To: Membership of X3T9.2

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Date: May 5, 1992

Subject: Proposal for Alternate 68 Position P Connector

This document describes the technical characteristics for a 68 position shielded connector pair (referred to as the IBM Ribbon I/O) which offers an alternative to the P connector in the SCSI-3 working draft. This alternative is proposed for those applications where "blind - plugging" by customers and repeated mating/unmating cycles may approach as many as 1500.

Table of Contents

Clause

1. Scope

This standard covers 68 pole rectangular shielded connectors with rectangular cross-section male contacts on 1.27 x 1.65 mm (0.050 x 0.065 in) contact spacing. Connector polarization is achieved by the trapezoidal configuration of the shell. The Right Angled Fixed connectors are soldered to the printed board and the free connector contacts use the insulation displacement type of termination for round cable with 0.09mm^2 (28 AWG) discrete conductors. It is recommended that the user have their cable evaluated by the connector manufacturer for their specific application.

The application of this range of connectors includes use for signals in telecommunication and information processing equipment and systems, and other electronic devices employing similar techniques.

1.1 *Normative Reference*

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

50 (581) (1978):	International Electrotechnical Vocabulary (IEV), Chapter 581: Electromechanical Components for Electronic Equipment.
410 (1973):	Sampling plans and procedures for inspection by attributes.
512-1 (1984):	Electromechanical Components for Electronic Equipment: Basic Testing Procedures and Measuring Methods, Part 1: General.
512-2 (1985):	Part 2: General Examination, Electrical Continuity and Contact Resistance Tests, Insulation Tests and Voltage Stress Tests.
512-3 (1976):	Part 3: Current - carrying Capacity Tests.
512-4 (1976):	Part 4: Dynamic Stress Tests.
512-5 (1977):	Part 5: Impact Tests (Free Components), Static Load Tests Fixed Components), Endurance Tests and Overload Tests.
512-5A (1980):	First supplement.

1.1 *Normative References (continued)*

512-5B (1981):	Second supplement.

512-6 (1984):	Part 6: Climatic Tests and Soldering Tests.
512-7 (1978):	Part 7: Mechanical Operating Tests and Sealing Tests.
512-8 (1984):	Part 8: Connector Tests (Mechanical) and Mechanical Tests on Contacts Termination.
512-9 (1977):	Part 9: Cable-clamping tests, explosion hazard tests, chemical resistance tests, fire hazard test, r.f. resistance tests, capacitance tests, shielding and filtering tests, and magnetic interference tests.
807-1 (1985):	Rectangular Connectors for Frequencies Below 3MHz Part 1: General Requirements and Guide for the Preparation of Detail Specifications.
QC001001 (1986):	Basic rules of the IEC Quality Assessment System for Electronic Components (IECQ).
QC001002 (1986):	Rules of procedure of the IEC Quality Assessment System for Electronic Components (IECQ).

2. IEC Type Designation

807 - XX - IEC - A B C D E F - G H J K [Coded Suffix]

Coded Suffix Key

K = Assessment Level: G

J = Performance Level: PL1

H = PC Board Thickness: A = 0.157mm [.062 in]

G = Stage of Assembly: C = Complete
K = Kit

F = Type of Termination : D = Insulation Displacement

E = Type of Contact: F = Female
M = Male

BCD = Number of Positions = 068 = 2 x 34 Circuits

A = Style of Connector "A" Fixed Connector
"B" Free Connector

3. Isometric View

3.1 Connectors with Screw Locks and Jackscrews

ISOMETRIC DRAWING OF FEMALE CONNECTOR TO BE ADDED IN NEXT REVISION.

Right Angle Fixed Connector with Female contacts and Screw Locks
FIGURE 1

ISOMETRIC DRAWING OF OVERMOLDED MALE CONNECTOR TO BE ADDED IN NEXT REVISION.

Free Connector with Male Contact and Jackscrews
FIGURE 2

3.2 Survey of Styles

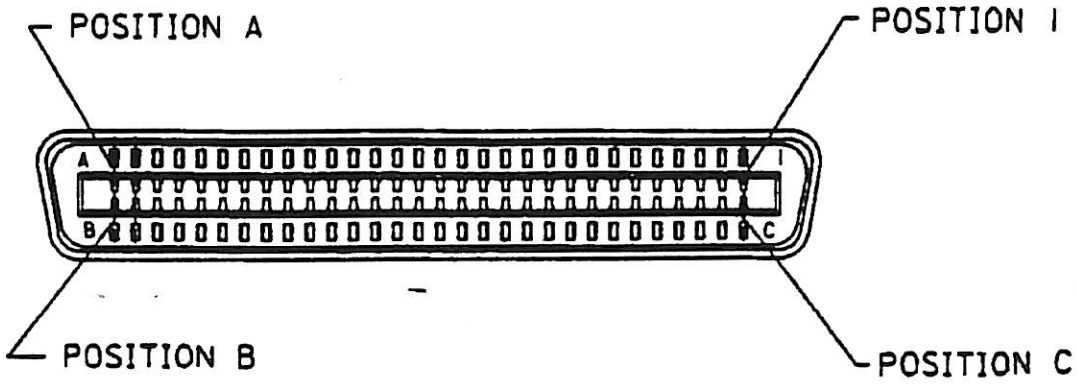
Table 1

	MOUNTING	CONTACTS		LOCKING	BACK SHELL	ACCESSORIES
	Board					
	Right Angle	Male	Female	Screw Locks Female	Jack Screws	Board Locks
Fixed Connector	XXX		XXX	XXX		XXX
Free Connector		XXX			XXX	

