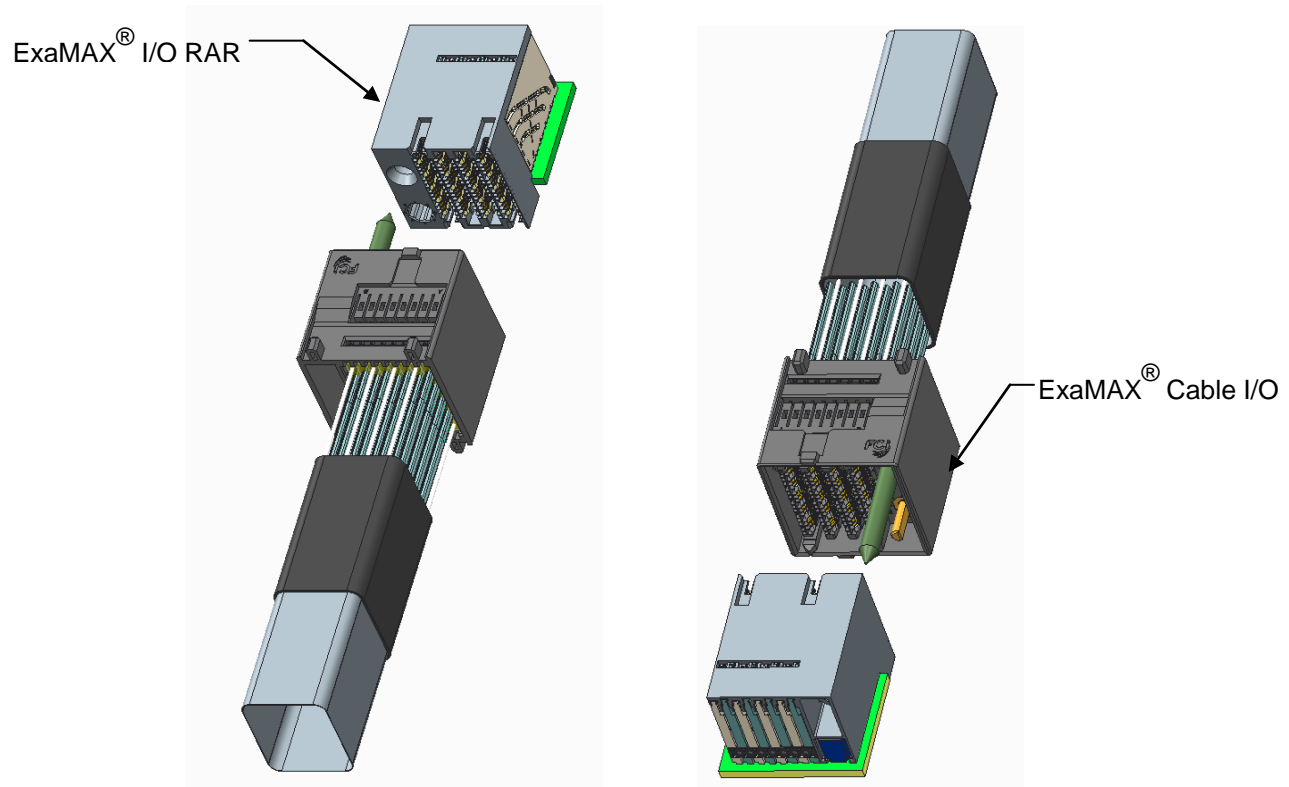


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ExaMAX[®] Cable Connector System



CABLE CONNECTOR MATED TO RIGHT ANGLE RECEPTACLE (RAR) ON DAUGHTERCARD
(4-pair passive latch version shown)

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1.0 Objective

This specification defines the performance, test, quality and reliability requirements of the ExaMAX[®] Cable Connector system.

