secondary	14 dB min.	
Return loss – common mode with common mode termination [1]	10 dB minimum	
Return loss – common mode without common mode termination [1]	1 dB max.	not applicable
Longitudinal balance [2]	50 dB	not applicable
Common mode rejection [3]	50 dB	40 dB
Output signal balance [3]	50 dB	40 dB
Power rating	0,1 W	

[1] Measured by connecting the balanced output terminals together and measuring the return loss. The nominal primary impedance shall terminate the primary input terminal.

[2] Applicable for baluns, which are used for balance measurements. Measured from primary input terminal to common mode terminal when secondary balanced terminal is terminated with 100 Ω.

[3] Measured according to ITU-T G.117 and ITU-T O.9.

D.5 Reference components for calibration

D.5.1 Reference loads for calibration

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

The reference load shall be calibrated against a calibration reference, which shall be a 50 Ω load, traceable to an international reference standard. Two 100 Ω reference loads in parallel shall be calibrated against the calibration reference. The reference loads for calibration shall be placed in a N type connector according to IEC 60169-16, meant for panel mounting, which is machined flat on the back side (see figure D.2). The loads shall be fixed to the flat side of the connector, distributed evenly around the centre conductor. A network analyser 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 at frequencies up to 100 MHz and > 40 dB at frequencies above 100 MHz and up to the limit for which the measurements are to be carried out.

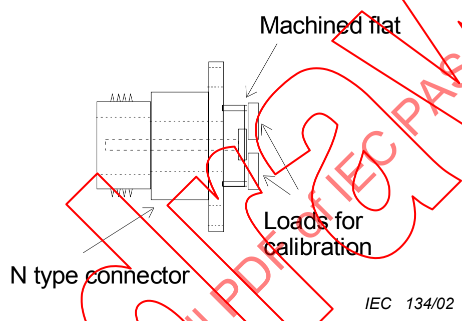


Figure D.2 – Calibration of reference loads

D.5.2 Reference cables for calibration

As a minimum, reference cable that is used to perform calibration of the test set-up shall satisfy the requirement of the same category according to IEC 61156 as the category of the connector. The reference cable shall be a length of horizontal cable for which the sheath is preserved. One of the pairs of the reference cable is used for the calibrations. The total length of reference cable shall be according to the length of the measurement cables as outlined in the calibration procedures for the various tests. Both ends of the reference cable must be well prepared, so that the twisting is maintained up to the test ports.

D.6 Termination loads for termination of conductor pairs

During measurement, conductor pairs of the measurement cables for the connector under test shall be terminated according to the specified test set-up 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. For differential mode only terminations, only resistor loads are allowed[1].

The nominal differential mode impedance of the termination shall be 100 Ω. The nominal common mode impedance shall be 50 Ω ± 25 Ω.

NOTE The exact value of the common mode impedance is not critical for most measurements. Normally, a value of 75 Ω is used for unscreened connectors, while a value of 25 Ω is used for screened connectors.

1 Unpredictable stray capacitances in baluns causes resonances at high frequencies, if they are used as terminations, when the common mode terminal is open.

Resistor loads shall use resistors specified for ±1 % accuracy at d.c. and have a return loss greater than 40 – 10 log(f) where f is the frequency in MHz[1]. For pairs connected to a balun, common mode load is implemented by applying a load at the common mode terminal (centre tap) of the balun. The impedance of the load is equal to the common mode impedance. For a balun without a common mode terminal (centre tap is not accessible), the requirement for common mode return loss shall be complied with by inserting a balanced attenuator between the balun and the connector pair. Guidance on how this is done is shown annex L. For pairs connected to resistor loads, common mode load is implemented by the Y configuration shown in figure D.3.

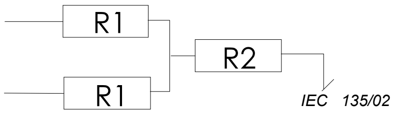


Figure D.3 – Resistor load

where

$$R_1 = \frac{R_{dif}}{2}$$

and

$$R_2 = R_{com} - \frac{R_{dif}}{4}$$

where

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

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

The two resistors R1 shall be matched to within 0,5 %. The termination shall be implemented at a small printed circuit board with surface mount resistors. The layout for the resistors R1 shall be symmetrical.

The common mode termination points for all pairs shall be connected to the ground plane.

D.7 Termination of screens

If the connector under test is screened, screened measurement cables shall be used.

The screen or screens of these cables shall be fixed to the ground plane as close as possible to the measurement baluns.

D.8 Test specimen and reference planes

The test specimen is a mated pair of relevant connectors. The electrical reference plane for the test specimen is the point at which the cable sheath enters the connector (the back end of the connector), or the point, at which the internal geometry of the cable is no longer maintained, whichever is farther from the connector (see figure D.4). This definition applies to both ends of the test specimen.

---

1 Return loss of terminations are measured with a network analyzer connected to one balun, which is calibrated (full one port calibration) using the reference loads (2.5.1)

