INTERNATIONAL STANDARD

IEC 61076-3-104

First edition
2003-04

Connectors for electronic equipment –

Part 3-104:
Rectangular connectors –
Detail specification for 8-way, shielded free and fixed connectors for data transmissions with frequencies up to 600 MHz minimum

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FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The 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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The International Electrotechnical commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning 8-way shielded free and fixed connectors for data transmissions with frequencies up to 600 MHz minimum.

The IEC takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured the IEC that he is willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with IEC. Information may be obtained from

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Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those identified above. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61076-3-104 has been prepared by subcommittee 48B: Connectors, of IEC technical committee 48: Electromechanical components and mechanical structures for electronic equipment.

This standard cancels and replaces IEC/PAS 61076-3-104 published in 2002. This first edition constitutes a technical revision.

The text of this standard is based on the following documents:

FDIS	Report on voting
48B/1303/FDIS	48B/1335/RVD

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

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

The committee has decided that the contents of this publication will remain unchanged until 2004. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

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

CONNECTORS FOR ELECTRONIC EQUIPMENT –

Part 3-104: Rectangular connectors – Detail specification for 8-way, shielded free and fixed connectors for data transmissions with frequencies up to 600 MHz minimum

1 General

1.1 Scope

This part of IEC 61076 establishes uniform specifications, type testing requirements and quality assessment procedures for 8-way connectors, with up to 4 pairs, for frequencies up to 600 MHz minimum, and intended to be used at different locations within cabling for information and communications technology, home entertainment and multimedia. It contains a choice of all test methods and sequences, severity and preferred values for dimensions and characteristics.

1.2 Normative references

The following referenced documents are indispensable for the application 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 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-6, *Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)*

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 60512 (all parts), *Connectors for electronic equipment – Tests and measurements*

IEC 60512-1-100:2001, *Connectors for electronic equipment – Tests and measurements – Part 1-100: General – Applicable publications*

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 60664-1, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

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

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

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

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

ISO 1302, *Geometrical Product Specifications (GPS) – Indication of surface texture in technical product documentation*

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 EN 50289-1-14, *Basic reference standard for communication cables – Specification – Part 1-14 Electrical test methods – Coupling attenuation or screening attenuation of connecting hardware*

2 Marking Information

2.1 IEC type designation

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

Connectors conforming to this standard shall be identified by the following indications and in the order given:

- the letters “IEC”;
- the number denoting this detail specification;
- the number of the detail specification (without dashes), being nine characters (e.g. IEC 61076-3-104 B08 FS-G101-1 Shielded connector, fixed version B, having 8 female contacts, solder termination, board mount));
- a letter denoting the style of the connector (the system shall be specified in the detail specification.

2.2 Marking

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

2.3 Groups of related connectors

Groups of connectors within a subfamily having common features. Typical examples are of the same type and range but of a different style. A group of related connectors is covered by a single detail specification.

– **type**: connectors within a particular subfamily such as a multicontact connector with one, two or four pairs;

– **range**: the housing (shell) sizes and contacts arrangements within a type. For example a housing containing one, two or four pairs;

– **style**: a particular connector within a type, for example fixed panel, PCB or free connector;

– **variant**: variations within a type, style or range.

2.4 Interchangeability level

These connectors shall be fully interchangeable and intermateable. The mechanical and electrical characteristics shall be met whatever is the source of the connector. Moreover, it is desirable that the mechanical and electrical compatibility with lower performance connecting hardware as defined in ISO/IEC 11801 and IEC 60603-7 is ensured when connected to this connector.

This can be achieved through the use of an adapter cord. Elements of connecting hardware, for example plugs, sockets that terminate more than one cable are permitted.

The plug/socket interface may be constructed so as to permit the use of multiple modules, for example 2 × 2 pairs or 4 × 1 pair plugs mated directly with a single 4 pairs socket.

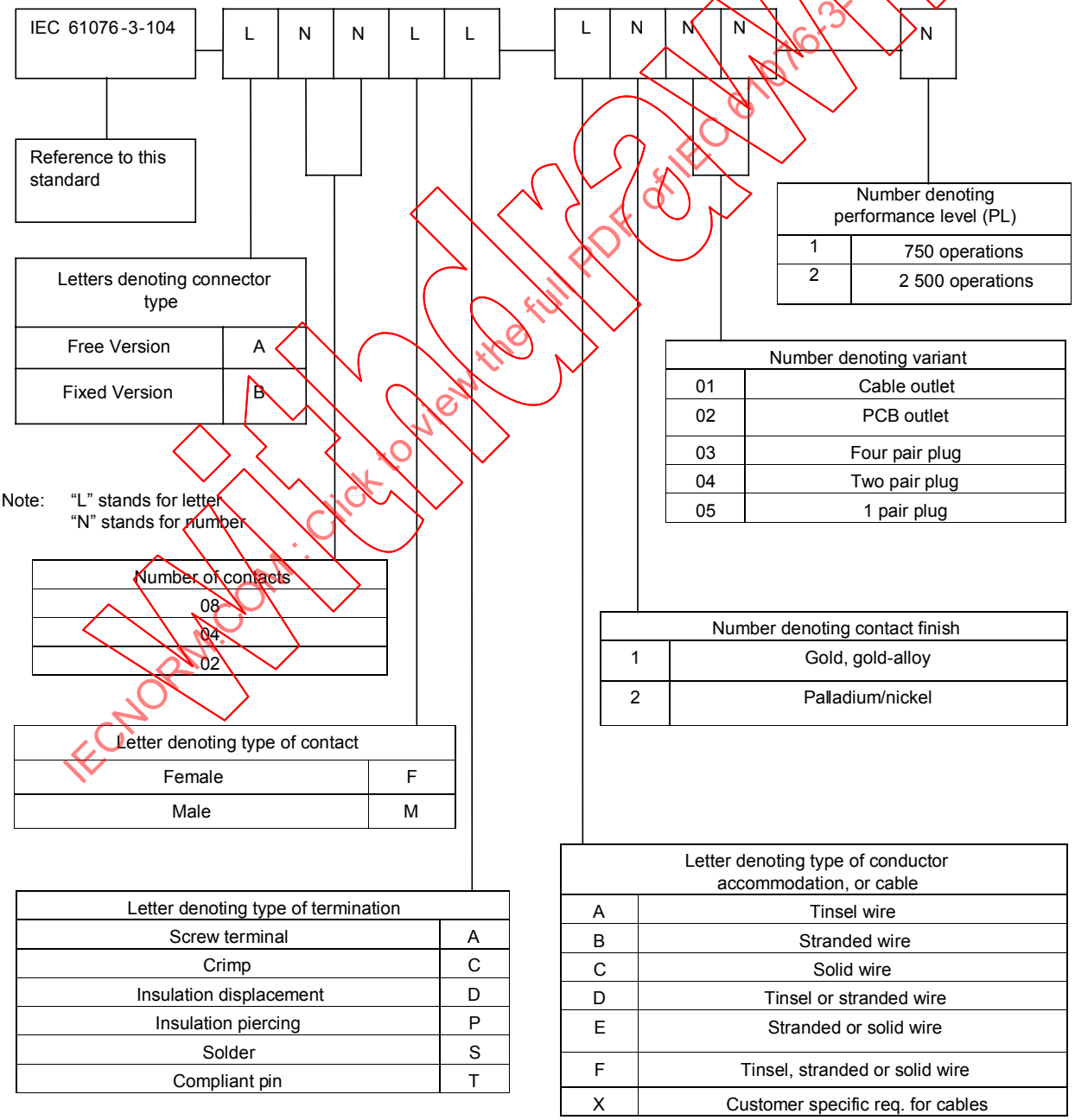


Figure 1 – IEC type designation

IEC 1013/03

2.5 Isometric views and common features

2.5.1 Fixed connector

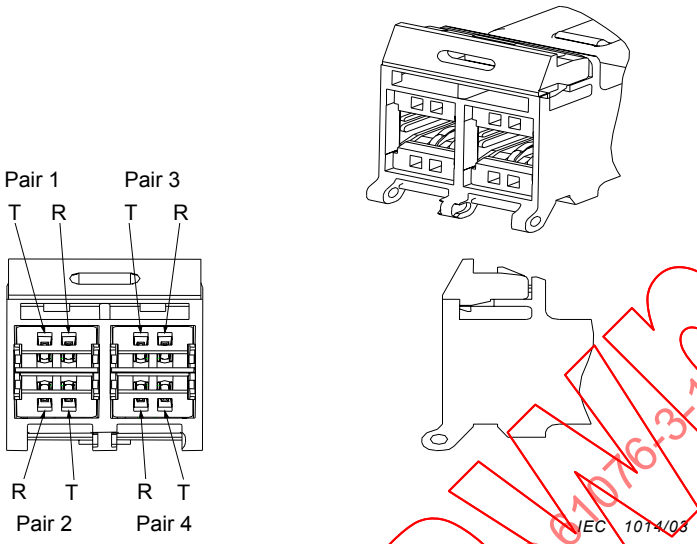


Figure 2 – Fixed connector

2.5.2 Free connector

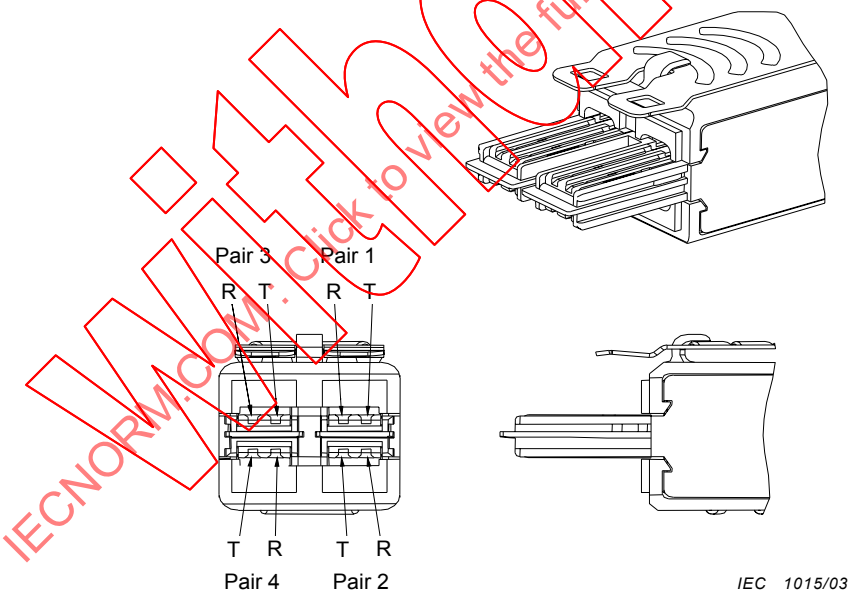


Figure 3 – Free connector

3 Dimensional information

3.1 General

Original dimensions are in millimetres except where noted.