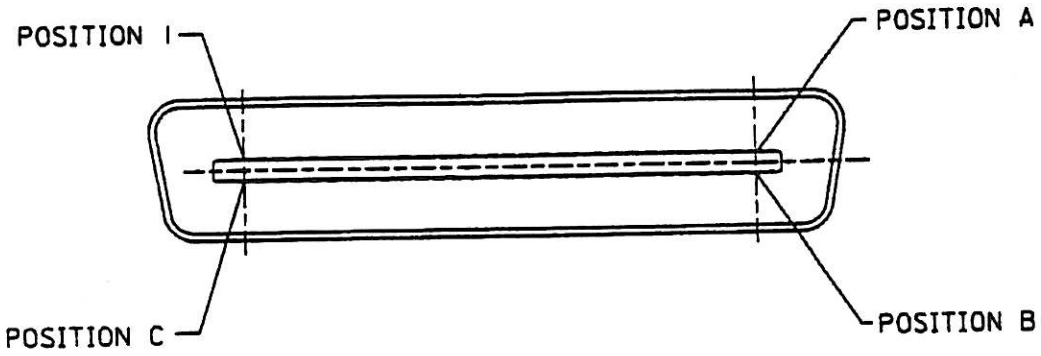
3.3 Contact Arrangement for Fixed and Free Connectors

Table 2

Number of Positions	A	B	C
68	34	68	35



Mating Face of Fixed Connector
with Female Connectors
Figure 3a



Mating Face of Free Connector
With Male Contacts
Figure 3b

4. Dimensions

4.1 *General*

Dimensions in inches are original. Drawings are shown in third angle projection. The shape of the connector may deviate from those given in the following drawings as long as the specified dimensions are maintained.

4.2 *Fixed Connector*

4.2.1 *Right Angle Fixed Connector with Female Contacts and Female Screw Locks*

– Table 3

	A				B				C	
	mm		inch		mm		inch		mm	in
	Min	Max	Min	Max	Min	Max	Min	Max	Basic	Basic
68	72.26	72.52	2.845	2.855	62.10	62.36	2.445	2.455	51.00	2.008

Table 3 (Continued)

	D		E				F		G			
	MM	IN	MM		IN		MM	IN	MM		IN	
	BASIC	**BASIC**	**MIN**	**MAX**	**MIN**	**MAX**	**BASIC**	**BASIC**	**MIN**	**MAX**	**MIN**	**MAX**
68	41.91	1.650	45.59	45.85	1.797	1.803	62.23	2.450	69.59	69.85	2.740	2.750

See Attached Drawing on Next Page

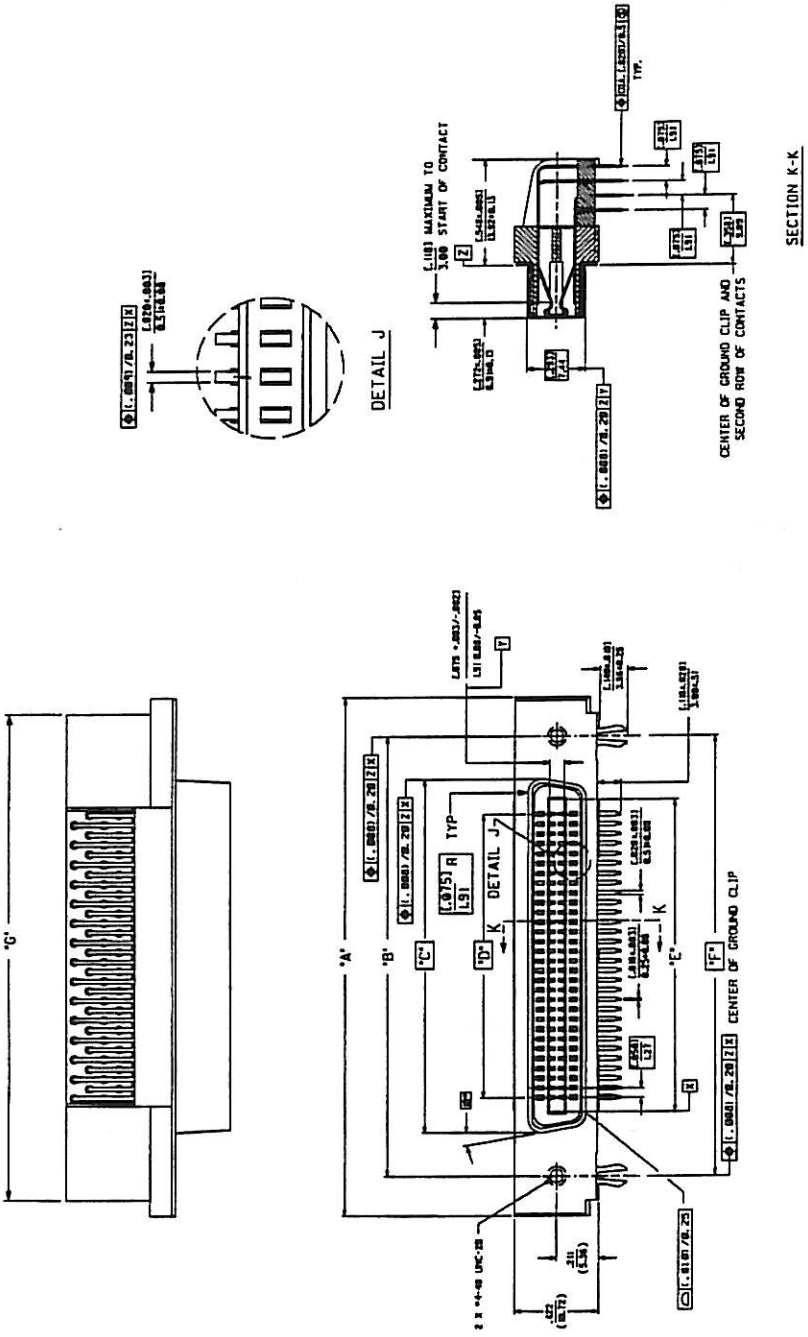

DETAIL J
SECTION K-K
CENTER OF GROUND CLIP AND SECOND ROW OF CONTACTS
CENTER OF GROUND CLIP
DETAIL J
TYP
'A'
'B'
'C'
'D'
'E'
'F'
'G'