2.0 Scope

This specification is applicable to the ExaMAX[®] Cable family of products, which provides a high speed cable-to-board interconnect for differential pairs and single-ended lines. Versions include 2-pair, 4-pair and 6-pair Cable Connectors. The test sequences defined in this specification meet the intent of Telcordia GR-1217-CORE requirements.

3.0 Ratings

- 3.1 Operating Voltage Rating = 50 VAC (RMS)
- 3.2 Operating Current Rating = 0.5 Amps/contact with all contacts powered
- 3.3 Operating Temperature Range = -55° C to +85° C

4.0 Applicable Documents

- 4.1 FCI Specifications
 - 4.1.1 Engineering drawings
 - FCI product customer drawings (Various)
 - FCI customer drawing 10127332 (Recommended Via Drill Sizes and Plating)
 - 4.1.2 Process drawings
 - FCI product inspection drawings (Various)
 - 4.1.3 Application specification
 - GS-20-0361 (ExaMAX[™] Connector System, press-fit products)
 - GS-20-0412 (ExaMAX[™] Connector System, HSIO Cables)
 - 4.1.4 Differential impedance evaluation guideline
 - GS-21-0044
- 4.2 Industry or Trade Association standards
 - Telcordia GR-1217-CORE (Separable Electrical Connectors Used in Telecommunications Hardware)
- 4.3 National or International Standards
 - 4.3.1 Flammability: UL94V-0 or similar applicable specification
 - 4.3.2 EIA 364: Electrical Connector/Socket Test Procedures Including Environmental Classifications.
 - 4.3.3 IEC 60512: Connectors for Electronic Equipment – Tests and Measurement
- 4.4 FCI Qualification Report
 - EL-2015-01-005A

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- 4.5 Safety Agency Approvals
- To be added when available

5.0 Requirements

5.1 Qualification

Connectors furnished under this specification shall be capable of meeting the qualification test requirements specified herein.

5.2 Material

The material for each component shall be as specified herein or equivalent.

- Contacts: Copper alloy
- Housings and IMLAs: High temperature thermoplastic; UL 94V-0 compliant
- Cable: Refer to the appropriate customer drawing for the materials, plating, and product markings.

5.3 Finish

The finish for applicable components shall be as specified herein or equivalent.

- Contact Areas: Performance-based plating, qualified to meet the requirements of this specification, including Telcordia GR-1217-CORE (December 2008) Central Office test sequence
- Press-Fit Tails: Tin over Nickel

5.4 Design and Construction

Connectors shall be of the design, construction, and physical dimensions specified on the applicable product drawing. There shall be no cracks, burrs, or other physical defects that may impair performance.

6.0 Electrical Characteristics

6.1 Contact Resistance, Low Level (LLCR) – EIA 364-23

The low level contact resistance shall not exceed 60 milliohms initially. The increase in low level contact resistance after any treatment and/or environmental exposure shall not exceed 10 milliohms. Subtract bulk cable resistance from LLCR readings. Grounds within each column shall be measured or calculated in parallel.

The following details shall apply:

- a. Test Voltage - 20 milli-volts DC max open circuit.
- b. Test Current - Not to exceed 100 milli-amperes.
- c. Number of readings: 100 minimum

6.2 Insulation Resistance – EIA 364-21

The insulation resistance between contacts of un-mated cable assemblies shall not be less than 1000 M-ohms.

The following details shall apply:

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- a. Test Voltage - 300 volts DC
- b. Electrification Time – 60 seconds.
- c. Points of Measurement - Between adjacent contacts in the same column (5 signal-to-signal contact measurements and 5 signal-to-ground contact measurements)
- d. Number of readings: 30 (10 readings per loose-piece connector set).

6.3 Dielectric Withstanding Voltage – EIA 364-20

There shall be no evidence of arc-over, insulation breakdown, or excessive leakage current > 0.5 mA between contacts of un-mated cable assemblies.