3.2 Free connector (plug)

3.2.1 Free connector isometric views

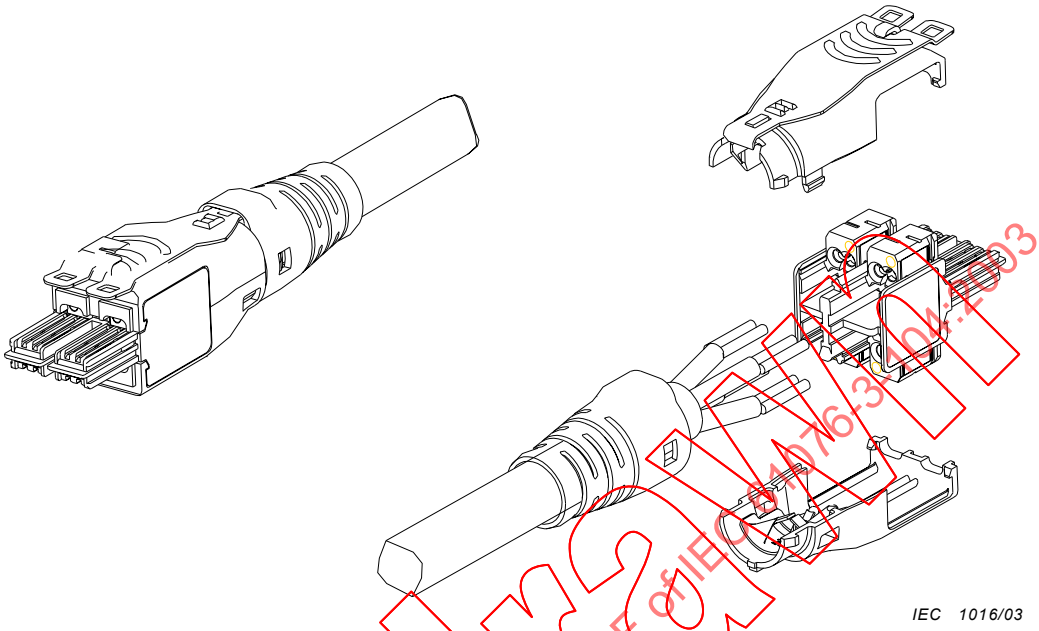


Figure 4 – Variant 03, 4-pair plug

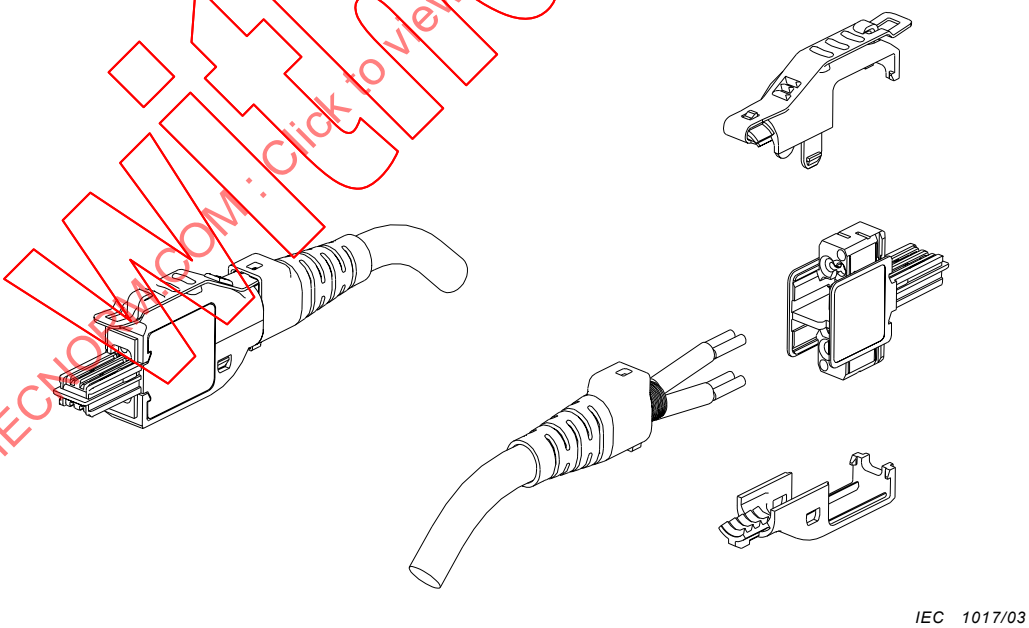


Figure 5 – Variant 04, 2-pair plug

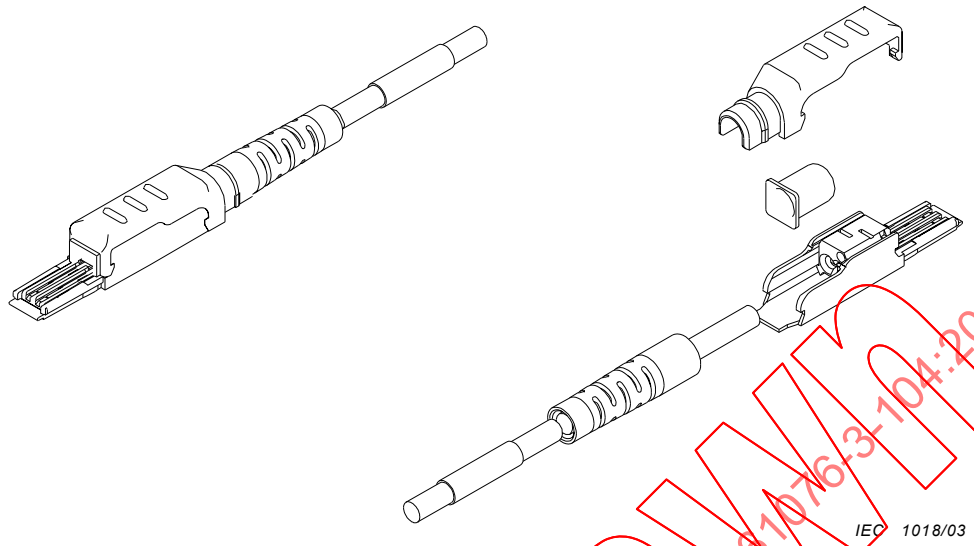


Figure 6 – Variant 05, 1-pair plug

3.2.2 Free connector dimensions

3.2.2.1 Variant 03, 4-pair plug drawings

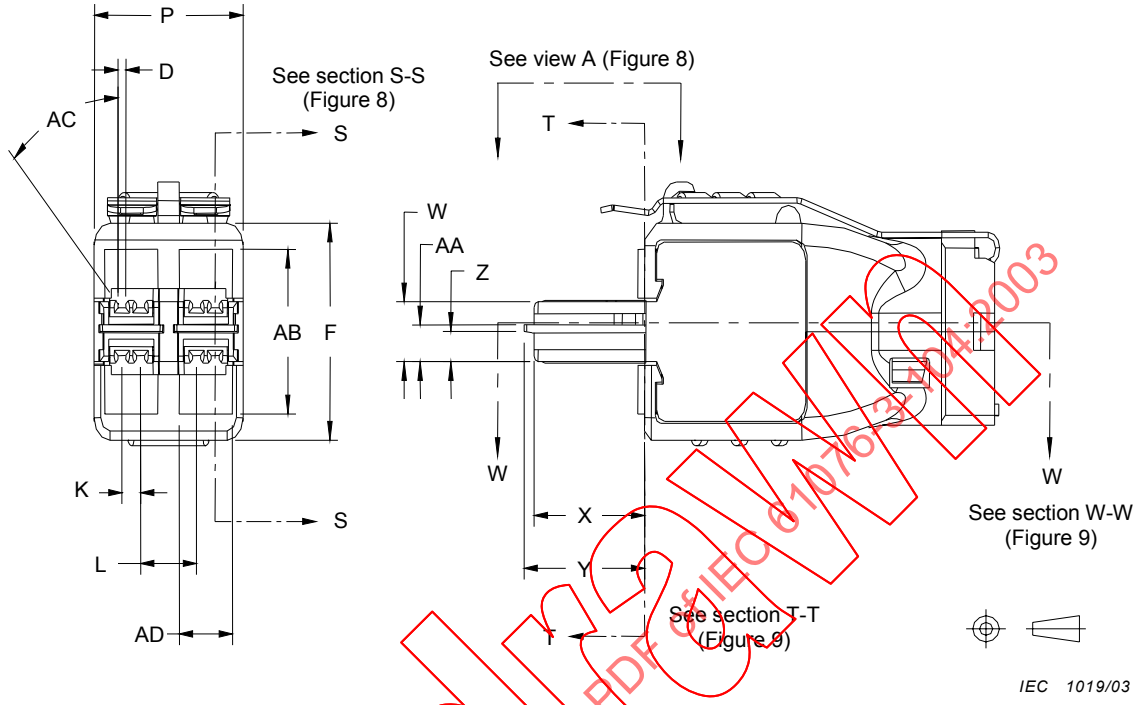


Figure 7 – Variant 03 drawing 1

Table 1 – Variant 03 drawing 1 dimensions

Dimensions in millimetres

	Nominal	Maximum	Minimum
D[1]	0,76	0,81	0,71
F	14,73	14,99	14,48
K	1,78	1,88	1,68
L	5,33	5,54	5,13
P	14,22	14,35	14,10
W	4,27	4,39	4,14
X	10,67	10,74	10,59
Y	11,86	11,91	11,81
Z	1,96	2,08	1,83
AA	2,59	2,72	2,46
AB	11,18	11,43	10,92
AC	45°	46°	44°
AD	5,08	5,21	4,95

[1] Dimension D is the same as ES in Figure 11 and GS in Figure 14.

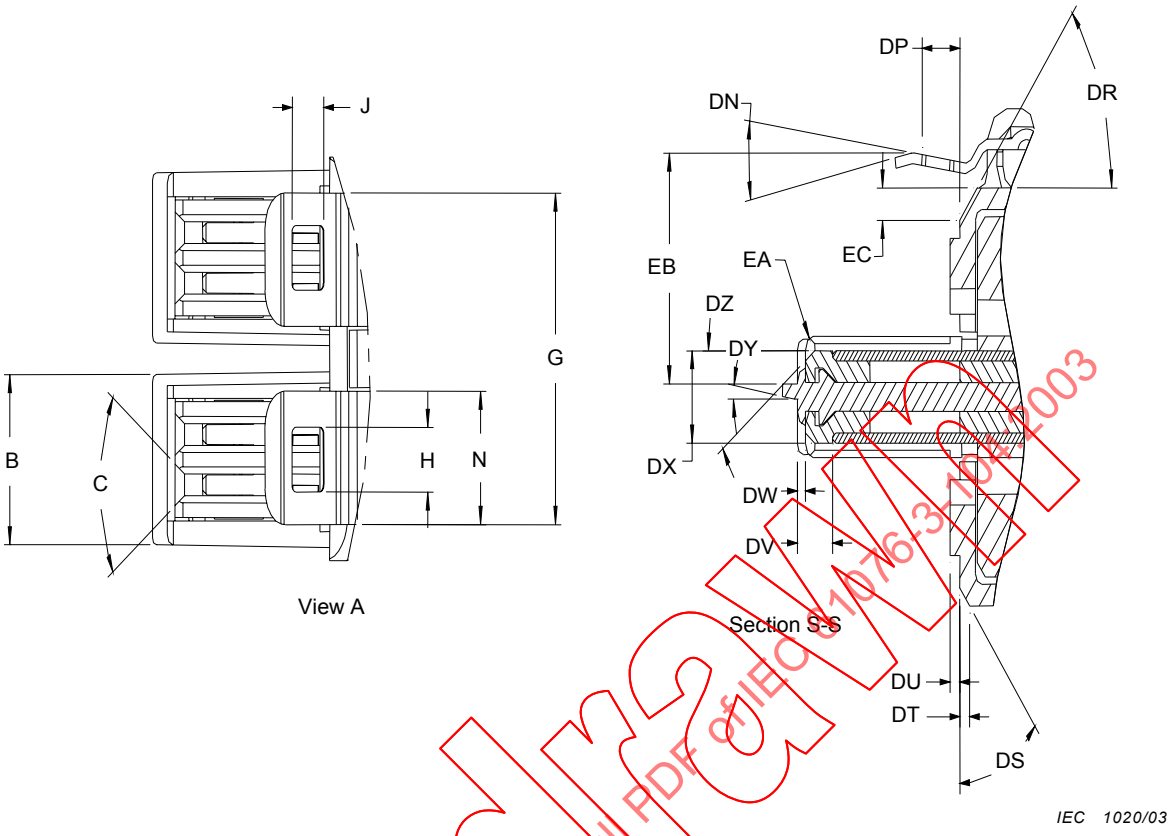


Figure 8 – Variant 03 drawing 2

Table 2 – Variant 03 drawing 2 dimensions

Dimensions in millimetres

	Nominal	Maximum	Minimum
B	5,99	6,05	5,94
C	60°	61°	59°
G	11,68	11,81	11,56
H	2,29	2,36	2,21
J	2,08	2,21	1,96
N	4,70	4,83	4,57
DN	15°	18°	12°
DP	2,57	2,69	2,44
DR	45°	46°	44°
DS	45°	46°	44°
DT	0,64	0,76	0,51
DU	0,64	0,76	0,51
DV	2,29	2,41	2,16
DW	0,51	0,64	0,38
DX	3,25	3,38	3,12
DY	7°	8°	6°
DZ	30°	31°	29°
EA	R 0,51	R 0,58	R 0,43
EB	8,13	8,26	8,00
EC	1,14	1,27	1,01

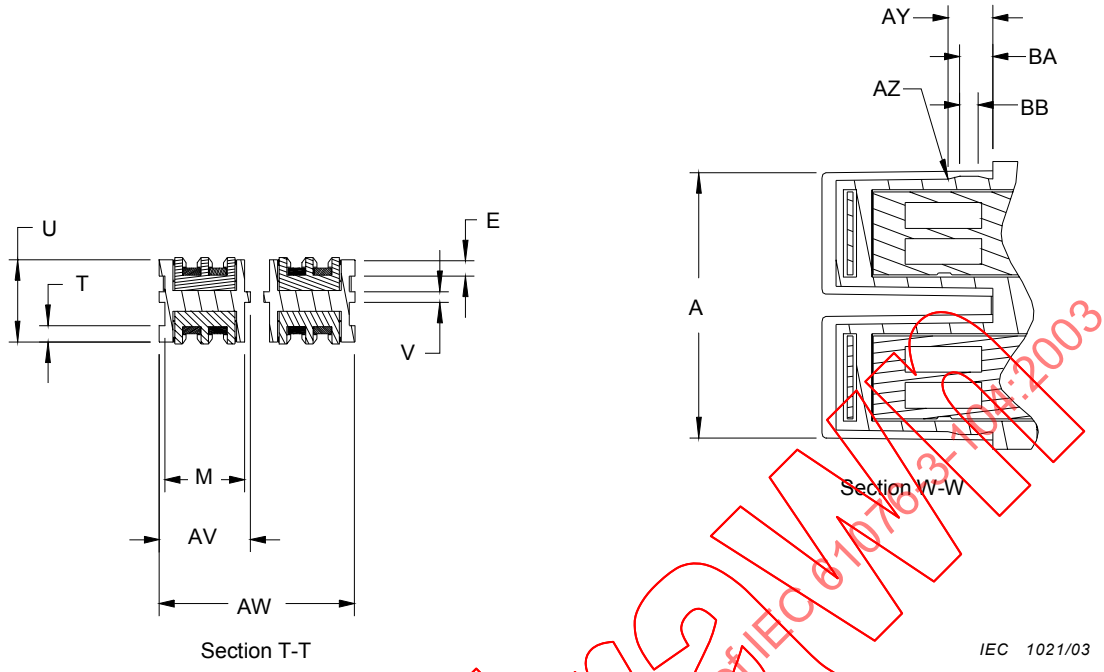


Figure 9 – Variant 03 drawing 3

Table 3 – Variant 03 drawing 3 dimensions

Dimensions in millimetres

	Nominal	Maximum	Minimum
A	13,11	13,16	13,06
E	0,81	0,86	0,76
M	5,41	5,46	5,36
T	0,81	0,86	0,76
U	4,06	4,14	3,99
V	0,53	0,58	0,48
AV	6,20	6,25	6,15
AW	13,31	13,36	13,26
AY	3,05	3,12	2,97
AZ	R 2,03	R 2,11	R 1,96
BA	2,26	2,34	2,19
BB	1,27	1,52	1,19

3.2.2.2 Variant 04, 2-pair plug drawings

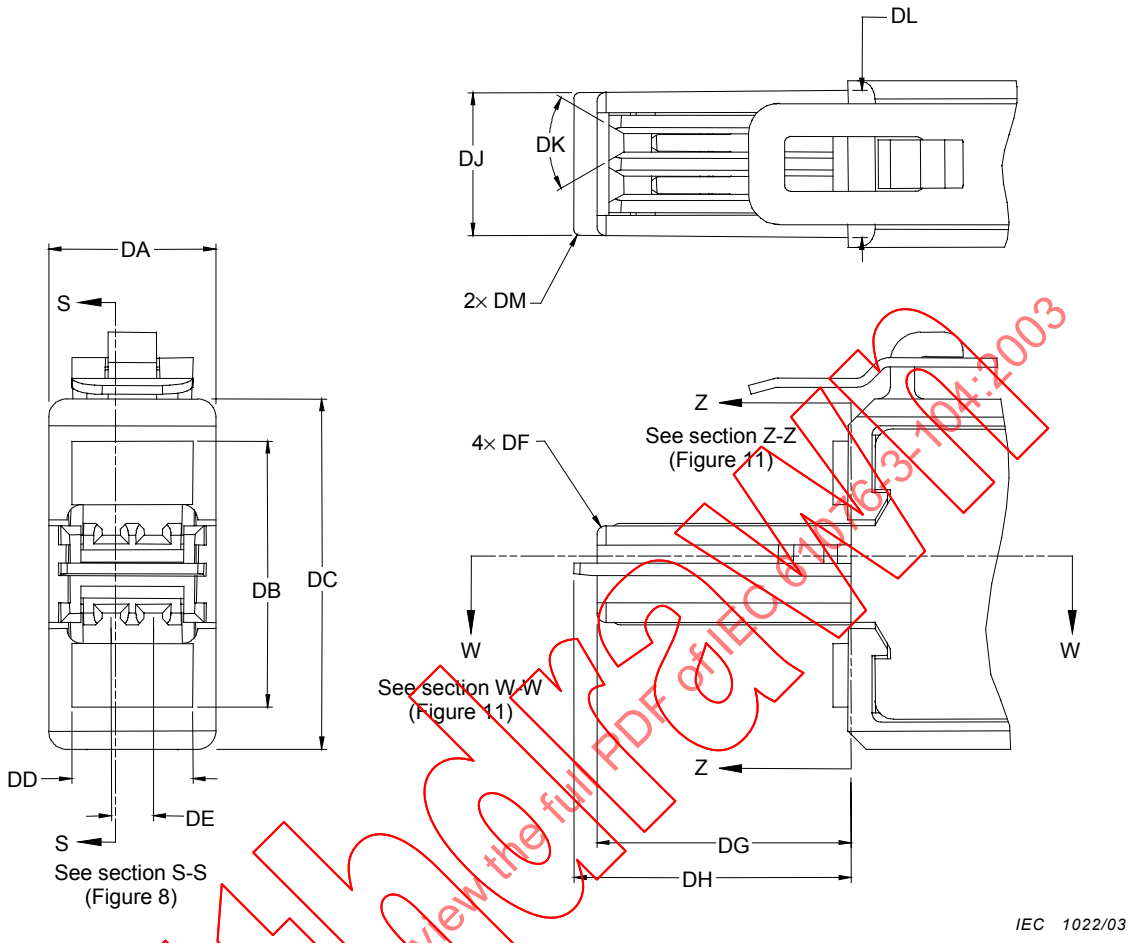


Figure 10 – Variant 04 drawing 1

Table 4 – Variant 04 drawing 1 dimensions

Dimensions in millimetres

	Nominal	Maximum	Minimum
DA	7,01	7,09	6,93
DB	11,18	11,43	10,92
DC	14,73	14,99	14,48
DD	5,08	5,21	4,95
DE	1,78	1,88	1,68
DF	R 0,38	R 0,46	R 0,30
DG	10,67	10,74	10,59
DH	11,86	11,91	11,81
DJ	5,99	6,05	5,94
DK	60°	61°	59°
DL	6,20	6,25	6,15
DM	0,25	0,30	0,20