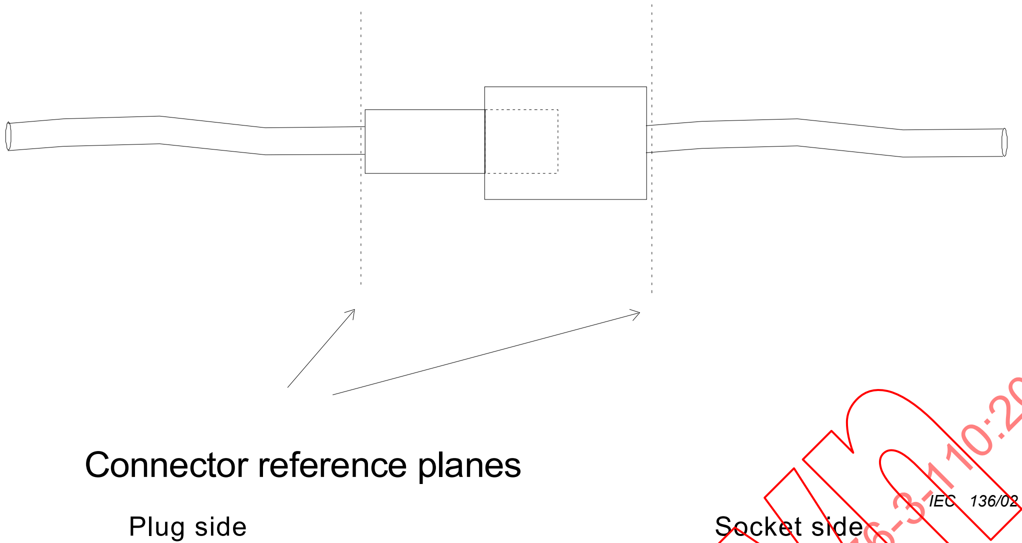


Figure D.4 – Definition of reference planes

Annex E
(normative)

Insertion loss[1]

E.1 Object

The object of this test is to measure the insertion loss, which is defined as the additional attenuation that is provided by a pair of mated connectors inserted in a communication cable.

E.2 Test method

Insertion loss is evaluated by measuring the scattering parameters, S_{21}, of all the conductor pairs.

E.3 Tests set up.

The test set-up consists of a network analyser and two baluns as defined in annex D.

It is not necessary to terminate the unused pairs.

E.4 Procedure.

E.4.1 Calibration

A full 2-port calibration shall be performed at the reference plane. This is performed by applying a reference cable of 14 cm maximum length between the terminals of the baluns and performing the transmission calibration measurement. Then a reference cable of 7 cm maximum length is connected to the terminals of the two baluns (see figure E.1). The total length of these cables shall be equal to the length of the reference cable used for transmission calibrations. At the end of these reference cables, the reflection calibrations are performed by applying open, short and load terminations.

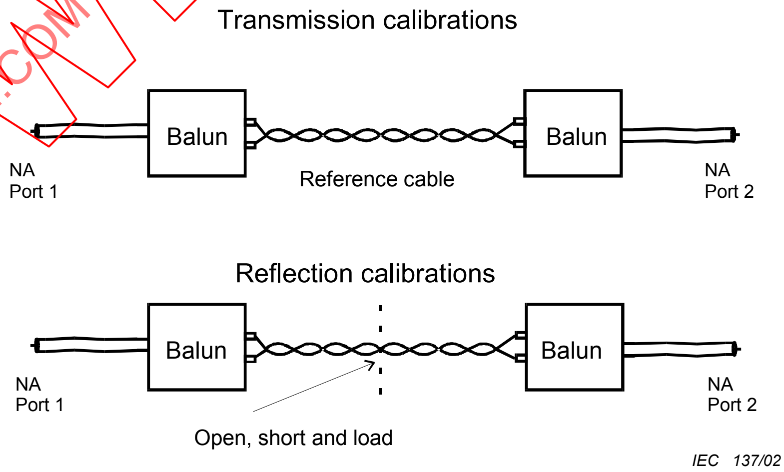


Figure E.1 – Calibration

1 Often referred to as attenuation.

E.4.2 Measurement

The test specimen shall be terminated with measurement cables at both ends. The length of the measurement cables shall be equal to the length of the reference cables used for reflection calibrations. The measurement cables shall be the cable types for which the connector is intended. A S_{21} measurement shall be performed.

