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## INDUSTRIAL M12 X-CODE AND RJ45 PLUG CONNECTOR

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### 1. SCOPE

#### 1.1. Content

This specification defines performance, tests and quality requirements for the M12 X-code to M12 X-code and M12 X-code to RJ45 plug.

#### 1.2. Qualification

When tests are performed on the subject product line, procedures specified in Figure 1 shall be used. All inspections shall be performed using the applicable inspection plan and product drawing.

### 2. APPLICABLE DOCUMENTS AND FORMS

2.1. The following documents form a part of this specification to the extent specified herein. In the event of conflict between the requirements of this specification and the product drawing, the product drawing shall take precedence. In the event of conflict between the requirements of this specification and the referenced documents, this specification shall take precedence.

#### 2.2. TE Documents

- 114-137538: Application Specification (M12 X-code series application specification)
- 501-137538: Qualification Test Report For M12 X-code series test report  
P/N: TAXXXXXXXXX-XXX and TCXXXXXXXX-XXX

#### 2.3. Industry Documents

- IEC 61076-2-109: Detail specification for M12 X-code connectors
- IEC 60512: Electromechanical Components For Electronic Equipment; Basic Testing Procedure and Measuring Methods
- IEC-60529: Degree of Protection Provided by Enclosures (IP Code)
- IEC 60603-7-1: Connectors for electronic equipment-Detail specification for 8 way, shielded, free and fixed connectors
- ISO/IEC 11801-1 for CAT6A category Patch Cord Performance

#### 2.4. Reference Document

- 109-197: Test Specification (TE Test Specification vs EIA and IEC Test Methods)
- IEC 61076-2-101: Connectors for use in DC. low-frequency analogue and digital high speed data applications-Part 2: Circular connectors with assessed quality-Sectional specification
- ISO 1302: Geometrical Product Specifications (GPS)-Indication of surface texture in technical production documentation

### 3. REQUIREMENTS

#### 3.1. Design and Construction

Product shall be of the design, construction, materials and physical dimensions specified on the applicable product drawing.

#### 3.2. Ratings

- Rated voltage: 30Volts for 8 position connector
- Current Rating: 0.5A Max.

- Contact resistance <15 mΩ
- Insulation Resistance >10<sup>8</sup>Ω
- Temperature Rating : -25° C to +80° C for X-CODE cable assembly  
-25° C to +60° C for X-CODE to RJ45 cable assembly

### 3.3. Environmental

Sealing Requirements: M12 X-code side IP67  
RJ45 Plug side IP20

Durability: 100 cycles

### 3.4. Test Requirements and Procedures Summary

Unless otherwise specified, all tests shall be performed at ambient environmental conditions.

#### Test Requirements and Procedures Summary For M12 X-code connector side

Test Description	Requirement	Procedure
Initial examination of product.	Meets requirements of product drawing and Application Specification	IEC 60512, Test 1a Visual and dimensional (C of C) inspection per product drawing.
<b>ELECTRICAL</b>		
Low Level Contact Resistance(LLCR)	Initial value: 15mΩ maximum Final value: Δ15mΩ maximum	IEC 60512-2-1, Test 2a Subject specimens to 100 milliamperes maximum and 20 millivolts maximum open circuit voltage
Insulation Resistance	100MΩMin.See Figure 3	IEC 60512-3-1, Method A 500V±15V DC between adjacent contacts, 1 minute hold
Voltage proof (withstanding voltage)	1 minute hold with no breakdown or flashover.	IEC 60512-4-1 Ramp at 500 volts per second maximum All contact connected together to shield.
Electrical load and temperature	See note	IEC60512, Test 9b Duration: 1000h Amp. Temp: 40°C Current load:0.5A, single contact Recovery time:2 h Temperature: sensor in center of specimen
<b>MECHANICAL</b>		
Sinusoidal vibration	No electrical discontinuity greater than 1μs See Figure 4	IEC 60512, Test 6d 10Hz to 500Hz and 0.35mm or 5g Sweep cycles:10 Full duration:6H
Mechanical Shock	No electrical discontinuity greater than 1μs	IEC 60512, Test 6c Half sine shock acceleration 490m/s <sup>2</sup> (50g) Duration of impact:11ms

Test Description	Requirement	Procedure
Durability	See note	IEC 60512, Test 9a Max speed of operations= 10 mm/s Rest:30s, unmated For gold contact finish, Mate and unmated specimens for 50 cycles.

