

Product Specification



M12 RAIL ECONOMICAL VERSION VALIDATION PLAN ACCORDING TO IEC 61076-2-101 AND IEC 11801-1

Project Number: PRJ-19-000901531

A	INITIAL RELEASE				21-SEP-2021	RAJAGOPAL N
LTR	Revision record				Date	Author
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1. SCOPE

1.1. Content

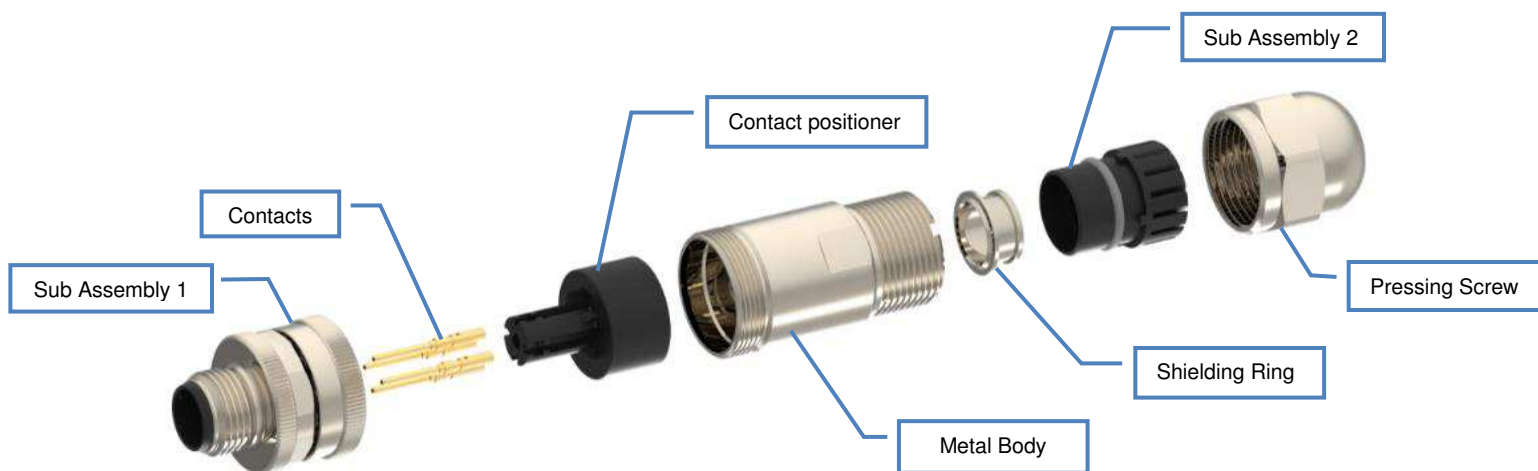
When tests are performed, the following specifications and standards listed in the document shall be used. All inspections shall be performed using the applicable inspection plan and product drawing.

This specification defines the performance, tests and quality standards for M12 Rail economical connectors for electrical connection intended for use in railway rolling stock.

M12 Rail connector is designed for power and data connectivity in railway.

The connectors under test are shown below (more details are done in paragraph 3.5 sampling):

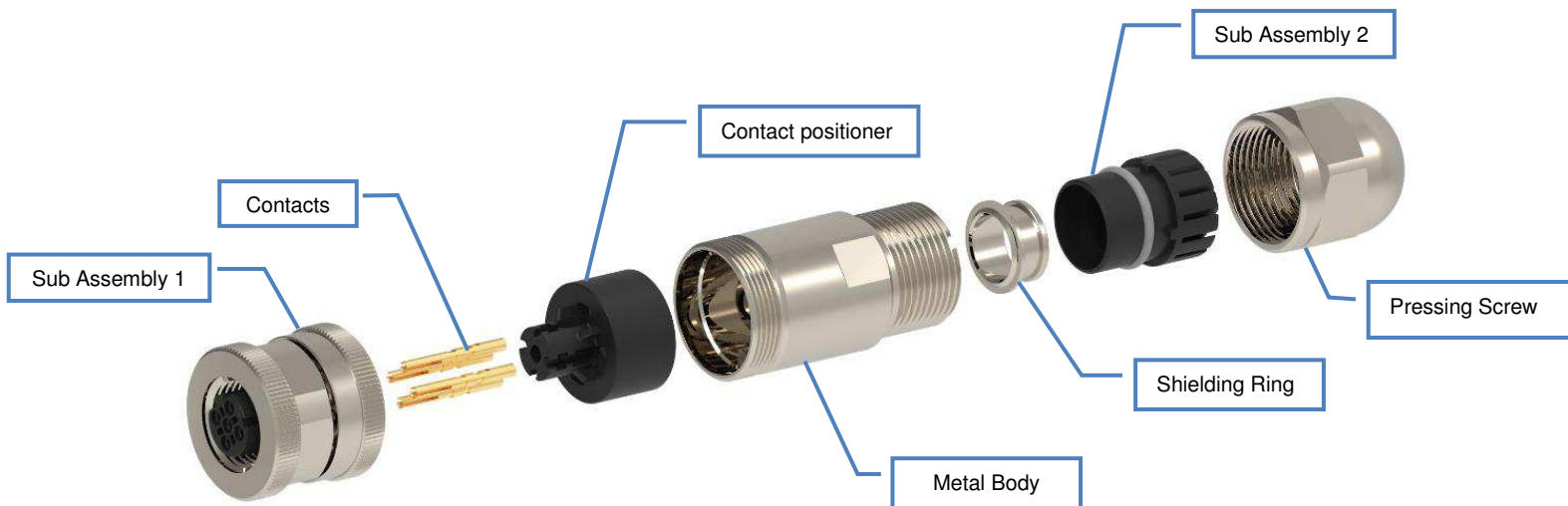
M12 Male connector:



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M12 Female connector:



1.2. Qualification

When tests are performed, the following specifications and standards listed in the document shall be used.
All inspections shall be performed using the applicable inspection plan and product drawing.

