IEC/PAS 61076-3-104

Edition 1.0
2002-06

Connectors for electronic equipment –

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

PUBLICLY AVAILABLE SPECIFICATION

INTERNATIONAL
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FOREWORD

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

IEC-PAS 61076-3-104 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/1167/PAS	48B/1215A/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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2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.

3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.

4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.

5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.

CONNECTORS FOR ELECTRONIC EQUIPMENT –

Part 3-104: 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 ways connectors, with up to 4 pairs, for frequencies up to 600 MHz minimum, and intended to be used at different locations within cabling for ICT, 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 normative documents contain provisions that, through reference in this text, constitute provisions of this part of IEC 61076. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 61076 are encouraged to investigate the possibility of applying the most recent editions of the normative documents listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

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*

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 specifications – Capability approval*

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

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

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 60512-1 *Electromechanical components for electronic equipment, Basic testing procedures and measuring methods – 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*

ISO 1302 *Technical Drawings – Method of indicating surface texture*

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 sectional specification.
The number of the detail specification (without dashes), being nine characters (e.g. 610764100).
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 same type and range but different style. A group of related connectors is covered by a single detail specification.

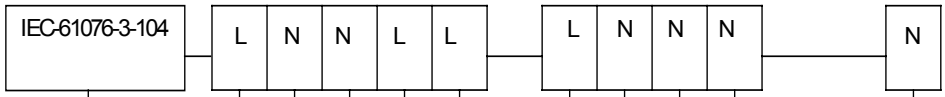
- **Type**: Connectors within a particular subfamily such as a multicontact connector with one, two or four pairs.
- **Range:** The housing (shell) sizes and contacts arrangements within a type. For example a housing containing one, two or four pairs.
- **Style:** A particular connector within a type, 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, e.g. 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 e.g. 2 × 2 pairs or 4 × 1 pair plugs mated directly with a single 4 pairs socket.



Reference to this standard

Number denoting performance level (PL)	
1	750 operations
2	2500 operations

Letters denoting connector type	
Free Version	A
Fixed Version	B

Number denoting variant	
01	Cable outlet
02	PCB outlet
03	Four pair plug
04	Two pair plug
05	1 pair plug

Note: "L" stands for letter
"N" stands for number

Number of contacts
08

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

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
X	Customer specific req. for cables

2.5 Wiring Conventions

2.5.1 Outlet

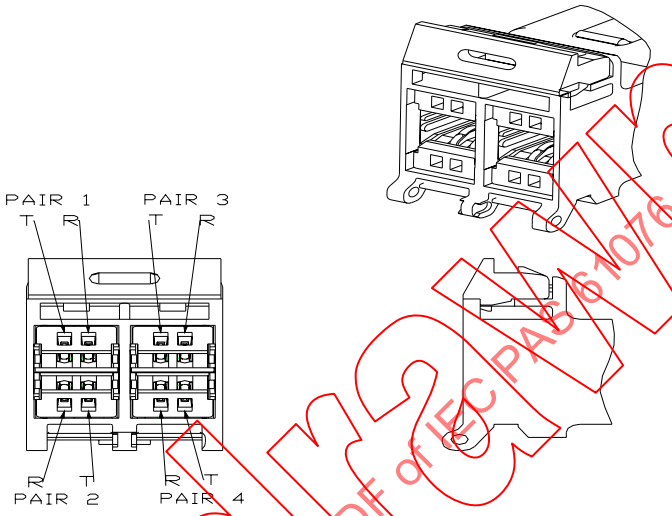


Figure 1

2.5.2 Plug

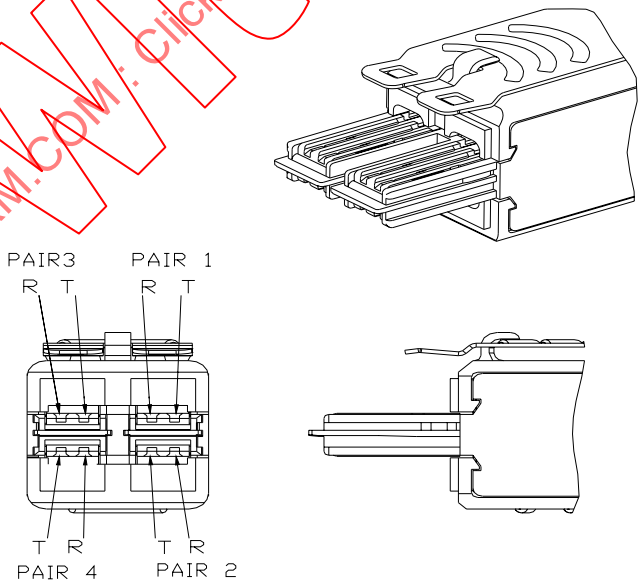


Figure 2

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

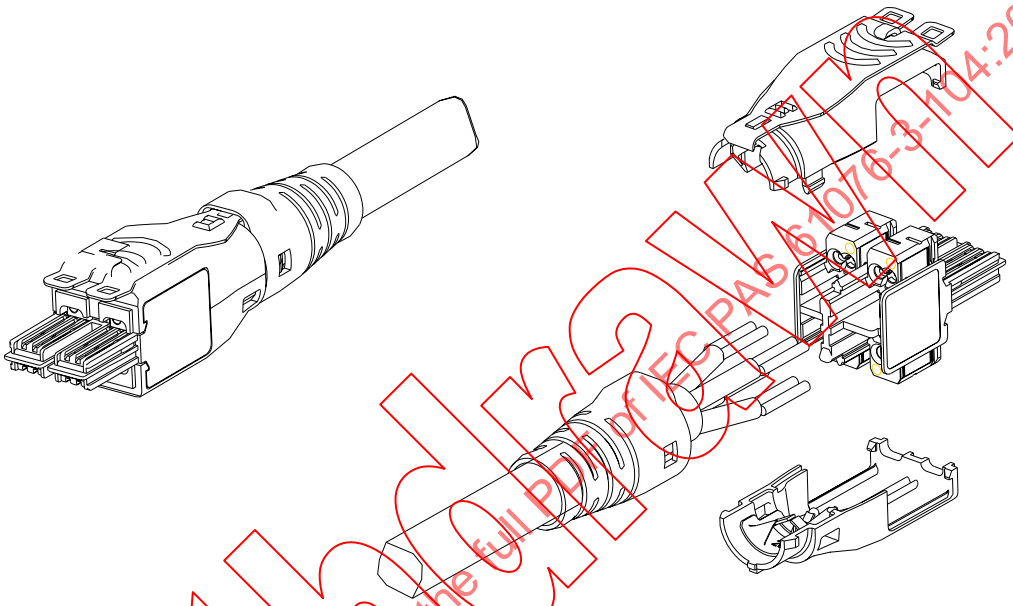


Figure 3 – Variant 03, 4-pair plug

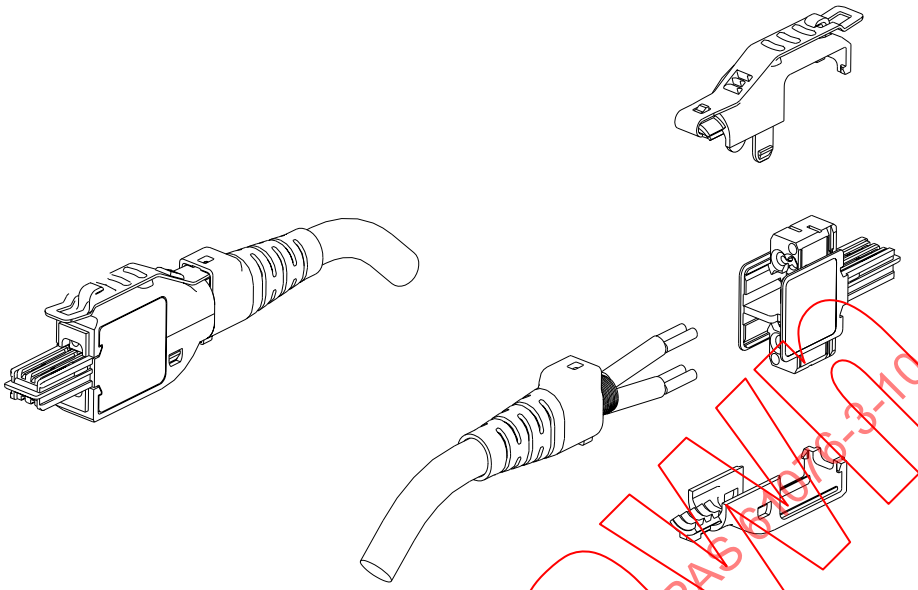


Figure 4 – Variant 04, 2-pair plug

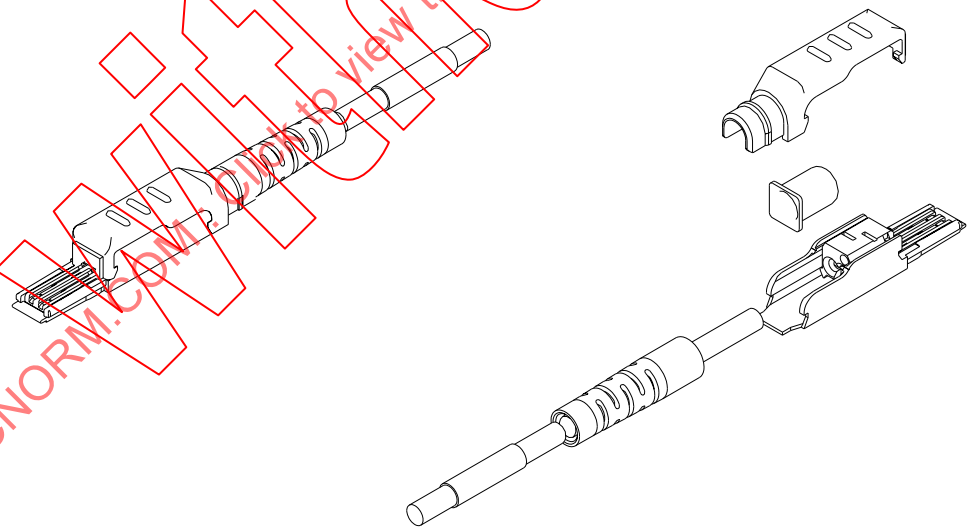


Figure 5 – Variant 05, 1-pair plug

3.2.2 Free Connector Dimensions

3.2.2.1 Variant 03, 4-pair plug drawings

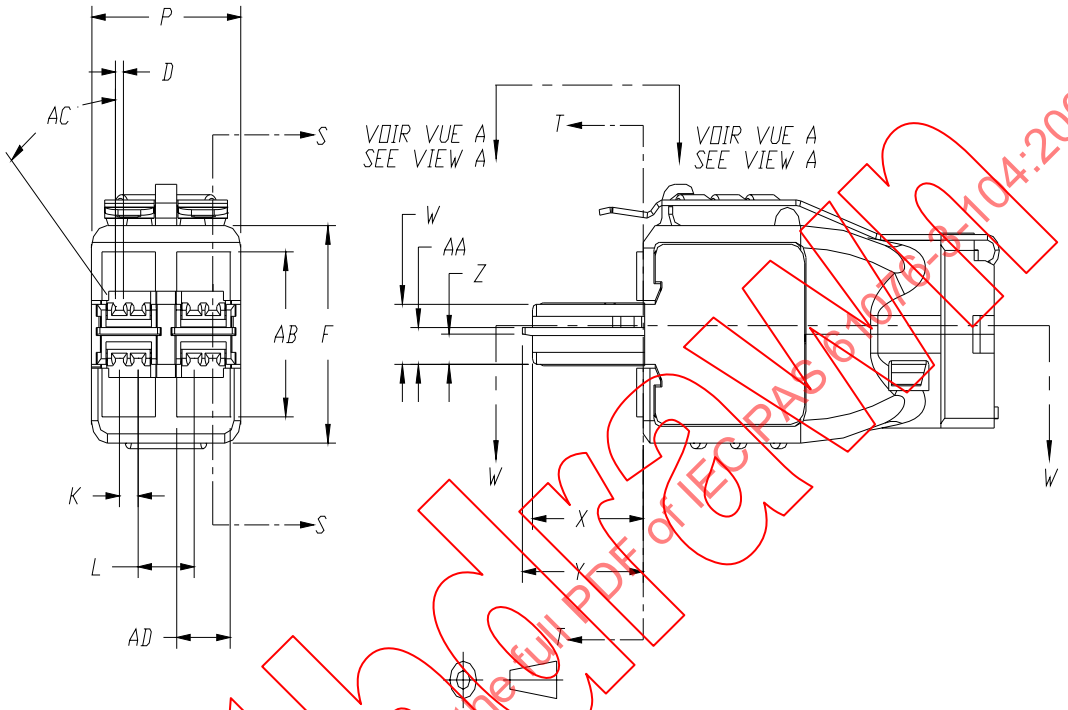


Figure 6 – Variant 03 drawing 1

Table 1 – Variant 03 drawing 1 dimensions

	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 8 and GS in figure 11.