The following details shall apply:

- a. Test Voltage – 300 volts AC RMS, 60Hz.
- b. Test Duration - 60 seconds.
- c. Test Condition - 1 (760 Torr - sea level).
- d. Points of Measurement - Between adjacent contacts in the same column (5 signal-to-signal contact measurements and 5 signal-to-ground contact measurements)
- e. Number of readings: 30 (10 readings per loose-piece connector set).

6.4 Current Rating – EIA 364-70

The temperature rise above ambient shall not exceed 30°C at any point in the system when all signal contacts are powered at 0.5 Amps. Ground contacts shall not be energized.

The following details shall apply:

- a. Ambient Conditions – Still air at 25°C
- b. Thermocouple location - mechanically attached to the base of the header contacts
- c. Quantity and location of thermocouples - 3 minimum (2 on interior column positions and 1 on an exterior column position).

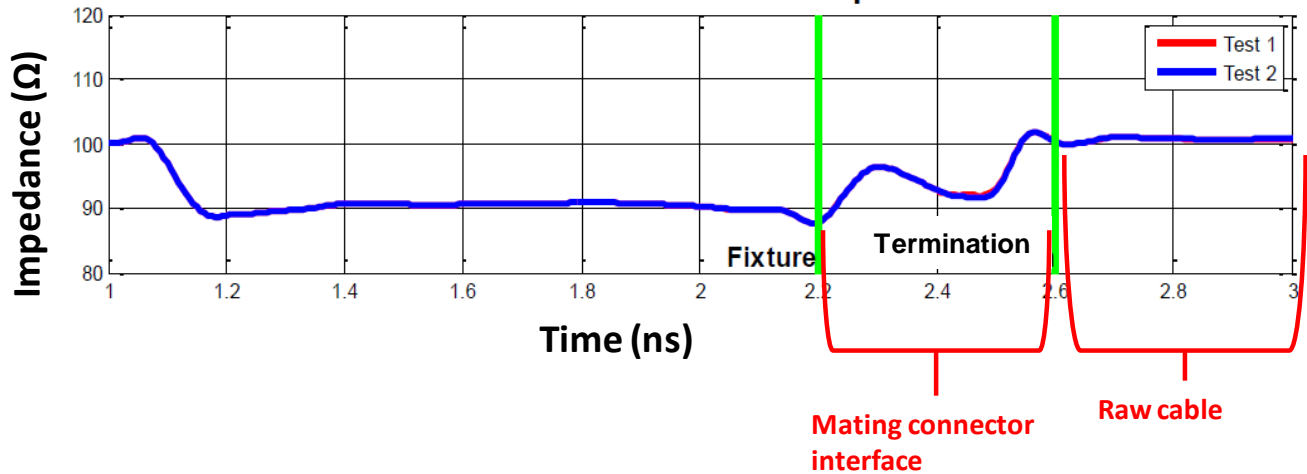
6.5 Differential Impedance

Measure impedance at a rise time of 70ps (20% - 80%) before applying mechanical stresses and verify that the reading meets the requirement for the regions of the electrical connection path that include the device under test. These regions are listed in the table below and identified in the sample impedance vs. time graph that follows.

Region of Connection Path	Applicable Requirement
Mating connector interface	MAX.: Greater of nominal raw cable impedance or nominal board connector impedance + 10Ω MIN.: Lesser of nominal raw cable impedance or nominal board connector impedance - 10Ω
Raw cable	Raw cable impedance ±10Ω

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P1 TX1 differential impedance



Repeat the impedance measurement after each mechanical test and compare it to the initial measurement. The responsible engineer shall establish a range of variation as a guideline for assessing acceptable performance. If the post-stress measurement should exceed the range of variation in either region, the responsible engineer shall evaluate and approve the reading before continuing testing. Any deviation from the pre-determined range of variation must be documented and explained in the final test report.

6.6 Continuity

Using a cable tester equipped with suitable ExaMAX® adapter fixtures, check continuity through all circuits before and after the full series of mechanical stresses. The test shall be conducted at 5VDC and 6mA max. Resistance above 100KΩ shall be considered an open circuit, and resistance below 4Ω shall be considered a short circuit.