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2. APPLICABLE DOCUMENTS

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

2.1. TE Connectivity documents

Connectors:

- C-2351378 - M12 Male, D4 code, str shielded connector
- C-2351414 - M12 Male, A5 code, str shielded connector
- C-2351415 - M12 Male, A8 code, str shielded connector
- C-2358990 - M12 Female, D4, str shielded connector
- C-2358991 - M12 Female, A5, str shielded connector
- C-2358992 - M12 Female, A8, str shielded connector

Other / Download documents:

- <http://www.te.com/>

2.2. Normative references

The following referenced standards are applicable, as well as the standards listed therein as applicable standards. For undated references, the last standard version in effect at the test date has been used.

- IEC60512-1-1 & IEC60512-1-2 – Visual & dimensional examination
- IEC60512-2-1 – Contact resistance test (Millivolt level)
- IEC60512-3-1 - Insulation resistance test
- IEC60352-2 - Cable pull test
- IEC 60512-9 - Mating cycle test
- IEC 60512-14-7 - Degree of protection test
- IEC60512-4-1 - Voltage proof test
- IEC60512-13-2 - Insertion and withdrawal forces test
- IEC60512-11-4 - Rapid change of temperature test
- IEC60512-11-9 - Dry heat test
- IEC60512-11-12 - Damp heat, cyclic test
- IEC60512-11-10 - Cold test
- IEC60512-9-2 - Electrical load and temperature test
- EN61373 cat 1, B - Railway Applications – Rolling Stock Equipment – Shock & Vibrations tests
- EN45545-2 HL2 R22/R23 - Railway Applications – Fire Protection on Railway Vehicles – Part 2: Requirements for fire behavior of materials and components

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- IEC60512-13-5 – Polarizing test
- IEC60352-2 – Solderless connection test
- IEC 60512-11-7– Mixed flowing gas test
- IEC61076-2-101 - M12 spec
- IEC11801-1- Data transmission

3. REQUIREMENTS

3.1. Design and Construction

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

3.2. Ratings

Unless otherwise specified, severity of the service conditions shall be those per EN60512.

- Insulation Resistance: $\geq 100\text{M}\Omega$
- Contact resistance: $\leq 8\text{m}\Omega$
- Current Rating: D4 & A5 code – 4A and A8 code – 2A
- Voltage Rating: D4 code – 250V, A5 code – 60V & A8 code – 30V
- Operating Temperature range: -25°C to 85°C (For cable assembly)
 -40°C to 85°C (Connector)
- Degree of Protection per IEC 60529: IP67
- Mating Cycles: 100
- Vibration & Shocks per EN61373 cat 1, B (Cat 2 as Objective)
- Fire & Smoke retardant per EN 45545-2, HL2, R22/23.

3.3. Performance and tests description

Product shall be designed to meet the electrical, mechanical and environmental performance requirements specified in Paragraph 3.4. Unless otherwise specified, all tests shall be performed at ambient environmental conditions per IEC 512.

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3.4. Tests Requirements and Procedures summary

Table 3 – Test Standards and Requirements

No.	Measurements to be performed		Condition	Requirements
	Test Items	Standard		
01	Visual & dimensional examination	IEC 60512-1-1 IEC 60512-1-2	Unmated connectors	No defect would impair normal operation
02	Voltage proof (withstanding voltage)	IEC 60512-4-1	1 minute hold with no breakdown or flashover.	1400(4 pins) /1000(5 pins) /650(8 pins) volts AC or DC, hold for 1 minute between adjacent contacts/ between contacts and shield
03	Insulation resistance test	IEC60512-3-1	500V DC between adjacent contacts, Method A	Insulation resistance should be $\geq 100\text{M}\Omega$
04	LLCR (Low level contact resistance)	IEC 60512-2-1	Subject specimens to 100 milliamps maximum and 20 millivolts maximum open circuit voltage Test points refer to Fig.1 Initial value: $8\text{m}\Omega$ max.	Contact resistance should be $\leq 8\text{m}\Omega$
05	Temperature rise test	IEC 60512-5-2	Stabilize at rated current level until 3 readings at 5 minutes intervals are within 1°C	ΔT 30°C Max under loaded rating current. (See Fig. 3)
06	Degree of protection test	IEC 60512-14-7	For impacting water: IEC 60529, Test 14.2.7 For dust: IEC 60529, Test 6, table 7 IP 67 This test shall be conducted after Test for withstanding shock and vibration	No ingress of water and No deposit dust on contact