FIG. 4

4.3 *Free Connector*

4.3.1 Free Connector with Male Contacts and male jackscrew backshell

Free Connector

Size	A			B				C		
	mm	in	mm		in		mm		in	
	Basic	Basic	Min	Max	Min	Max	Min	Max	Min	Max
68	41.91	1.650	69.72	69.98	2.745	2.755	62.10	62.36	2.445	2.455

Size		D			E	
	mm		in		mm	in
	Min	Max	Min	Max	Basic	Basic
68	45.44	45.70	1.792	1.796	51.56	2.030

See Attached Drawing on Next Page

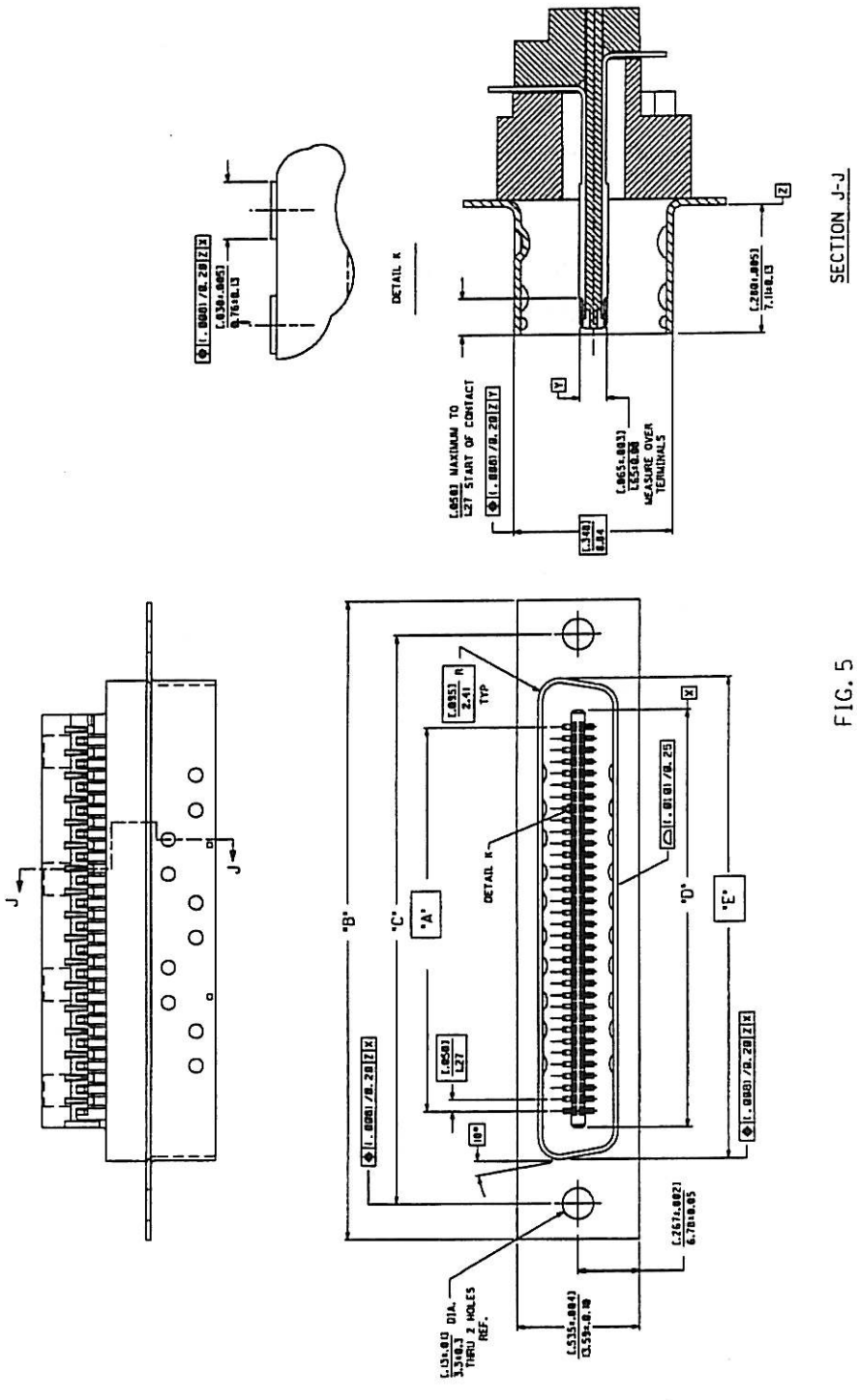

DETAIL K
SECTION J-J
MEASURE OVER TERMINALS
MAXIMUM TO START OF CONTACT
DETAIL K
"A"
"B"
"C"
"D"
"E"
DIA. THRU 2 HOLES REF.

FIG. 5

4.4 *Mating Information*

The Trapezoidal design of the shell prevents mismating. The shells mate before the contacts.

4.5 *Accessories*

4.5.1 Board Locks
For Boardlock configuration and PC Board hole requirements contact manufacturer
4.5.2 Jack Screws, 4-40
For Jackscrew configuration contact manufacturer
4.5.3 Female Screwlock, 4-40
For Female Screwlock configuration contact manufacturer

4.6 *Mounting information for fixed connectors - Female Contacts*

4.6.1 Printed Board
4.6.1.1 Hole patterns on printed boards fixed connectors with female contacts
4.6.1.1.1 Right Angle fixed connector.