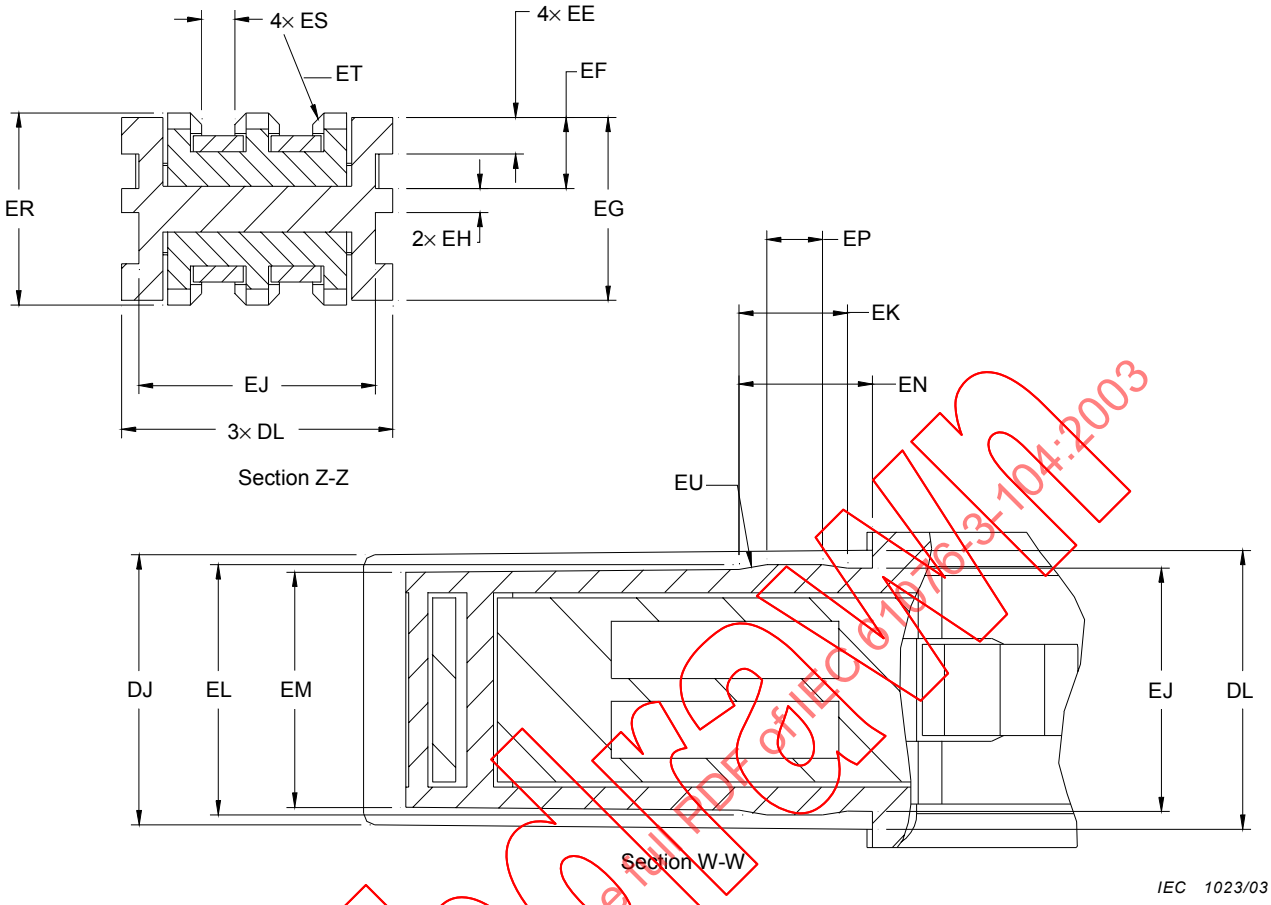


Figure 11 – Variant 04 drawing 2

Table 5 – Variant 04 drawing 2 dimensions

Dimensions in millimetres

	Nominal	Maximum	Minimum
EE	0,81	0,86	0,76
EF	1,57	1,65	1,50
EG	4,06	4,14	3,99
EH	0,53	0,58	0,48
EJ	5,41	5,46	5,36
EK	2,84	2,92	2,77
EL	5,64	5,69	5,61
EM	5,23	5,28	5,18
EN	3,35	3,43	3,28
EP	1,57	1,65	1,50
ER	4,27	4,39	4,14
ES[1]	0,76	0,81	0,71
ET	45°× 0,25	45°× 0,33	45°× 0,18
EU	R 2,03	R 2,16	R 1,91

[1] Dimension ES is the same as D in Figure 7 and GS in Figure 14

3.2.2.3 Variant 05, 1-pair plug drawings

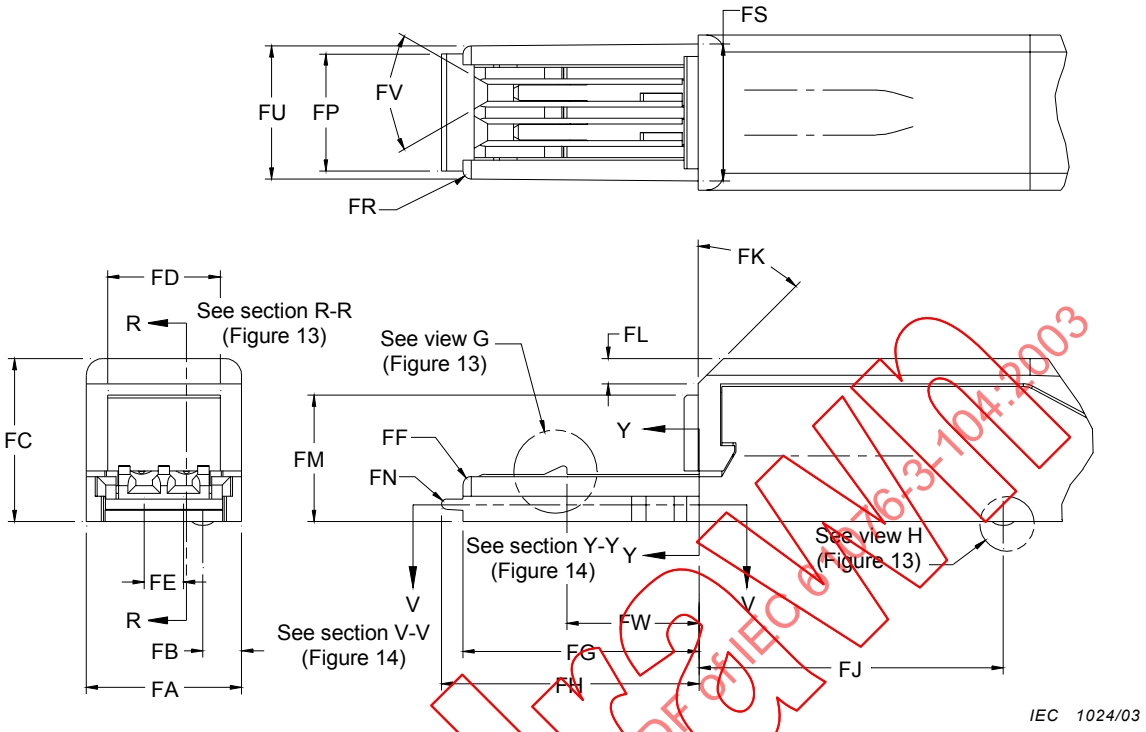


Figure 12 – Variant 05 drawing 1

Table 6 – Variant 05 drawing 1 dimensions

Dimensions in millimetres

	Nominal	Maximum	Minimum
FA	7,01	7,09	6,93
FB	1,75	1,83	1,67
FC	7,37	7,45	7,29
FD	5,08	5,16	5,00
FE	1,78	1,86	1,70
FF	R 0,38	R 0,46	R 0,30
FG	10,67	10,74	10,59
FH	12,01	12,07	11,96
FJ	13,72	13,80	13,64
FK	45°	46°	44°
FL	1,14	1,22	1,06
FM	5,72	5,80	5,64
FN	R 0,23	R 0,31	R 0,15
FP	5,29	5,37	5,21
FR	R 0,38	R 0,46	R 0,30
FS	6,20	6,28	6,12
FU	6,02	6,10	5,94
FV	60,00	61	59
FW	2,34	2,46	2,21

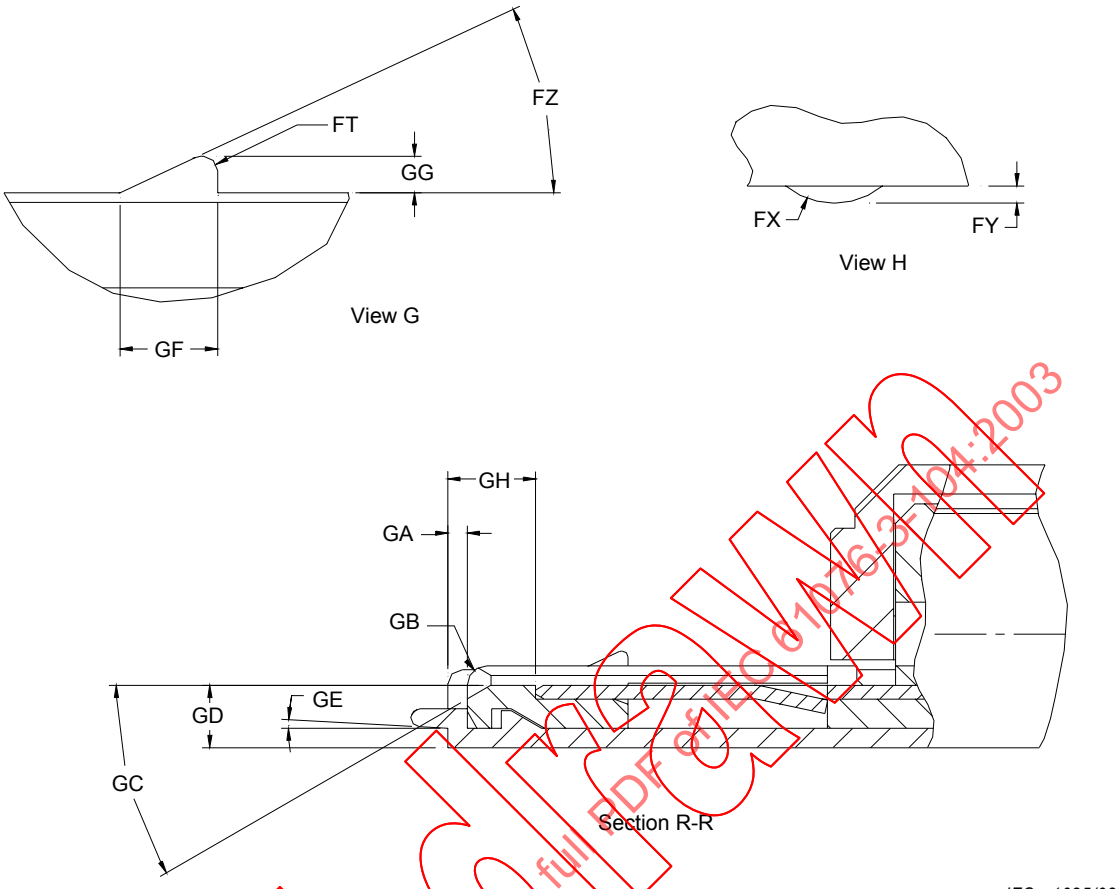


Figure 13 – Variant 05 drawing 2

Table 7 – Variant 05 drawing 2 dimensions

Dimensions in millimetres

	Nominal	Maximum	Minimum
FT	R 0,15	R 0,23	R 0,07
FX	R 0,76	R 0,84	R 0,68
FY	0,18	0,26	0,10
FZ	25°	26°	24°
GA	0,51	0,59	0,43
GB	R 0,51	R 0,59	R 0,43
GC	30°	31°	29°
GD	1,63	1,71	1,55
GE	3°	4°	2°
GF	1,02	1,10	0,94
GG	0,38°	0,46°	0,30°
GH	2,29	2,37	2,21

3.2.2.4 1-pair plug drawing 3 (see Table 8 for dimensions)

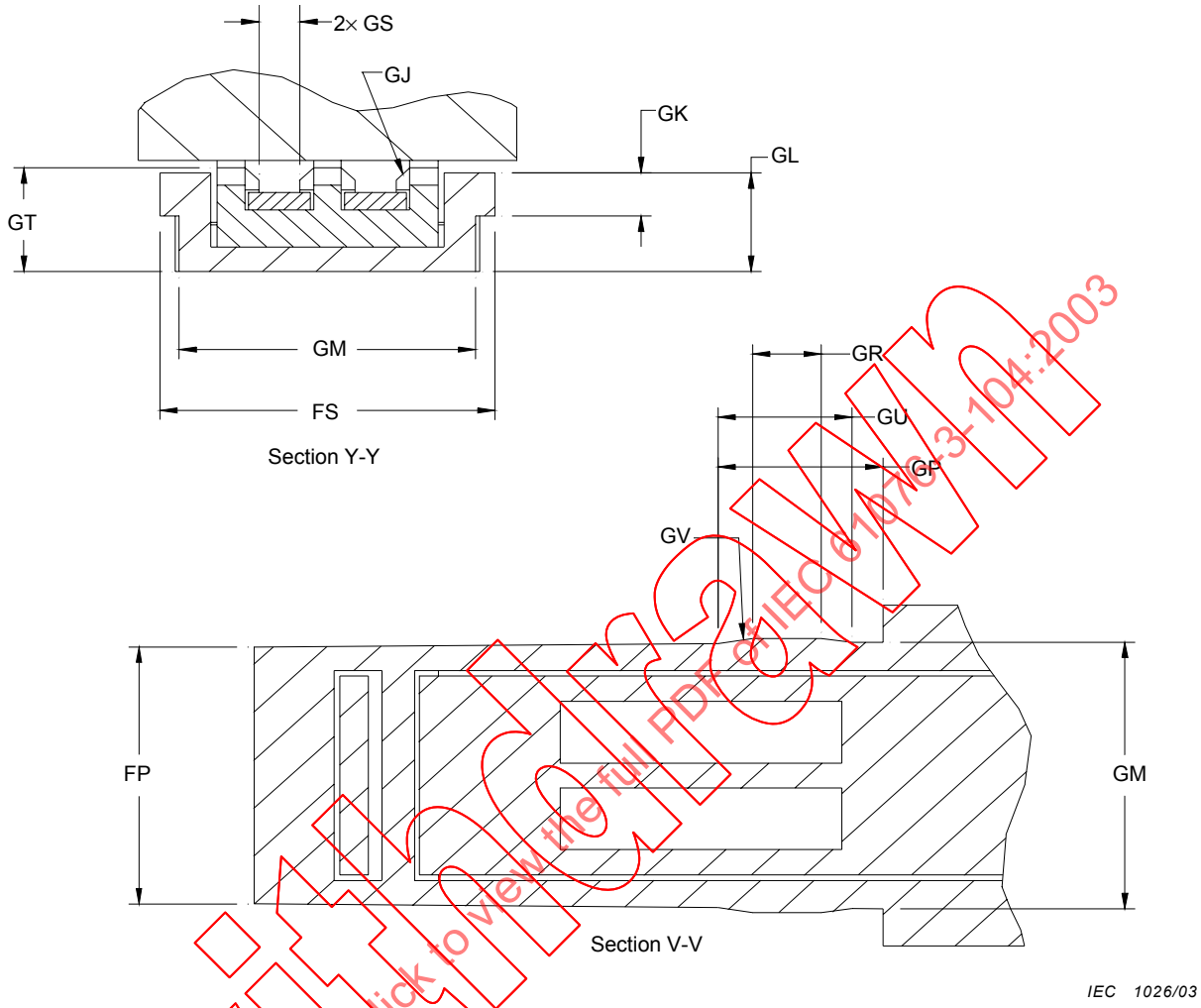


Figure 14 – Variant 05 drawing 3

Table 8 – Variant 05 drawing 3 dimensions

Dimensions in millimetres

	Nominal	Maximum	Minimum
GJ	45°× 0,25	45°× 0,33	45°× 0,18
GK	0,89	0,97	0,81
GL	2,41	2,54	2,29
GM	5,49	5,57	5,41
GP	3,35	3,43	3,28
GR	1,57	1,65	1,50
GS	0,76	0,81	0,71
GT	2,13	2,21	2,05
GU	2,84	2,92	2,77
GV	R 2,03	R 2,11	R 1,96
NOTE Dimension GS is the same as D in Figure 7 and ES in Figure 11.			