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07	Electrical load and temperature test	IEC 60512-9-2	<p>Duration: 1 000 h Amb.temp.: 40 °C Current load acc. To Fig.3 (IEC61076-2-101, 5.2.3) Recovery time: 2 h</p> <p>Temp. sensor in centre Of specimen</p>	<p>Contact resistance: Rise in relation to initial values 15 mΩ max</p> <p>Insulation resistance should be ≥100MΩ</p> <p>Voltage proof according to IEC 61076-2-101, 5.2.2</p>
08	Mating cycle test	IEC 60512-9-1	<p>100 mating cycles</p> <p>Mate and un-mate specimens for cycles at a maximum speed of operations=10mm/s, Rest:30s, unmated</p>	<p>Contact resistance: Rise in relation to initial values 15 mΩ max.</p> <p>Visual examination: No defect would impair normal operation</p>
09	Mating/Un-mating Force	IEC 60512-13-2	<p>Operation speed: 10mm/min. Measure force necessary to mate samples.</p>	<p>For 2-5 pins: Total insertion force 10N Max. Total withdrawal force 15N Max.</p> <p>For 6-12 pins: Total insertion force 23N Max. Total withdrawal force 30 N Max.</p>
10	Sinusoidal vibration	IEC 60512-6-4	<p>10 Hz–500 Hz 0,35 mm or 50 m/s²</p> <p>Sweep cycles: 10 Full duration: 6 h</p>	<p>Duration of contact disturbance 1 μs max.</p> <p>Contact resistance: Rise in relation to initial values 15 mΩ max</p> <p>Visual examination: There shall be no defect that would impair normal operation</p>
11	Mechanical Shock	IEC 60512-6-3	<p>Arrangement according to IEC 61076-2-101, 6.3 Half sine shock acceleration 490 m/s² (50 g) Duration of impact: 11 ms</p>	<p>Duration of contact disturbance 1 μs max.</p> <p>Contact resistance: Rise in relation to initial values 15 mΩ max</p> <p>Visual examination: There shall be no defect that would impair normal operation</p>
12	<p>Simulated long life random vibration at increased levels – CAT 1, B</p> <p>*applicable only for Sample group F</p>	IEC61373:1999 CAT 1, B	<p>Connectors mated, all contacts wired in series and monitored for micro interruption. According to classification of intended mounting location (see Annex B): category 1, class B</p>	<p>Duration of contact disturbance 1 μs max.</p> <p>Contact resistance: Rise in relation to initial values 15 mΩ max</p>

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			Vertical axis: 7.90 m/s ² Transversal: 3.50 m/s ² Longitudinal: 5.50 m/s ² Frequency: 5 – 150 Hz, Duration 5h / axis	Visual examination: There shall be no defect that would impair normal operation
13	Simulated long life random vibration at increased levels – CAT 2 *applicable only for Sample group G	IEC61373:1999 CAT 2	Connectors mated, all contacts wired in series and monitored for micro interruption. According to classification of intended mounting location (see Annex B): category 2 Vertical axis: 42.5 m/s ² Transversal: 37 m/s ² Longitudinal: 20 m/s ² Frequency: 5 – 250 Hz, Duration 5h / axis	Duration of contact disturbance 1 µs max. Contact resistance: Rise in relation to initial values 15 mΩ max Visual examination: There shall be no defect that would impair normal operation
14	Random vibration test – CAT 1, B *applicable only for Sample group F	IEC61373:1999 CAT 1, B	Connectors mated, all contacts wired in series and monitored for micro interruption. According to classification of intended mounting location: category 1, class B Vertical axis: 1.00 m/s ² Transversal: 0.45 m/s ² Longitudinal: 0.7 m/s ² Frequency: 5 – 150 Hz, Duration 10 min. / axis	Duration of contact disturbance 1 µs max. Contact resistance: Rise in relation to initial values 15 mΩ max Visual examination: There shall be no defect that would impair normal operation
15	Random vibration test – CAT 2 *applicable only for Sample group G	IEC61373:1999 CAT 2	Connectors mated, all contacts wired in series and monitored for micro interruption. According to classification of intended mounting location: category 2 Vertical axis: 5.4 m/s ² Transversal: 4.7 m/s ² Longitudinal: 2.5 m/s ² Frequency: 5 – 250 Hz, Duration 10 min. / axis	Duration of contact disturbance 1 µs max. Contact resistance: Rise in relation to initial values 15 mΩ max Visual examination: There shall be no defect that would impair normal operation

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16	Mechanical Shock test – CAT 1, B *applicable only for Sample group F	IEC61373:1999 CAT 1, B	Connectors mated. According to classification of intended mounting location (see Annex B): category 1, class B Vertical axis: 30 m/s ² Transversal: 30 m/s ² Longitudinal: 50 m/s ² Duration: 18 micro sec. Number of impacts: 3 +ve and 3 -ve shocks in orthogonal plane	Duration of contact disturbance 1 µs max. Contact resistance: Rise in relation to initial values 15 mΩ max Visual examination: There shall be no defect that would impair normal operation
17	Mechanical Shock test – CAT 2 *applicable only for Sample group G	IEC61373:1999 CAT 2	Connectors mated. According to classification of intended mounting location (see Annex B): category 2 Vertical axis: 300 m/s ² Transversal: 300 m/s ² Longitudinal: 300 m/s ² Duration: 18 micro sec. Number of impacts: 3 +ve and 3 -ve shocks in orthogonal plane	Duration of contact disturbance 1 µs max. Contact resistance: Rise in relation to initial values 15 mΩ max Visual examination: There shall be no defect that would impair normal operation
18	Rapid change in temperature	IEC 60512-11-4	Subject specimens to 5 cycles between -40°C to 85°C or -25°C to 85°C with 30 minutes dwells at temperature extremes Refer to 3.2 : Temperature Rating	Contact resistance: Rise in relation to initial values 15 mΩ max Insulation resistance should be ≥100MΩ Voltage proof per IEC 61076-2-101, table 8 Visual examination: There shall be no defect that would impair normal operation
19	Dry heat	IEC 60512-11-9	Subject mated specimens to 85°C for 16 h	Insulation resistance should be ≥100MΩ

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20	Damp heat, cyclic	IEC 60512-11-12	Method Db Temp.: 40 °C Recovery time: 2 h Subject specimens to 5 cycles (5 days)	Visual examination: There shall be no defect that would impair normal operation (for first cycle and remaining cycle) Contact resistance: Rise in relation to initial values 15 mΩ max (for remaining cycle) Insulation resistance should be ≥100MΩ (for remaining cycle) Voltage proof according to 5.2.2 (IEC 60512-4-1) (for remaining cycle)
21	Cold	IEC 60512-11-10	Temp.: -40° C or -25°C Duration: 2h Recovery time: 2h Refer to 3.2 : Temperature Rating	Visual examination: There shall be no defect that would impair normal operation
22	Mixed flowing gas	IEC 60512-11-7	Flowing mixed gas corrosion – 4 days, test method 4 according IEC 60068-2-60	Contact resistance: Rise in relation to initial values 15 mΩ max.
23	Cable pull out test (Contact crimp test)	IEC 60352-2	Pull out force followed from IEC 60352-2, table 1	There shall be no defect that would impair normal operation
24	Polarizing test	IEC 60512-13-5	Insertion force: 35 N min.	It shall be possible to correctly align and mate the appropriate mating connectors. It shall not be possible to mate the connectors in any other than the correct manner
25	Signal integrity / Data test	IEC 61076-2-101	Test per IEC 61076-2-101, 6.4.7	Should meet IEC 61076-2-101, table 18