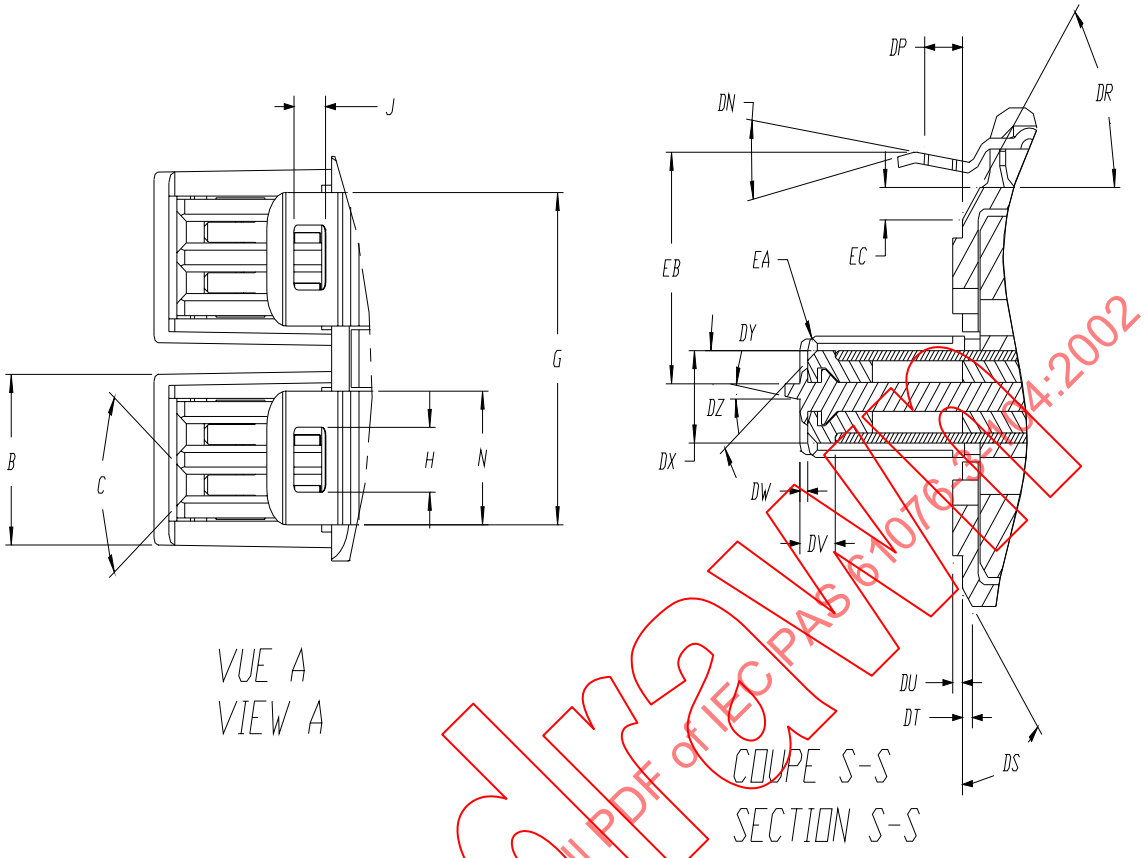


Figure 7 – Variant 03 drawing 2

Table 2 – Variant 03 drawing 2 dimensions

	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	R0,51	R0,58	R0,43
EB	8,13	8,26	8,00
EC	1,14	1,27	1,01

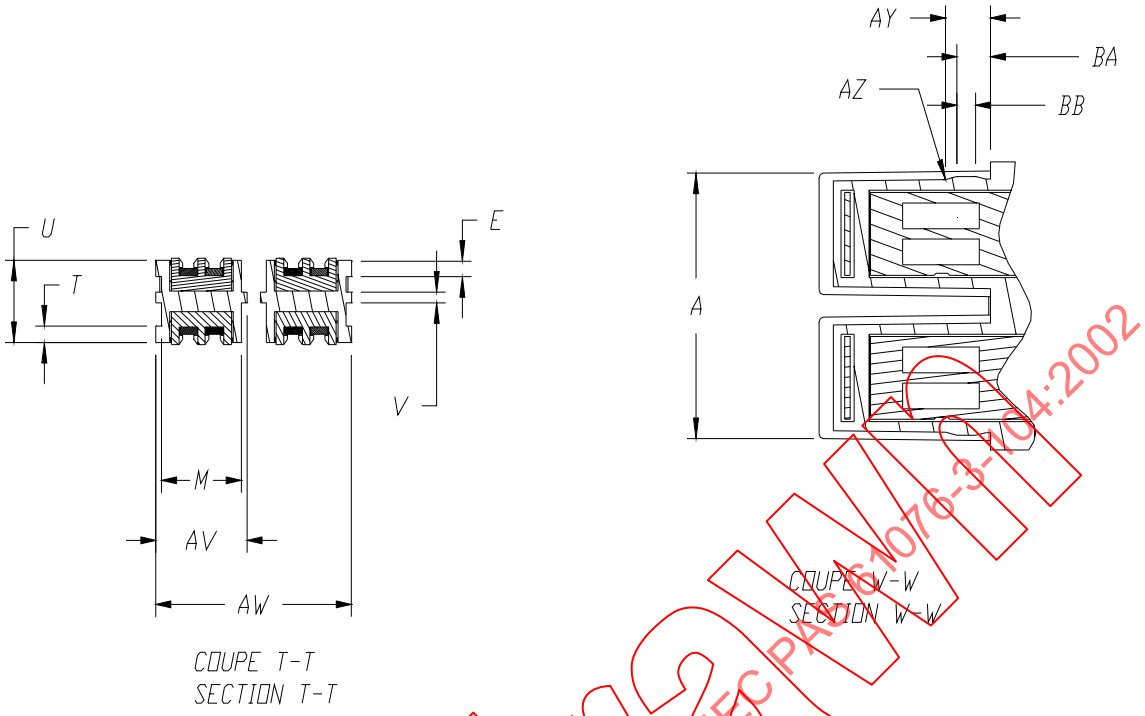


Figure 8 – Variant 03 drawing 3

Table 3 – Variant 03 drawing 3 dimensions

	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	R2,03	R2,11	R1,96
BA	2,26	2,34	2,19
BB	1,27	1,52	1,19

3.2.2.2 Variant 04, 2-Pair Plug Drawings

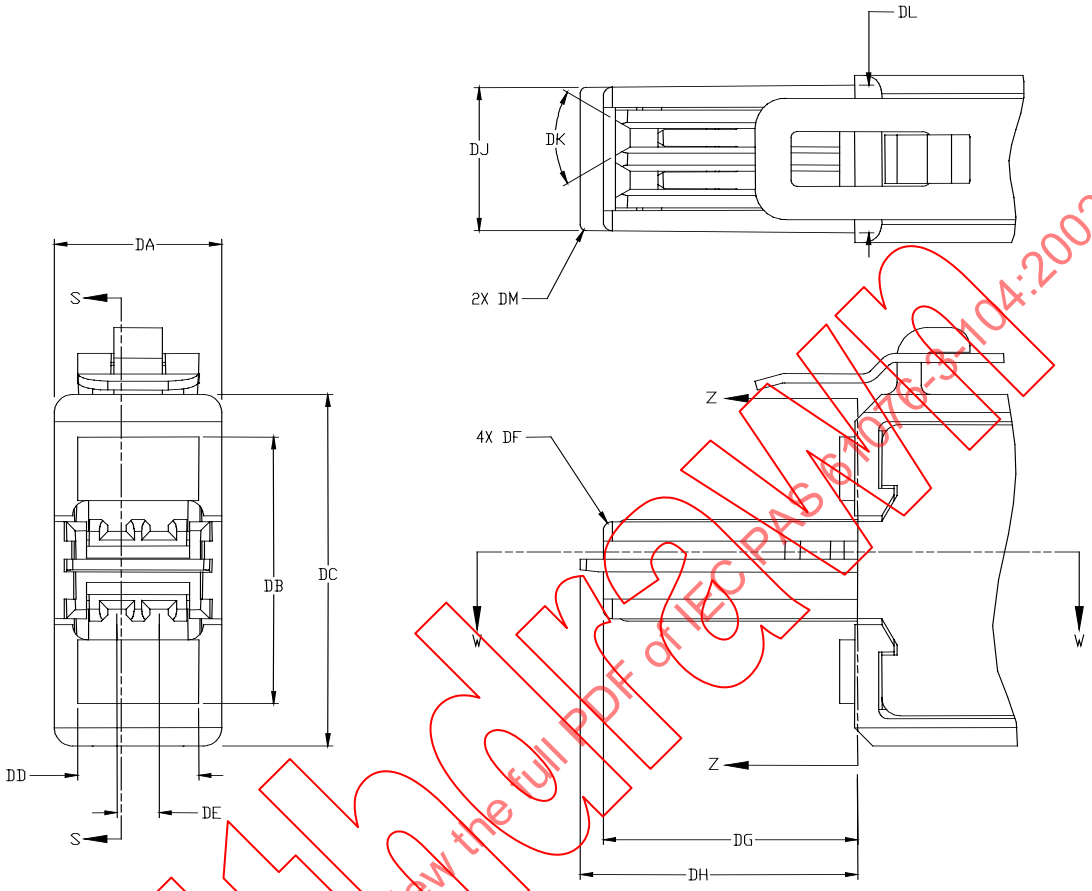


Figure 9 – Variant 04 drawing 1

Table 4 – Variant 04 drawing 1 dimensions

	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	R0,38	R0,46	R0,30
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