### ENVIRONMENTAL

Rapid change in temperature (30 minutes dwells at temperature extremes)	See note.	IEC 60512 test 11d Subject specimens to 5 cycles between -25 and 85°C with 30 minute at temperature extremes.
Rapid change in temperature (60 minutes dwells at temperature extremes)	See note.	IEC 60512 test 11d Subject specimens to 5 cycles between -25 and 85°C with 60 minute at temperature extremes.
Damp heat, cycle, first cycle	See note	IEC 60512-11-12 Method dB Subject specimens to 5 cycles (5 days) between 40 and 55°C at 90 to 100% RH
Damp heat, remaining cycle	See note	IEC 60512-11-12 Method dB Subject specimens to 5 cycles (5 days) between 40 and 55°C at 90 to 100% RH
Dry heat	See note	IEC 60512-11-9 Temperature:85°C Duration: 16 hours
Max flowing gas	See note	IEC 60512-11-7 test method 4 Flowing mixed gas – 4 days, according 60068-2-60
Impacting water(IPX7)	No ingress of water	IEC 60529, Test 14.2.7
Cold	There shall be no defect that would impair normal operation	IEC 60512-11 Temperature:-25°C Duration: 2h Recovery time:2h



#### NOTE

Shall meet visual requirements, show no physical damage, and meet requirements of additional tests as specified in the Product Qualification and Requalification Test Sequence shown in Figure 2.

### 3.5. ELECTRICAL TRANSMISSION REQUIREMENTS

Insertion loss	Mated connectors Mated connectors all pairs: $\leq 0.02 \sqrt{f}$ db from 1 to 500MHz, whenever the formula results in a value less than 0.1 db, the requirement shall revert to 0.1db	IEC60512-27-100 Test 27a
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NEXT loss	Mated connectors All pair combinations: $\geq 94-20\log(f)$ dB from 1MHz to 250MHz All pair combinations: $\geq 46.04-30\log(f/250)$ dB from 250 to 500MHz	IEC 60512-27-100 Test 27c
Return loss	Mated connectors All pairs: $\geq 68-20\log(f)$ dB from 1 MHz to 500MHz. whenever the formula results in a value greater than 30db, the requirement shall revert to 30db	IEC 60512-27-100 Test 27b
FEXT loss	Mated connectors All pair combinations: $\geq 83.1-20\log(f)$ dB from 1MHz to 500MHz whenever the formula results in a value greater than 75db, the requirement shall revert to 75db	IEC 60512-27-100 Test 27d



**NOTE**

- A. Electrical transmission tests are applicable for connector for symmetrical pair cabling. The measurements shall be performed according to the contact and pair designation in figure 3.
- B. Category 6A transmission performance interoperability shall be demonstrated by testing the female connectors with full range of male connectors in the style of IEC 60512-27-100 and IEC 60512-25-9. Transmission performance and backward compatibility shall be demonstrated by testing the female connectors with range of male connectors or “test plugs” described in IEC 60512-26-100. All transmission performance requirement apply between the reference lanes specified in IEC 60512-27-100.
- C. f is the frequency expressed in MHz in above table.