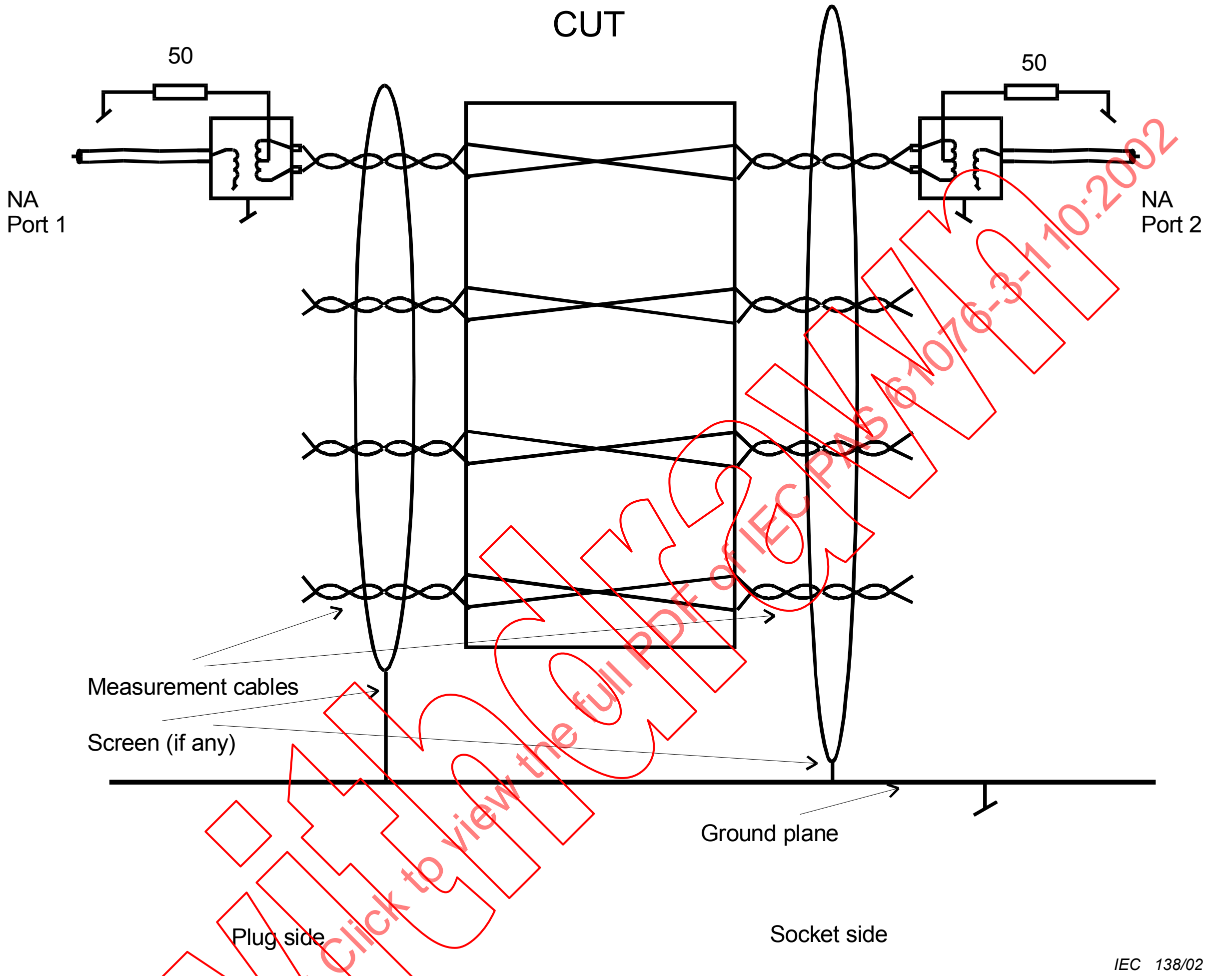


Figure E.2 – Measuring set-up

E.5 Test report

The measured results shall be reported in graphical or table format with the specification limits shown on the graphs or in the table at the same frequencies as specified in the relevant detail specification. Results for all pairs shall be reported. It shall be explicitly noted if the measured results exceed the test limits.

E.6 Accuracy

The accuracy shall be within ± 0,05 dB.

Annex F
(normative)

Return loss

F.1 Object

The object of this test is to measure the return loss of a mated connector pair at the two reference planes.

F.2 Test method

Return loss is measured by measuring the scattering parameters, S_{11} and S_{22} of all the conductor pairs.

NOTE As a connector is a low loss device, the return loss of the two sides are nearly equal.

F.3 Test set-up

The test set-up is as described in annex D.

F.4 Procedure

F.4.1 Calibration

Calibration shall be performed as described in clause E.4.1.

F.4.2 Measurement

The test specimen shall be terminated with measurement cables at both ends. The length of measurement cables shall be equal to the length of the reference cables used for reflection calibrations. The measurement cables shall be the cable types for which the connector is intended. S_{11} and S_{22} measurements shall be carried out for each of the pairs.

F.5 Test report

The measured results shall be reported in graphical or table format with the specification limits shown on the graphs or in the table at the same frequencies as specified in the relevant detail specification. Results for all pairs shall be reported. It shall be explicitly noted if the measured results exceed the test limits.

F.6 Accuracy

The return loss of the load for calibration is verified to be greater than 46 dB up to 100 MHz and greater than 40 dB at higher frequencies. The uncertainty of the connection between the connector under test and the baluns are expected to deteriorate the return loss of the set-up (the directional bridge implemented by the test set-up) by 6 dB. The accuracy of the return loss measurements is then equivalent with measurements performed by a directional bridge, with a directivity of 40 dB and 34 dB. The accuracy (uncertainty band) is tabled in table F.1.

Table F.1 – Uncertainty band of return loss measurement at frequencies below 100 MHz

Measured RL	10	12	15	18	20	22	25	28	30
Lower uncertainty limit	–0,3	–0,3	–0,5	–0,7	–0,8	–1,0	–1,4	–1,9	–2,4
Higher uncertainty limit	+0,3	+0,4	+0,5	+0,7	+0,9	+1,2	+1,7	+2,5	+3,3

Annex G
(normative)