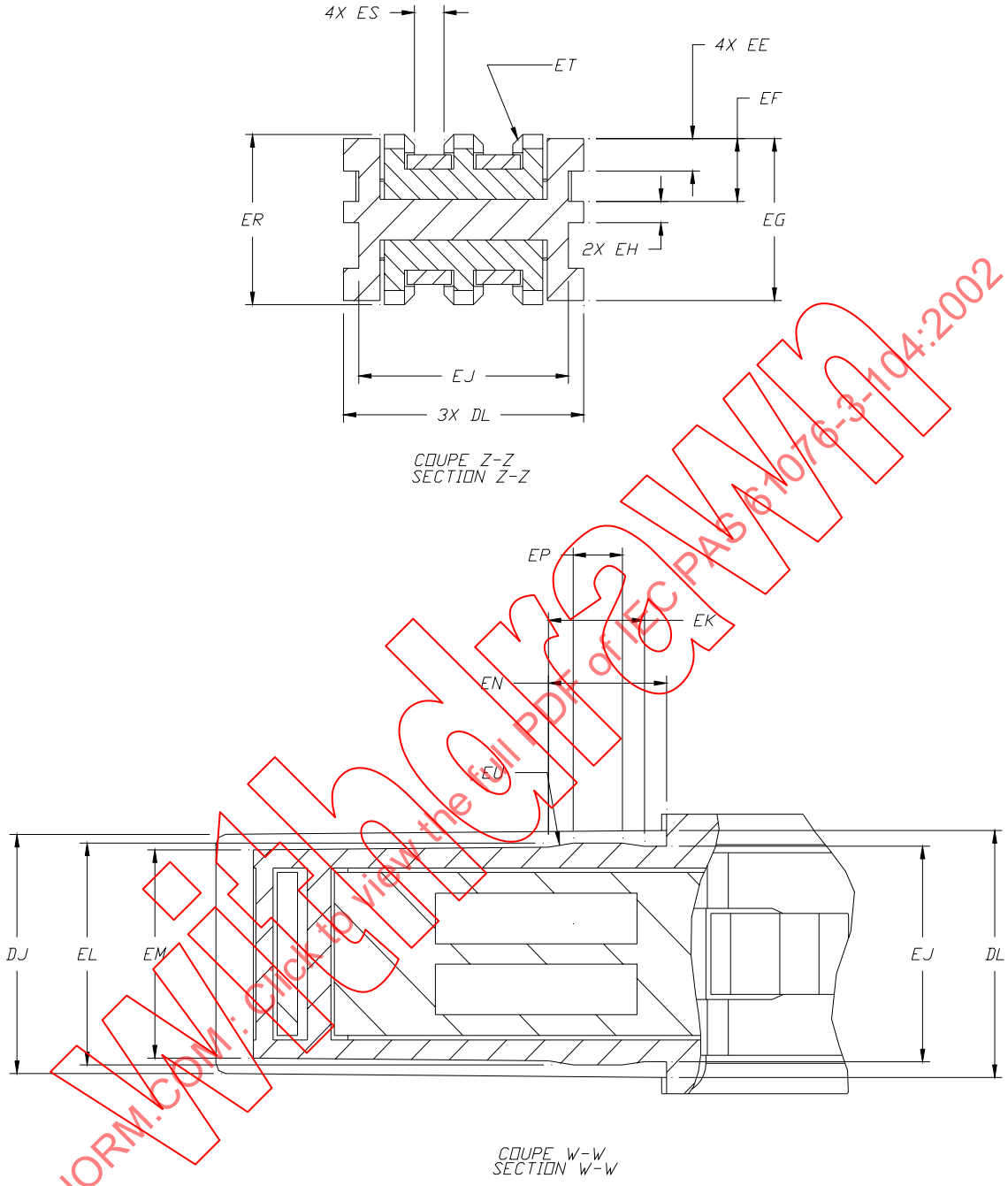


Figure 10 – Variant 04 drawing 2

Table 5 – Variant 04 drawing 2 dimensions

	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°X0,25	45°X0.33	45°X0.18
EU	R2,03	R2,16	R1,91
[1] Dimension ES is the same as D in figure 4 and GS in figure 11			

3.2.2.3 Variant 05,1-Pair Plug Drawings

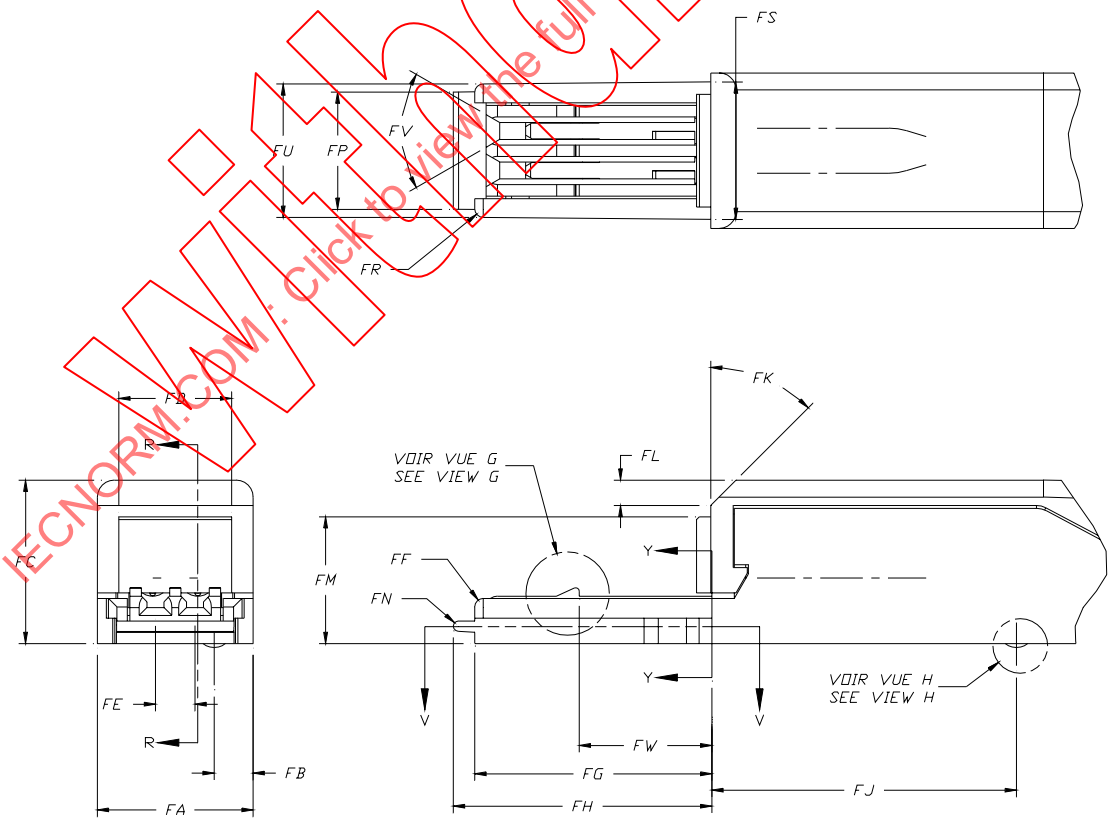


Figure 11 – Variant 05 drawing 1

Table 6 – Variant 05 drawing 1 dimensions

	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	R0,38	R0,46	R0,30
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	R0,23	R0,31	R0,15
FP	5,29	5,37	5,21
FR	R0,38	R0,46	R0,30
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

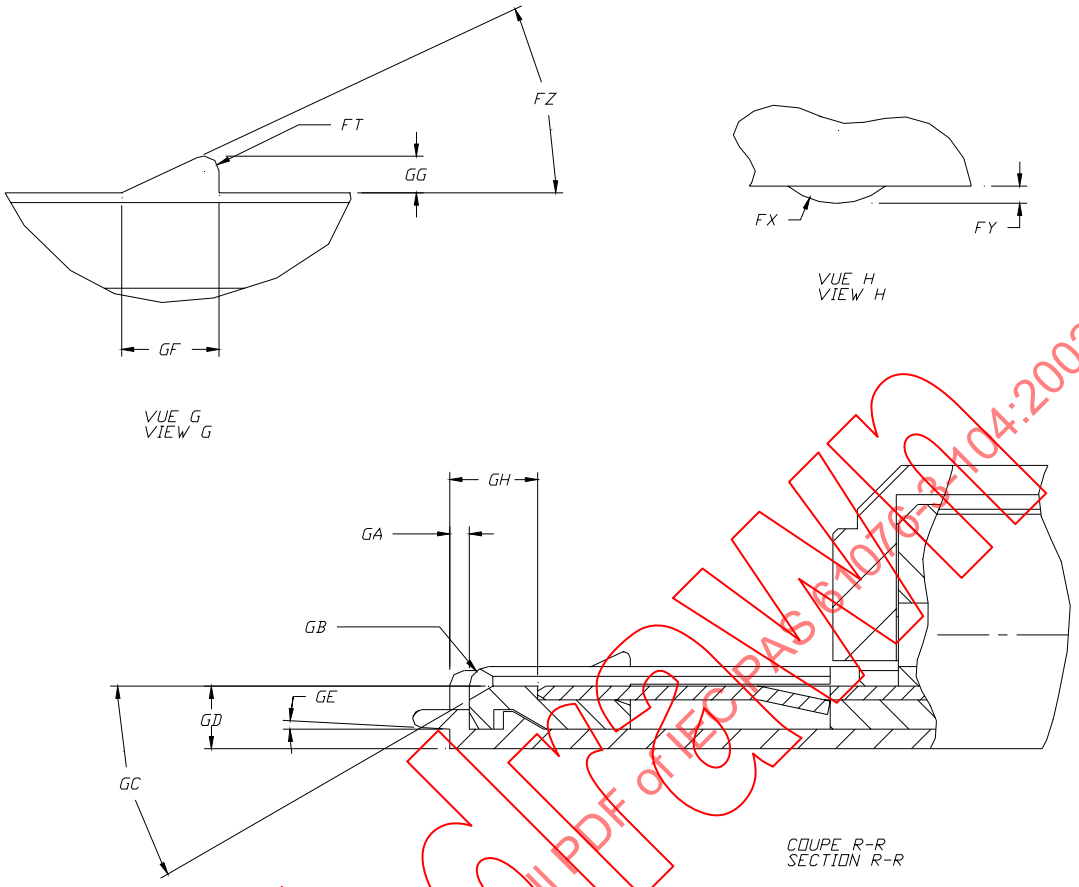


Figure 12 – Variant 05 drawing 2

Table 7 – Variant 05 drawing 2 dimensions

	Nominal	Maximum	Minimum
FT	R0,15	0,23	0,07
FX	R0,76	0,84	0,68
FY	0,18	0,26	0,10
FZ	25°	26°	24°
GA	0,51	0,59	0,43
GB	R0,51	R0,59	R0,43
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)