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3.5. Sampling

3.5.1. Samples BOM

A pair of connectors is composed of a plug and a receptacle, equipped of contacts and cable glands per hereafter table:

Table 13 – Samples BOM	
Assembly	Part number
M12 Male, D4 code, str shielded connector	2351378
M12 Male, A5 code, str shielded connector	2351414
M12 Male, A8 code, str shielded connector	2351415
M12 Female, D4, str shielded connector	2358990
M12 Female, A5, str shielded connector	2358991
M12 Female, A8, str shielded connector	2358992

3.5.2. Number of test specimens

Table 13 – Number of test specimens								
	Test group							
No. of specimen	A	B	C	D	E	F	G	H
	23	3	3	3	3	3	3	5

*For M12 Male and Female A5 code connectors, Test group H is not applicable.

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3.6. Tests Sequence

Table 15 - Tests Sequence

Test or Examination	Qualification Test sequence							
	Sample A (a)	Sample B	Sample C	Sample D	Sample E (f)	Sample F	Sample G	Sample H
Dimensional and visual inspection test	1	3, 6, 11, 20, 26	8	9	1	3, 6, 9	3, 6, 9	
Voltage proof (withstanding voltage)	4	10, 19, 25	4, 7	4, 8	7			
Insulation resistance test	3	9, 13, 18, 24	3, 6	3, 7	3, 6			
LLCR (Low level contact resistance)	2	2, 5, 8, 17, 23	2	2	2, 5, 11	2, 5, 8	2, 5, 8	
Temperature rise test				5 (e)				
Impacting water		21	5	6				
Dust (IP6X)		22 (b)						
Electrical load and temperature test					4			
Mating cycle test					9			
Mating/Un-mating Force					8, 10			
Sinusoidal vibration test		1						
Mechanical Shock test		4						
Simulated long life random vibration at increased levels – CAT 1, B						1		
Simulated long life random vibration at increased levels – CAT 2							1	
Random vibration test – CAT 1, B						4		
Random vibration test – CAT 2							4	
Mechanical Shock test – CAT 1, B						7		
Mechanical Shock test – CAT 2							7	
Rapid change in temperature		7		1				
Dry heat		12						
Damp heat, cyclic		14 (c), 16 (d)						
Cold		15						
Polarizing test		27						
Mixed flowing gas			1					
Cable pull out test			9					
Signal integrity / Data speed test								1

Notes:

- (a) When the initial test group A has been completed the specimens are divided in the 7 groups B, C, D, E, F, G, H. All connectors in each group shall undergo the tests specified for the relevant group numbers indicate sequence in which tests are performed.
- (b) It's allowed to perform with an additional specimen, extending the total number of specimen by 1.
- (c) First cycle
- (d) Remaining cycles
- (e) Test with additional specimen for over-molding type cable assembly
- (f) This test group should be tested without the screw nut
- (g) Sample group F & G are for dedicated test sequence for Rail application and these two sequences are additional tests from M12 spec. (IEC 61076-2-101).

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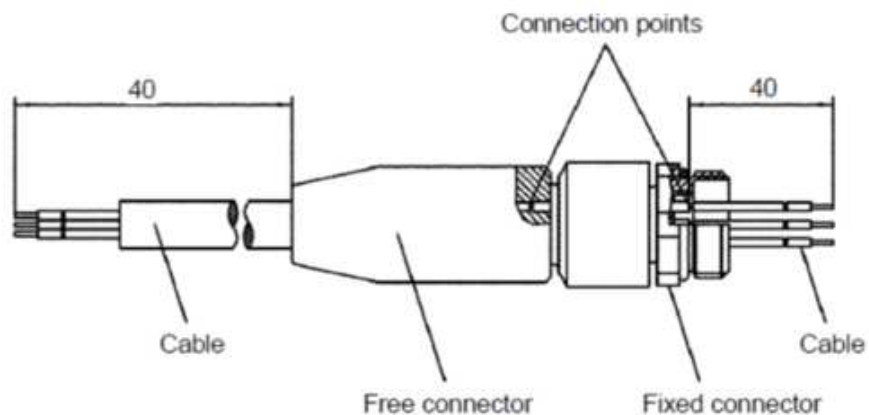