3.3 Fixed connector (outlet)

3.3.1 Isometric views

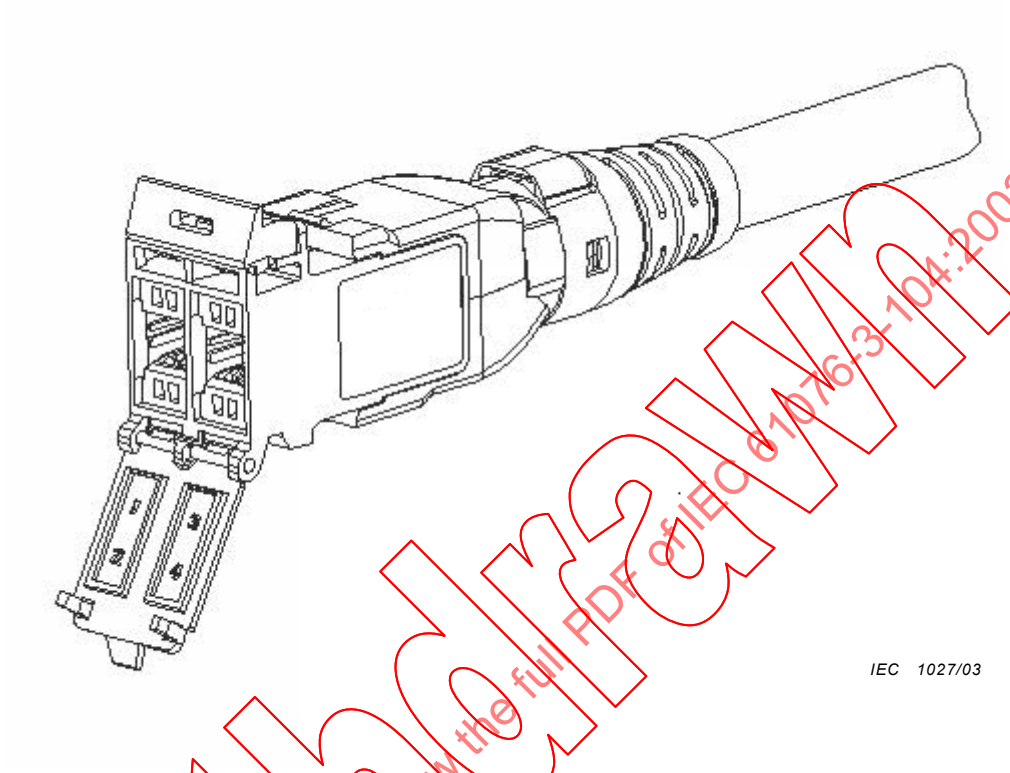


Figure 15 – Isometric view of variant 01 (cable outlet)

3.3.2 Variant 01 (cable outlet) drawings

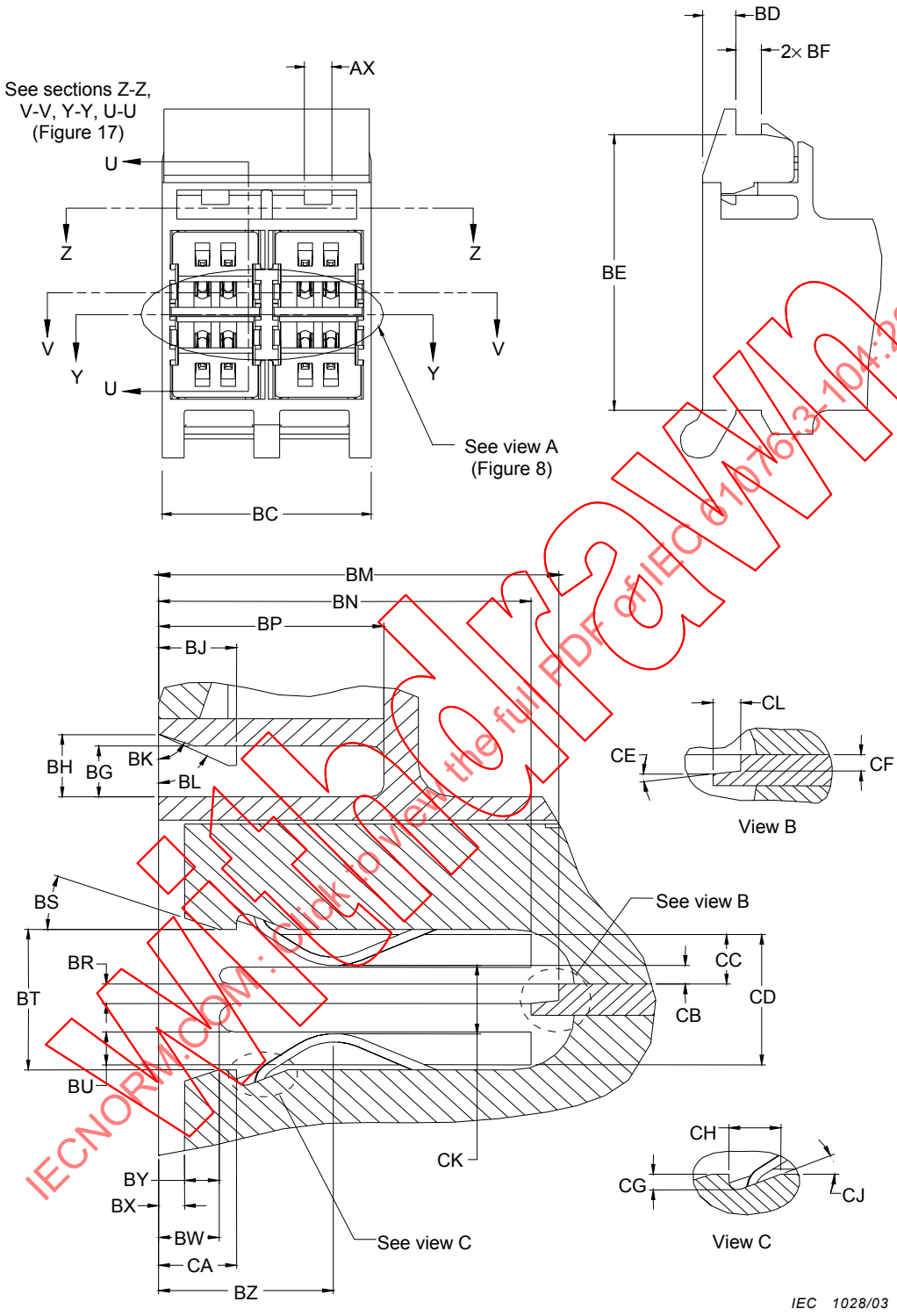


Figure 16 – Variant 01 cable outlet drawing 1

Table 9 – Variant 01 drawing 1 dimensions

Dimensions in millimetres

	Nominal	Maximum	Minimum
AX	1,91	2,03	1,78
BC	14,48	14,61	14,35
BD	2,29	2,41	2,16
BE	19,05	19,30	18,80
BF	1,78	1,85	1,70
BG	1,65	1,78	1,52
BH	2,03	2,16	1,91
BJ	2,29	2,36	2,21
BK	70°	71°	67°
BL	63°	66°	60°
BM	11,73	11,79	11,68
BN	10,92	11,00	10,85
BP	6,60	6,73	6,48
BR	0,64	0,71	0,61
BS	20°	23°	17°
BT	4,57	4,70	4,45
BU	1,07	1,12	1,02
BW	1,78	1,85	0,00
BX	0,76	0,90	0,64
BY	1,02	1,14	0,89
BZ	5,16	5,28	5,03
CA	2,29	2,36	2,21
CB	0,61	0,69	0,53
CC	1,61	1,66	1,56
CD	4,24	4,29	4,19
CE	7°	8°	6°
CF	0,51	0,56	0,46
CG	0,51	0,58	0,43
CH	1,52	1,65	1,40
CJ	23°	28°	18°
CK	2,21	2,34	2,08
CL	1,19	1,24	1,14

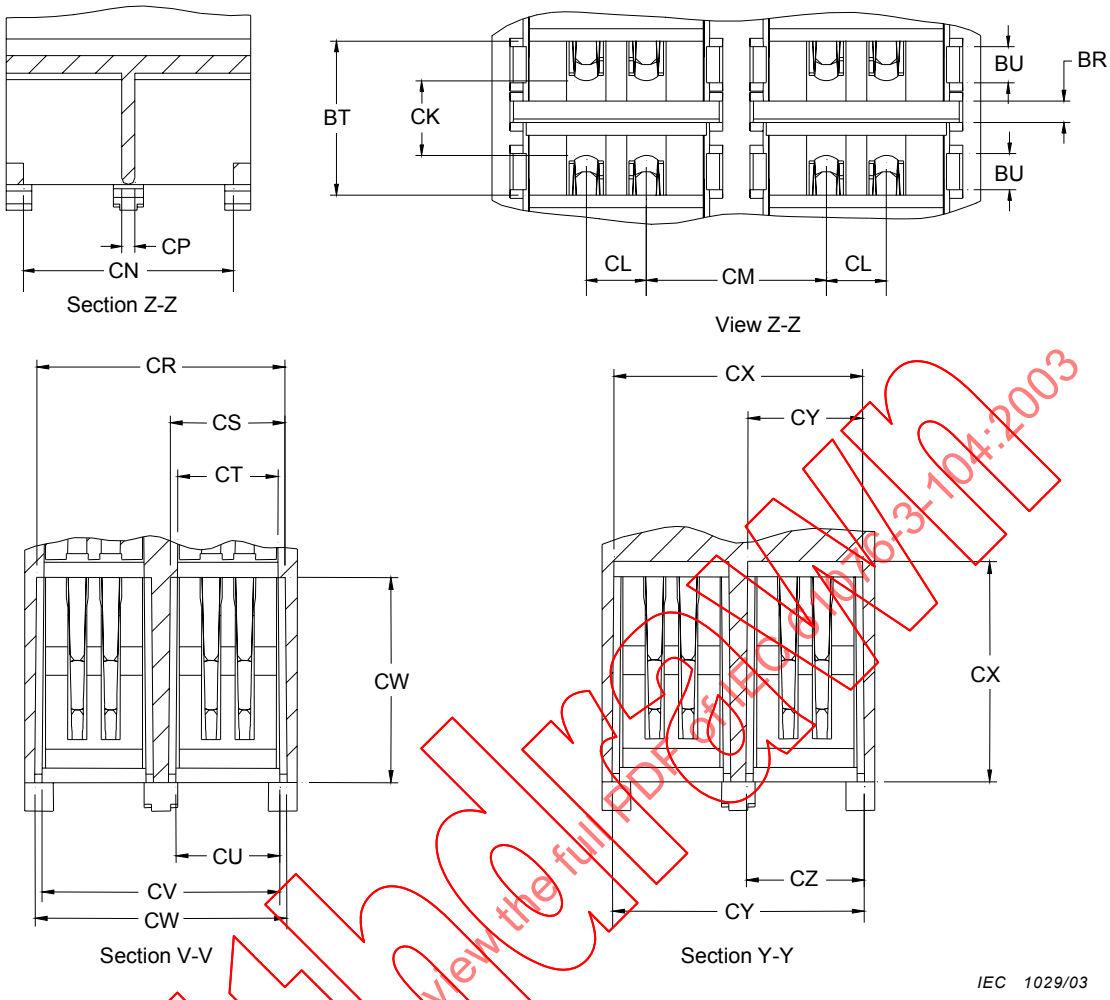


Figure 17 – Variant 01 cable outlet drawing 2

Table 10 – Variant 01 cable outlet drawing 2 dimensions

Dimensions in millimetres

	Nominal	Maximum	Minimum
CK	2,21	2,34	2,08
CL	1,78	1,88	1,68
CM	5,33	5,54	5,13
CN	12,45	12,57	12,32
CP	0,76	1,02	0,69
CR	13,18	13,26	13,10
CS	6,09	6,17	6,01
CT	5,33	5,41	5,25
CU	5,49	5,51	5,46
CV	6,26	6,34	6,18
CW	13,37	13,45	13,29
CX	13,21	13,29	13,13
CY	6,10	6,18	6,02
CZ	6,26	6,34	6,18

3.3.3 Variant 02, printed circuit board (PCB) outlet drawing

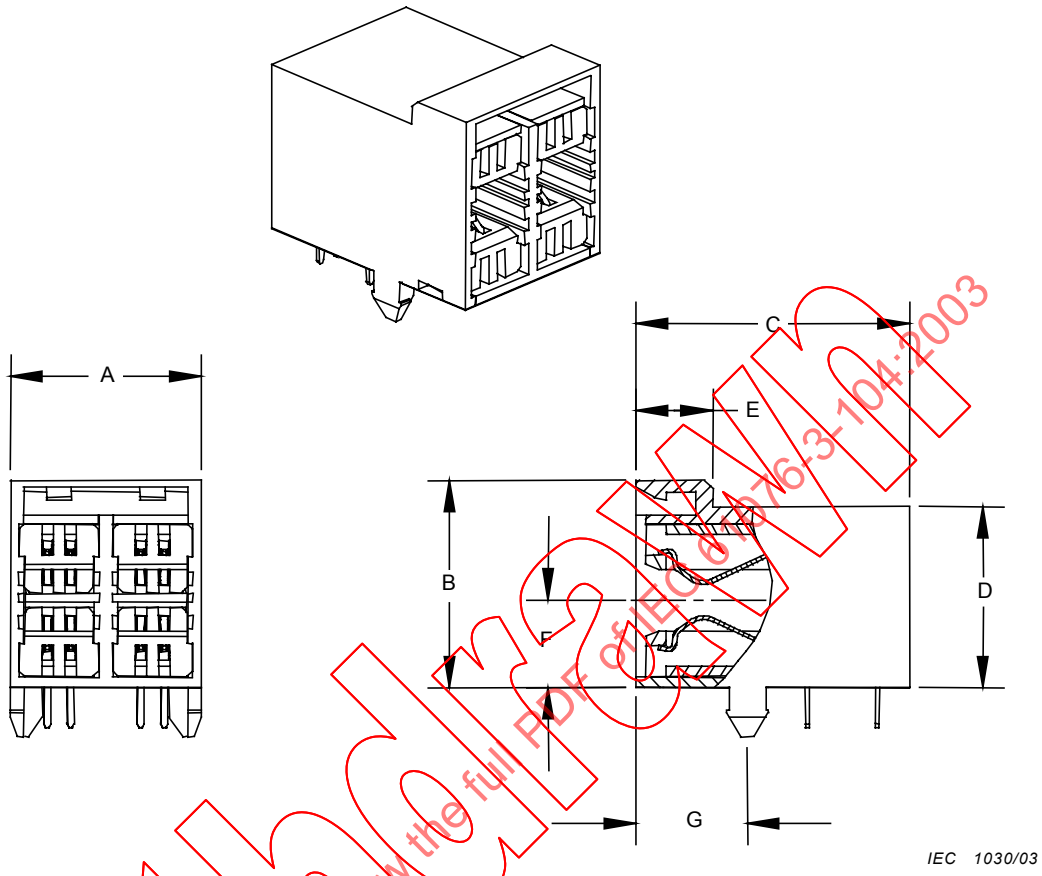


Figure 18 – Variant 02 printed circuit board (PCB) outlet drawing

Table 11 – Variant 02 drawing dimensions

Dimensions in millimetres

	Nominal	Maximum	Minimum
A	14,48	14,55	14,40
B	15,75	15,88	15,62
C	20,78	20,85	20,70
D	13,72	13,84	13,59
E	5,84	5,97	5,72
F	6,60	6,73	6,48
G	8,46	8,53	8,38

NOTE See Figure 16 for internal dimensions.

3.4 Gauges

Gauges shall be made according to the following requirements:

Material: tool steel, hardened.
√ = Surface roughness, according to ISO 1302
Ra = 0,25 µm max. (10 µin max.)
A 0,01 mm (0,0004 in) wear tolerance shall be applied.

Clearance shall be provided for connector contacts.

Annex A and B have additional information about using the gauges.