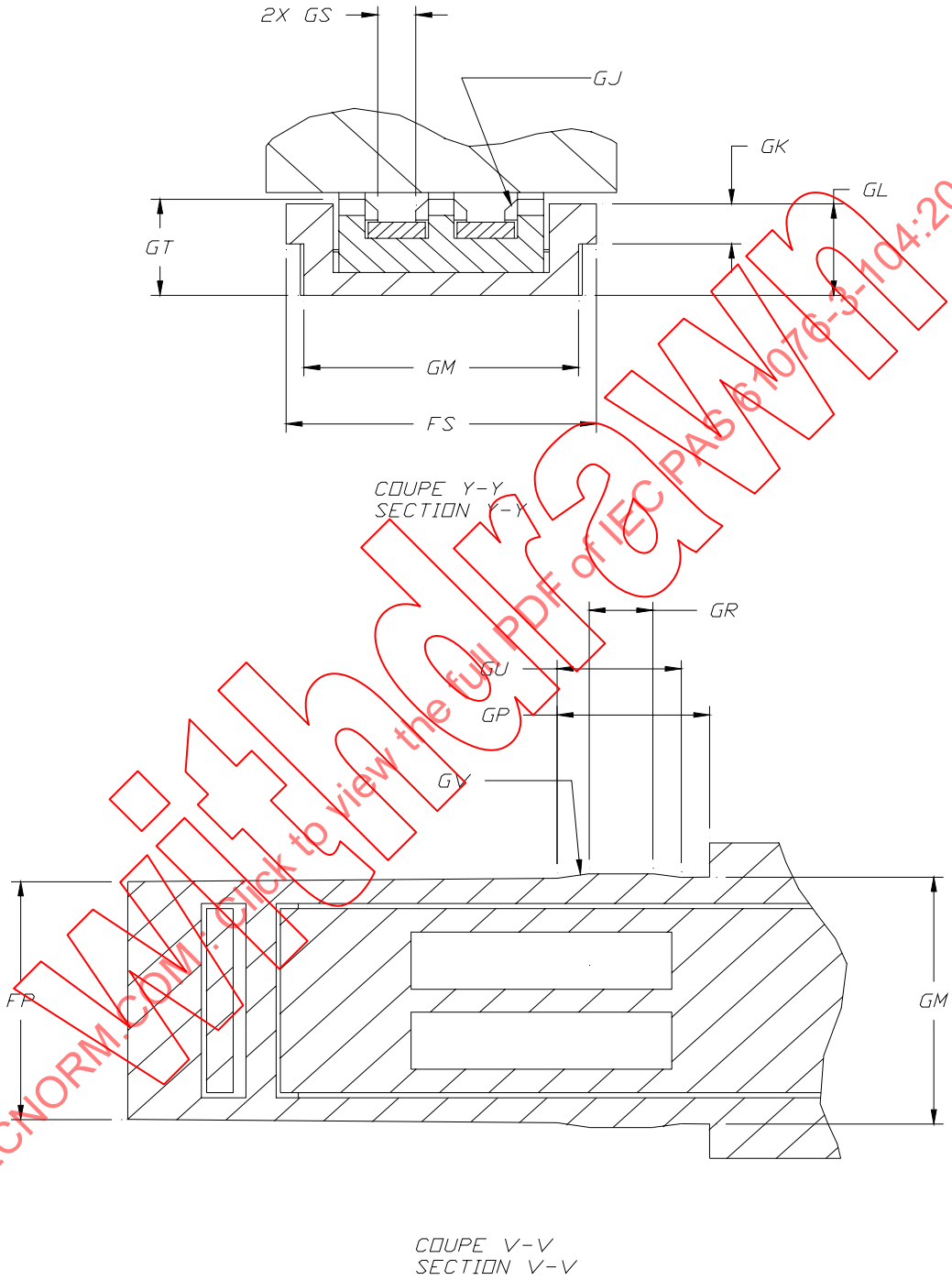


Figure 13 – Variant 05 drawing 3

Table 8 – Variant 05 drawing 3 dimensions

	Nominal	Maximum	Minimum
GJ	45°X0,25	45°X0,33	45°X0,33
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	R2,03	R2,11	R1,96

1 Dimension GS is the same as D in figure 4 and ES in figure 8.

3.3 Fixed Connector (Outlet)

3.3.1 Isometric Views

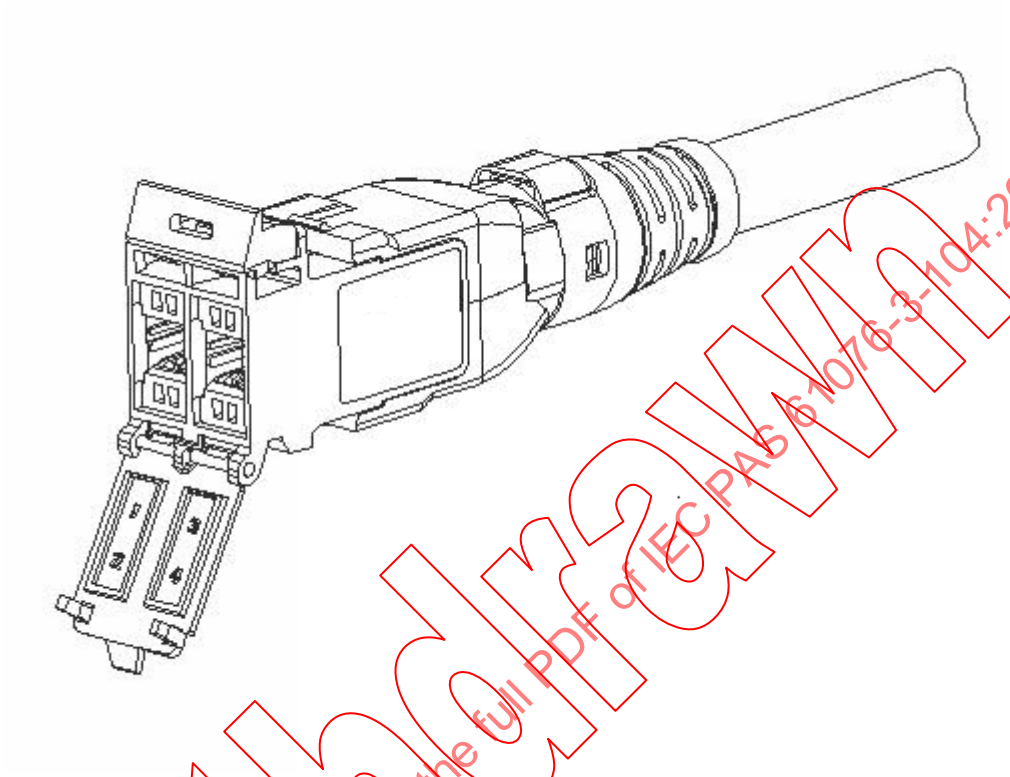


Figure 14 – Isometric view of variant 01 (cable outlet)