Fig. 1 Contact resistance arrangement

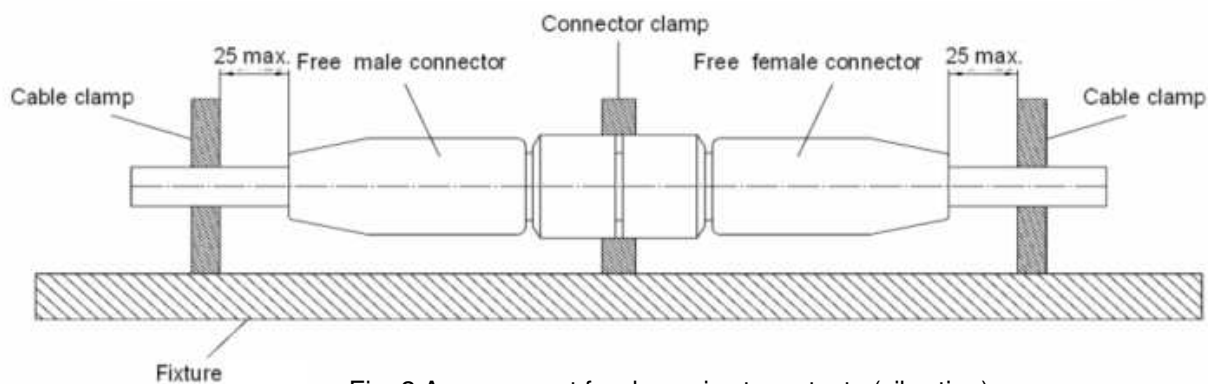
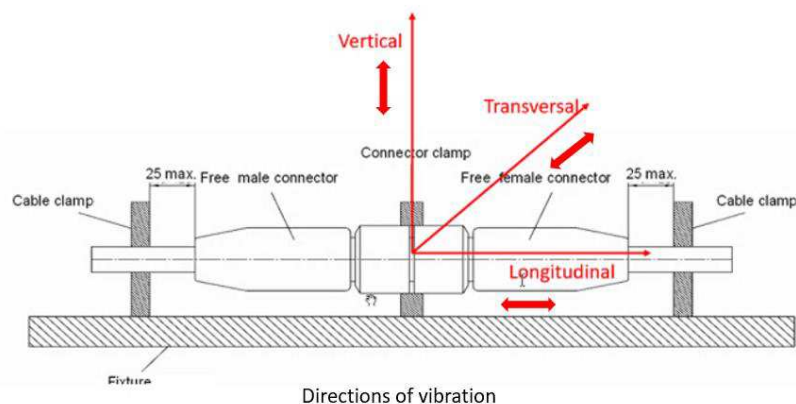


Fig. 2 Arrangement for dynamic stress tests (vibration)

IEC 1184:08

For M12:	
A-coding 2- 5 ways	=4 A
6- 8 ways	=2 A
9- 17 ways	=1.5 A
B-coding 5 ways	=4A
C-coding 3 ways (2+PE)	=4A
4 ways (3+PE)	=4A
5 ways (4+PE)	=2A
6 ways (5+PE)	=2A
D-coding 4 ways	=4A
P-coding 5 ways (4+PE)	=4A
For M8: 3A	

Fig.3 (Rating Current)



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4. QUALITY ASSURANCE PROVISIONS

4.1. Qualification Testing

4.1.1. Specimens Selection

Specimens shall be prepared in accordance with applicable Instruction Sheets and shall be selected at random from the released tool in a production environment.

4.1.2. Test Sequence

The samples shall be prepared in accordance with product drawings. They shall be selected at random from the released tool in a production environment.

4.1.3. Test Report

A test report shall be released based on herein test specification added to below information:

- Samples working order
- Tests devices list + calibration dates
- General conclusion
- For each test:
 - Sampling number
 - Samples setting-up
 - Test devices
 - Methodology description
 - Test date(s)
 - Results summary
 - Test conclusion

4.2. Requalification Testing

If changes significantly affecting form, fit or functions are made to the product or manufacturing process, 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 paragraph 3.4. Failures attributed to equipment, test setup or operator deficiencies shall not disqualify the product. If product failure occurs, corrective action shall be taken and specimens resubmitted for qualification. Testing to confirm corrective action is required before re-submittal.

4.4. Quality Conformance Inspection

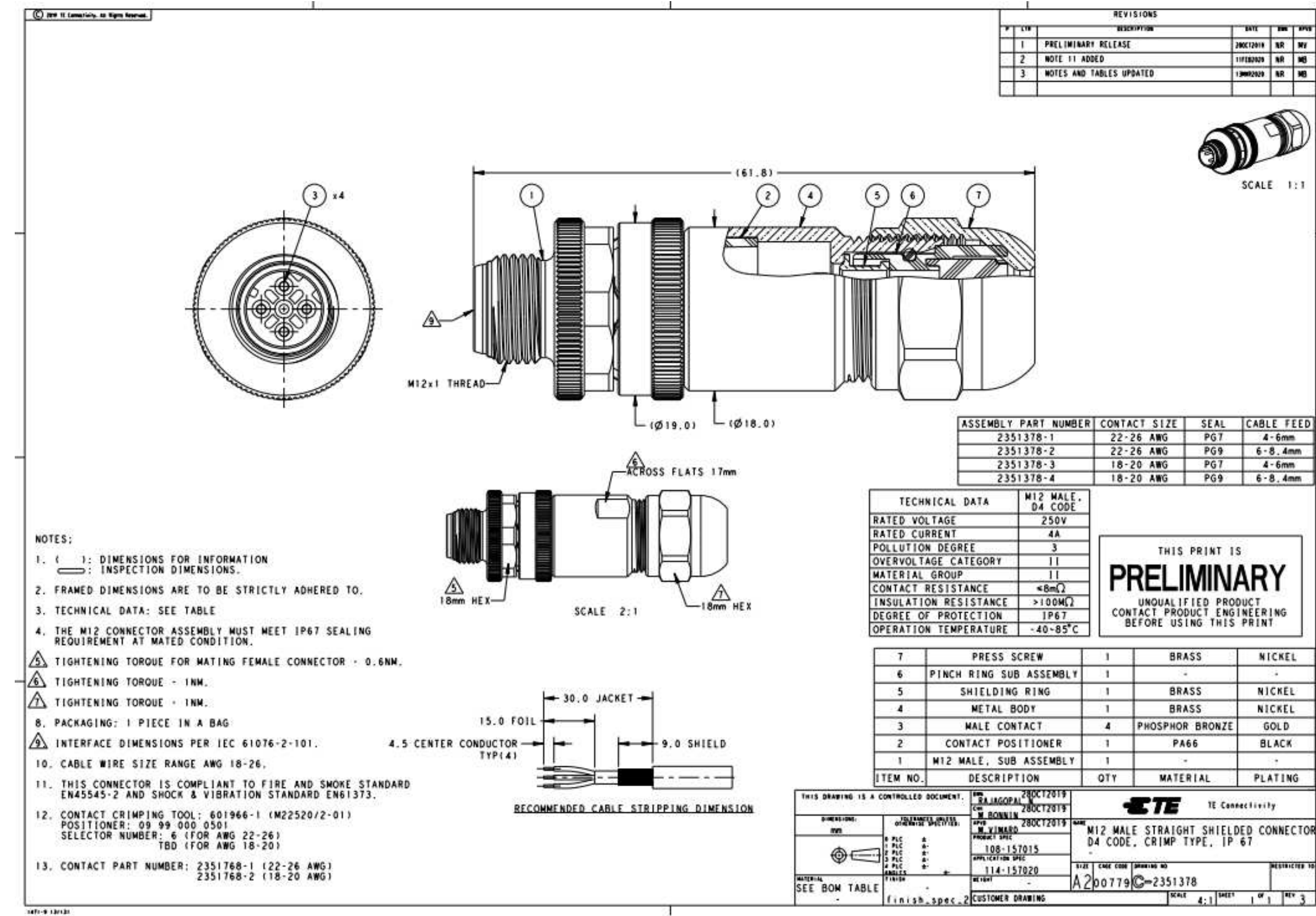
The applicable quality inspection plan shall specify the sampling acceptable quality level to be used. Dimensional and functional requirements shall be in accordance with the applicable product drawing and this specification. Bulk wire resistance shall be subtracted from resistance readings.