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7.0 Mechanical Characteristics

7.1 Mating/Un-mating Force – EIA 364-13

The force to mate a cable I/O connector with a corresponding board connector shall not exceed 0.45 N per contact. The un-mating force shall not be less than 0.10 N per contact.

The following details shall apply:

- a. Cross Head Speed – 25.4 mm per minute.
- b. Utilize free floating fixtures.
- c. Number of mate/un-mate cycles: 3
- d. Latch disengaged.

7.2 Cable Related Mechanical Verification Testing

7.2.1 Latch Mating Force (for active latch cables)

The force to mate a cable connector with the latch engaged to a corresponding board connector shall be 10 N maximum per module in addition to the maximum contact mating force of 0.45 N per contact as specified per section 7.1 (Mating / Un-mating Forces).

7.2.2 Cable Pull-Out Force (for active latch cables)

The mated cable connector, with latch engaged, shall withstand a minimum force of 50 N when an axial load is applied directly to the cable connector. Force shall be applied at a rate of 25mm per minute.

7.2.3 Cable Strain Relief

The cable assembly shall withstand a minimum force of 100 N when an axial load is applied directly to the cable bundle. Force shall be applied at a rate of 25mm per minute in an unmated condition.

7.2.4 Wire Flex

Test shall be performed in accordance with EIA-364-41, condition I and Figure 1. Flex the cable 20 times around mandrels through a 180° arc with a 5 N tension force applied at the free end. Flex the cable in the plane perpendicular to the wide surface of the twinax or ribbon wire. A sweep through 180° in one direction and 180° in the opposite direction shall constitute one cycle. Flex rate shall be 12-14 cycles/min. Distance “X” between the center of the mandrels and the rear surface of the cable housing shall be 120mm ±5mm. Mandrel radii are specified in the table below. The cable shall show no physical damage and maintain the specified impedance per the test condition of section 6.5.

Wire AWG	Column Count	Measured cable OD (mm)	Mandrel Radius (mm)
26 discrete twinax	8	16	R48
30 discrete twinax and ribbonized twinax	8	8	R24

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7.2.5 Cable Minimum Bend Radius

Bend the cable bundle through a 180° angle around mandrels 2 times. The bend shall be in the plane perpendicular to the wide surface of the twinax or ribbon wire. The distance between the center of the mandrels and the rear surface of the cable housing shall be 120mm ±5mm. Mandrel radii are specified in the table below. The cable shall show no physical damage and maintain the specified impedance per the test condition of section 6.5.

Wire AWG	Column Count	Measured cable OD (mm)	Mandrel Radius (mm)
26 discrete twinax	8	16	R32
30 discrete twinax and ribbonized twinax	8	8	R16

7.2.6 Connector Longitudinal Loading (Latched Interface Only)

Mated connectors shall withstand a minimum force of 30 N applied to the cable housing in a direction parallel to the width of the contacts. Apply the force at a rate of 25mm per minute by means of a pin having a diameter of 6mm and a tip with a full radius. Load one surface of the housing then repeat for the opposite surface. The mated connector and housing must have no open circuits and sustain no damage.

7.2.7 Connector Latitudinal Loading (Latched Interface Only)

Mated connectors shall withstand a minimum force of 30 N applied to the cable housing in a direction normal to the width of the contacts. Apply the force at a rate of 25mm per minute by means of a pin having a diameter of 6mm and a tip with a full radius. Load one surface of the housing then repeat for the opposite surface. The mated connector and housing must have no open circuits and sustain no damage.

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8.0 Environmental Conditions

After exposure to the following environmental conditions in accordance with the specified test procedure and/or details, the product shall show no physical damage and shall meet the electrical and mechanical requirements per paragraphs 6.0 and 7.0 as specified in the Table 1 test sequences. Unless specified otherwise, assemblies shall be mated during exposure.