3.6. M12 X-CODE Product Qualification and Requalification Test Sequence

Test Examination	Test Group			
	1	2	3	4
	Test Sequence (a)			
Examination of product	1,21	1,13	1,15	
Voltage proof(withstanding voltage)	4,11,19	4,12	4,8,14	
Insulation resistance	3,10,13,18	3,11	3,7,13	
LLCR	2,7,9,17	2,6,8,10	2,6,10,12	
Impacting water(IPX7)	20			
Durability 50cycles		5,9	9	
Sinusoidal vibration	5			
Mechanical shock	6			
Rapid change in temperature (30 minutes dwells at temperature extremes)	8			
Rapid change in temperature (60 minutes dwells at temperature extremes)			5	
Dry heat	12			
Damp heat, cyclic, first cycle	14			
Damp heat, cyclic, remaining cycles	16			
Cold	15			
Mixed flowing gas		7		
Electrical load and temperature			11	

Tensile strength (crimped connection)				
Transmission requirement				1



**NOTE**

- (a) Numbers indicate sequence in which tests are performed.
- (b) Test group 5 is according to Electrical transmission requirements table.

End Figure 2

3.7. Test Requirements and Procedures Summary For RJ45 Plug side

<b>General</b>			
No.	Test Items	Requirements	Condition according to
1.1	Visual and dimensional examination	Meets requirements of product drawing, No defect would impair normal operation	Visual inspection No physical damage. IEC 60512, Test 1a
<b>Electrical Requirements</b>			
2.1	Contact Resistance	Initial	Measure at to 20mV open circuit at 100mA maximum. see figure IEC 60512-2-1, Test 2a
		Final	
2.2	Insulation Resistance	1000M $\Omega$ Min. See Figure 5	IEC 60512-3-1, Method A 500V $\pm$ 15V DC between adjacent contacts, 1 minute hold
2.3	Voltage proof (withstanding voltage)	1 minute hold with no breakdown or flashover.	IEC 60512-4-1 1000 volts AC at sea level. Test between adjacent contacts of mated plug and jack.
<b>Mechanical Requirements</b>			
3.1	Vibration, jack-plug interface.	No discontinuities of 1 microsecond maximum. Shall remain mated and show no evidence of physical damage.	Subject mated specimens to 50 G's half-sine shock pulsed of 11 milliseconds duration. Three shocks in each direction applied along 3 mutually perpendicular planes, 18 total shock. Discontinuity less than 1 $\mu$ s, No damage.
3.2	Mechanical shock, jack-plug interface.	No discontinuities of 1 microseconds maximum. No damage.	Subject mated specimens to 3.10G's rms between 20~500Hz. 15 minutes in each of 3 mutually perpendicular planes. Discontinuity less than 1 $\mu$ s, No damage.
3.3	Durability, jack-plug interface.	$\Delta R$ 10 milliohms maximum. No physical damage.	IEC 60512-9-1. Mate and unmated plug and jack interface with latch inoperative for 1000 cycles at a maximum rate of 500 (automatic) per hour.

3.4	Plug withdrawal force, jack-plug interface	30N MAX.(Shielded)	IEC 60512-13-1. Measure force required to unmated plug and jack with latch depressed at a maximum rate of 0.5 inch(1.27mm) inch per minute. plug and jack with latch depressed at a maximum rate of 0.5 inch(1.27mm) inch per minute.
3.5	Plug retention in jack, jack-plug interface.	Plug shall not dislodge from jack.	EIA 364-98. Apply an axial load of 50N or 90N to plug housing at a rate of 1.27mm per minute with plug mated in jack and latch engaged. Maintain load for 60 seconds.

Environmental Requirements			
4.1	Thermal shock	$\Delta R$ 10 milliohms maximum. No physical damage.	IEC 60512-11-9. Subject mated plug and terminated jack to 25 cycles between - 40°C and 70° C.
4.2	Humidity / temperature cycling	$\Delta R$ 10 milliohms maximum. No physical damage.	IEC 60068-2-38. Subject mated plug and terminated jack to 21 cycles (cycle time 24 hours) between 25 and 65°C at 95% RH with a -10°C sub-cycle shock.
4.4	Humidity, steady state	$\Delta R$ 10 milliohms maximum. No physical damage.	IEC 60512-11-12. Subject mated plug and terminated jack to 55°C (PC) or 85°C (TR55) and 95% RH for 10 days.
4.5	Stress relaxation	$\Delta R$ 10 milliohms maximum. No physical damage.	IEC 60068-2-2, Test Method Ba. Subject mated plug and terminated jack to 70° C (PC), or 85°C (TR55) for 500 hours.
4.6	Salt Spray Test	1) $\Delta R$ 10 milliohms maximum. 2)10 times under the magnifying glass to observe the coating without peeling, cracks wrinkling, separation and other phenomena, allowing up to one terminal has a corrosion point, the area does not exceed 5%	Temperature: 35 ± 2° C, humidity: 100% RH, NaCl concentration: 5%