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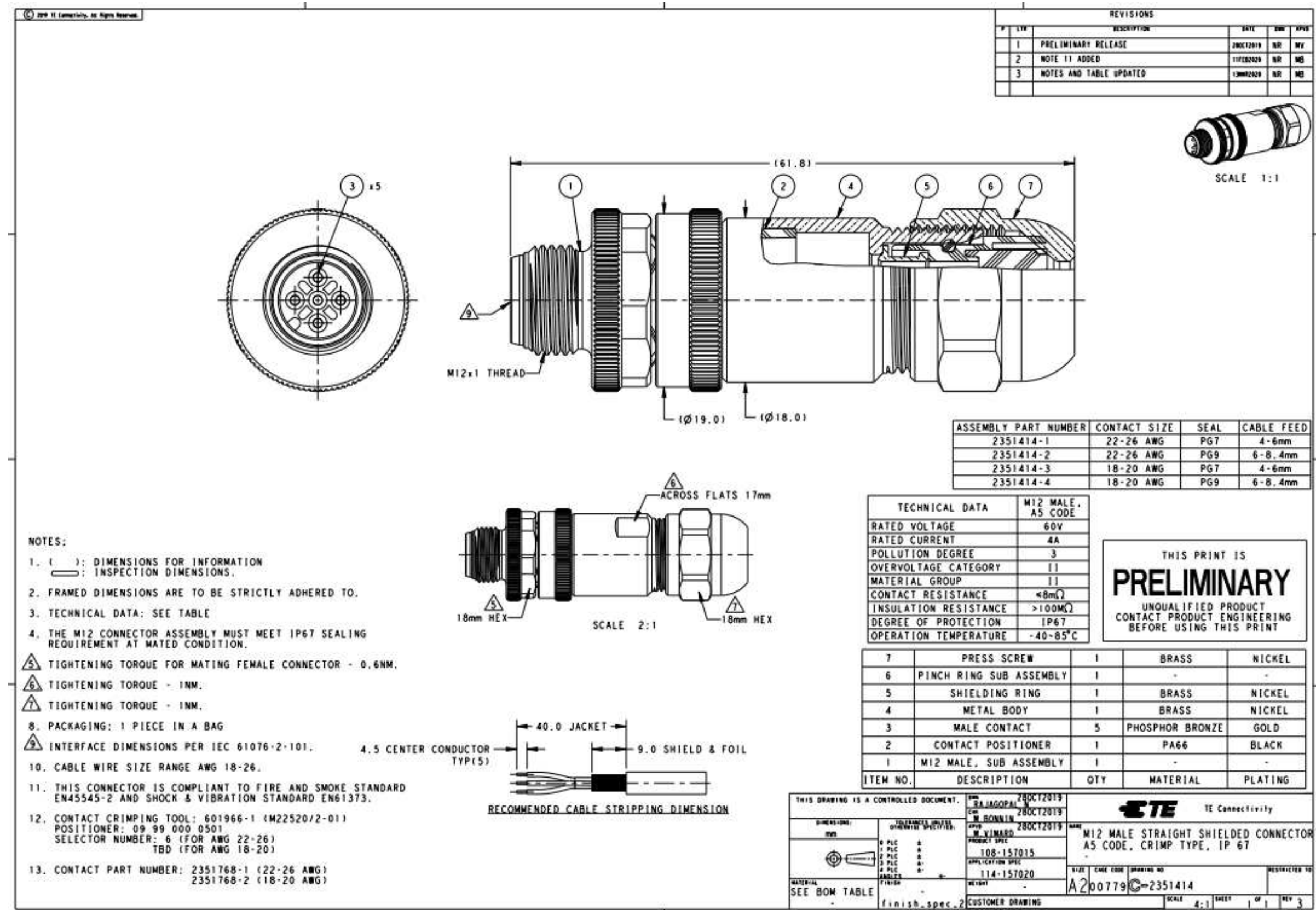
Drawing C-2351378: M12 Male, D4 code, str shielded connector