3.3.2 Variant 01 (Cable Outlet) Drawings

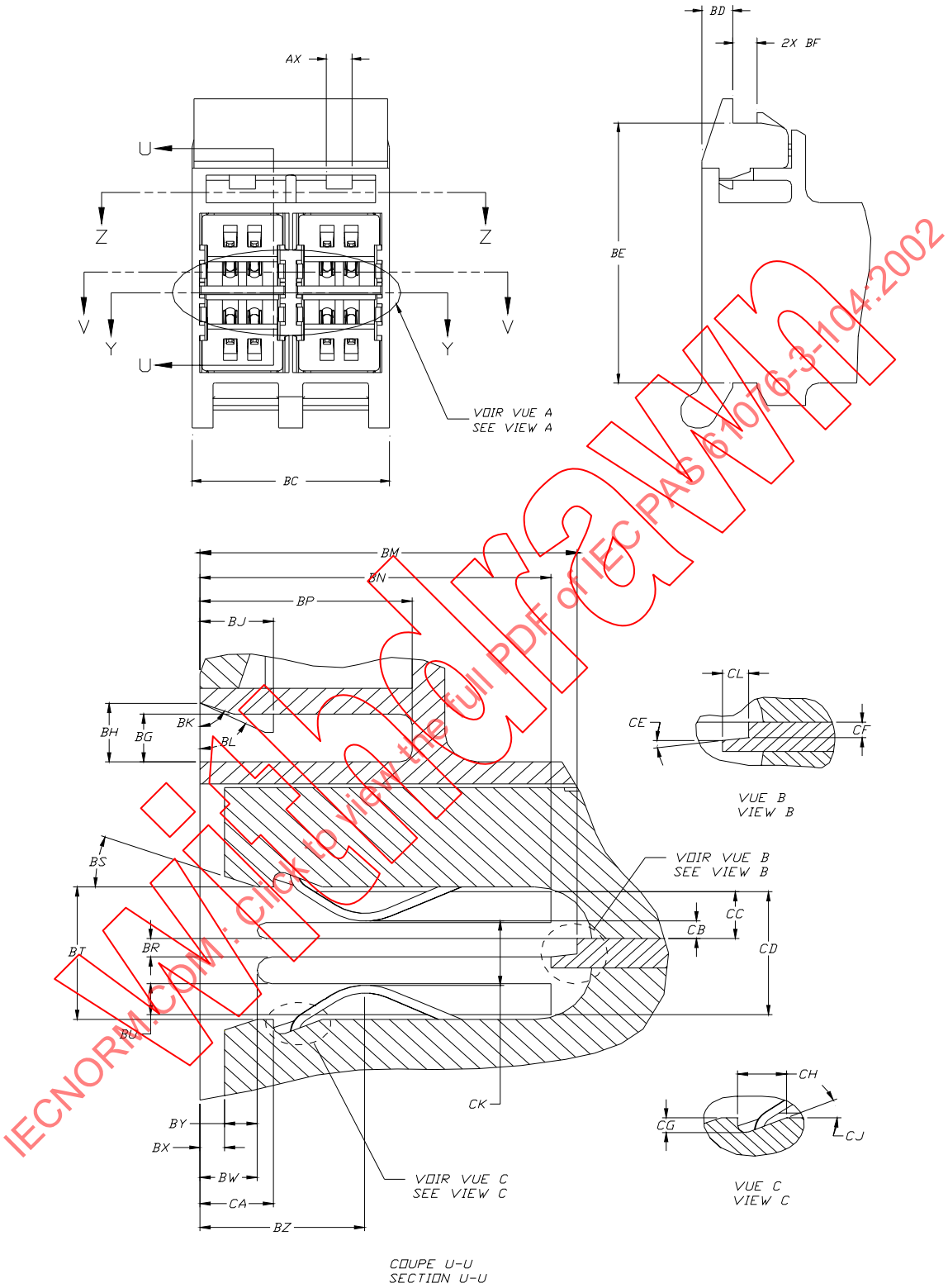


Figure 15 – Variant 01, Cable outlet drawing 1

Table 9 – Variant 01 drawing 1 dimensions

	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

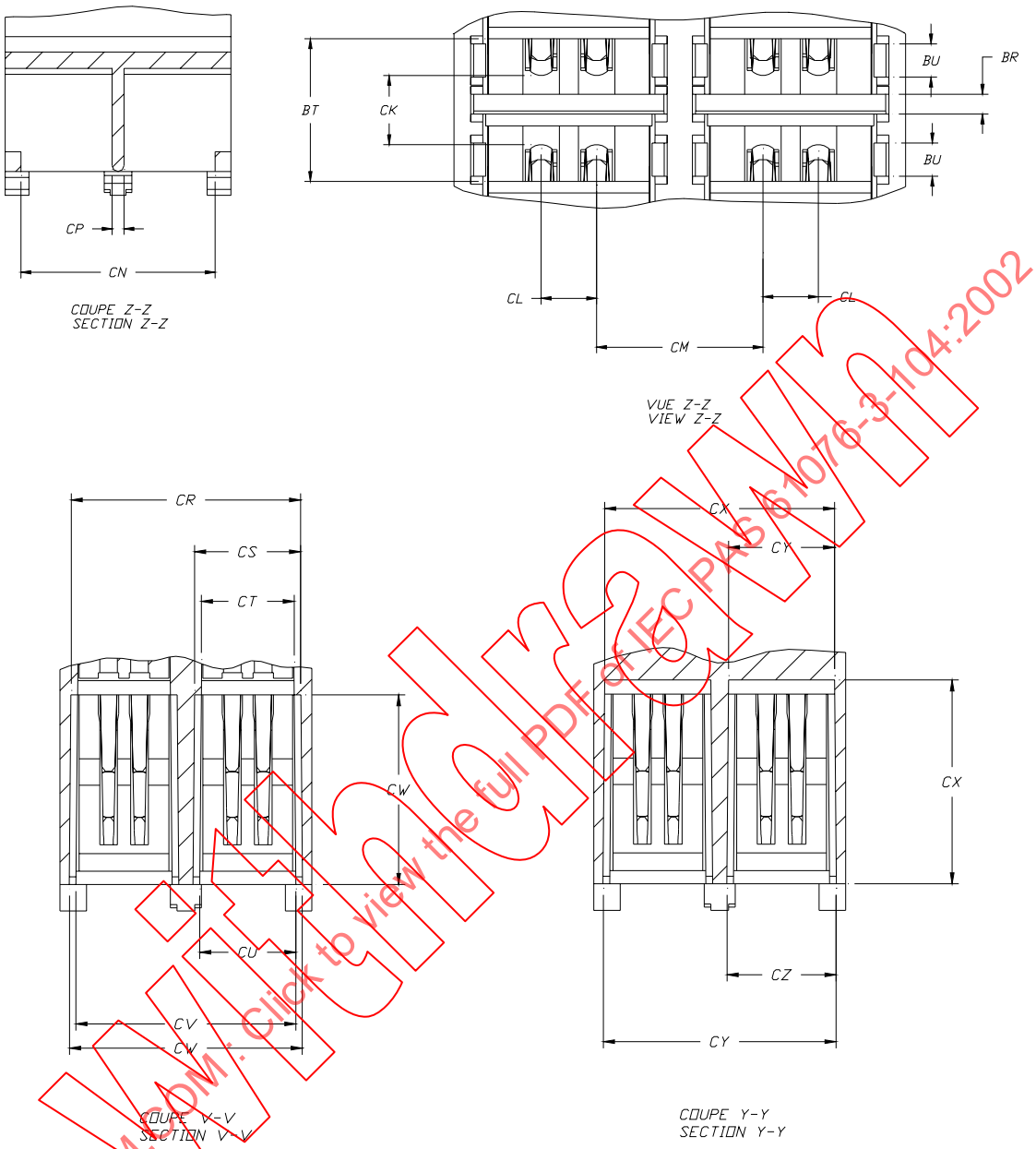


Figure 16 – Variant 01 cable outlet drawing 2

Table 10 – Variant 01 cable outlet drawing 2 dimensions

	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

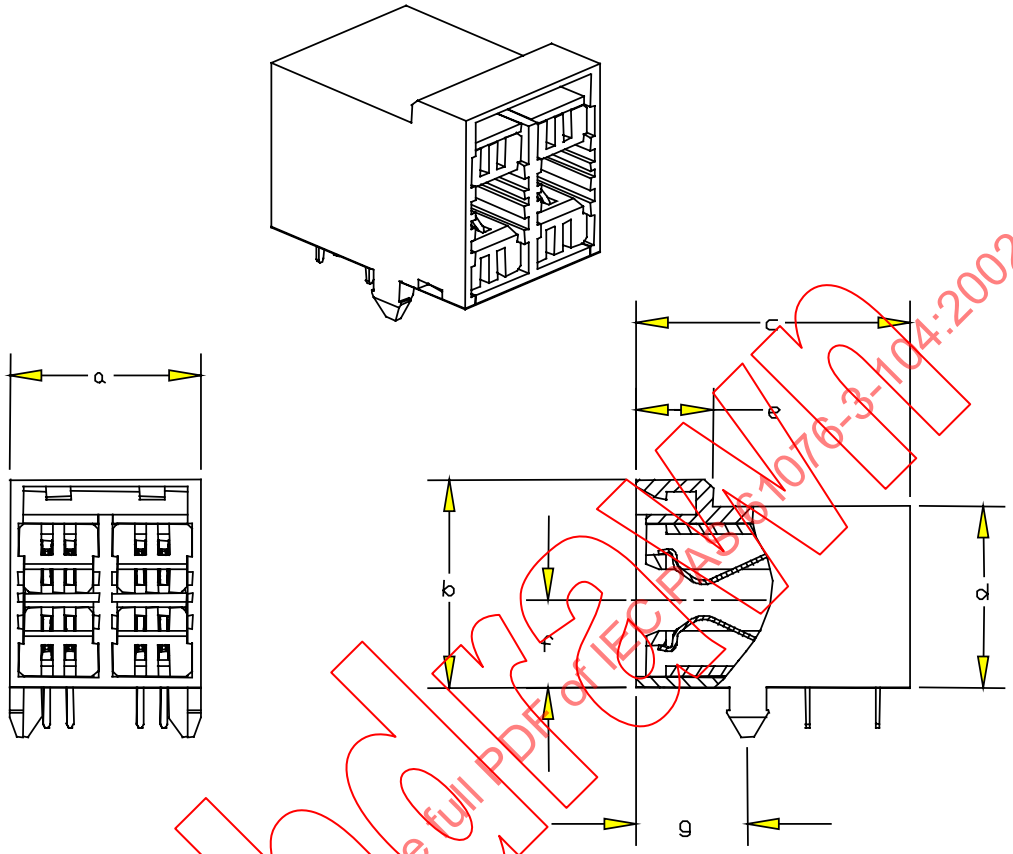


Figure 17 – Variant 02 drawing

Table 11 – Variant 02 drawing dimensions

	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 13 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

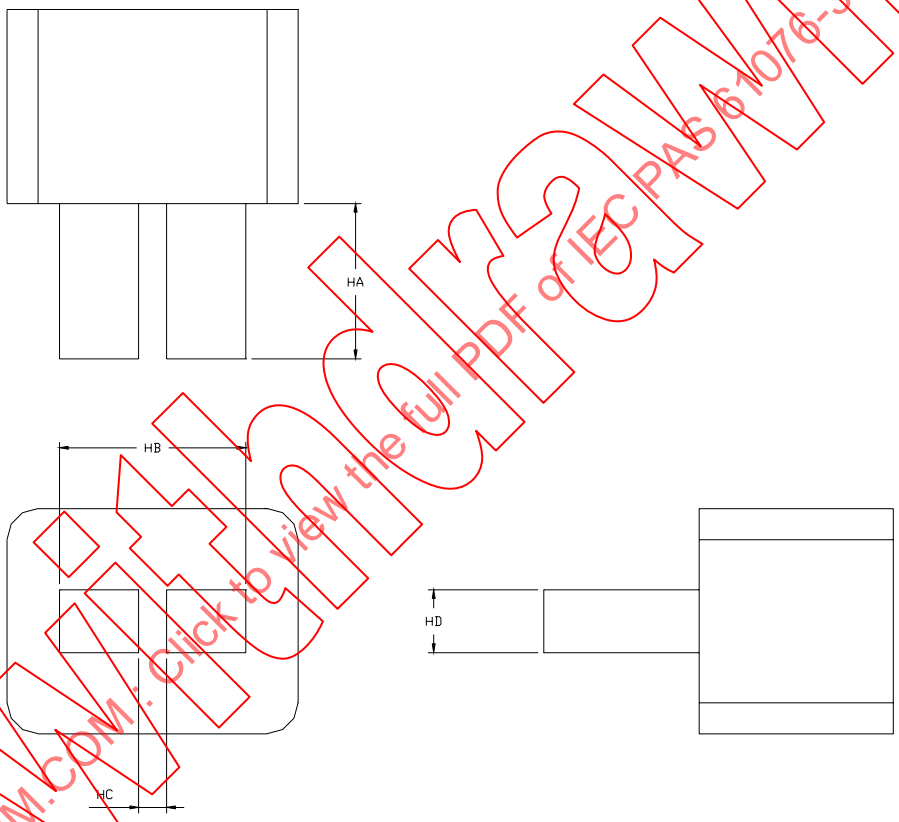


Figure 18

3.4.1.2 Fixed connector Location No Go Gauge

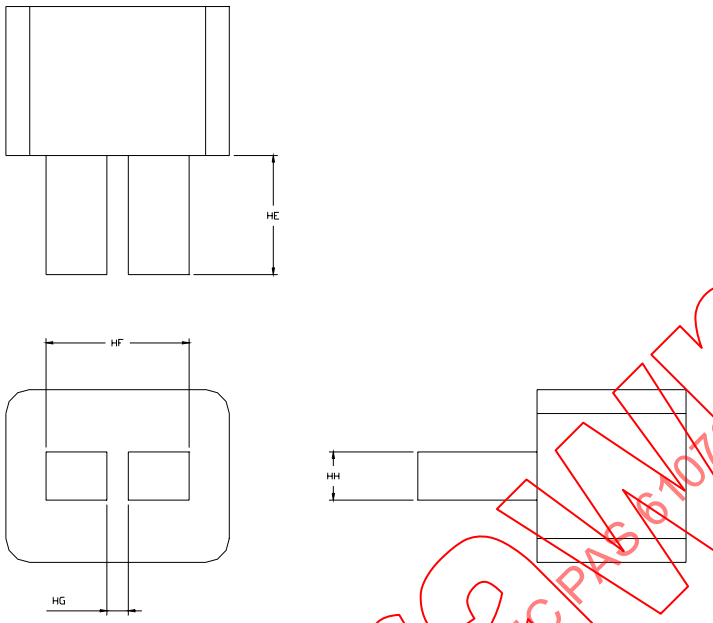


Figure 19

3.4.1.3 Fixed connector Size Go Gauge

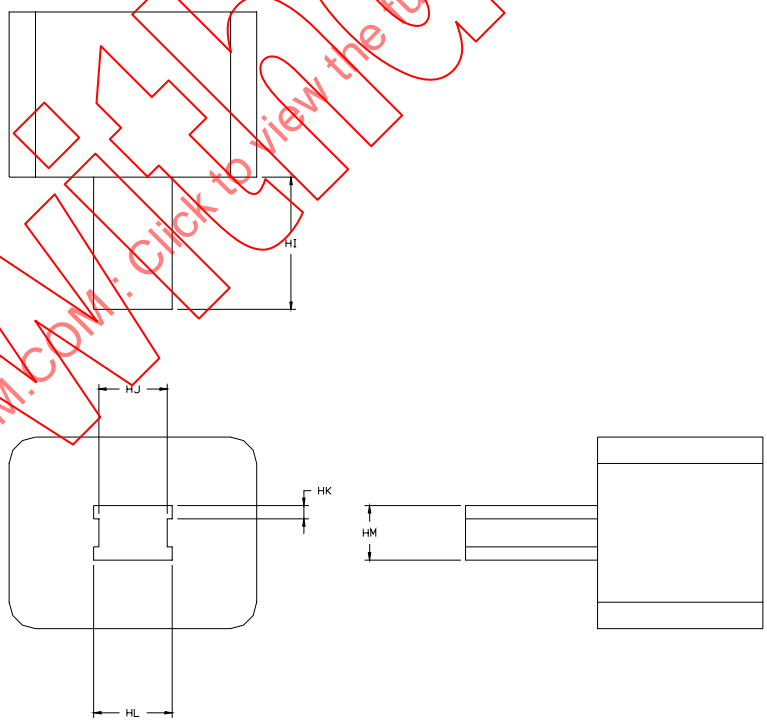


Figure 20

3.4.1.4 Fixed connector Size No Go Gauge

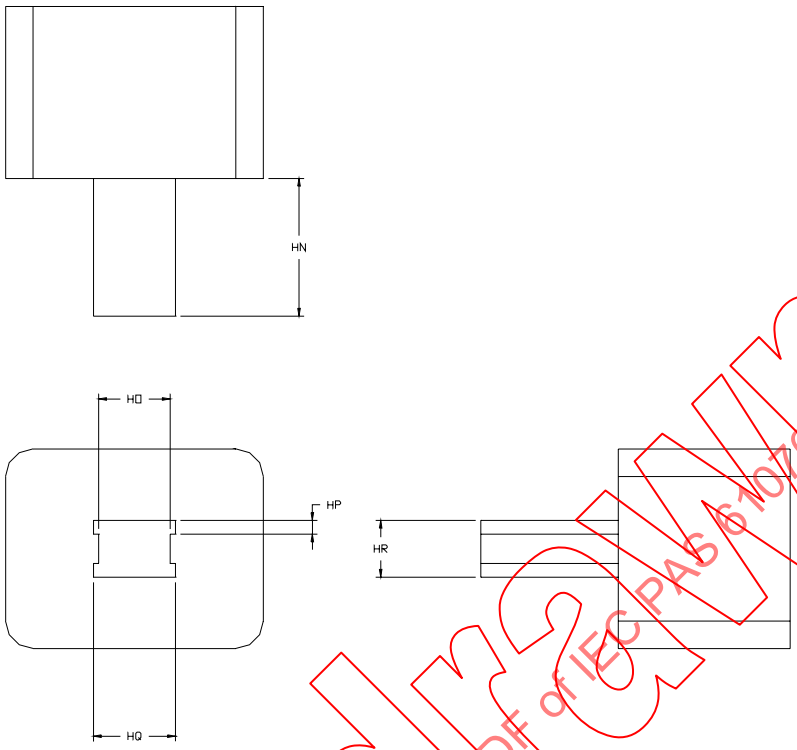


Figure 21

Table 12

	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) Gages (See Table 13 for dimensions)