8.1 Thermal Shock – EIA 364-32

- a. Number of Cycles - 5
- b. Temperature Range - Between -55°C and +85° C
- c. Time at Each Temperature - 30 minutes minimum
- d. Transfer Time - 30 seconds, maximum

8.2 Cyclical Humidity and Temperature – EIA 364-31 method IV

Samples are to be subjected to 50 cycles of 10-hour duration for a total of 500 hours.

A cycle consists of the following steps:

- a. 2 hour ramp from 25°C at 80%-98% RH to 65°C at 90%-98% RH
- b. 4 hour dwell at 65°C at 90%-98% RH
- c. 2 hour ramp down to 25°C at 80%-98% RH
- d. 2 hour dwell at 25°C at 80%-98% RH

8.3 Temperature Life – EIA 364-17

Headers and receptacles shall remain mated without any electrical load

- a. Test Temperature - 85° C
- b. Test Duration – 500 hours

8.4 Mixed Flowing Gas corrosion (MFG) – EIA 364-65, class IIA, 4-gas

- a. Duration – 20 days
- b. Temperature – 30°C
- c. Humidity – 70%
- d. Un-mated cable assemblies shall be exposed to gas mixture for 10 days, then mated and exposed for an additional 10 days.

e. Gas compositions, per Central Office requirements:

<u>Gas Type</u>	<u>Gas Concentration</u>
NO ₂	200 ppb
Cl ₂	10 ppb
H ₂ S	10 ppb
SO ₂	100 ppb

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- 8.5 Vibration – EIA 364-28, Test Condition II
 - a. Vibration Amplitude – 1.5 mm double amplitude or 10G acceleration
 - b. Frequency Range - 10 to 500 to 10 hertz
 - c. Sweep Time and Duration – 15 minutes per sweep, 2 hours along each of three orthogonal axes (6 hours total)
 - d. Mounting - Rigidly mount assemblies
 - e. No discontinuities greater than 1 microsecond
- 8.6 Mechanical Shock – EIA 364-27, Test Condition H
 - a. Amplitude – half sine 30G
 - b. Duration – 11 milliseconds
 - c. Shocks - 3 shocks along each of three orthogonal axes (18 shocks total)
 - d. Mounting - Rigidly mount assemblies
 - e. Measure LLCR at the end of the test.
 - f. No discontinuities greater than 1 microsecond
- 8.7 Durability - EIA 364-09
 - a. Number Cycles – See table 1 (200 total mating cycles)
 - b. Cycling Rate – 127 mm/min
 - c. Use free floating fixtures
- 8.8 Dust – EIA 364-91
 - a. Samples to be exposed to one-hour dust exposure
 - b. Use benign dust composition number 1
 - c. Expose the un-mated cable assembly to dust.
- 8.9 Disturb – Telcordia GR-1217-CORE, Issue 2, December 2008, Section 9.1.3.3, paragraph 5.
The mated connectors shall be subjected to an interface disturbance that consists of slightly un-mating the sample approximately 0.10 mm. The sample is then resealed and measurements are taken.

9.0 Quality Assurance Provisions

9.1 Equipment Calibration

All test equipment and inspection facilities used in the performance of any test shall be maintained in a calibration system in accordance with ANSI Z-540 and ISO 9000.

9.2 Inspection Conditions

Unless otherwise specified herein, all inspections shall be performed under the following ambient conditions:

- a. Temperature: 25 +/- 5 deg C
- b. Relative Humidity: 30% to 60%
- c. Barometric Pressure: Local ambient

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9.3 Sample Quantity and Description

The test sequences for qualification testing are shown in table 1 and the connector sample sizes for 5-pair connectors is shown in Table 2. The number of readings is specified in the description for each test. For connector sizes with fewer contacts than 5-pair connectors, additional samples may be required to meet the minimum number of readings for specific tests.