### 3.8 RJ45 Plug side Product Qualification and Requalification Test Sequence

No.	Test or Examination	Test Group						
		A	B	C	D	E	F	G
		Test Sequence						
1	Examination of product	1	1	1	1,5	1,5	1,4	1,4
2	Contact resistance	2	2,4		2,6	2,6	2,5	2,5
3	Insulation resistance	3			7	7	6	

4	Voltage proof	4			8	8	7	
5	Durability, jack-plug interface	5	3		9		8	
6	Plug insertion force, jack-plug interface			2				
7	Plug withdrawal force, jack-plug interface			3				
8	Plug retention in jack, jack-plug interface			4		9	9	
9	Thermal shock				3	3		
10	Humidity/temperature cycling					4		
11	Humidity, steady state				4			
12	Salt Spray Test							3
13	Stress relaxation						3	

3.9 Electrical transmission requirements (For M12 X code to M12 X code or RJ45 plug )

Requirements: The results were compared to the limit lines specified in the ISO/IEC 11801-1 for category CAT6A Patch Cord level performance

CAT6A Patch Cord level performance		
Signal transmission for cable assembly	CAT6A – Patch Cord Requirements	ISO/IEC 11801-1

## 4. QUALITY ASSURANCE PROVISIONS

### 4.1. Qualification Testing

#### A Specimen Selection

Plugs and receptacles should be prepared in accordance with applicable Instruction Sheet and should be elected at random from current production. Each test group shall consist of 3 specimens Min. unless otherwise stated.

#### B Test Sequence

Qualification inspection shall be verified by testing specimens as specified in figure 2.

### 4.2. Requalification testing

If changes significantly affecting form, fit or function are made to the product or manufacturing process or controlling industry specification, product assurance, shall coordinate requalification testing, consisting of all or part of the original testing sequence as determined by development/product, quality and reliability engineering.

### 4.3. Acceptance

Acceptance is based on verification that the product meets the requirements of Figure 1. Failures attributed to equipment, test setup or operator deficiencies shall not disqualify the product. If product failure occurs, corrective action shall be taken and samples resubmitted for qualification. Testing to confirm corrective action is required before resubmitted.

### 4.4. Quality conformance Inspection

The applicable quality inspection plan shall specify the sampling acceptable quality level to be used. Dimensional and functional requirements shall be in accordance with the applicable product drawing and this specification.