3.4.1 Fixed connector (outlet) gauges (see Table 12 for dimensions)

3.4.1.1 Fixed connector location GO gauge

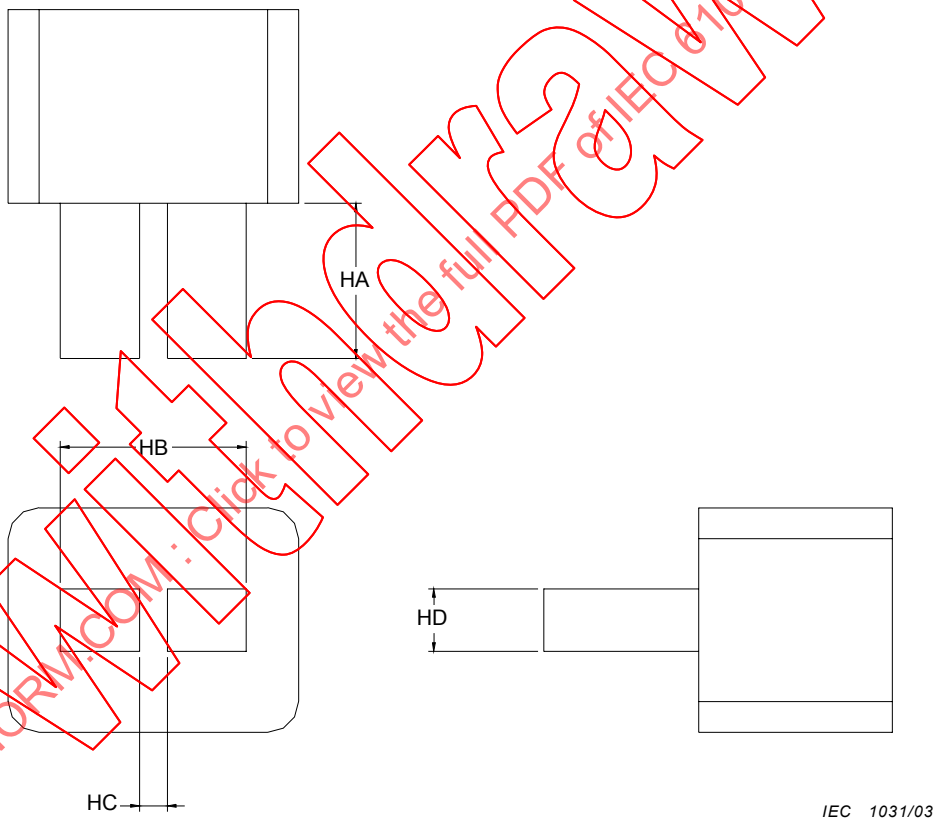


Figure 19 – Fixed connector location GO gauge

3.4.1.2 Fixed connector location NO-GO gauge

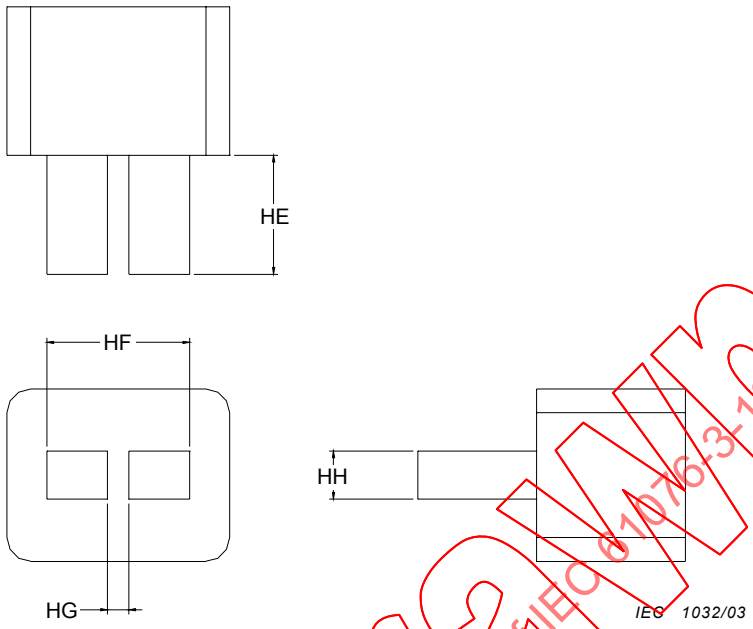


Figure 20 – Fixed connector location NO-GO gauge

3.4.1.3 Fixed connector size GO gauge

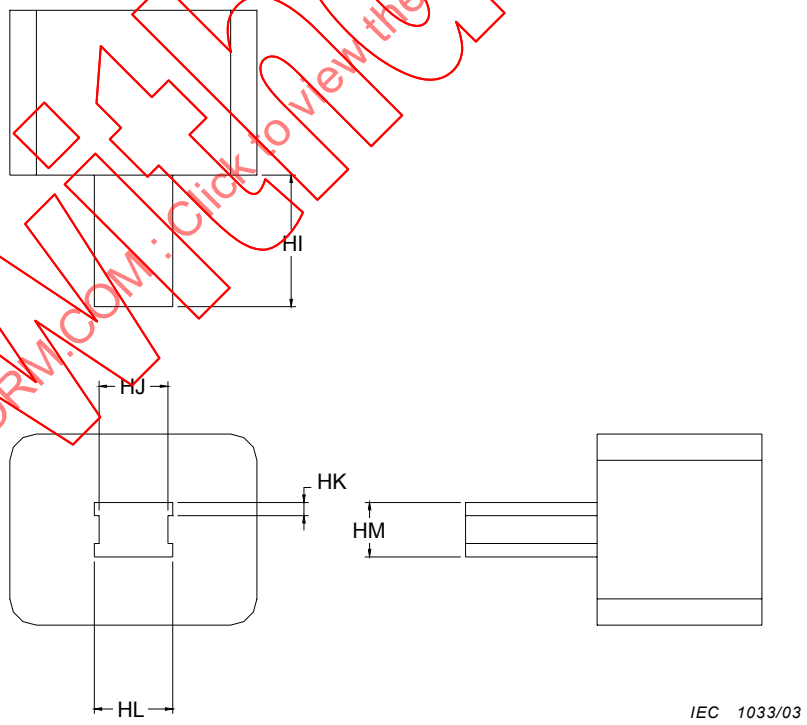


Figure 21 – Fixed connector size GO gauge

3.4.1.4 Fixed connector size NO-GO gauge

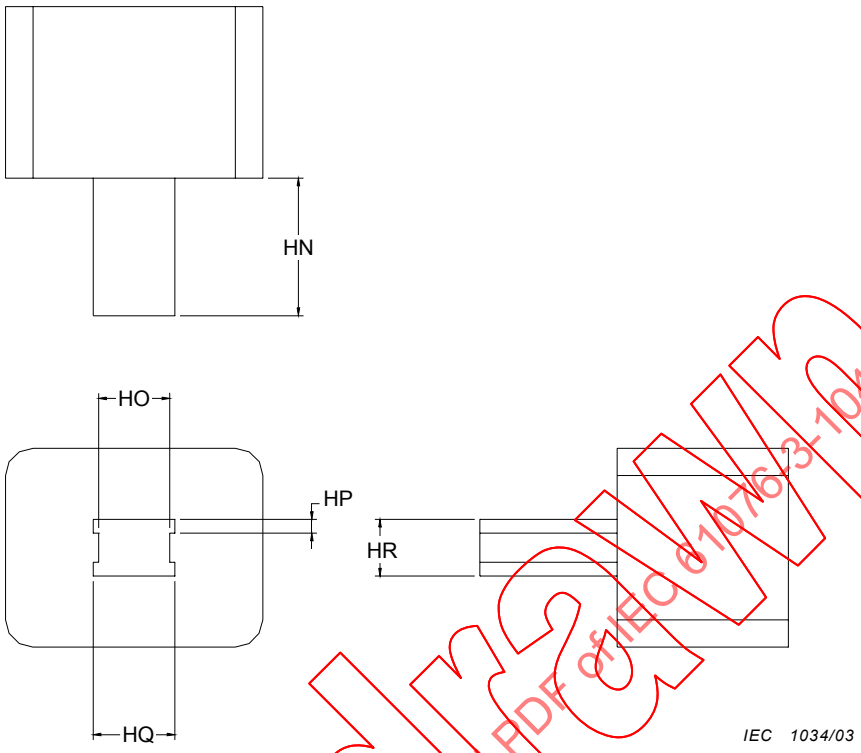


Figure 22 – Fixed connector size NO-GO gauge

Table 12 – Fixed connector gauge dimensions

Dimensions in millimetres

	Nominal	Maximum	Minimum
HA	10,16	10,211	10,109
HB	12,19	12,241	12,139
HC	1,603	1,6043	1,6017
HD	4,11	4,161	4,059
HE	10,16	10,211	10,109
HF	12,19	12,241	12,139
HG	1,395	1,3963	1,3937
HH	4,11	4,161	4,059
HI	10,16	10,211	10,109
HJ	5,281	5,2823	5,2797
HK	1,003	1,016	0,99
HL	6,043	6,094	5,992
HM	4,11	4,161	4,059
HN	10,16	10,211	10,109
HO	5,387	5,3883	5,3857
HP	1,003	1,016	0,99
HQ	6,043	6,094	5,992
HR	4,11	4,161	4,059

3.4.2 Free connector (plug) gauges (see Table 13 for dimensions)

3.4.2.1 Free connector location GO gauge

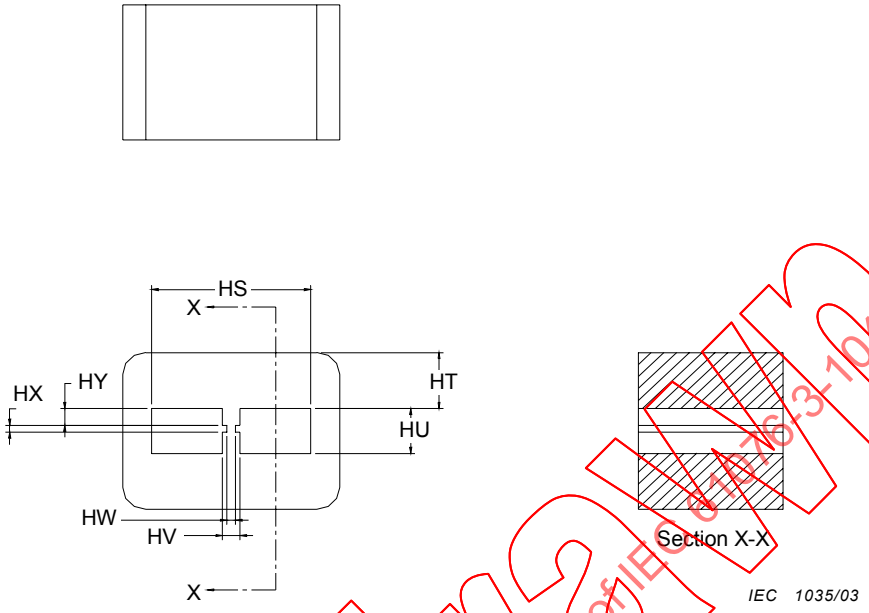


Figure 23 – Free connector location GO gauge

3.4.2.2 Free connector location NO-GO gauge

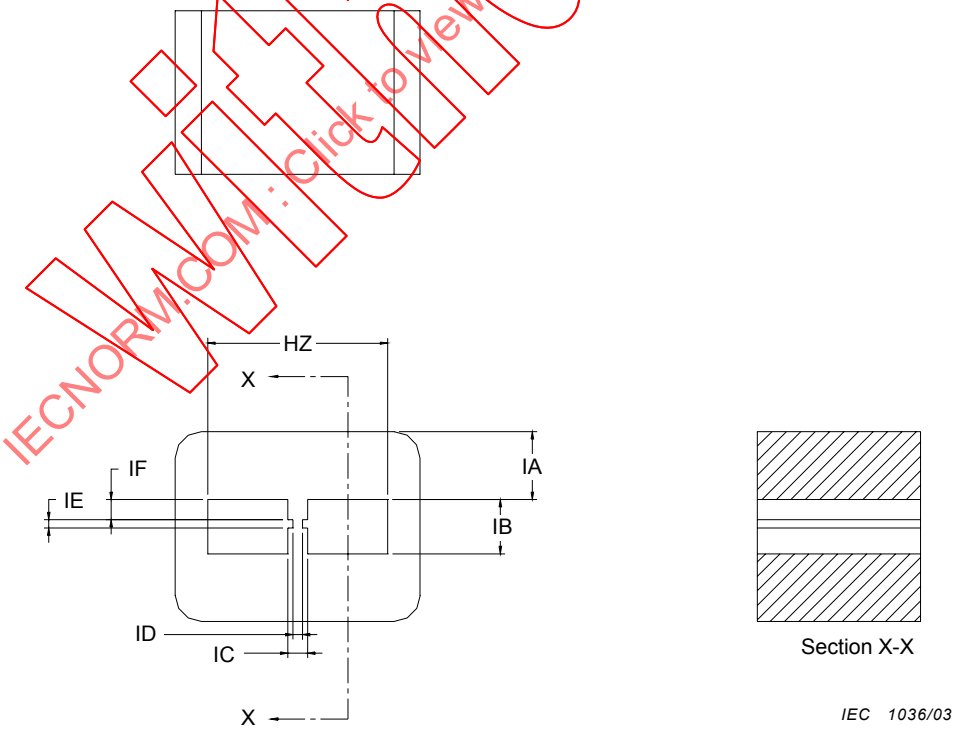


Figure 24 – Free connector location NO-GO gauge

3.4.2.3 Free connector plug size GO gauge

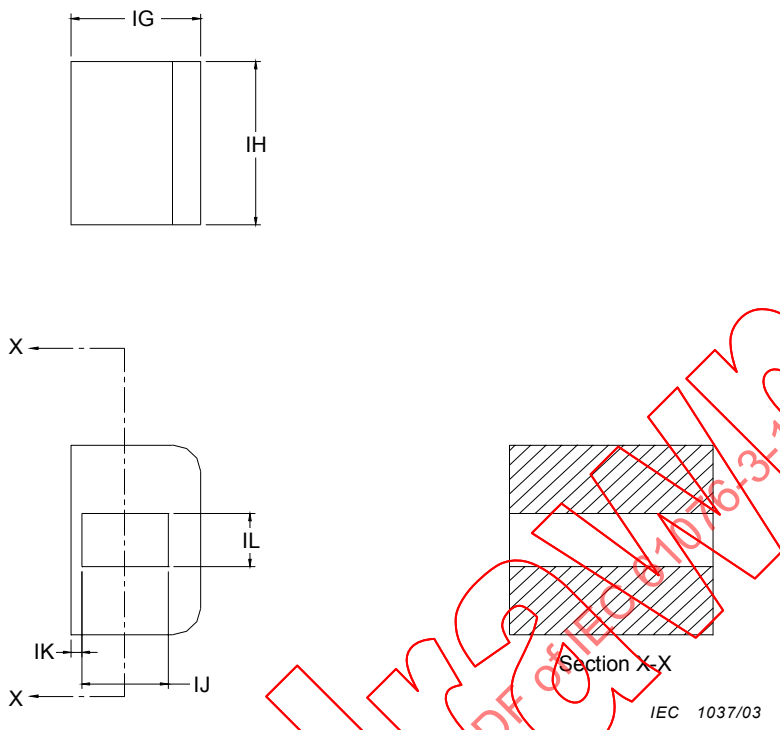


Figure 25 – Free connector plug size GO gauge

3.4.2.4 Free connector size NO-GO gauge

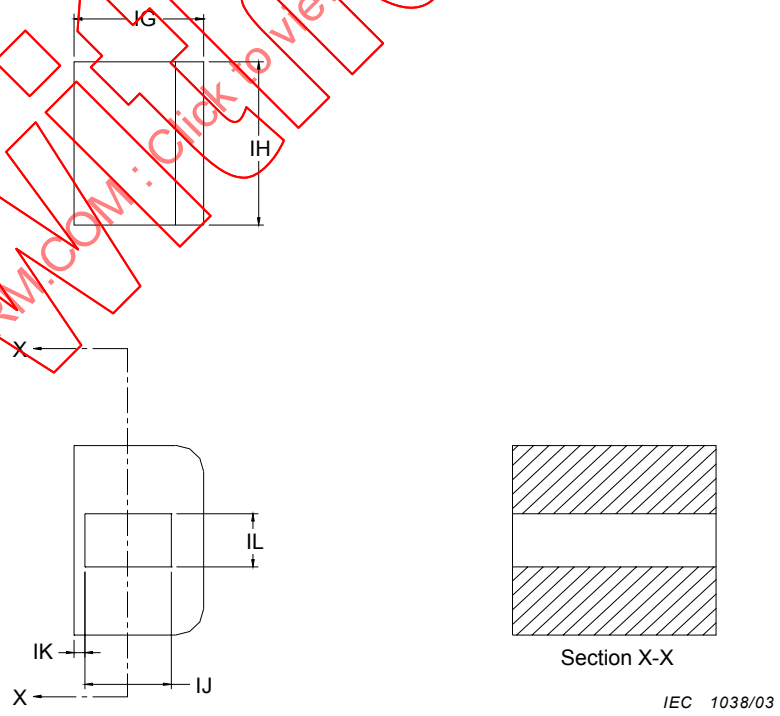


Figure 26 – Free connector size NO-GO gauge

Table 13 – Free connector gauge dimensions

Dimensions in millimetres

	Nominal	Maximum	Minimum
HS	13,97	13,985	13,955
HT	5,26	5,273	5,247
HU	4,219	4,234	4,204
HV	1,547	1,5753	1,5727
HW	0,759	0,774	0,744
HX	0,638	0,653	0,623
HY	1,791	1,806	1,776
HZ	13,97	13,985	13,955
IA	5,26	5,273	5,247
IB	4,219	4,234	4,204
IC	1,755	1,7563	1,7537
ID	0,759	0,774	0,744
IE	0,638	0,653	0,623
IF	1,791	1,806	1,776
IG	9,53	9,545	9,515
IH	12,7	12,715	12,685
II	4,117	4,1183	4,1157
IJ	6,251	6,2523	6,2497
IK	0,762	0,777	0,747
IL	9,53	9,545	9,515
IM	12,7	12,715	12,685
IN	5,565	5,5800	5,5500
IO	4,117	4,1183	4,1157
IP	6,144	6,1453	6,1427
IQ	0,762	0,777	0,747
IR	0,866	0,881	0,851
IS	1,036	1,051	1,021