Near end cross talk

G.1 Object

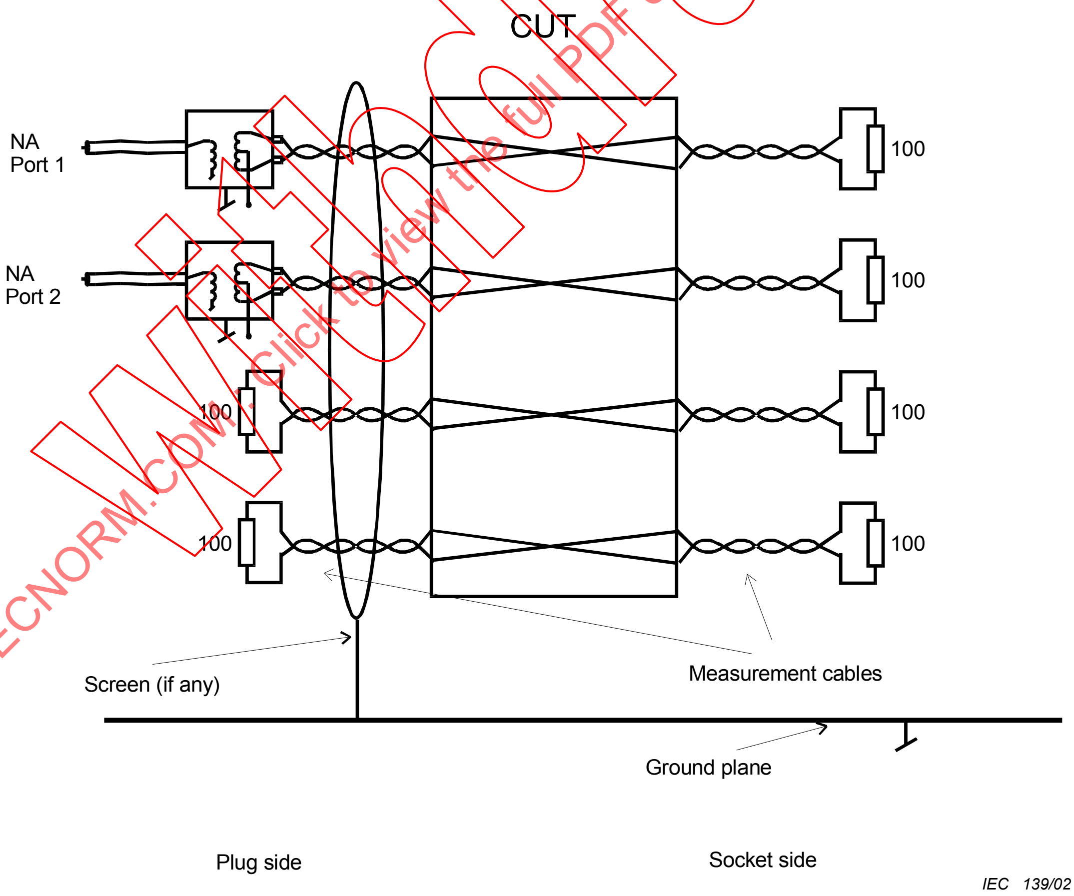
The object of this test procedure is to measure the magnitude of the electric and magnetic coupling between driven (disturbing) and quiet (disturbed) pairs of a mated connector pair.

G.2 Test method

Near end crosstalk is evaluated by measuring the scattering parameters, S21, of the possible conductor pair combinations at one end of the mated connector, while the other end of the pairs are terminated.

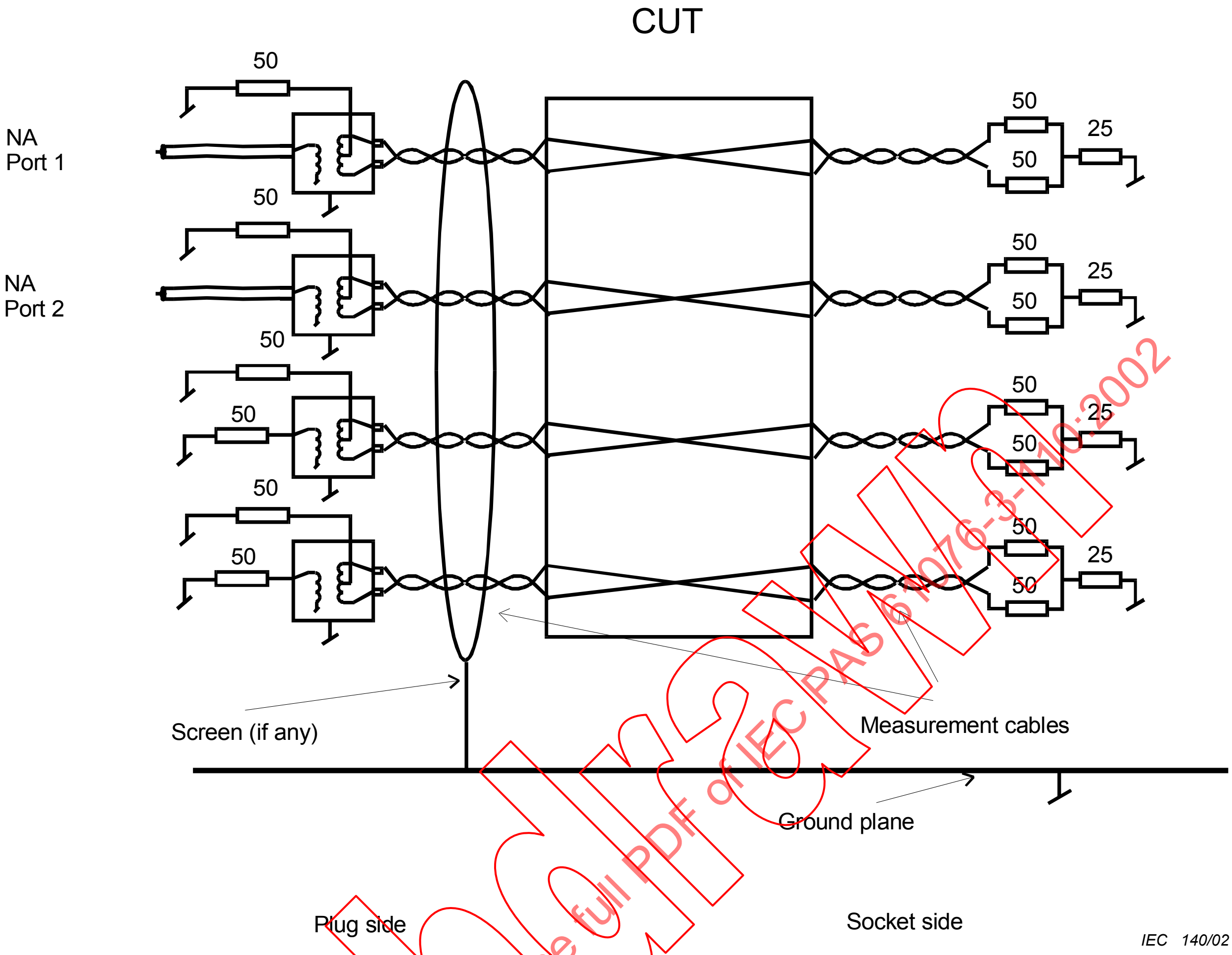
G.3 Test set-up

The test set-up consists of two baluns and a network analyser as defined in annex D. A figure of the set-up, which also shows the termination principles, is shown in figures G.1 and G.2.