9.4 Acceptance

- a. Electrical and mechanical requirements placed on test samples as indicated in paragraphs 6.0 and 7.0 shall be established from test data using appropriate statistical techniques or shall otherwise be customer specified, and all samples tested in accordance with this product specification shall meet the stated requirements.
- b. Failures attributed to equipment, test setup, or operator error shall not disqualify the product. If product failure occurs, corrective action shall be taken and samples resubmitted for qualification.

9.5 Qualification Testing

Qualification testing shall be performed on sample units produced with equipment and procedures normally used in production. The test sequences shall be as shown in the qualification test table. Data shall be provided with the samples noting production history: production lot codes for components and assemblies, print revisions for components and assemblies, and plating composition and thickness.

9.6 Re-Qualification Testing

If any of the following conditions occur, the responsible product engineer shall initiate requalification testing consisting of all applicable parts of the qualification test matrix.

- a. A significant design change is made to the existing product which impacts the product form, fit or function. Examples of significant changes shall include, but not be limited to, changes in the plating material composition or thickness, contact force, contact surface geometry, insulator design, contact base material, or contact lubrication requirements.
- b. A significant change is made to the manufacturing process which impacts the product form, fit or function.
- c. A significant event occurs during production or end use requiring corrective action to be taken relative to the product design or manufacturing process.

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9.7 Qualification Test Tables

TEST GROUP ID ►		P ⁽¹⁾	1	2	3	4 ⁽³⁾	5	6	7
TEST DESCRIPTION	SECTION	Design Verification for Product Extension	Mixed Flowing Gas	Temp Life	Thermal Shock & Humidity	Vibration & Mech. Shock	Current Rating	Cable Testing	Mechanical Mated Connector Testing (Active Latch only)
DESIGN AND CONSTRUCTION	5.4	1,7	1,16	1, 7	1, 21	1,14	1,5	1,10	1,5,7,9
MATE HEADER AND RECEPTACLE	--	2	2,8		4,14	2,8	2		2
UN-MATE HEADER AND RECEPTACLE	--	6	6		10,18	6	4		
ELECTRICAL									
LOW LEVEL CONTACT RESISTANCE	6.1	3,5	3,5,9,11,13,15	3, 5	5,7,9,15,17	3,5,9,11,13			
INSULATION RESISTANCE	6.2				2,12,19				
DIELECTRIC WITHSTANDING VOLTAGE	6.3				3,13,20				
CURRENT RATING	6.4						3		
DIFFERENTIAL IMPEDANCE	6.5							3,5,7,9	
CONTINUITY	6.6							2, 11	
MECHANICAL									
MATING / UN-MATING FORCE	7.1	See Note 2		2, 6	See Note 2				
COMPLIANT PIN INSERTION FORCE	7.2								
COMPLIANT PIN RETENTION FORCE	7.3								
PCB HOLE DEFORMATION RADIUS	7.4								
PCB WALL DAMAGE	7.5								
CABLE TESTING									
LATCH MATING FORCE	7.6.1								3
CABLE PULL-OUT FORCE	7.6.2								4
CABLE STRAIN RELIEF	7.6.3							8	
WIRE FLEX	7.6.4							6	
CABLE MINIMUM BEND RADIUS	7.6.5							4	
CONNECTOR LATITUDINAL LOADING	7.6.6								6

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CONNECTOR LONGITUDINAL LOADING	7.6.7								8
ENVIRONMENTAL									
THERMAL SHOCK	8.1				6				
CYCLICAL HUMIDITY & TEMPERATURE	8.2				16				
TEMPERATURE LIFE	8.3			4					
MFG, UN-MATED, 10-DAYS	8.4		7						
MFG, MATED, 10-DAYS	8.4		10						
SALT SPRAY	8.5								
VIBRATION	8.6					10			
MECHANICAL SHOCK	8.7					12			
DURABILITY, 100-CYCLES	8.8	4	4,14		8	4			
DUST CONTAMINATION	8.9				11	7			
DISTURB	8.10		12						