3.4.3 Test panels (see Table 14 for dimensions)

Test panels for panel mounted fixed connectors shall be as defined below,

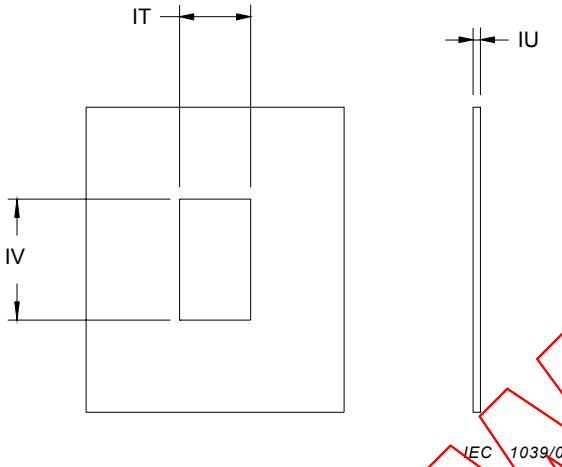


Figure 27 – Test panels

Table 14 – Test panel dimensions

Dimensions in millimetres

	Nominal	Maximum	Minimum
IT	14,732	14,808	14,656
IU	1,524	1,6	1,448
IV	19,304	19,38	19,228

4 Characteristics

4.1 General

Compliance to the test schedules is intended to ensure the reliability of all performance parameters, including transmission parameters. Stable and compliant contact resistance is a good indication of the stability of transmission performance.

4.2 Terminology

The terminology used in and applicable to this standard is stated in 2.1 of IEC 61076-1. IEC 60512-1 also contains applicable terms.

4.3 Classification into climatic categories

The lower and upper 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 has been selected.

Table 15 – Climatic categories – selected values

Climatic category	Lower temperature °C	Upper temperature °C	Damp heat steady state days
40/070/21	–40	70	21

4.4 Creepage and clearance distances

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 16 – Creepage and clearance 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	1,40	0,055	0,51	0,020	0,36	0,014	0,36	0,014

4.5 Electrical characteristics

4.5.1 Current-carrying capacity

The current-carrying capacity of connectors in accordance with the requirements of 2.4 of IEC 61076-1 shall be greater or equal to 1 A at 20 °C.

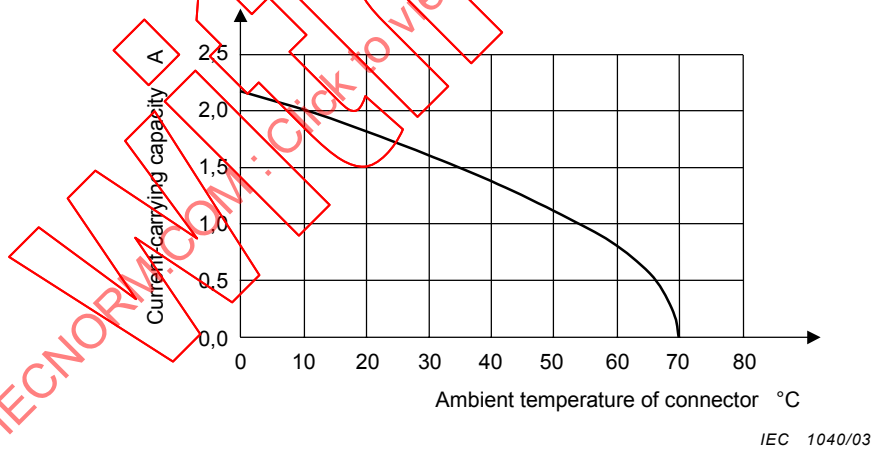


Figure 28 – Current-carrying capacity

4.5.2 Voltage proof

Conditions:

IEC 60512, 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 shield

4.5.3 Initial contact and shield resistance

Conditions:

IEC 60512, test 2a

Mated connectors

All types: 20 mΩ max.

4.5.4 Input to output resistance

Conditions:

IEC 60512, test 2a

Mated connectors

All types: 200 mΩ max.

4.5.5 Input to output resistance unbalance

Conditions:

IEC 60512, test 2a

Mated connectors

All types: 50 mΩ max.

4.5.6 Insulation resistance

Conditions :

IEC 60512, test 3a, method A

Mated connectors

Test voltage: 100 V d.c.

All types: 500 MΩ min.

4.5.7 Insertion loss

Conditions:

Annex F, insertion loss

Mated connectors, all pairs of contacts

All types: $\leq 0{,}0162 \times \sqrt{f}$ rounded to superior 0,1 dB

Where f is frequency in MHz.

4.5.8 Return loss

Conditions:

Annex G, return loss

Mated connectors, all pairs of contacts

All types: 70 – 20 × lg (f) dB up to 600 MHz Not > 30 dB

Where f is frequency in MHz.

4.5.9 Propagation delay

Conditions:

IEC 60512, test 25d, propagation delay

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.

4.5.10 Delay skew

Conditions:

IEC 60512, test 25d, delay skew

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.

4.5.11 NEXT loss

Conditions:

Annex H, NEXT loss

Mated connectors, between all combinations of 2 pairs of contacts

All types: $110 - 15 \times \lg(f)$ up to 600 MHz Not >80 dB

Where f is frequency in MHz.

4.5.12 FEXT loss

Conditions:

Annex I, FEXT pair to pair

Mated connectors, between all combinations of 2 pairs of contacts

All types: $90 - 15 \times \lg(f)$ up to 600 MHz Not >65 dB

Where f is frequency in MHz.

4.5.13 Unbalanced attenuation (longitudinal conversion loss (LCL), near end)

Conditions:

Annex J, unbalanced attenuation

Mated connectors, all pairs of contacts

All types: $66 - 20 \times \lg(f)$ up to 60 MHz (f.f.s.)

where f is frequency in MHz.

4.5.14 Coupling attenuation

Conditions:

Annex L, coupling attenuation test method under development

Mated connectors, all pairs of contacts

$55 - 20 \times \lg(f/100)$

where f is frequency in MHz.

NOTE 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.

4.5.15 Transfer impedance

Conditions:

Annex K, transfer impedance test method under development

Mated connectors

All types: under study

$0{,}05 \times f^{0,3}$ Ω from 1 MHz to 10 MHz (f.f.s.)

$0{,}01 \times f$ Ω from 10 MHz to 80 MHz.

The values from 80 MHz to 600 MHz are (f.f.s.)

Where f is frequency in MHz.

4.6 Mechanical

4.6.1 Mechanical operation

Conditions:

IEC 60512, test 9a

Speed: 10 mm/s (0,4 in/s) max.

Rest: 5 s min. (unmated)

PL1: 750 operations

PL2: 2 500 operations

4.6.2 Effectiveness of connector coupling devices

Conditions:

IEC 60512, test 15f

Mated connectors

All types: 50 N for 60 s min.

4.6.3 Insertion and withdrawal forces

Conditions:

IEC 60512, test 13b

Speed: 10 mm/s maximum

All types, insertion and withdrawal: 20 N maximum.

5 Quality assessment procedures

See Clause 3 of IEC 61076-1.

6 Qualification approval test schedule

6.1 General

See Clause 4 of IEC 61076-1.

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.

6.2 Test procedures and measuring methods

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

6.3 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 h unless otherwise specified by the detail specification.

6.4 Wiring and mounting of specimens

6.4.1 Wiring

Wiring of these connectors shall take into account wire diameter of the cables defined in IEC 61156-2, IEC 61156-3 and IEC 61156-4 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.

6.4.2 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 this.

6.4.3 Basic (minimum) test schedule

Not applicable.

6.4.4 Full test schedule

The detail specification shall call for the following tests and shall specify the characteristics to be examined 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 EP).

6.4.4.1 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 detail specification and in the sequence given, unless the detail specification requires alteration of the sequence of tests or adds new tests to verify additional connector characteristics (see 4.5).

The test parameters required shall be not less than those listed in 6.4.4. Unless otherwise specified, the requirements included in the following tables should be viewed as target values.

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

Table 17 – 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 A.1 All contacts/ specimens	Millivolt level method or contact resistance – specified test current method	2a	Contact resistance = 20 mΩ max. Shield resistance = 20 mΩ max.
P 4			100 V ± 15 V d.c.	Insulation resistance	3a	500 MΩ min.
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 connectors			1 500 V d.c. or a.c. peak

6.4.4.2 Test group AP

Table 18 – Test group AP

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 Test No.	Severity or condition of test	Title	IEC 60512 Test No.	Requirements
AP 1	Insertion and withdrawal forces	13b	Connector locking device depressed			Insertion force 20 N max. Withdrawal force 20 N max.
AP 2	Effectiveness of connector coupling device	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 A.1 All contacts/specimens	Contact and shield 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	Damp heat, cyclic	11m	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 A.1 All Contacts/Specimens	Contact and shield resistance	2a	20 mΩ max. change from initial
AP 10	Insertion and withdrawal forces	13b	Connector locking device depressed			Insertion force 20 N max. Withdrawal force 20 N max.

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 Test No.	Severity or condition of test	Title	IEC 60512 Test No.	Requirements
AP 11	Effectiveness of connector coupling device	15f	Rate of load application 44,5 N/s max.			50 N for 60 s ± 5 s
AP 12			Unmated connectors	Visual examin-ation	1a	There shall be no defects that would impair normal operation
AP 13	Solderability		As applicable			
AP 14	Resistance to soldering heat		As applicable			
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.

6.4.4.3 Test group BP

Table 19 – 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. Rest 5 s (when unmated). Locking device inoperative			N is: PL1 = 750 PL2 = 2500
BP 3	Flowing mixed gas corrosion	11g	4 days Half of the samples in mated state Half of the samples in unmated state		11g	
BP 4			Measurement points as in Figure A.1 All contacts/specimen	Contact and shield resistance	2a	20 mΩ max. change from intial
BP 5	Mechanical operations	9a	N/2 operations see mechanical operations. Speed 10 mm/s Rest 5 s (when unmated). Locking device inoperative			
BP 6			Measurement points as in Figure A.1 All contacts/specimen	Contact and shield 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

6.4.4.4 Test group CP

Table 20 – 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	6d	Frequency: 10 Hz – 55 Hz Displacement: 0,75 mm Sweep cycles: 20 (each of three linear axes) Endurance: 1 h 45 min each axis IEC 60068-2-6	Contact disturbance	2e	10 µs
CP 2			Test voltage 100 V ± 15 V d.c. Method A Mated connectors	Insulation resistance	3a	500 MΩ min.
CP 3			Measurement points as in Figure A.1 All contacts/specimens	Contact and shield 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

6.4.4.5 Test group DP

Table 21 – 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 ± 15 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 A.1 All contacts/specimens	Contact and shield resistance	2a	20 mΩ max. change from initial

6.4.4.6 Test group EP

Table 22 – Test group EP

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 Test No.	Severity or condition of test	Title	IEC 60512 Test No.	Requirements
EP1				Insertion loss	Annex F	$< 0{,}0162 \times \sqrt{f}$ rounded to superior 0,1 dB See notes 4, 6, 7 and 8
EP 2			All pairs, both directions, (pair to pair)	NEXT loss	25a; Annex H	110 – 15 × lg (*f*) See notes 1, 6, 7 and 8
EP 3			All pairs, both directions	Return loss	Annex G	70 – 20 × lg (*f*) See notes 2, 6, 7 and 8
EP 4			All pairs, both directions, (pair to pair)	FEXT loss	Annex J	90 – 15 × lg (*f*) See notes 3, 6, 7 and 8
EP 5				Unbalanced Attenuation	Annex J	66 – 20 × lg (*f*) See notes 5, 6, 7 and 8
EP 6				Transfer impedance	Annex K	0, 05 $f^{0,3}$ Ω from 1 MHz to 10 MHz 0,01 f Ω from 10 MHz to 80 MHz. See note 8
EP 7				Coupling attenuation	Annex L	55 – 20 × lg (*f*/100) See note 8
EP 8		2a		Input to output resistance	2a	200 mΩ
EP 9				Input to output resistance unbalance	2a	50 mΩ

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 worst case overall for the corresponding pair or pair combination after testing the 10 samples.

NOTE 7 All measurements to be performed on mated connectors.

NOTE 8 Where f is the frequency in MHz.

6.4.4.7 Test group FP

Table 23 – Test group FP

Test phase	Test			Measurement to be performed		
	Title	IEC 60512 Test No.	Severity or condition of test	Title	IEC 60512 Test No.	Requirements
FP 1	Surge test	ITU-T K.20	Contact/contact Unexposed environments Mated connectors tests 1, 2 and 3			Test 1, 2 – Withstand per ITU-T K.20, Clause 7, criterion A Test 3 – No fire hazard per ITU-T K.20, Clause 7, criterion B
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)

Contact resistance arrangement

A.1 Procedure

Determine the bulk resistance of the fixed connector between points A and B of Figure A.1 by calculation or by measurement.

Determine the bulk resistance of the free connector between points B and C of Figure A.1 by calculation or by measurement.

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

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

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

where I indicates initial value.

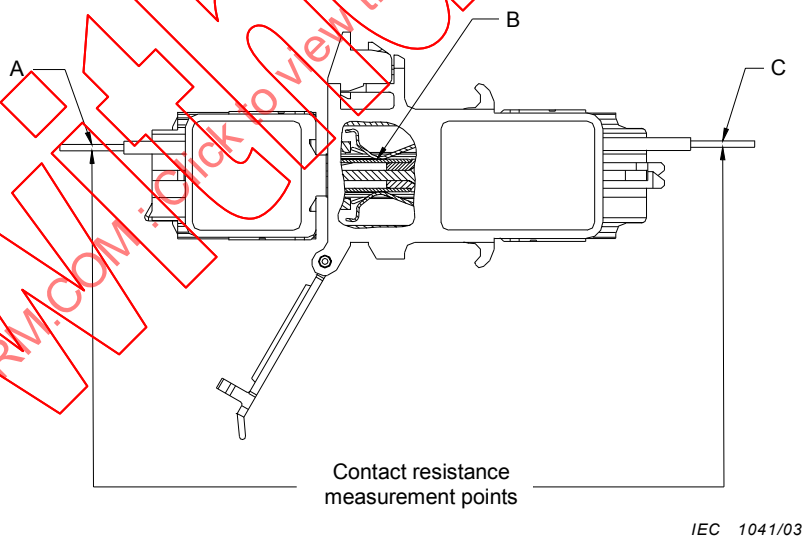


Figure A.1 – Contact resistance arrangement

Annex B
(normative)

Gauging requirements

B.1 Fixed connectors

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

The NO-GO gauges 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.