	G		H	
	mm	in	mm	in
Size	Basic	Basic	Basic	Basic
68	41.91	1.650	62.23	2.450

Table 5

See Figure 6 on next page

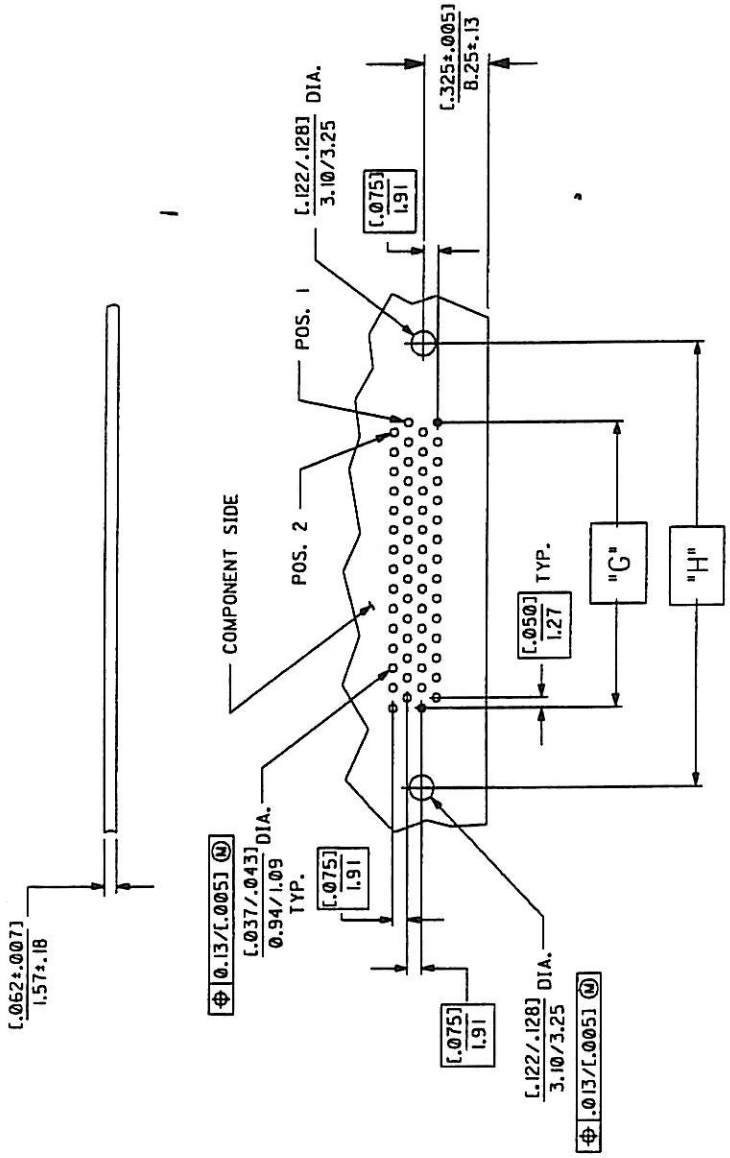

[.062±.007]
1.57±.18
⌖ 0.13/[.005] M
[.037/.043]
0.94/1.09
DIA.
TYP.
[.075]
1.91
COMPONENT SIDE
POS. 2
POS. 1
[.122/.128]
3.10/3.25
DIA.
[.075]
1.91
[.325±.005]
8.25±.13
[.0501]
1.27
TYP.
"G"
"H"
[.075]
1.91
[.122/.128]
3.10/3.25
DIA.
⌖ .013/[.005] M

FIG. 6

4.6.1.2 Printed Board installation requirement

When connector is fully seated, the solder post must extend a minimum of 0,71 mm (0.028 in) beyond the board point. This requirement applies to all printed board thicknesses.

5 *Gauges*

Under consideration.

6 *Characteristics*

6.1 Climatic category

Category	Temperature Range	Damp Heat Steady State
55/100/21	-55° C to 100 ° C	21 days

Table 6

6.2 *Electrical*

6.2.1 *Creepage and Clearance Distances*

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

Therefore, the clearance and creepage distances are given as operating characteristics. In practice, reductions in creepage or clearance distances may occur due to the wiring used and shall duly be taken into account. The minimum creepage and clearance distances between adjacent contacts is 0.3808 mm (0.015 in). The minimum creepage and clearance distance between contacts and shell or chassis is 1,016 mm (0,040 in).

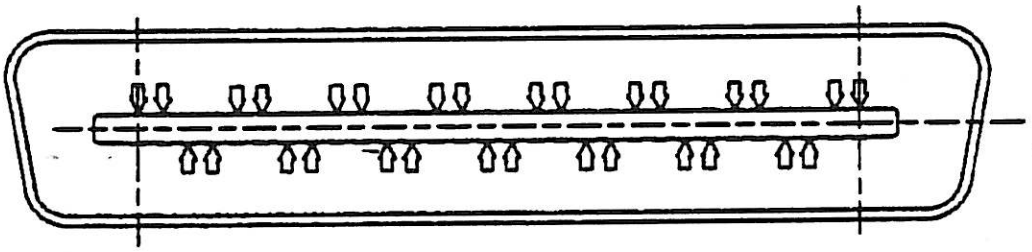
6.2.2 *Proof Voltage*

Conditions: IEC Publication 512-2, Test 4a, Method C. Standard atmospheric conditions, mated connectors.

Contact/Contact - **500 V r.m.s.**

6.2.3 *Current Carrying Capacity*

Conditions: IEC Publication 512-3, Test 5a.
1 ampere at 30 degrees Celsius T-rise maximum 50% energized.
Terminations are wired with 0.09mm 2 (28 AWG) wire.



Free Connector Mating Face

⇓ Denotes Energized Circuit (1 Ampere per contact).