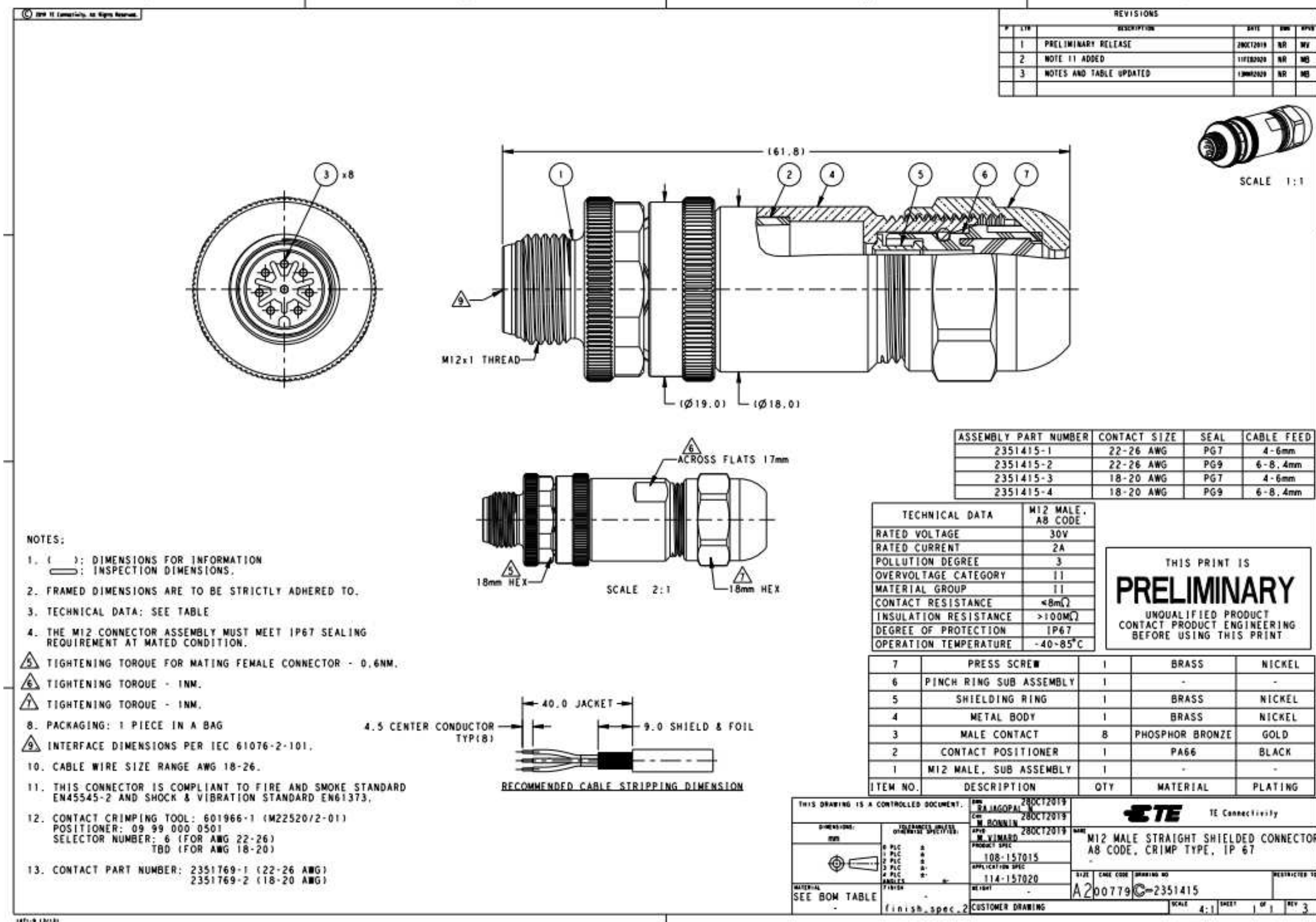
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Drawing C- 2351414: M12 Male, A5 code, str shielded connector



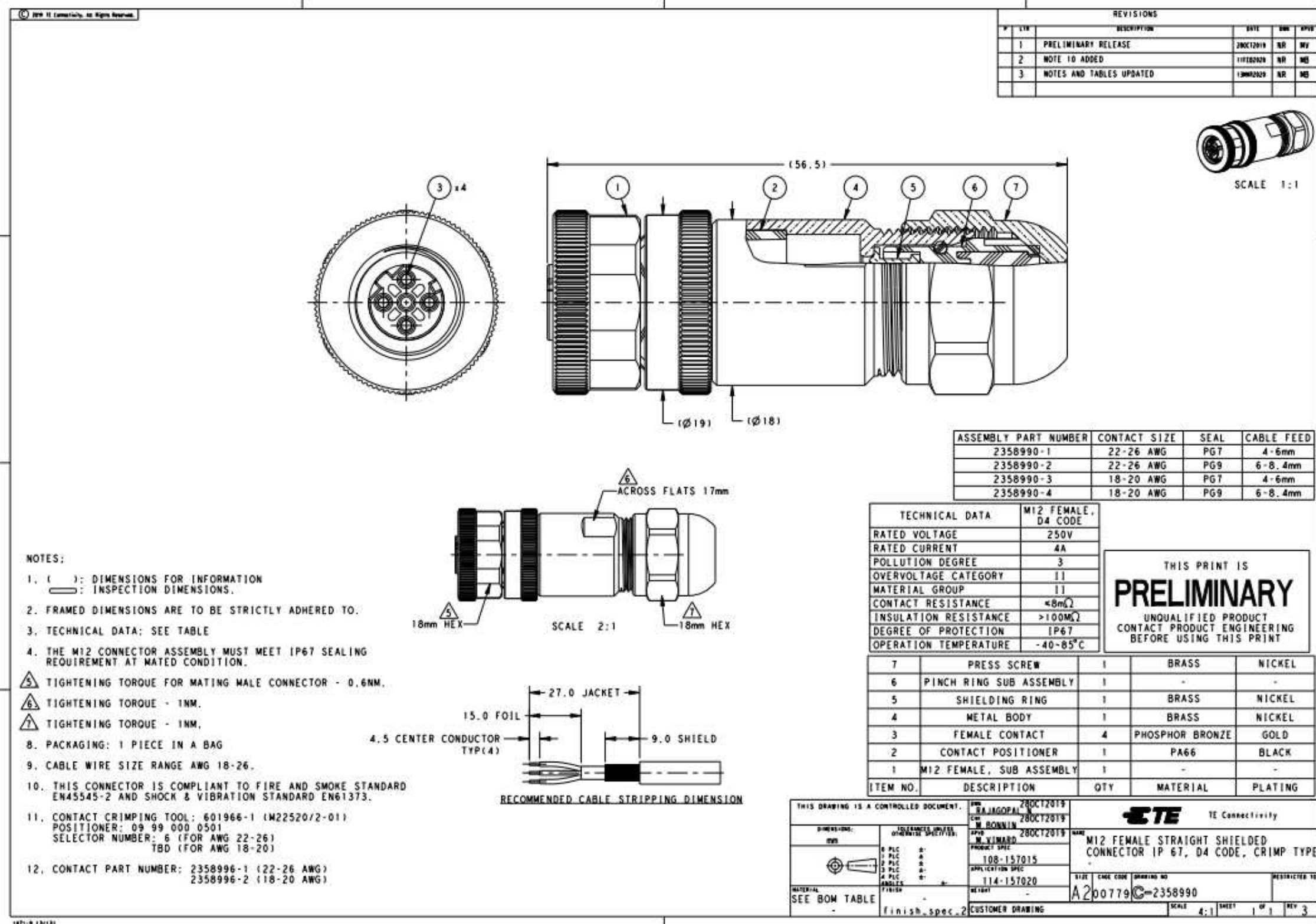
Drawing C-2351415: M12 Male, A8 code, str shielded connector