B.2 Free connectors

The connector shall be capable of insertion and latching into the GO gauge 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 advantages angle.

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

Annex C
(normative)

Locking device mechanical operation

C.1 Object

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

C.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.

C.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 19.

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.

C.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 D
(normative)

Plug and outlet interoperability qualification

D.1 Object

This annex is intended to define the test procedure for ensuring the IEC 61076-3-104 plug and outlet used to quantify mated performance meet the minimum transmission requirements separately.

D.2 Test equipment

The equipment used shall be as described in Annex E.

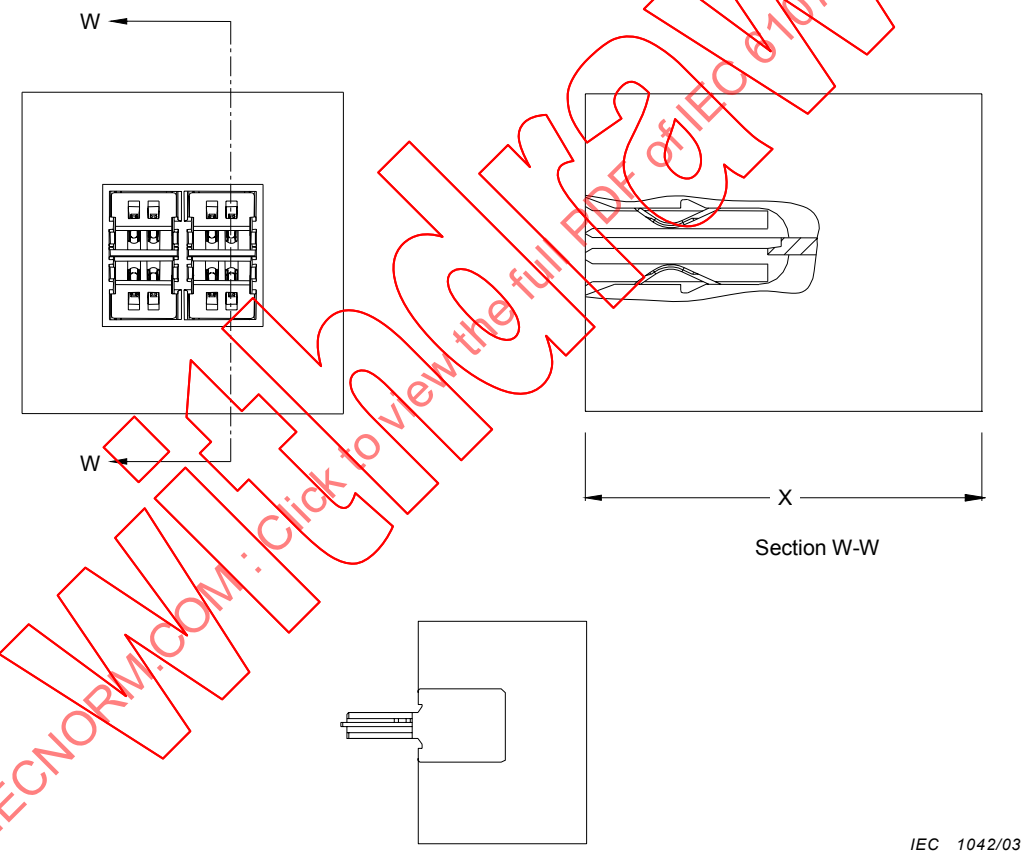


Figure D.1 – Precision test fixtures (covers)

The precision free connector test fixture “cover” and fixed connector test fixture “cover” shall be used to shield the terminations on the far side of the connector under test.

The test covers shall be similar to those shown above in Figure D.1. The internal dimensions are as given in 3.2.2.1 and 3.3.2. The fixture consists of an outlet with a cover over the termination area that completely isolates the pairs. The cover portion (dimension X) may vary from manufacturer to manufacturer due to the overall length of the connector.

An alternate fixture using the PCB oulet mounted on a printed circuit board with appropriate connections for connecting to a network analyzer can also be used. A similar plug version on a printed circuit board can also be used.

D.3 Test procedure

With the connector mated to the appropriate test fixture described in D.2, measure the NEXT and FEXT performance for each pair combination as outlined in Annexes H and I respectively.

The performance of the precision test fixture, plug and outlet, are verified to have return loss, NEXT and FEXT performance that are a minimum of 6 dB superior to the standard performance requirements in test group EP.

Annex E
(normative)

General requirements for the measurement set-up

E.1 Test instrumentation

These electrical test procedures require the use of a vector network analyzer. The analyzer should have the capability of full two port calibrations. The analyzer 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 E.4.

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

Termination loads are needed for termination of pairs, used and unused, which are not terminated by the test baluns. Requirements for the termination loads are given in Clause E.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 K.

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

E.2 Coaxial cables and test leads for network analyzers

Coaxial cable assemblies between network analyzers 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 M).

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 maximum 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.

E.3 Measurement precautions

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

a) consistent and stable balun and resistor loads shall be used for each pair throughout the test sequence;

b) cable and adapter discontinuities, as introduced by physical flexing, sharp bends and restraints shall be avoided before, during and after the tests;

c) the relative spacing of conductors in the pairs shall be preserved throughout the tests to the greatest extent possible;

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

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

E.4 Balun requirements

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

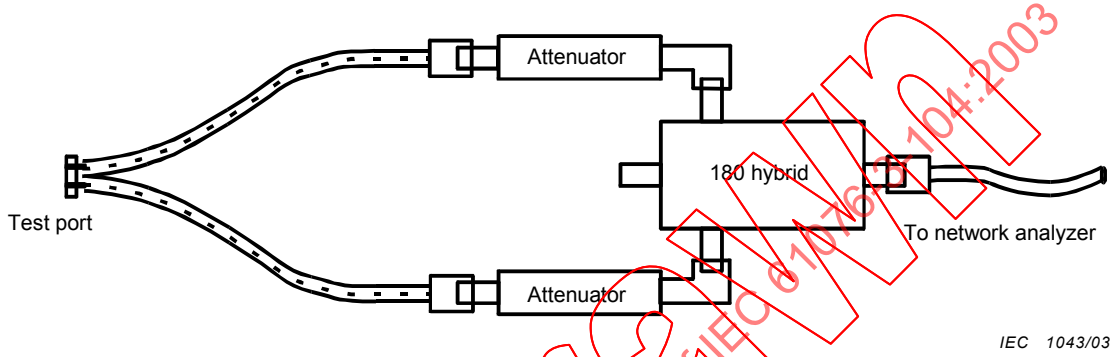


Figure E.1 – 180° hybrid used as a balun

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 E.1.

Table E.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 analyzer	
Impedance, secondary	100 Ω	
Insertion loss	10 dB max.	
Return loss secondary	14 dB min.	
Return loss common mode with common mode termination [a]	10 dB min.	
Return loss common mode without common mode termination [a]	1 dB max.	Not applicable
Longitudinal balance [b]	50 dB	Not applicable
Common mode rejection[c]	50 dB	40 dB
Output signal balance[c]	50 dB	40 dB
Power rating	0,1 W	

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

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

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

E.5 Reference components for calibration

E.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 E.2). The loads shall be fixed to the flat side of the connector, distributed evenly around the centre 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 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.

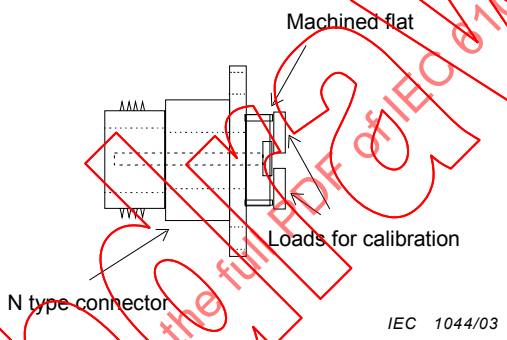


Figure E.2 – Calibration of reference loads

E.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

E.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 cause 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 × lg (f) where f is the frequency in megahertz[2]. 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 given in Annex K. For pairs connected to resistor loads, common mode load is implemented by the Y configuration shown in Figure E.3.

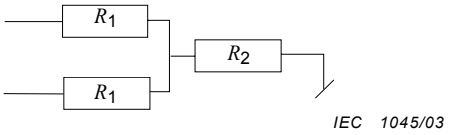


Figure E.3 – Resistor load

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 R_1 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 R_1 shall be symmetrical.

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

E.7 Termination of screens

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

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

E.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 E.4). This definition applies to both ends of the test specimen.

2 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 (see E.5.1)

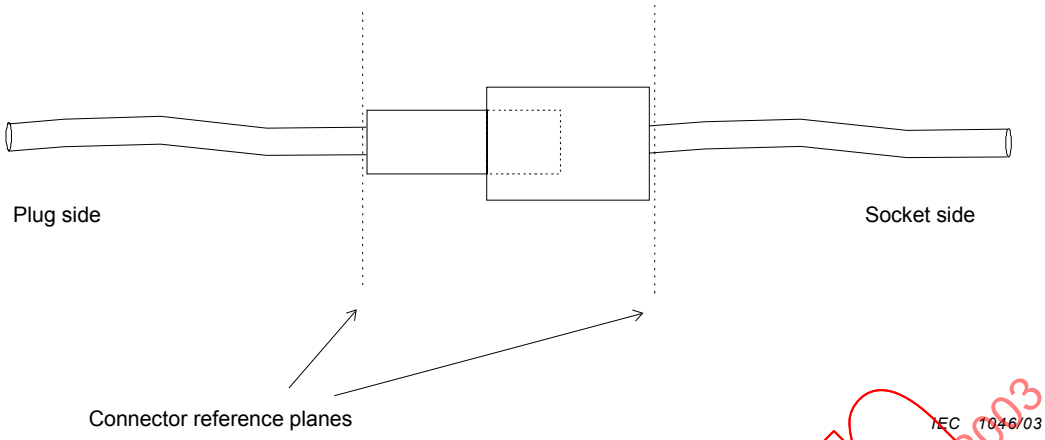


Figure E.4 – Definition of reference planes

Annex F
(normative)

Insertion loss[3]

F.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.

F.2 Test method

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

F.3 Tests set-up

The test set-up consists of a network analyzer and two baluns as defined in Annex E.

It is not needed to terminate the unused pairs.

F.4 Procedure

F.4.1 Calibration.

A full 2-port calibration shall be performed at the reference plane. This is done by applying a maximum length of 14 cm reference cable between the terminals of the baluns and performing the transmission calibration measurement. Then a maximum length of 7 cm reference cables are connected to the terminals of the two baluns (see Figure F.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.

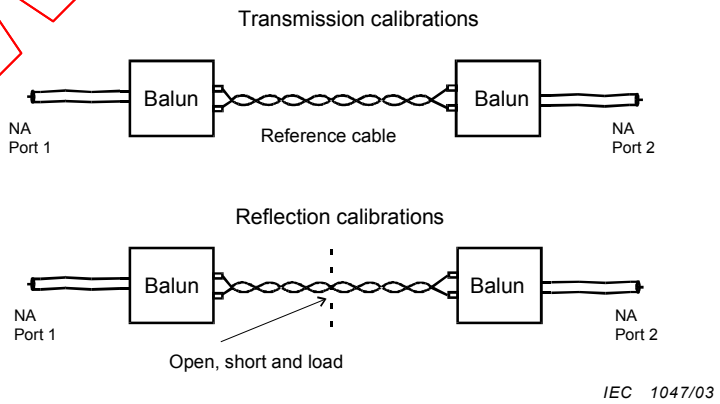


Figure F.1 – Calibration

3 Often referred to as attenuation.

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. An S_{21} measurement shall be performed.

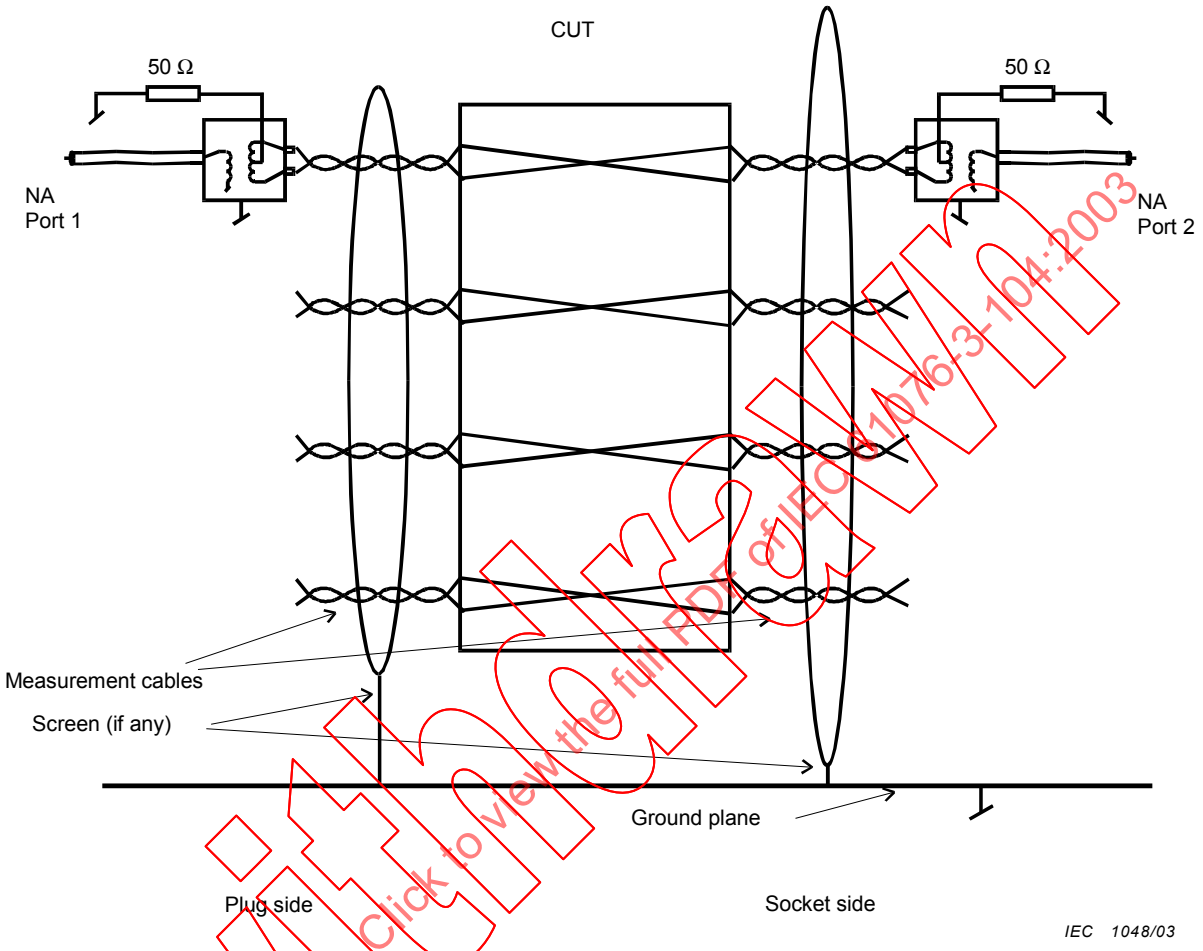


Figure F.2 – Measuring set-up

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 accuracy shall be within ±0,05 dB.

Annex G
(normative)

Return loss

G.1 Object

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

G.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 is nearly equal.