Figure 7

6.2.4 *Contact Resistance*

Conditions: IEC Publication 512-2. Test 2b.
Standard Atmospheric condition, mated connectors.
Connection Points
Measurement Points to be Determined

Figure 8

Performance Level PL1: **15 mΩ Maximum Change From Initial**

6.2.5 *Initial Insulation Resistance*

Conditions: IEC Publication 512-2, Test 3a, Method C.
Standard atmospheric conditions
Test Voltage 500 V ± 50 V d.c.
Mated connectors

Performance Level PL1: **1 G Ω Minimum**

6.3 *Mechanical*

6.3.1 *Insertion and Withdrawal Forces, contacts only*

Conditions: IEC Publication 512-7, Test 13a.

INSERTION	
POSITION	**N MAXIMUM**
68	56.71

Table 7

WITHDRAWAL	
POSITION	**N MAXIMUM**
68	11.34

Table 8

6.3.2 *Vibration*

Conditions: IEC Publication 512-4, Test 6d.

Severities
10 Hz to 55Hz

Table 9

6.3.3 *Mechanical Operation*

Condition: IEC Publication 512-5, Test 9a.
Speed: 10 mm/s maximum
Rest: 10 s minimum (unmated).

Performance Level PL1: **1500 operations.**

7 Test Schedule

The contact specimens shall be prepared with tools recommended by the connector manufacturer. Fixed connectors must meet subclause 4.6.1.2 when fully seated on printed board.

7.1 *General*

This test schedule shows all tests and the order in which they shall be carried out as well as the requirements to be met:

Unless otherwise specified, mated sets of connectors shall be tested. Care shall be taken to keep a particular combination of connectors together during the complete test sequence, i.e. when unmating is necessary for a certain test, the same connectors as before shall be mated for the subsequent tests.

In the following, a mated set of connectors is called a "specimen".
For a complete test sequence, the number of specimens according to Table 10 are necessary.

Table 10 - Number of Specimens

Test Group	Performance Level PL1
P	30
AP	5
BP	5
CP	5
DP	5
GP	5
HP	5

7.2 *All Specimens Shall be Subjected to the following tests in sequence.*

Group P

	IEC Tests			Measurements to be Performed		Requirements
Test Phase	**Title**	**IEC 512**	**Severity or Conditions of Test**	**Title**	**IEC 512**	**Performance Level PL1**
P1	General Exam		Unmated Connectors	Visual Exam	1a	There shall be no defects that would impair normal operations.
P1	General Exam		Unmated Connectors	Exam of Dimensions	1b	The dimensions shall comply with those specified in subclauses 4.2, 4.3, 6.2.1.
P2	Polarizing Method	13c	Engaging Forces according to the maximum insertion forces Subclause 6.3.1			It shall be possible to correctly align and mate the appropriate mating connectors. It shall not be possible to mate the connectors in any manner other than the correct one.
P3			Connection Point as in SubClause 6.2.4 6 contact/specimen	Contact Resistance at 1 A	2b	25 mΩ Max. Initial
P4			Test Voltage 500 V ±50 V d.c. Method C	Insulation Resistance	3a	1 G Ωmin
P5			contact/contact	Voltage proof	4a	500 V r.m.s.

7.3 *The specimens shall be divided into six groups. All connectors in each group shall undergo the tests specified for the relevant group.*

Group AP

	IEC Tests			Measurements to be Performed		Requirements
Test Phase	**Title**	**IEC 512**	**Severity or Conditions of Test**	**Title**	**IEC 512**	**Performance Level PL1**
AP1	Gauge Retention Force	16e	–			Retains Gauge
AP2	Insertion and Withdrawal Forces	13b	Rate = 25mm/min (1in/min)			See subclause 6.3.1
AP3	Soldering	12a				
AP4			contact/contact	Voltage Proof	4a	500 V r.m.s
AP5						N/A
AP6	Vibration	6d	Wires clamped 203mm (8 in.) min. behind fixed connector to non-vibrating point or wires clamped 87mm to 114 mm (3.5 into 4.5 in) behind free connector to vibrating point.	Contact Disturbance	2e	Monitor all contacts in series 100 mA for a discontinuity of 1 µs.
			10 Hz to 55Hz 1.5 mm (0.06 in) d.a. (displacement amplitude) 196 m/s^2 (20g) 20 min/sweep 12 sweeps/axes 3 axes (12h total)	Contact Disturbance	2e	
AP7	Shock	6c	490 m/s^2 (50g) peak sawtooth 11 milliseconds duration. 1 shock each direction 3 axes (6 shocks total) Clamping of wires for vibration test.	Contact Disturbance		Monitor all contacts in series 100 mA min. for a discontinuity of 1 µs
AP8						N/A
AP9	Rapid change of Temperature	11d	Mated connectors nonoperated. 30 min. exposure 5 cycles. Recovery time 2 h.			-55°C to + 105°C
AP10			Test Voltage 500 ±50 V d.c. Method C.	Insulation Resistance	3a	1 G Ω min.

Group AP (continued)

	IEC Test			Measurements to be performed		Requirements
Test Phase	**Title**	**IEC 512**	**Severity or Conditions of Test**	**Title**	**IEC 512**	**Performance Level PL1**
AP11			Method C	Voltage Proof	4a	500 V r.m.s
AP12			Unmated Connectors	Visual Examination	1a	No damage due to conditioning
AP13	Climatic Sequence	11a	Mated, non-operated			
AP13.1	Dry Heat	11i	Duration 16h			105°C
AP13.1	Dry heat	11i	Test Voltage 500±50 V d.c. Method C	Insulation Resistance at High voltage	3a	1 G Ω min.
AP13.2	Damp heat cyclic	11m	Upper temperature 55°C 1 cycle variant 2 Recovery time: 2h. Room ambient temperature			
AP13.3	Cold	11j	-55°C duration 2h; Recovery time: 2h			
AP13.4						N/A
AP13.5	Damping heat cyclic remaining cycles	11m	Upper temperature 55°C, 5 cycles as in AP13.2			
AP14			Test Voltage 500±50 V d.c. Method C	Insulation Resistance	3a	1 G Ω min.
AP15			Connection points as in Subclause 6.2.4 6 contacts/specimen	Contact Resistance at 1 A	2b	15 mΩ max. change from initial
AP16			contact/contact	Voltage proof	2b	500 V r.m.s.
AP17				Insertion and Withdrawal Forces	13b	See Subclause 6.3.1 and Gauges
AP18			Unmated connectors	Visual Exam	1a	No damage due to conditioning.