NOTE Passive terminations must be resistor terminations.

Figure G.1 – NEXT measurement for differential mode only terminations



NOTE Passive terminations may be either balun or resistor terminations.

Figure G.2 – NEXT measurement differential and common mode terminations

G.4 Procedure

G.4.1 Calibration

A through calibration shall be applied as a minimum. Full two port calibrations are recommended in order to enhance the measurement accuracy

G.4.2 Establishment of noise floor

The noise floor of the set up shall be measured. The level of the noise floor is determined by white noise, which may be reduced by increasing the test power and by reducing the bandwidth of the network analyser, and by residual crosstalk between the test baluns. The noise floor shall be measured by terminating the baluns with resistors and performing a S21 measurement. The noise floor shall be 20 dB lower than any specified limit for the crosstalk. If the measured value is closer to the noise floor than 10 dB, this shall be reported

NOTE For high crosstalk values, it may be needed to screen the terminating resistors.

G.4.3 Measurement

Connect the disturbing pair of the CUT to the signal source and the disturbed pair to the receiver port. Terminate according to figure G.1 and figure G.2. It is recommended that the socket be terminated with short separated pairs without a jacket. Test all possible pair combinations[1] and record the results.

The CUT shall be tested in the following configuration:

With differential and common mode terminations.

The measurements have to be performed from both ends of the mated connector. As a connector is a low loss device near end cross talk values from the two ends are nearly equal.

Differential and common mode terminations shall be provided on at least one end of each pair, including the unused pairs. This may be the near or far end. Differential terminations shall be provided at both ends. Optionally, differential and common mode terminations may be provided at both ends of all pairs, as shown in figure G.2.

G.5 Test report

The measured results shall be reported in graphical or table format with the specification limits shown on the graphs or in the table at the same frequencies as specified in the relevant detail specification. Results for all pairs shall be reported. It shall be explicitly noted if the measured results exceed the test limits.

G.6 Accuracy

The accuracy shall be better than ±1 dB at measurements up to 60 dB and ±2 dB at measurements up to 85 dB.

---

1 There are 6 different combinations of near end crosstalk in a four pair connector from each side, which gives a total of 12 measurements for each kind of termination method.

Annex H
(normative)

Far end cross talk

H.1 Object

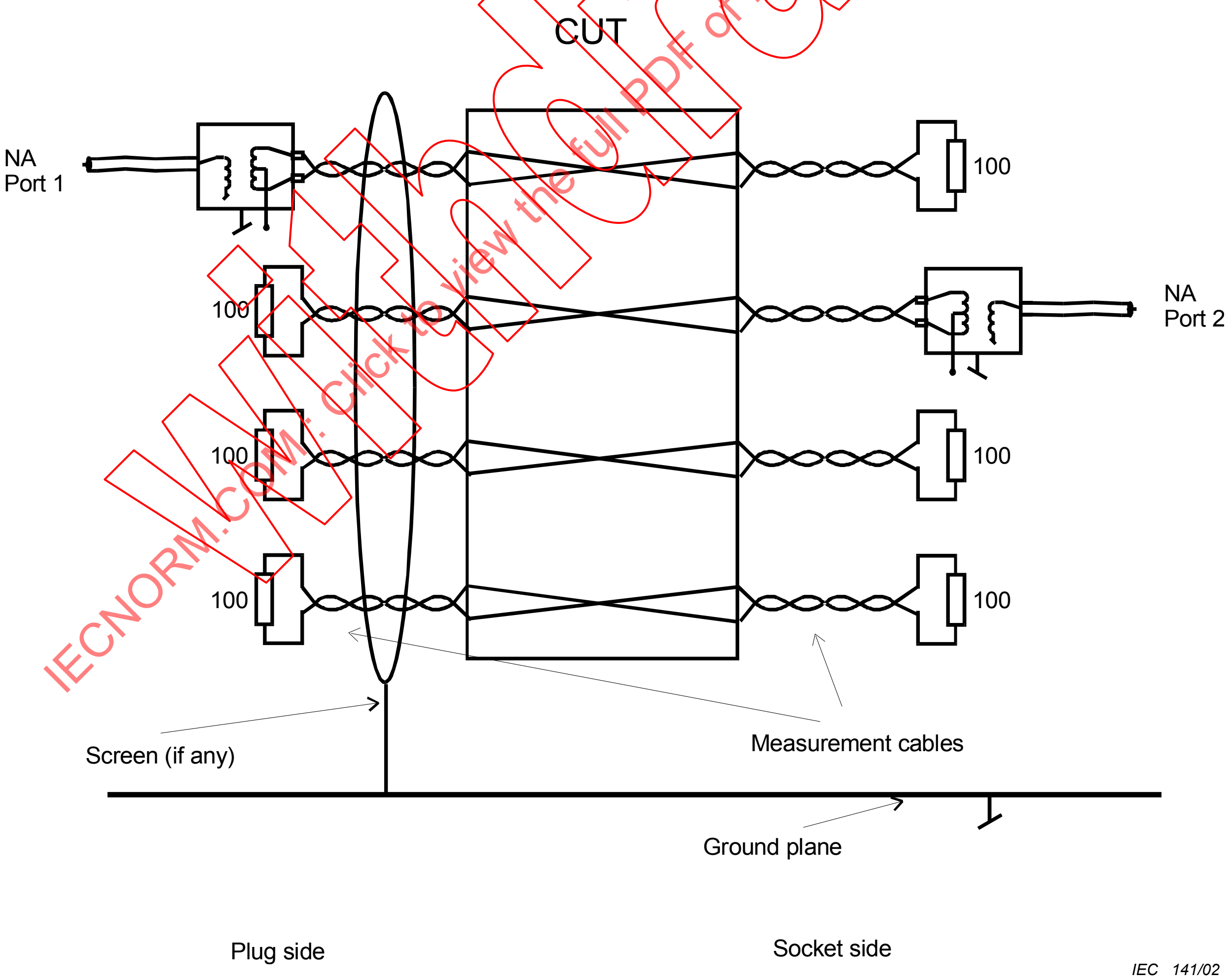
The object of this test procedure is to measure the magnitude of the electric and magnetic coupling between driven (disturbing) and quiet (disturbed) pairs of a mated connector pair.