G.3 Test set-up

The test set-up is as described in Annex E.

G.4 Procedure

G.4.1 Calibration

Calibration shall be performed as described in F.4.1.

G.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.

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 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 (effectively 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 given in Table G.1.

Table G.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 H
(normative)

Near end crosstalk

H.1 Object

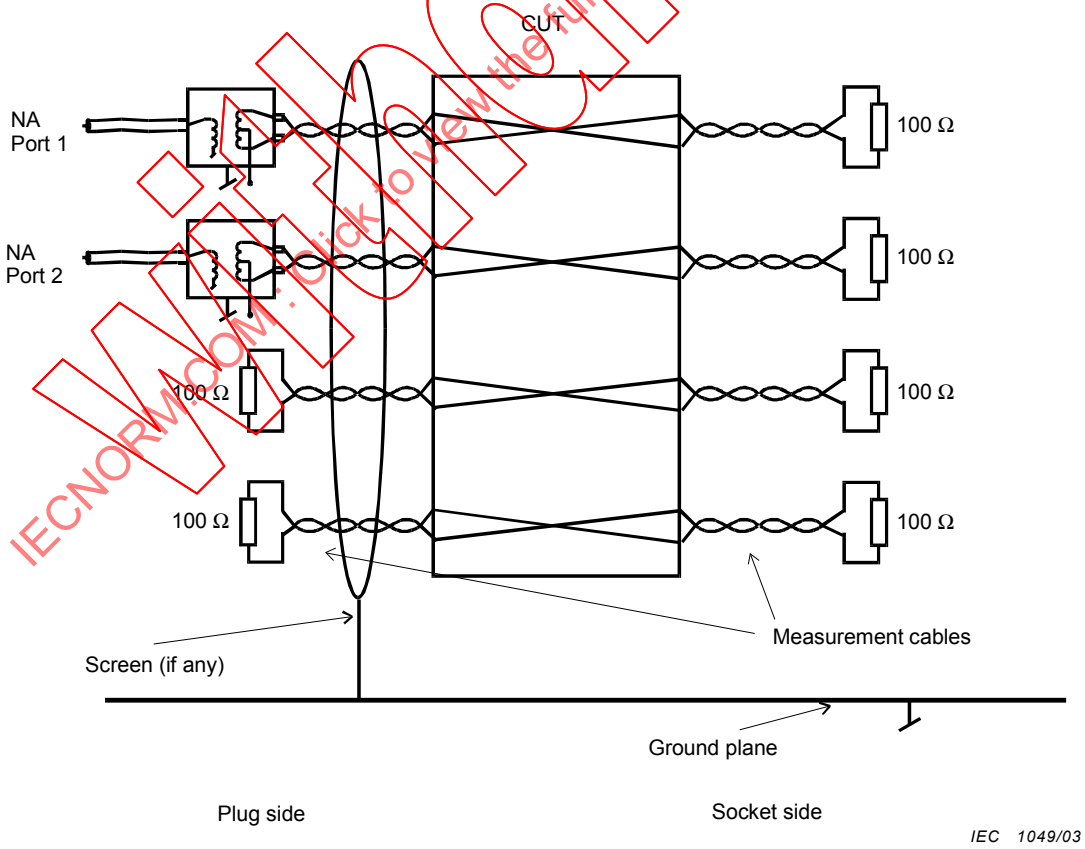
The object of this test procedure is to measure the magnitude of the electric and magnetic coupling between driven (disturbing) and quiet (disturbed) pairs of a mated connector pair.

H.2 Test method

Near end crosstalk is evaluated by measuring the scattering parameters, S_{21}, of the possible conductor pair combinations at one end of the mated connector, while the other end of the pairs are terminated.

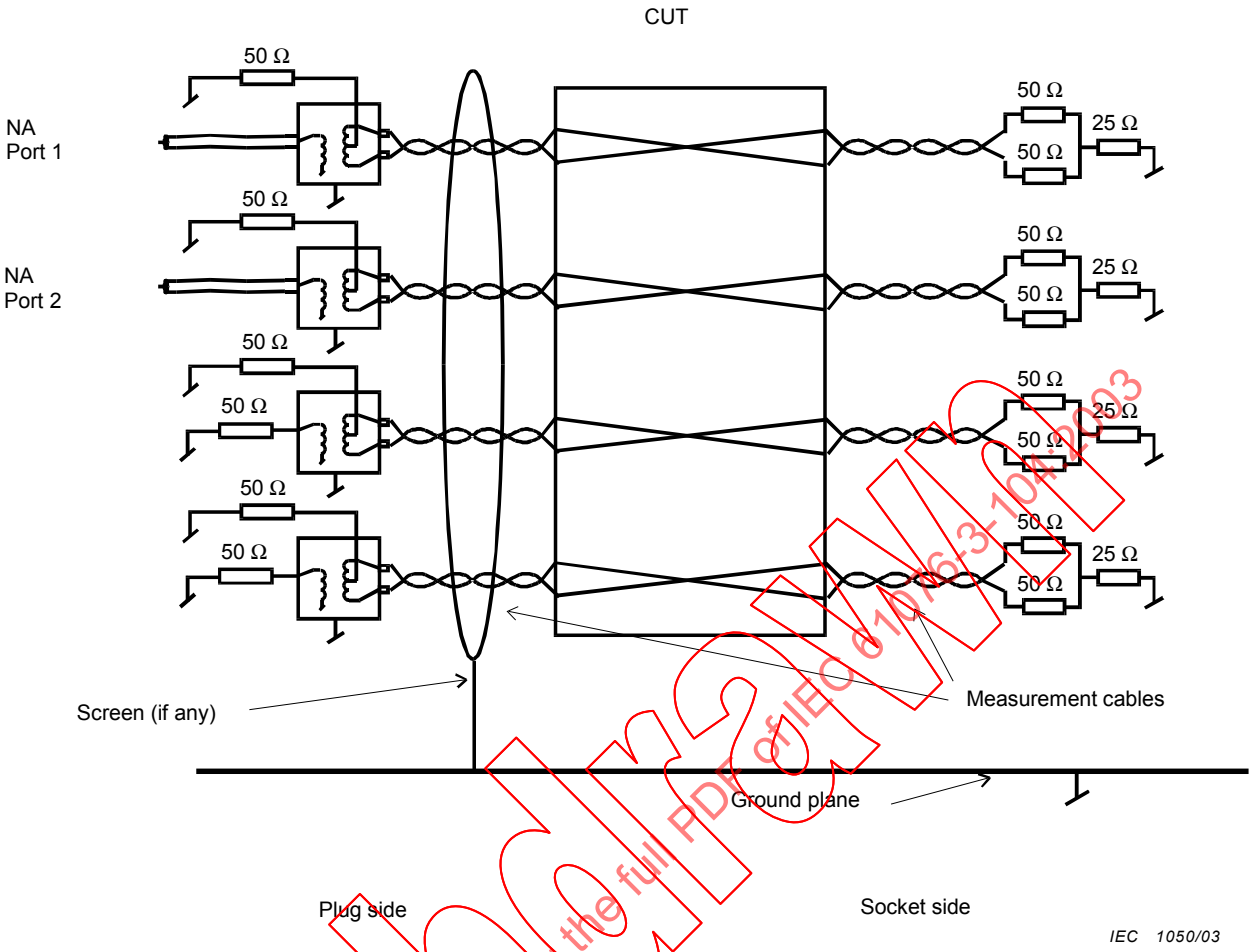
H.3 Test set-up

The test set-up consists of two baluns and a network analyzer as defined in Annex E. 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 – NEXT measurement differential mode only terminations



NOTE Passive terminations may be either balun or resistor terminations.

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

H.4 Procedure

H.4.1 Calibration

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

H.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 analyzer, and by residual crosstalk between the test baluns. The noise floor shall be measured by terminating the baluns with resistors and perform 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.

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 be terminated with short separated pairs without jacket. Test all possible pair combinations[4] and record the results.

The CUT shall be tested in the following configurations:

a) with differential mode terminations only (this is not requested for category 7 connectors, and the requirement will be removed for all categories if experience shows that a requirement for balance can replace this requirement);

b) 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 crosstalk values from the two ends are nearly equal.

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.

4 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 I
(normative)

Far end crosstalk

I.1 Object

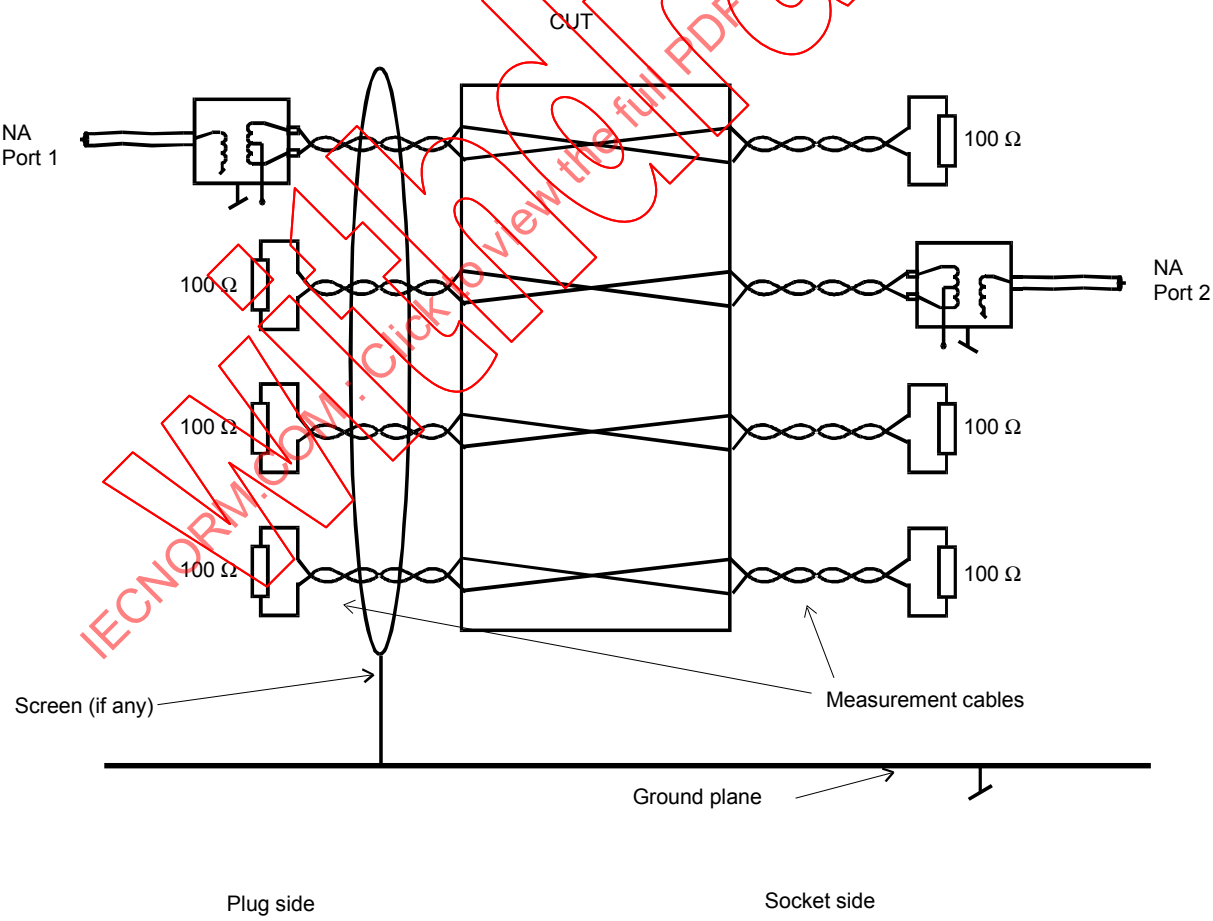
The object of this test procedure is to measure the magnitude of the electric and magnetic coupling between driven (disturbing) and quiet (disturbed) pairs of a mated connector pair.

I.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.

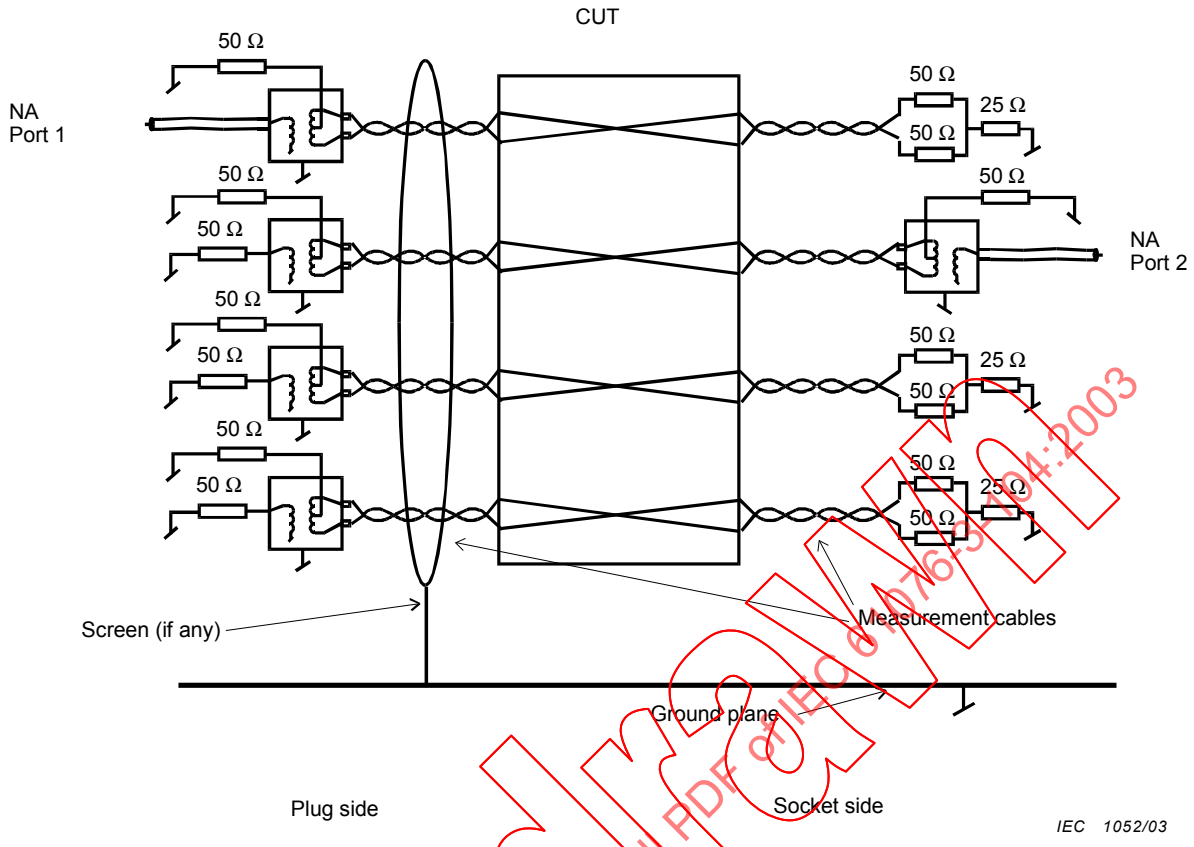
I.3 Test set-up

The test set-up consists of two baluns and a network analyzer as defined in Annex E. The set-up, which also shows the termination principles, is shown in Figures I.1 and I.2.



NOTE Passive terminations must be resistor terminations.

Figure I.1 – FEXT measurement differential mode only terminations



NOTE Passive terminations may be either balun or resistor terminations.

Figure I.2 – FEXT measurement differential and common mode terminations

I.4 Procedure

I.4.1 Calibration

Calibration is performed as shown in H.4.1.

I.4.2 Establishment of noise floor

The noise floor of the set-up is established as shown in H.4.2.

I.5 Measurement

Connect the disturbing pair of the CUT to the signal source and the disturbed pair to the receiver port. Terminate according to Figure I.1 and Figure I.2. It is recommended that the socket is terminated with short separated pairs without jacket. Test all possible pair combinations[5] and record the results.

5 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.