Group BP

	IEC Test			Measurements to be performed		Requirements
Test Phase	Title	IEC 512	Severity or Conditions of Test	Title	IEC 512	Performance Level PL 1
BP1			Female contacts only. 6 contacts/specimen	Gauge retention forces	16e	Retains Gauge
BP2	Mechanical operation	9a	Speed 10 mm/s (0.4 in/s) max. Rest 30 s min. (when unmated) 10 operation			
BP3	Climatic test					
BP3.1						N/A
BP3.2	Corrosion, industrial atmosphere (under consideration)		See Annex A			
BP3.3						N/A
BP3.4						N/A
BP4			Connection points as in subclause 6.2.4 6 contact/specimen	Contact resistance at 1 A	2b	15 Ωmax change from initial
BP5	Mechanical operation (remaining number of operations)	9a	Speed 10 mm/s (0.04 in/s) max. Rest 30 s min (when unmated) 1490 operations.			
BP6			Test voltage 500 ± 50 V d.c. Method C	Insulation resistance	3a	1 G Ωmin
BP7			Female contacts only 6 contacts/specimen	Gauge retention force	16e	Retains Gauge
BP8						N/A
BP9						N/A
BP10				Visual Exam	1a	There shall be no damage that would impair normal operation.

Group CP

	IEC Test			Measurements to be performed		Requirements
Test Phase	Title	IEC 512	Severity or Conditions of Test	Title	IEC 512	Performance Level PL 1
CP1	Damp heat Steady state	11c	Mated, non-operational 21 days Recovery time: 2h –			
CP2			Test Voltage 500±50 V d.c. Method C	Insulation Resistance	3a	1 G Ω min.
CP3			Connection points as in subclause 6.2.4 6 contact/specimen	Contact resistance at 1 A	2b	15 mΩ max change from initial
CP4			contact/contact	Voltage proof	4a	500 V r.m.s.
CP5			Unmated connectors	Visual exam	1a	No damage due to conditioning

Group DP

Test Phase	IEC Test			Measurements to be performed		Requirements
	Title	IEC 512	Severity or Conditions of Test	Title	IEC 512	Performance Level PL 1
DP1	Mechanical Operation	9a	Speed 10 mm/s (0.4 in/s) max Rest 30 s min (when unmated) 1500 operations			
DP2	Electrical load and temperature	9b	100°C max 250 hours max 1 A			
DP3			Connection points as in subclause 6.2.4 6 contacts per specimen	Contact resistance at 1 A	2b	15 mΩmax change from initial
DP4			contact/contact	Voltage proof	4a	500 V r.m.s.
DP5			Unmated connectors	Visual exam	1a	No damage due to conditioning
DP6						N/A
DP7						N/A
DP8						N/A

Group EP - Not Applicable

Group FP - Not Applicable

Group GP

	IEC Test			Measurements to be performed		Requirements
Test Phase	Title	IEC 512	Severity or Conditions of Test	Title	IEC 512	Performance Level PL 1
GP1	Cable Clamp Tests	17a, b,c, d				
GP2				Visual Exam	1a	
GP3	Effectiveness of connector coupling device	15f	Apply 30 lb. at a rate of 0.5 in/min to cable			
GP4				Visual Exam	1a	
GP5	Free fall or mechanical impact	7a,b				
GP6				Visual Exam	1a	
GP7						N/A

Group HP

	IEC Test			Measurements to be performed		Requirements
Test Phase	**Title**	IEC 512	Severity or Conditions of Test	Title	IEC 512	Performance Level PL 1
HP1	Shielding Coupling Resistance (under consideration)	23a				
HP2						N/A
HP3				Visual Exam	1a	

8 Quality Assessment Procedures

8.1 *Qualification Approval Testing*

8.1.1 *Method 1*

The qualification approval procedure Method 1 in accordance with IEC QC 001001, QC 001002, IEC 410 and IEC 512 may be applied.

The following number of specimens shall be subjected to the tests under the conditions as specified in subclause 7.2 and 7.3. The specimens shall meet the requirements with not more than the number of defectives permitted in accordance with the following Table.

Table 11

		Performance Level One	
Test Group	**Test Phase**	**Number of Connectors to be tested**	**Number of Defectives Permitted**
P	**P1-5**	30	0
AP	**AP1-18**	5	0
BP	**BP1-11**	5	0
CP	**CP1-5**	5	0
DP	**DP1-8**	5	0
GP	**GP1-7**	5	0
HP	**HP1-3**	5	0
Total number of defectives permitted - sum of all groups.		**0**	

8.1.2 *Method 2*

Alternatively the qualification approval procedure Method 2 can be used. The following inspection shall be included:

1) Lot-vs-Lot tests in accordance with Subclause 9.1 on three consecutive inspection lots, and

2) Periodic tests in accordance with Subclause 9.2 on a sample taken of one of these lots

3) Supplementary qualification approval tests of D2, Table 13a.

9 Quality conformance inspection

9.1 *Lot by Lot Tests*

Applicable combinations of performance and assessment levels: Assessment Level G only.