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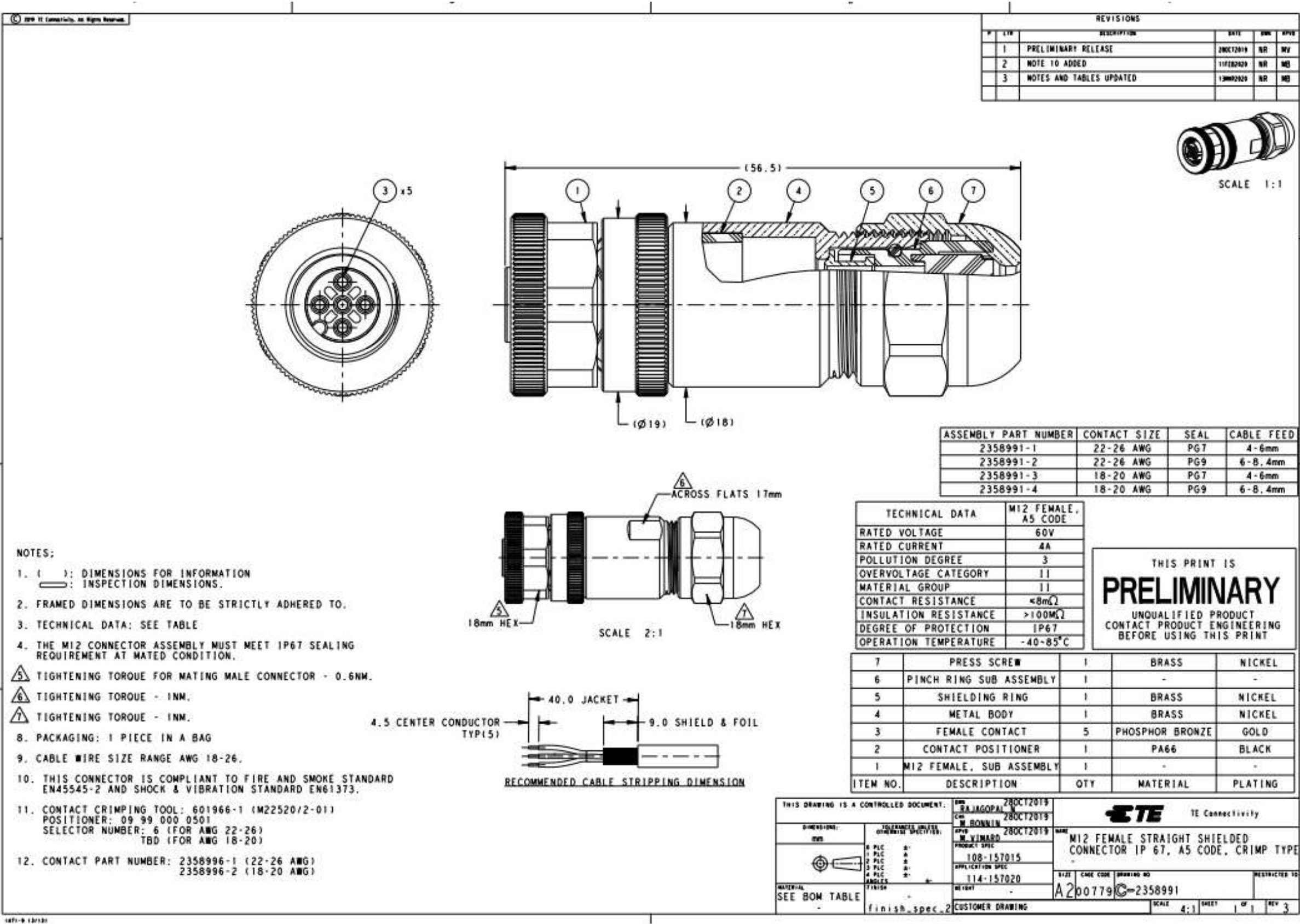
Drawing C-2358990: M12 Female, D4, str shielded connector



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Drawing C- 2358991: M12 Female, A5, str shielded connector



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Drawing C-2358992: M12 Female, A8, str shielded connector