3.4.2.1 Free connector Location Go Gauge

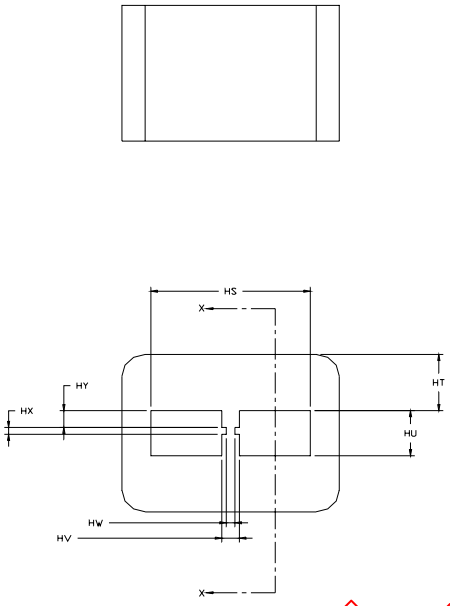


Figure 22

3.4.2.2 Free connector location No Go Gauge

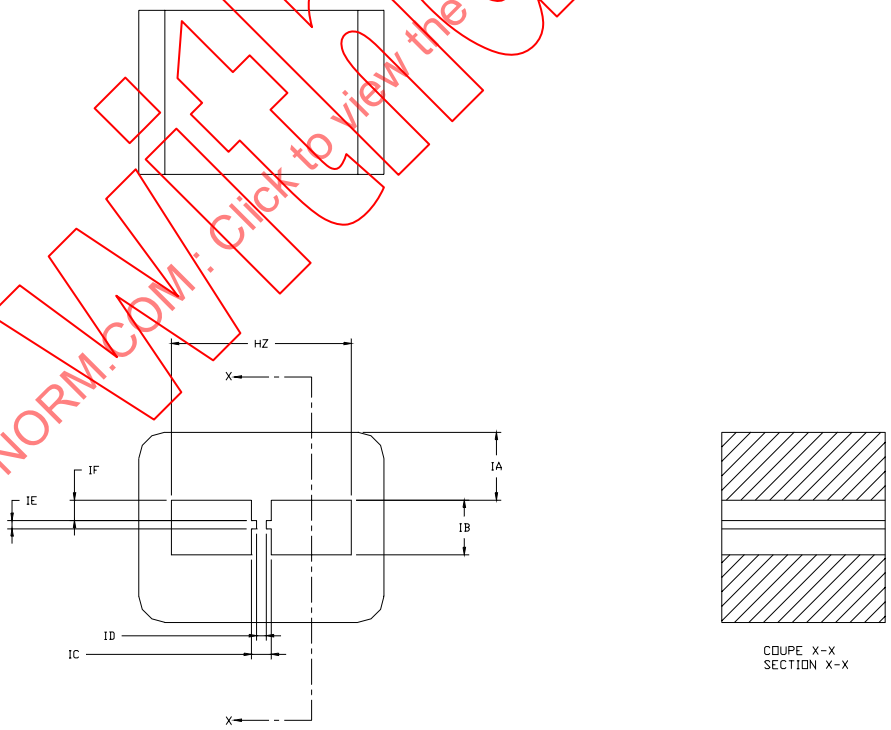


Figure 23

3.4.2.3 Free connector Plug Size Go Gauge

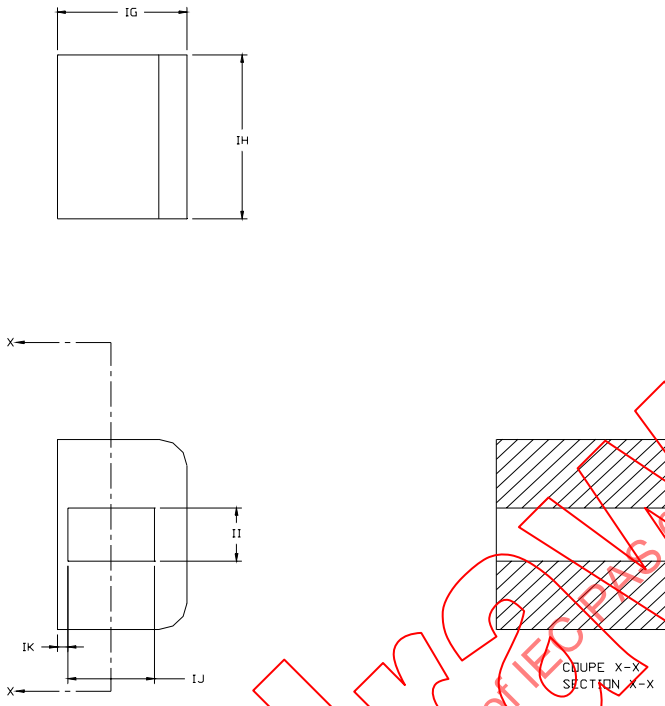


Figure 24

3.4.2.4 Free connector Size No Go Gauge

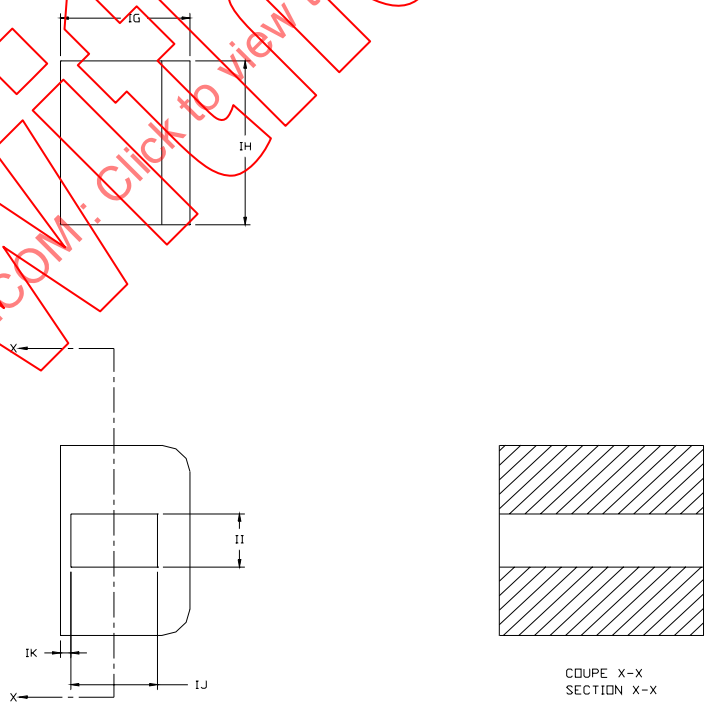


Figure 25

Table 14

	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,

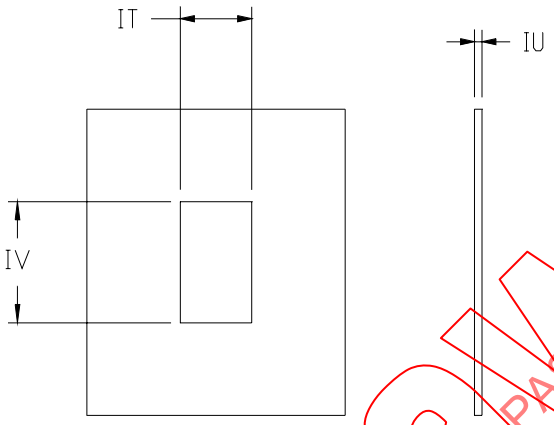


Figure 26

Table 14

	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 specification 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	UpperTemperature °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

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

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.

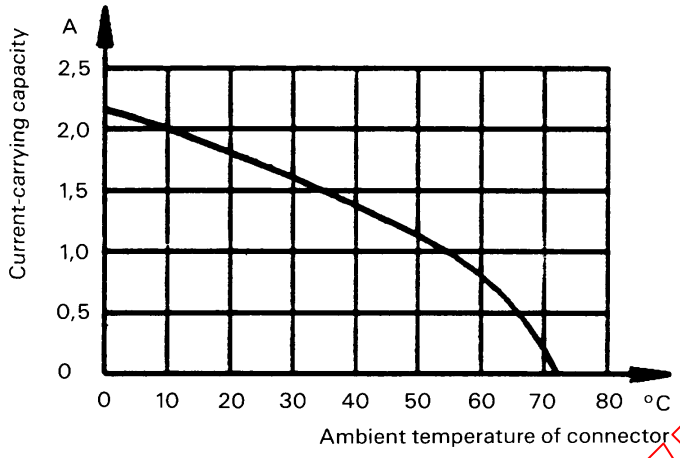


Figure 26

4.5.2 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 shield

4.5.3 Initial contact and shield resistance

Conditions:

IEC 60512-2, Test 2a
Mated connectors
All types: 20 mΩ max.

4.5.4 Input to output resistance

Conditions:

IEC 60512-2, Test 2a
Mated connectors
All types: 200 mΩ max.

4.5.5 Input to output resistance unbalance

Conditions:

IEC 60512-2, Test 2a
Mated connectors
All types: 50 mΩ max.

4.5.6 Insulation resistance

Conditions:

IEC 60512-2, 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: 70-20Log (*f*) dB up to 600 MHz Not >30 dB
Where *f* is frequency in MHz

4.5.9 Propagation delay

Conditions:

IEC 60512-25-4, 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 60512-25-4, 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: 110-15Log (*f*) up to 600 MHz Not >80 dB

Where f is frequency in MHz.

4.5.12 FEXT loss

Conditions:

Annex I, 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

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: 66-20Log (*f*) up to 60 MHz (*ffs*)
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

55-20Log(*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
$0.05*f^{0,3}$ Ohm from 1 to 10 MHz *f*fs
0.01**f* Ohm from 10 to 80 MHz.

The values from 80 MHz to 600 MHz are *f*fs.
Where *f* is frequency in MHz.