Table 12

Inspection Group	**Test Phase in Clause 7**	**Test or measurement to be performed (Requirements & Severities in clause 7)**	**IEC 512**	**Assessment Level G** IL	**Assessment Level G** AQL
A1	P1	Visual Examination	Test 1a	II	0.015
A2	P1	Dimensional Examination	Test 1b	II	0.015
B1	P4	Insulation Resistance	Test 3a	S-1	0.015
B1	P5	Voltage proof	Test 4a	S-1	0.015
B2	AP2	Insertion and Withdrawal Forces	Test 13b	S-1	0.015

Certified Test records (RCE) information to be given to:
Results from inspection group B1 and B2.

9.2 *Periodic Tests*

The periodic tests with complete tests groups (Inspection groups D1 and D2) shall be carried out on specimens that have successfully passed tests P1 to P5 and that have been taken from lots which have already satisfied the lot-by-lot tests (see Subclause 9.1).

The periodic tests with single test phases (Inspection groups C1 and C2) shall be carried out on specimens that have successfully passed the lot-by-lot tests (see Subclause 9.1).

Applicable combinations of performance and assessment level. Assessment Level G only.

Table 13

Inspection Group	Test Phase in Clause 7	Test or Test Group	IEC 512	Assessment Periodicity	Level G # of specimens	# of defectives
C1	AP3	Soldering, Sodler bath method	Test 12a	1	5	0
C2	P3	Contact resistance	Test 2a	3	5	0
	Maintenance	of qualification				
D1	AP2	Insertion and withdrawal forces	Test 13b	60	5	0
D1	AP4	Voltage proof	Test 4a			
D1	AP1-12	Test Group AP				
D1	AP13,.5-16	Test Group AP				
D1	BP2	Test Group BP				
D1	BP4-10	Test Group BP				
D1	CP1-5	Test Group CP				

Certified test records (RCE) information to be given:
Results from inspection groups C1, C2, and D1.

Table 13a

Inspection Group	Test Phase in Clause 7	Test or Test Group	IEC 512	Assessment Periodicity	Level G # of specimens	# of defectives
Initial Qualification testing where 7.2 is applied						
D2	AP2	Insertion and Withdrawal Forces	Test 13b		1	0
D2	AP4	Voltage proof			1	0
D2	AP1-18	Test Group AP	Test 4a		5	0
D2	BP1-11	Test Group BP			5	0
D2	CP1-5	Test Group CP			5	0
D2	DP1-8	Test Group DP			5	0
D2	GP1-7	Test Group GP			5	0
D2	HP1-3	Test Group HP			5	0

Certified test records (RCE) information to be given:
Qualification test report

9.3 *Delayed Delivery, Re-inspection.*

Any connectors stored for a period of more than 24 months after the release of the lot shall be tested prior to delivery according to the following table. Once a lot has been satisfactorily re-inspected the quality is assessed for a further 24 months.

Table 14

Inspection Group	Test phase in Cl. 7	Test	IEC 512	Assessment Level G
A1	P1	Visual Examination	Test 1a	IL: S-3 AQL: 0.015
C1	AP3	Soldering, Solder bath method	Test 12a	No of specimens: 20 No of defectives: 0

Certified test records (RCE) information to be given:
Results from inspection Group C1

10 Ordering Information

For ordering connectors according to this detail specification, the style designation described in Clause 2 shall be used.

Annex A (Normative)

Mixed Industrial Gas Test Procedure.

A1. Scope

A1.1 *Content*

This specification covers the test procedure for producing environmentally related corrosive atmospheres to determine the reaction of plated or unplated surfaces when exposed to different concentrations of industrial flowing gas mixtures.

A1.2 *Description*

Samples, both mated or unmated connectors, components or experimental gases are placed in an environmentally controlled chamber. Chamber is monitored by gas analyzing system for controlled concentrations of the industrial gas mixture. Corrosion rates are monitored by silver and copper control coupons placed in the chamber for each test. These control coupons are removed and analyzed using coulometric reduction for factors related to amount and type of corrosive product growth to confirm severity control level.

A2 Materials

A2.1 *Copper coupons*

A. Copper sheet, oxygen free high conductivity, 0,127 mm (0.005 in) thick
B. Silver foil, pure fine grain 0,127 mm (0.005 in)
C. Acid, sulfuric concentrated
D. Jeweler's rouge
E. 1,1,1-trichloroethane
F. Deionized or distilled water
G. Hydrochloric Acid

A2.2 *Exposure materials*

A. Nitrogen gas, pro-purified grade or better
B. Nitrogen dioxide gas, chemically pure grade or better
C. Hydrogen sulfide gas, chemically pure grade or better
D. Chlorine gas, chemically pure grade or better
E. Clear, dry and oil free air
F. Teflon permeation tubes

A3 Test Equipment

A3.1 *Coulometric Analyzer*

Coulometric reduction measurement system capable of quantifying the corrosion products on the control coupons.

A3.2 *Environmental Chamber, see Figure A3*

A. Environmental chamber shall be a combination of an enclosure within an enclosure made of noncorrosive materials. A commercially available environmental chamber will suffice. Space between the inner and outer enclosure shall be approximately 50 mm (2 in). The chamber shall be capable of maintaining the temperature within the specified ranges.

B. Constant temperature chamber for permeation tubes, if used, capable of controlling t temperature within 1 degree Celsius over a temperature of 15 - 30 degrees Celsius.

A3.3 *Source of clean dry air*

A3.4 *Appropriate gas analysis equipment*

Appropriate gas analysis equipment for calibrating and monitoring the gas concentration in the chamber. The gas analysis equipment shall be capable of the following accuracy:

Total Sulfur Analyzer	±1 ppb at 20% upper range limit ±4 ppb at 80% upper range limit
NO_x analyzer	±2 ppb at 20% upper range limit ±3 ppb at 80% upper range limit
Cl_2	±4%

A3.5 *Temperature and humidity monitoring equipment*

Temperature and humidity monitoring equipment, capable of an accuracy of ±0.5 C and ±1% relative humidity, respectively.