H.2 Test method

Far end crosstalk is evaluated by measuring the scattering parameters, S_{21}, of the possible conductor pair combinations at one end of the mated connector, to the other end.

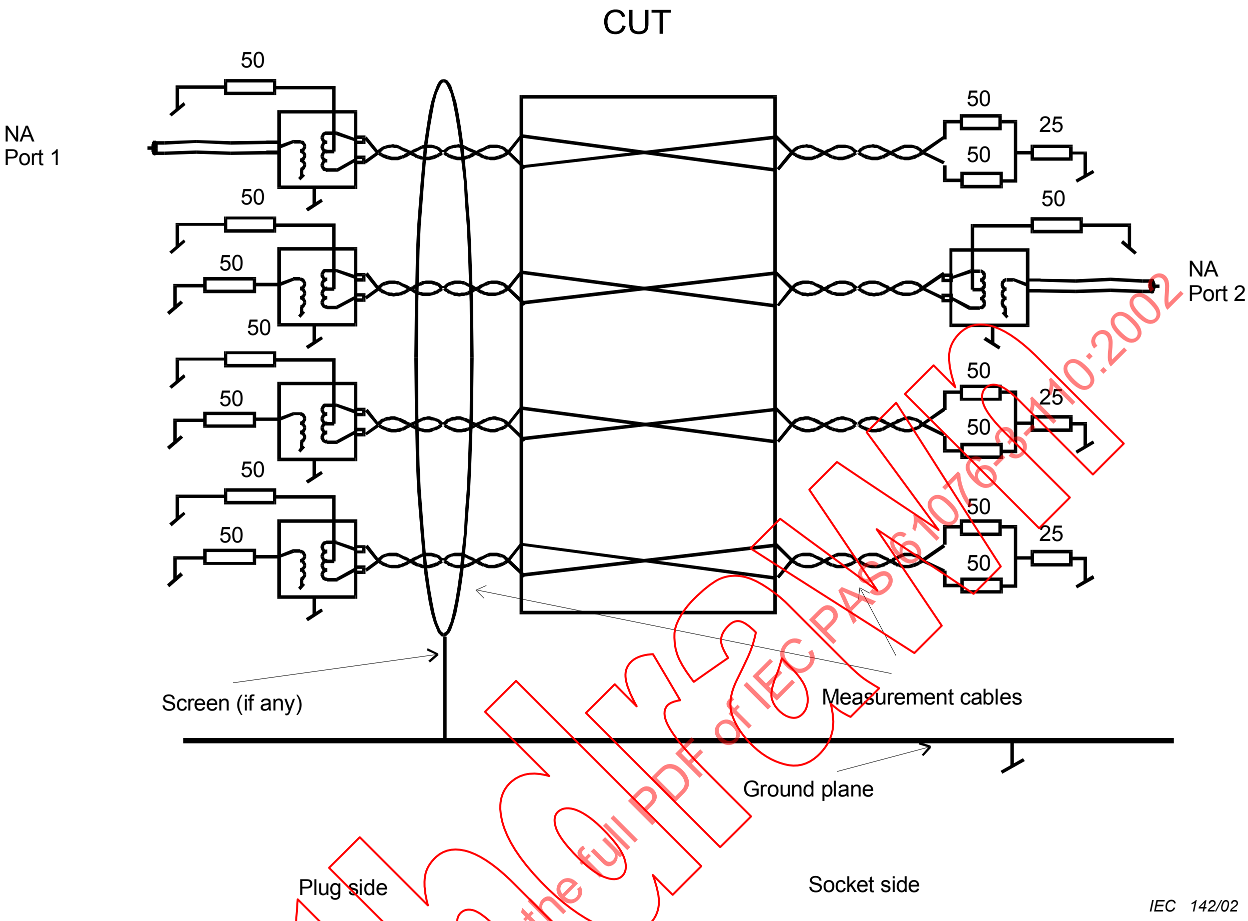
H.3 Test set-up

The test set-up consists of two baluns and a network analyser as defined in annex D. A figure of the set-up, which also shows the termination principles, is shown in figures H.1 and H.2.



NOTE Passive terminations must be resistor terminations.

Figure H.1 – FEXT measurement for differential mode only terminations



NOTE Passive terminations may be either balun or resistor terminations.

Figure H.2 – FEXT measurement for differential and common mode terminations

H.4 Procedure

H.4.1 Calibration

Calibration is performed as shown in clause E.4.1.

H.4.2 Establishment of noise floor

The noise floor of the set up is established as shown in clause G.4.2.

H.4.3 Measurement

Connect the disturbing pair of the CUT to the signal source and the disturbed pair to the receiver port. Terminate according to figure H.1 and figure H.2. It is recommended that the socket is terminated with short separated pairs without jacket. Test all possible pair combinations,[1] and record the results.

The CUT shall be tested in the following configuration:

With differential and common mode terminations.

---

1 There are 12 different combinations for far end crosstalk in a four pair connector, which gives a total of 12 measurements for each termination method.