4.6 Mechanical

4.6.1 Mechanical operation

Conditions:

IEC 60512-5, Test 9a
Speed: 10 mm/s (0,4 in/s) max
Rest: 5 s min. (unmated)
PL1: 750 operations
PL2: 2500 operations

4.6.2 Effectiveness of connector coupling devices

Conditions:

IEC 60512-8, Test 15f
Mated connectors
All types: 50 N for 60 sec. Min.

4.6.3 Insertion and Withdrawal Forces

Conditions:

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

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 hours 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 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.

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 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.

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 spec.
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 maximum Shield resistance = 20 mΩ maximum
P 4			100 V ± 15 d. c.	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 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 examin-ation	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
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 not 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) = 750 or 2 500
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 A.1 All contacts/specimen	Contact and shield resistance	2a	20 mΩ max. change from initial
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 hour 45 min. each axis 60068-2-6	Contact disturbance	2e	10 µs
CP 2			Test voltage 100 V ± 15 d.c. Method A Mated connectors	Insulation resistance	3a	500 MΩ Minimum
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 Amp 5 connectors no current 5 connectors
DP 2			Test voltage 100 V ± 15 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 4,6,7,8
EP 2			All pairs, both directions, (pair to pair)	NEXT loss	25-1; Annex H	110-15LLog(*f*) See Notes 1,6,7,8
EP 3			All pairs, both directions	Return loss	Annex G	70-20Log(*f*) See Notes 2,6,7,8
EP 4			All pairs, both directions, (pair to pair)	FEXT loss	Annex I	90 –15Log(*f*) See note 3,6,7,8
EP 5				Unbalanced Attenuation	Annex J	66-20Log(*f*) See Note 5,6,7,8
EP 6				Transfer impedance	Annex K	$0.05 f^{+0.301}$ from 1 to 10 MHz 0,01**f* ohm from 10 to 80 MHz. See note 8
EP 7				Coupling attenuation	Annex L	55-20Log (*f*/100) See note 8
EP 8		2		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 7 All transmission results shall report worst case overall for the corresponding pair or pair combination after testing the ten samples.

NOTE 7 All measurements to be performed on mated connectors.

NOTE 8 Where f is 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			10 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 60512-2, 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.

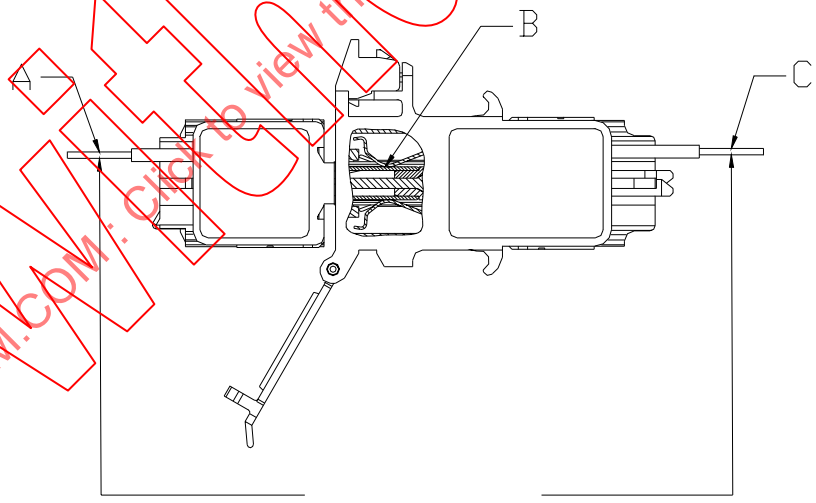


Figure A.1 – Contact Resistance Arrangement

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) max.
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 part 3, table 4, group BP, test BP2.
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

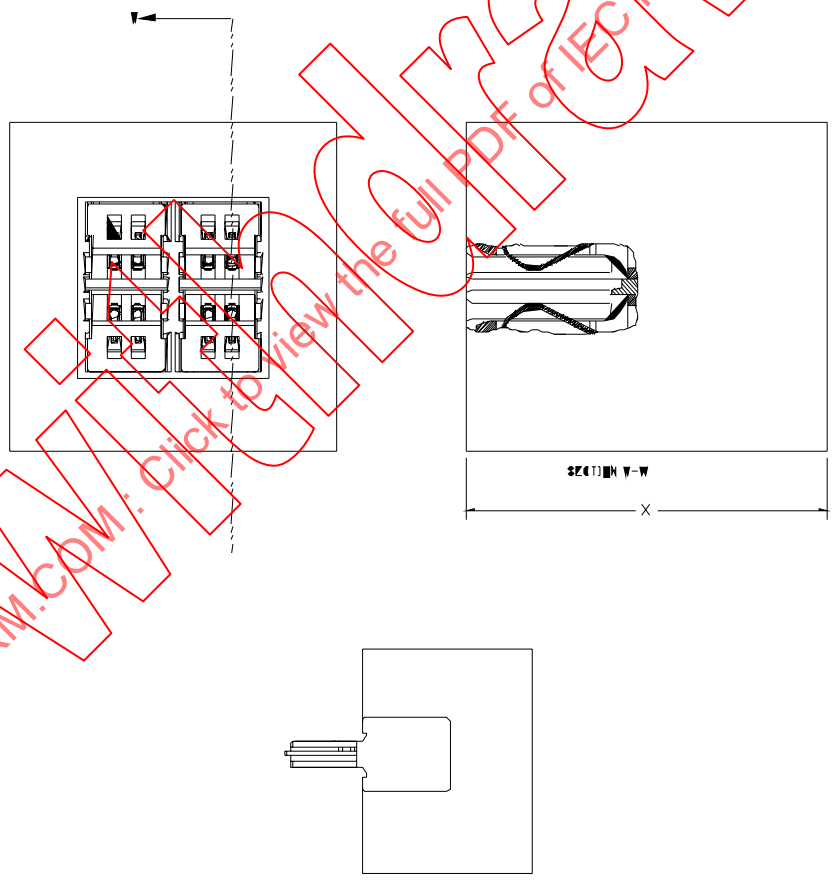


Figure D.1 – Precision Test Fixtures (covers)

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 shown in part 2 clause 2.3. 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 overall length of connector.

An alternate fixture using the PCB outlet mounted on a printed circuit board with appropriate connections for connecting to a network analyser 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.2.2, measure the NEXT and FEXT performance for each pair combination as outlined in annexes G and H 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 analyser. The analyser should have the capability 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 E.4.
Reference loads and cables are needed for the calibration of the set-up. Requirements for the reference components are given in clause 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 clause 11

E.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 K).
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:

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 details 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).

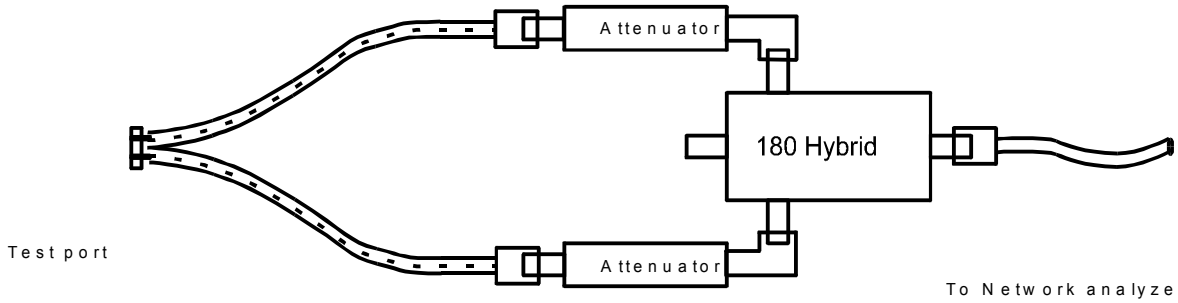


Figure E.1 – 180° hybrid used as a balun

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 analyser	
Impedance, Secondary	100 Ω	
Insertion loss	10 dB maximum	
Return loss secondary	14 dB minimum	
Return loss Common mode with common mode termination [1]	10 dB minimum	
Return loss Common mode without common mode termination [1]	1 dB maximum	NA [a]
Longitudinal balance [2]	50 dB	NA
Common mode rejection[3]	50 dB	40 dB
Output signal balance[3]	50 dB	40 dB
Power rating	0,1 W	

[a] NA: not applicable

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

d Measured according to ITU-T (formerly CCITT recommendations G.117 and 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 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.

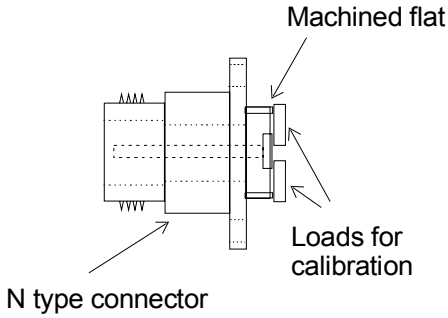


Figure E.2 – Calibration of reference loads

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.

Resistor loads shall use resistors specified for ± 1 % accuracy at D.C. and have a return loss greater than 40 – 10Log(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 shown annex K. For pairs connected to resistor loads, common mode load is implemented by the Y configuration shown in figure E.3.

---

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

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

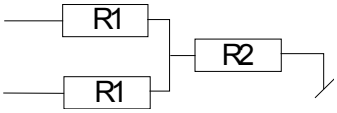


Figure E.3 – Resistor load

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 R1 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.

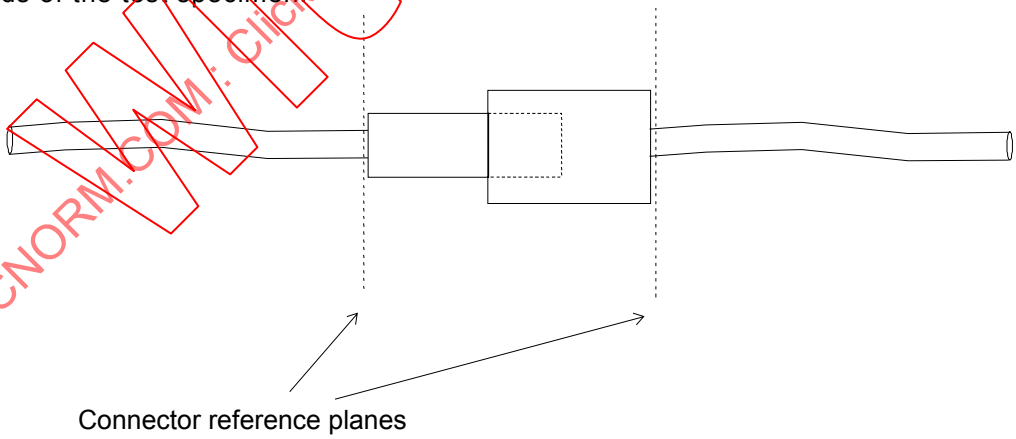


Figure E.4 – Definition of reference planes

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 analyser 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 performed by applying a maximum length of 14 cm reference cable between the terminals of the baluns and perform 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.

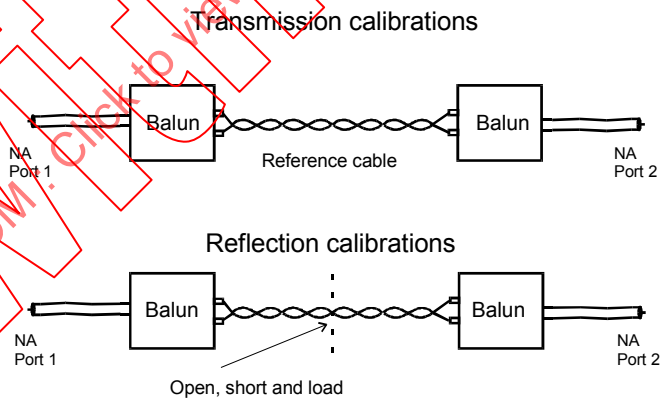


Figure F.1 – Calibration

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. A S_{21} measurement shall be performed.