A4 Sample Preparation

A4.1 Control Coupon Preparation

A. Copper
   (1) Vapor degrease with 1,1,1-trichloroethane or equivalent for one minute.
   (2) Rinse thoroughly with deionized or distilled water.
   (3) Etch with 15% solution of sulfuric acid at 50 C for 2 minutes.
   (4) Rinse with deionized or distilled water.
   (5) Dry with clean, dry, filtered air.

B. Silver
   (1) Dip in concentrated hydrochloric acid for 2 minutes.
   (2) Rinse with deionized or distilled water.
   (3) Dry with clean, dry, filtered air.
   (4) Buff with jeweler's rouge.
   (5) Ultrasonically clean with 1,1,1-trichloroethane or equivalent for 1 minute.
   (6) Repeat cleaning with fresh 1,1,1-trichloroethane.
   (7) Air dry (not blown).

(8) Vapor degrease with 1,1,1-trichloroethane or equivalent for 1 minute.
(9) Air dry (not blown).
(10) Clean cathodically in a boiling solution of trisodium phosphate using an inert anode for 1 minute at a current of 1.0 ampere.
(11) Rinse thoroughly with deionized or distilled water.
(12) Dry with clean, dry, filtered air.

Note: 1. Control coupons should be handled with clean forceps at all times with the exception of buffing.

2. Store coupons in a sealed container which has been filled with an inert gas (i.e., nitrogen) or an evacuated desiccator until used.

A4.2 *Test Sample Preparation*

Samples shall be prepared as appropriate. Cleaning shall not be performed when a coating on the sample is part of the test. All surfaces that are not intended for exposure and could influence the various measurements shall be protected.

A5 Procedure

A5.1 *Calibration*

Prior to the start of a test, all gas concentration monitoring equipment shall be calibrated by the operator to known standards following procedures outlined by the equivalent manufacturers. After start of the test, the monitoring equipment shall be calibrated at least every 5 days and on the final day of testing in order to ensure that the reading are accurate.

Note: Some Chlorine monitors cannot differentiate between chlorine and some other pollutant gases. Those monitors will only require calibration prior to the beginning of testing and just prior to the final day of testing as there are only times that the other gases can be eliminated from the chamber to allow a determination of the chlorine levels.

A5.2 *Pre-test Procedures*

A. Adjust humidity and temperature as indicated in Table 1. without samples in chamber.

Table A1

Relative Humidity %	Temperature in Celsius	Pollutant concentration ppb		
		Cl_2	NO_2	H_2S
75 ± 2	$30^o \pm 2^o$	20 ± 5	200± 50	100 ± 20

B. Allow chamber to stabilize for temperature and humidity without samples. Exchange rate shall be adjusted to provide 6 changes per hour.

C. Currently, chlorine concentration shall be adjusted and stabilized first; this gas cannot be monitored in combination with the other pollutants.

D. Figure 1 defines the zone configuration of a typical test chamber. Control coupons shall be placed in the shaded zones of Figure A2. Inert, noncorrosive materials shall be used for suspending the test samples and control coupons in the test chamber.

E. Place samples and control coupons in chamber as soon as possible after stabilization period. They shall be placed such that there is a minimum of 50 mm (2 in) between samples, coupons and the chamber walls.

F. The direction of the air flow is primarily in the upward direction. The choice of sample orientations shall take this fact into account to minimize surface area perpendicular to the air flow.

G. Due to absorption of gases by the samples, allow chlorine concentrations to stabilize and adjust, if necessary, to the desired concentration.

H. The remaining pollutants (NO_2 and H_2S) shall then be introduced into the test chamber and adjusted for the concentrations of the requested exposure class in table 1.

I. Total reactive corrosion area samples and control coupons compared to volume of inner chamber shall not exceed a ratio of 1:2000.

A5.3 *Test Procedure*

A. A recommended exposure time for the test samples is 20 days, unless otherwise specified in the referencing document.

B. In many cases it may be advantageous to withdraw samples for periodic testing prior or the full time of the test. After removal from the chamber, such samples shall be stabilized at room ambient for a minimum of 2 hours, measured for appropriate response, and returned to the chamber if required. Such withdrawals shall be noted in the test report.

C. The interior of the environmental chamber shall be monitored and adjusted periodically for humidity, temperature and pollutant concentration. Concentration of the chlorine gas shall be adjusted only at the start of the test and checked at the completion of the test, since chlorine concentration cannot be analyzed in combination with the other pollutants. However, the initial chlorine flow rate shall be maintained throughout the test.

D. At the conclusion of the test, the test samples shall be removed from the chamber and stabilized at room ambient for a minimum of 2 hours before making the final readings or measurements.

A5.4 *Control coupon exposures.*

A. A minimum of 3 coupons each of copper and silver, for each time interval and location in the test chamber, shall be placed in the chamber to monitor corrosion film growth rates. These coupons shall be removed after exposure times of 48 and 96 hours, unless otherwise specified. A new set of coupons shall then be placed in the chamber to monitor the next major time interval, and again removed after the 48 and 96 hour exposure time.

B. Recommended time intervals during a typical 20-day test are as follows:

(1) Between the 1st and 4th day of the test
(2) Between the 9th and 12th day, and
(3) From the 16th through the 20th day.

C. Control coupons are used to monitor the reaction rate in the chamber and not the deterioration of the test samples. Coupons removed from the chamber shall not be returned to the chamber.

D. In order to minimize instability of the test conditions within the chamber, wherever possible any test samples required to be removed on a certain day shall be removed at the same time ss the control coupons are being removed or replaced.

A5.5 *Control Coupon Evaluation*

Control coupons removed from the chamber shall be analyzed coulometrically for factors related to film thickness and composition. If desired, coupons may also be weighed before and after exposure (but before the coulometric analysis) to determine weight gain.