Table 1: Qualification Test Matrix

TEST GROUP ID ▶	P ⁽¹⁾	1	2	3	4 ⁽³⁾	5	6	7
COMPONENT DESCRIPTION	Design Verification for Product Extension	Mixed Flowing Gas	Temp Life	Thermal Shock & Humidity	Vibration & Mech. Shock (26 AWG Only)	Current Rating (30 AWG Only)	Cable Testing (per AWG size)	Mechanical Mated Connector Testing (Active Latch only)
Number of RARs	3	3	3	3	6	3	2	6
Number of Cable I/Os (pig tails)	3	3	3	3	6	3		6
Number of RAR LLCR Boards	3	3	3	3	3			
Number of RAR Continuity Board					3	3		6
Number of Cable Assy's (double ended)							1	
Number of RAR SI boards							2	
Number of RAR mechanical boards								

Table 2: Qualification Sample Requirements

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Notes:

1. Group P is not required for a full qualification. Group P is a design verification sequence for product extensions after a full qualification has been completed.
2. Record mating and un-mating forces on first three cycles of durability.
3. For test group 4, LLCR is measured on 3 sample sets and 3 sets are used for discontinuity monitoring.

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REVISION RECORD

Rev	Page	Description	Date
1	All	Preliminary Specification	2013-12-06
2	All	Modified per feedback from US Test Lab Group recommendations	2014-04-16
3	14,16	Removed normal force from testing table and updated testing notes	2014-05-08
4	9	Add wire flex and bend radius tables	2014-06-20
5	7	Section 7.1. Mating force per contact was 0.45N. Un-mating force per contact was 0.15N.	2014-09-08
6	13-15	Removed Press-Fit Evaluation from Tables 1 and 2. Added insulation resistance and dielectric withstanding voltage verification to Test Group 3. Revised notes under Table 2. Sample quantity for RAR's and RAR continuity boards in Test Group 6 was 3.	2014-10-24
7	5	Section 6.1. Specified 60mΩ as initial LLCR for IO cable interfaces removed references to connector-to-connector interfaces.	2015-03-09
	5	Section 6.2. Specified un-mated cable assemblies for insulation resistance test.	
	5	Section 6.3. Specified un-mated cable assemblies and points of measurement for dielectric withstanding voltage test.	
	6	Section 6.4. Specified that only signal circuits will be energized during current rating. Deleted reference to copper trace weight.	
	6	Section 6.5. Revised impedance measurement procedure.	
	8-9	Section 7.6.4. Added distance from housing to mandrel center to test procedure. Corrected mandrel sizes in table.	
	9	Section 7.6.5. Corrected mandrel sizes in table.	
	9	Section 7.6.6. Specified test for latched housing interfaces only.	
	9	Section 7.6.7. Specified test for latched housing interfaces only.	
	11	Section 8.5. Specified the correct test condition for 48-hour salt spray test.	
	11	Section 8.7. Removed LLCR measurement after each axis.	
	11	Section 8.9. Specified un-mated cable assemblies in dust exposure test.	
	11	Section 8.10. Reference document was Telcordia GR-1217-CORE, November 1995, Section 9.1.3.3, Paragraph 7.	
A	10	Section 8.2. EIA 364-31 method IV was method III.	2015-04-23
B	4, 6-7, 14	Section 4.1.4. Noted differential impedance evaluation guideline. Section 4.4. Noted qualification test report document EL-2015-01-005A. Section 6.5. Added a table specifying acceptance criteria and a sample graph to the differential impedance test description. Section 6.6 and Table 1. Added continuity test to Test Group 7. Table 1. Removed "Mate Header and Receptacle" steps from Test Group 7 and renumbered the sequence. Added "Un-mate Header and Receptacle" step to Test Group P. Added "Mate Header and Receptacle" and "Un-mate Header and Receptacle" steps to Test Groups 5 and 6.	2015-11-19
C	8, 9	Removed sections pertaining to board connector application, extraction, and EON deformation	2017-11-10
D	11, 13, 14	Removed Salt Spray Requirement	2020-01-22