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[3] Often referred to as Attenuation.

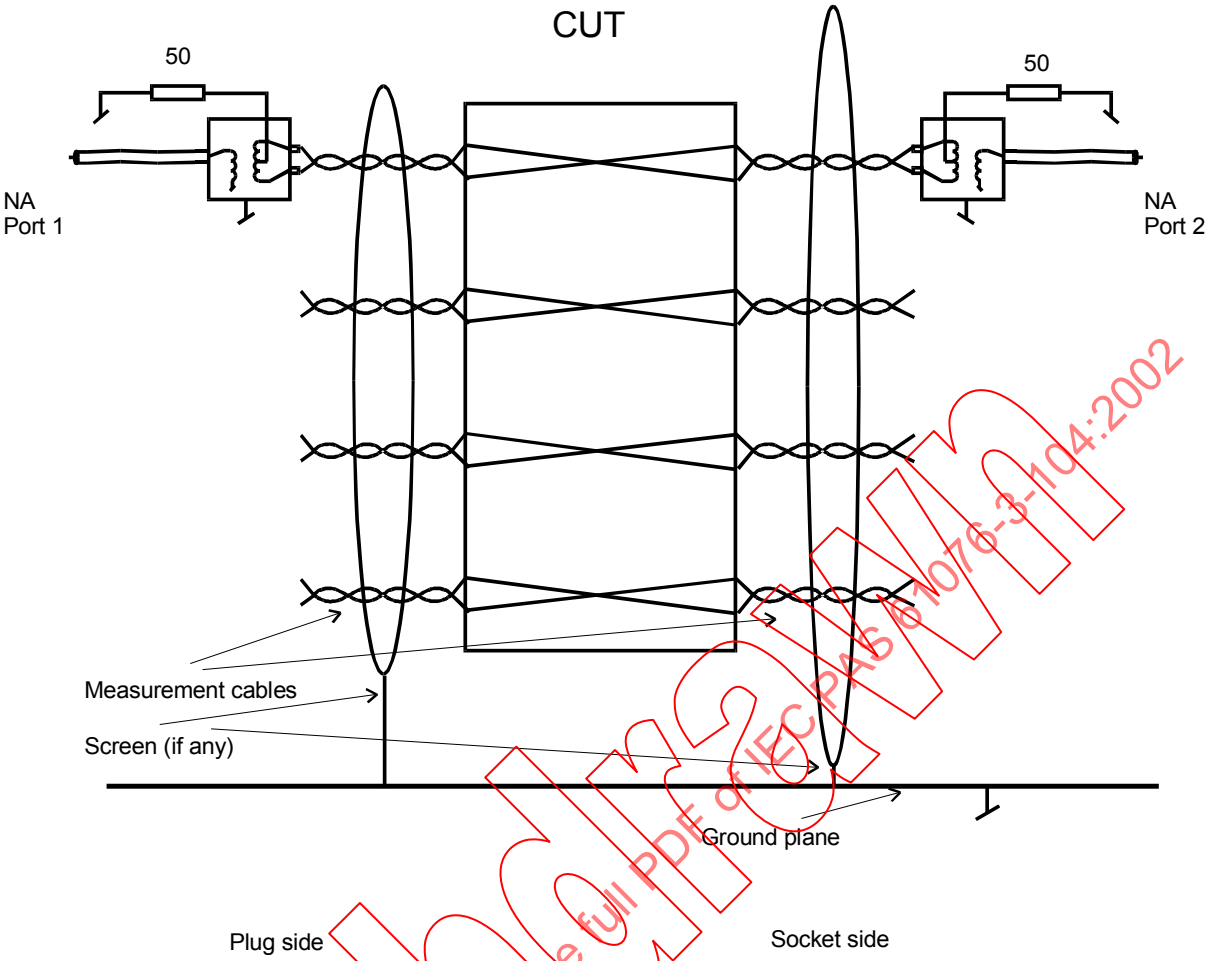

Figure F.2 – Measuring Set-up

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 are 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 clause 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 tabled 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 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

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.

H.3 Test set-up

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

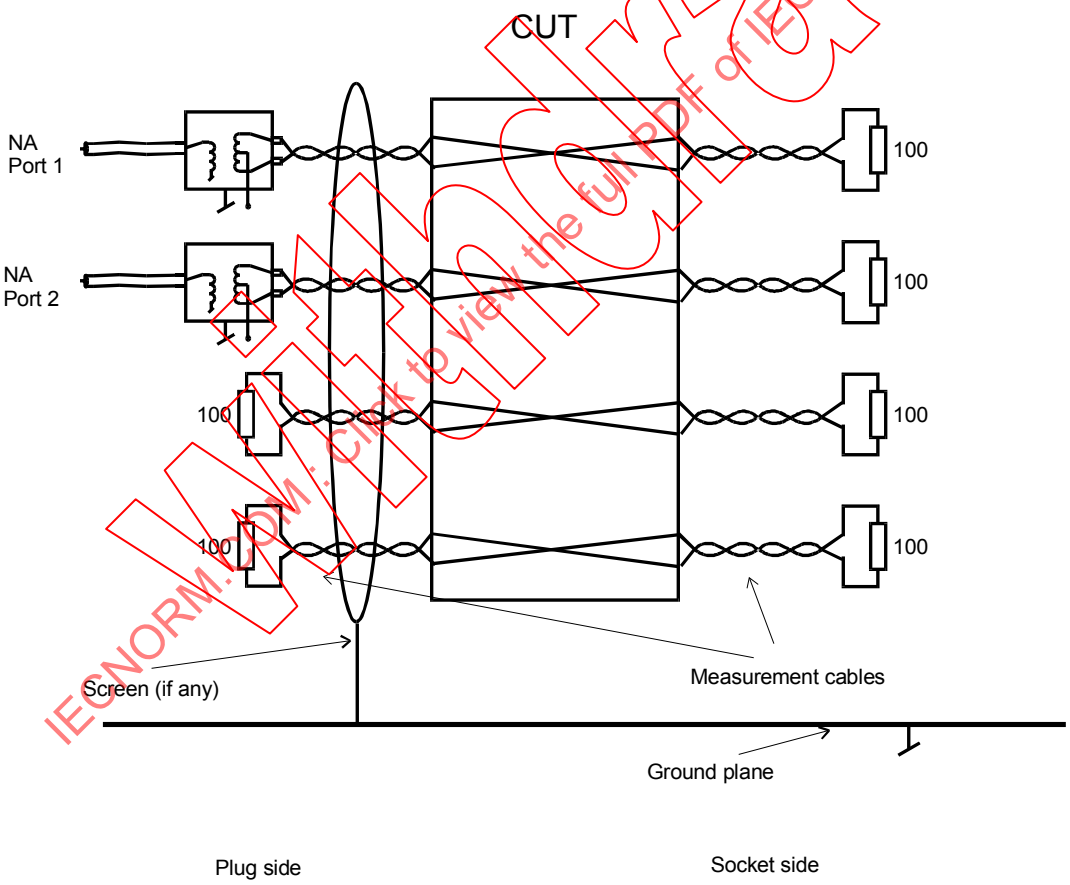

Figure H.1 – NEXT measurement differential mode only terminations

(Passive terminations must be resistor terminations)

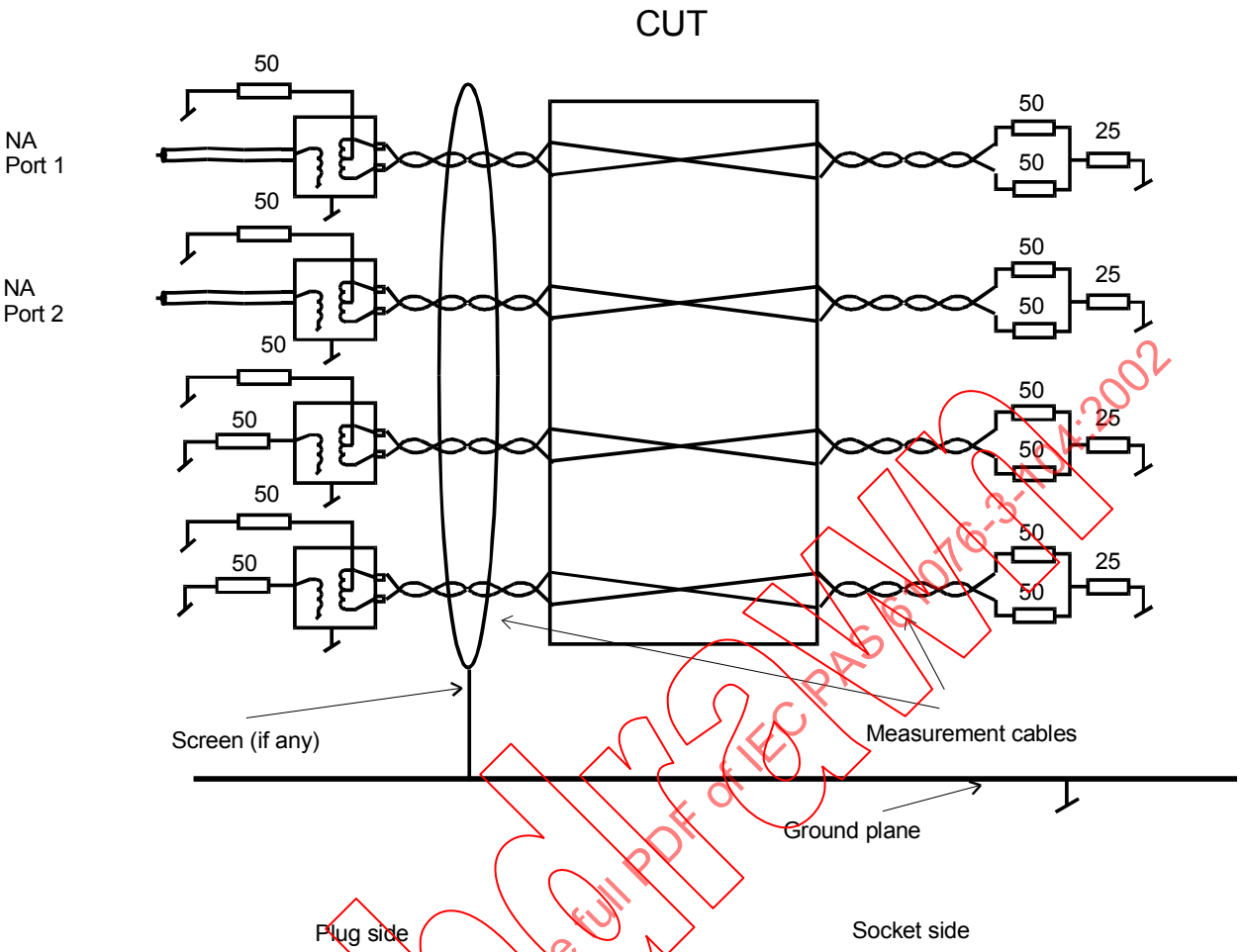

Figure H.2 – NEXT measurement differential and common mode terminations

(Passive terminations may be either balun or resistor 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 analyser, 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:
1. With differential mode terminations only (This is not requested for cat 7 connectors, and the requirement will be removed for all categories if experience show that a requirement for balance can replace this requirement.)
2. 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 devise near end cross talk 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.