Differential and common mode terminations shall be provided on at least one end of each pair, including the unused pairs. This may be the near or far end. Differential terminations shall be provided at both ends. Optionally, differential and common mode terminations may be provided at both ends of all pairs, as shown in figure G.2.

H.5 Test report

The measured results shall be reported in graphical or table format with the specification limits shown on the graphs or in the table at the same frequencies as specified in the relevant detail specification. Results for all pairs shall be reported. It shall be explicitly noted if the measured results exceed the test limits.

H.6 Accuracy

The accuracy shall be better than ±1 dB at measurements up to 60 dB and ±2 dB at measurements up to 85 dB.

Annex I
(normative)

Longitudinal conversion loss

I.1 Object

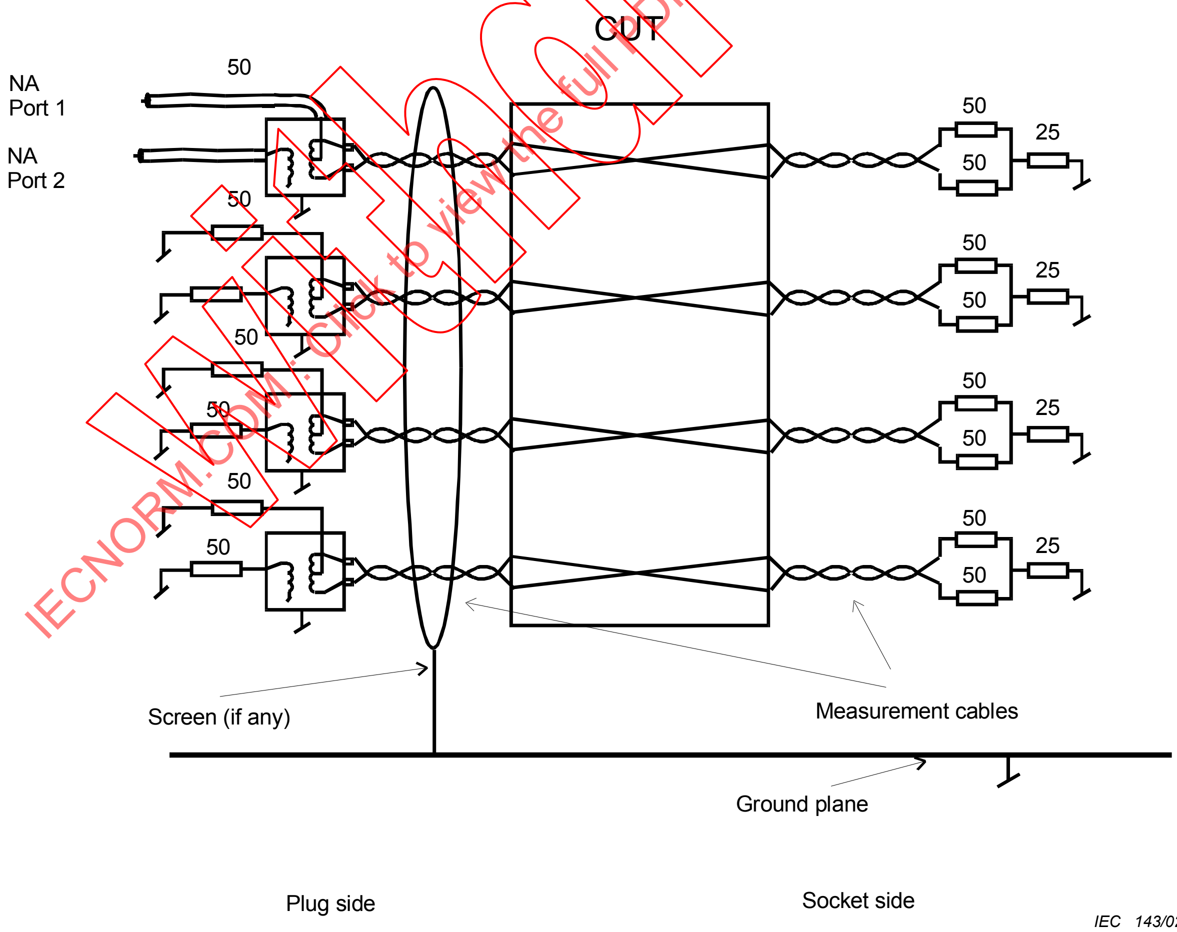
The object of this test is to measure the mode conversion (differential to common mode) of a signal in the conductor pairs of the CUT. This is also called unbalance attenuation or longitudinal conversion loss, LCL.

I.2 Test method

Balance is evaluated by measuring the common mode part of a differential mode signal, which is launched in one of the conductor pairs of the CUT.

I.3 Test set-up

The test set-up consists of a network analyser and a balun with a differential and common mode test port. A figure of the set-up, which also shows the termination principles, is shown in figure I.1.



NOTE Passive terminations may be either balun or resistor terminations.

Figure I.1 – LCL measurement

I.4 Procedure

I.4.1 Calibration

Calibration is performed in tree steps:

1. The attenuation of the coaxial test leads to the network analyser is calibrated out by performing a through calibration with these test leads connected together.
2. The attenuation of differential signals of the test balun, $a_{bal,DM}$ is measured by connecting two identical baluns back to back. The insertion loss of these baluns is measured, and half of this loss is the insertion loss of the balun for a differential signal.
3. The attenuation of common mode signals of the test balun, $a_{bal,CM}$ is measured by measuring the insertion loss from the common mode test port of the balun to the differential output terminals. The two differential output terminals shall be short-circuited and connected to the inner conductor of the coaxial test lead to the network analyser.