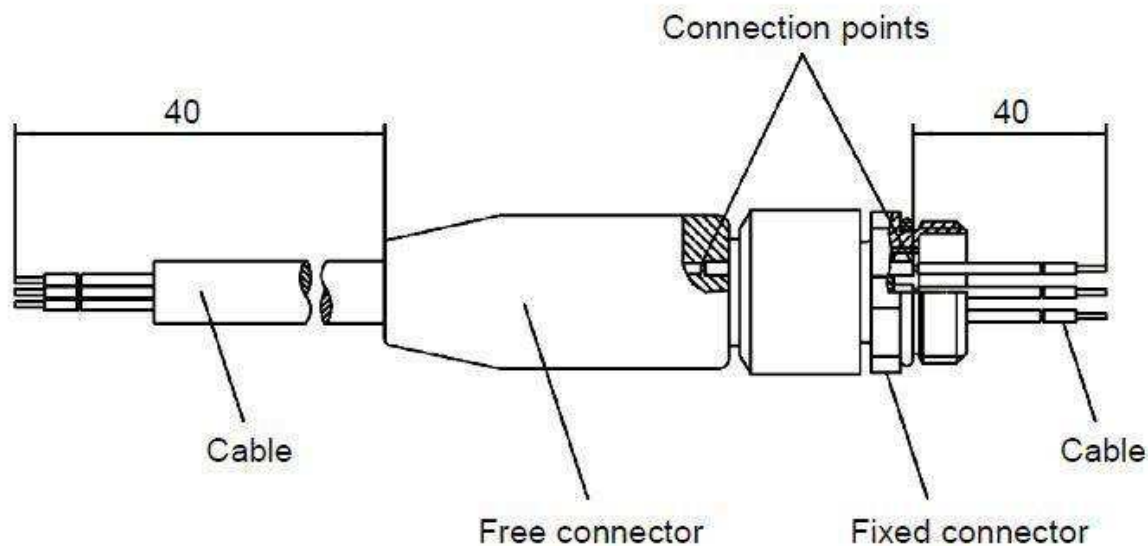


Figure 3- Contact resistance arrangement



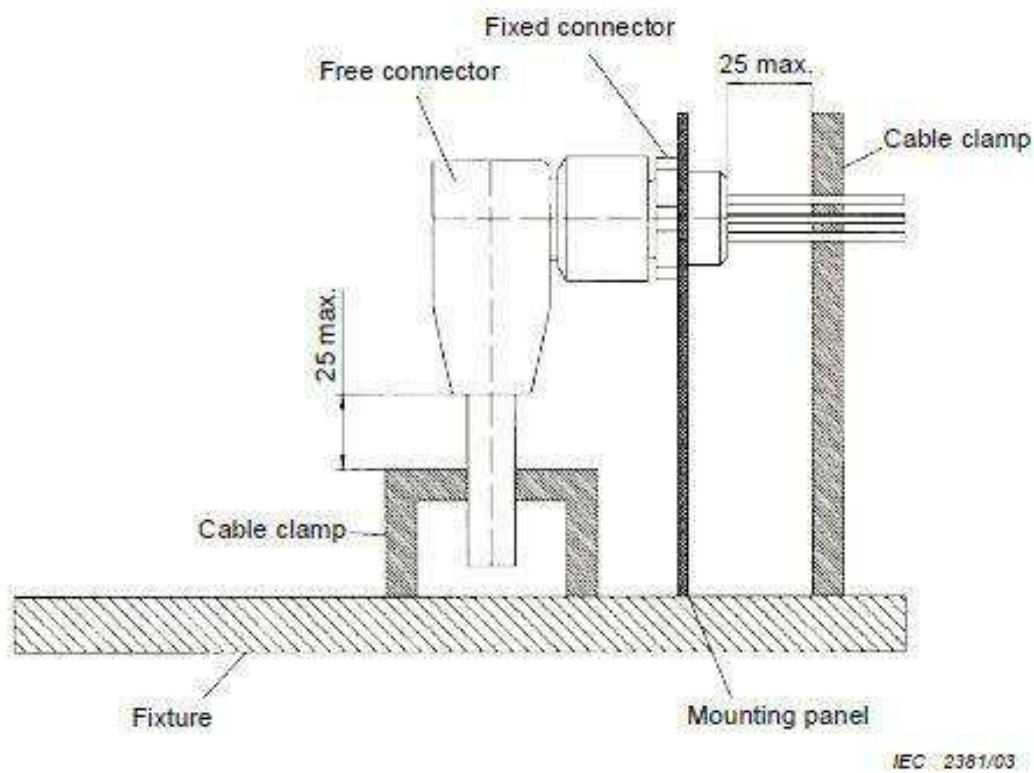
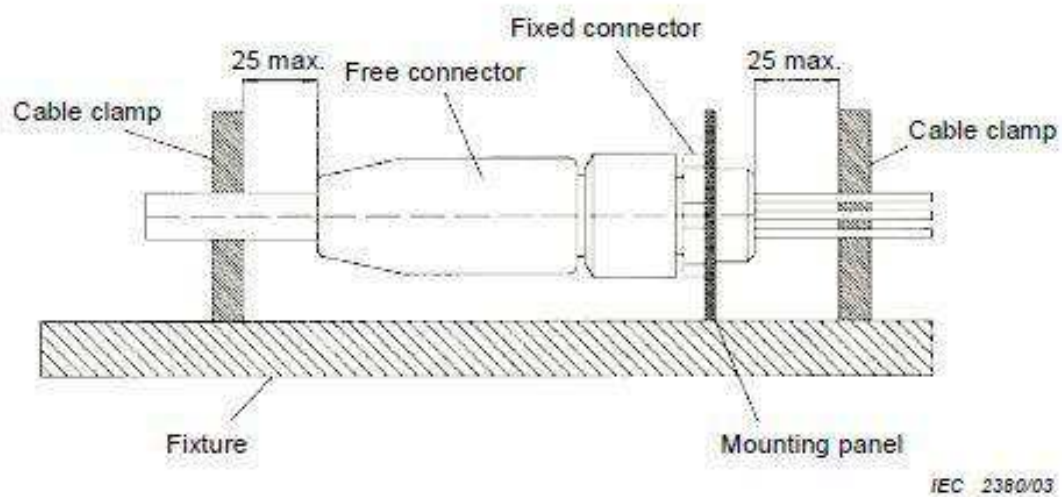
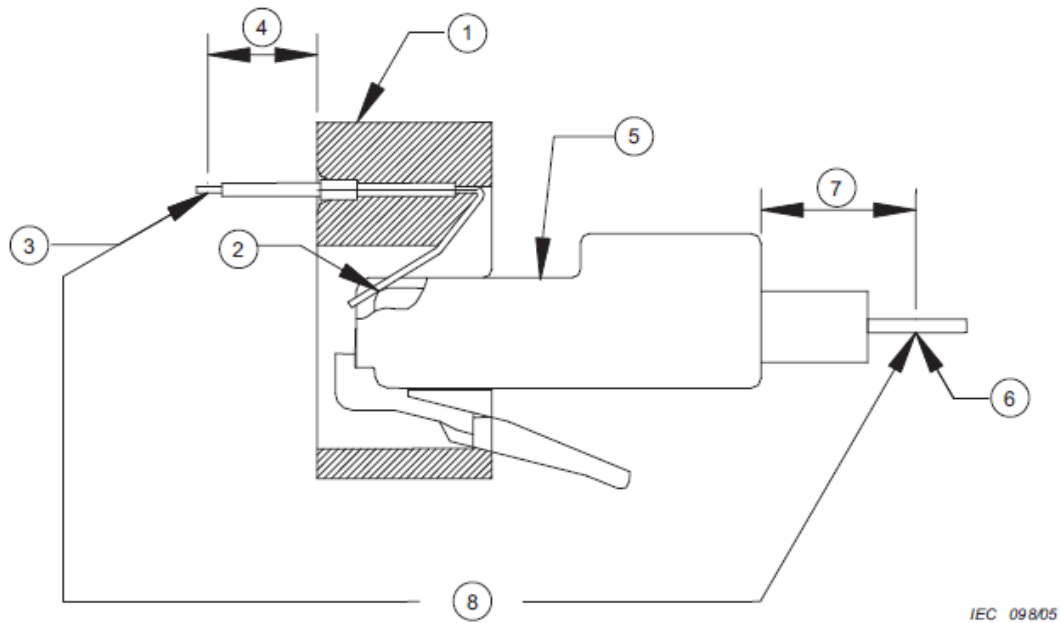


Figure 4- Dynamic stress test arrangement



IEC 09805

**Key**

- 1 Fixed connector.
- 2 Point B.
- 3 Point A.
- 4 As short as practical (except for vibration test CP2, see 7.3).
- 5 Free connector.
- 6 Point C.
- 7 As short as practical (except for vibration test CP2, see 7.3).
- 8 Contact resistance measurement points.

Figure 5