I.4.2 Noise floor

The noise floor of the set-up shall be measured. The level of the noise floor is determined by white noise, which may be reduced by increasing the test power and by reducing the bandwidth of the network analyser, and by the longitudinal balance (see table D.1) of the test balun.

The noise floor, $a_{noise,m}$ shall be measured by terminating the differential output of the balun with a 100 Ω resistor and perform a S_{21} measurement between the differential mode and common mode test port of the balun. a_{noise} is calculated as:

$$a_{noise,m} = -20\log|S21|$$

$$a_{noise} = a_{noise,m} - a_{bal,DM} - a_{bal,CM}$$

The noise floor shall be 20 dB lower than any specified limit for balance. If the measured value is closer to the noise floor than 10 dB, this shall be reported.

I.4.3 Measurement

Connect the measured pair of the CUT to the differential output of the test balun. Terminate the CUT according to clause K.3. Perform a S_{21} measurement between the differential mode and common mode test port of the balun. The balance, LCL is calculated as:

$$a_{meas} = -20\log|S21|$$

$$LCL = a_{meas} - a_{bal,DM} - a_{bal,CM}$$

I.5 Test report

The measured results shall be reported in graphical or table format with the specification limits shown on the graphs or in the table at the same frequencies as specified in the relevant detail specification. Results for all pairs shall be reported. It shall be explicitly noted if the measured results exceed the test limits.

I.6 Accuracy

The accuracy shall be better than ±1 dB at the specification limit.

Annex J
(normative)

Transfer impedance[1]

J.1 Object

The object of this test is to measure the transfer impedance of the test specimen. The transfer impedance, ZT [Ω] of an electrically short uniform connector is defined as the quotient of the longitudinal voltage in the outer system to the current in the inner system.

J.2 Test method

The test determines the transfer impedance of the screened connector by measuring the connector in a triaxial test set-up. This set-up is also used for measurement of transfer impedance for cables (IEC 61196 series).

J.3 Definitions

J.3.1 Inner and outer circuit

The inner circuit consists of the screens and the conductors of the test specimen. The voltages and currents of the inner circuit are indicated by a subscript 1. The outer circuit consists of the outer screen surface and the inner surface of the test (triaxial) tube. The voltages and currents of the outer circuit are indicated by a subscript 2.

J.3.2 Coupling length

Two cables in the test set-up terminate to the connector under test. The combined length of connector and cable, which is inside the triaxial tube is called the coupling length. The maximum allowed coupling length depends on the highest frequency to be measured:

$$L_{c,max} \leq \frac{50 \cdot 10^6}{\sqrt{\varepsilon_{r1}} \cdot f_{max}}$$

where

$L_{c,max}$ maximum coupling length;

f_{max} highest frequency;

ε_{r1} resulting relative permittivity of the dielectric of the connecting cable.

The condition means that the phase constant of the cable multiplied by the length is less than 1.

J.4 Test set-up

J.4.1 Preparation of test specimen

The principle for preparation of the test specimen is shown in figure J.1.

---

1 This test measures the magnetic component of the transfer impedance. A test, which measures the effective (note) transfer impedance is under consideration. If experience shows that the test under consideration can replace the test proposed here, reference to the other test will be made and the current proposal withdrawn. Note: Effective transfer impedance is the vector summation of magnetically and electrically coupled transfer impedance. It is expected that the current requirements for transfer impedance of connectors have to be revised if effective transfer impedance is measured.

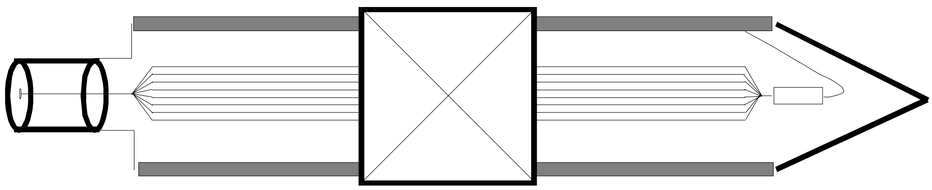


Figure J.1 – Preparation of test specimen

Category 6 or category 7 measurement cables as prescribed by the manufacturer shall terminate the test specimen.

The length of the measurement cable shall be 7 cm. The length of the tube determines the length of the other measurement cable. The signal conductors of the measurement cables shall be connected together in both ends. The short measurement cable shall be terminated by R1, (see J.4.2) which shall be connected between the inner conductors and the cable screens. R1 shall be screened by a metallic screen, which is bonded to the screens of the measurement cable.

J.4.2 Triaxial set-up

The test set-up consists of a network analyser and a triaxial test set-up for measuring transfer impedance. The triaxial test set-up consists of a metallic (e.g. brass) tube, resistors and impedance matching networks.

The metallic tube is closed at both ends with metallic endplates with provisions for cable feed through. The diameter of the tube shall be large enough to be able to accommodate the test specimen. The length of the tube should preferably be equal to or less than 30 cm. The directions given in J.3.2 shall be used to determine the maximum frequency for valid measurements.

The resistors are terminating resistors. R1 terminates the inner circuit. This resistor shall have a value close to the impedance of the inner circuit (see J.4.3). The other, R2, terminates the outer circuit. This resistor shall have a value close to

$$R_2 \approx 1{,}4 \cdot 60 \cdot \log_2 \frac{d_o}{d_c} - 50$$

where

d_o inner diameter of tube

d_c outer diameter of the measurement cable screen

The test specimen shall be mounted in the centre of the tube. (It may be supported by plastic foam).

The test set-up shall be connected to the network analyser through the impedance matching network. The impedance matching network is a minimum loss 2 resistor network, which matches the inner circuit to the impedance of the network analyser port (see J.4.4).

In figure J.2 the complete triaxial set-up is shown.