



Connector Test and Validation Specification

1 Introduction.....	6
1.1 Scope.....	6
1.2 Mission/Theme.	6
1.3 Classification.	6
2 References	6
2.1 External Standards/Specifications.....	6
2.2 GM Standards/Specifications.	6
2.3 Additional References.	6
3 Test Preparation and Evaluation.....	6
3.1 Resources.	6
3.1.1 Calibration.....	6
3.1.2 Alternatives.	6
3.1.3 Facilities.	6
3.1.4 Equipment.....	6
3.1.5 Test Vehicle/Test Piece.	6
3.1.6 Test Time.....	7
3.1.7 Test Required Information.	7
3.1.8 Personnel/Skills.	7
3.2 Preparation.	7
3.2.1 Conditioning.....	7
Figure 1: Terminal Conditioning	7
3.3 Conditions.....	7
3.3.1 Environmental Conditions.....	8
3.3.2 Test Conditions.....	8
3.4 Instructions.	8
3.4.1 Visual Examination.	8
3.5 Data.....	8
3.6 Safety.....	8
3.7 Documentation..	8
3.7.1 Test Results.....	8
3.7.2 Deviations from Test Procedure.	9
3.8 Test Tolerances.....	9

3.8.1 Default Tolerances.....	9
Table 1: Parameters and Tolerances.....	9
4 Requirements and Procedure	9
4.1 Classification.	9
4.1.1 Temperature Class..	9
Table 2: Temperature Class (T)	10
4.1.2 Vibration Class.....	10
Table 3: Vibration Class (V)	10
4.1.3 Sealing Class.	10
Table 4: Sealing Class (S)	10
4.1.4 Connector Mating Force Class.	10
Table 5: Connector Mating Force Class (M)	11
4.1.5 Test Procedures and Sequences..	11
4.2 Mechanical Tests.....	11
4.2.1 Crack Corrosion.	11
4.2.2 Crimp Weld Integrity.	11
4.2.3 Terminal-to-Terminal Engagement Force.....	12
4.2.4 Terminal-to-Connector Engagement Force	12
4.2.5 Terminal-from-Connector Extraction Force.	13
Table 6: Minimum Extraction Force – Terminal from Connector Cavity	14
4.2.6 Terminal Cavity Polarization.	14
4.2.7 Terminal Bend Resistance.....	15
Figure 2: Terminal Design Style.....	16
Figure 3: Terminal Bend Test.....	16
Table 7: Terminal Size and Applied Bending Force.....	16
4.2.8 Connector-to-Connector Engagement Force.	16
4.2.9 Terminal Position Assurance (TPA).....	17
Table 8: TPA Removal Force Table.....	18
4.2.10 Lever and Slide Open Position Retention.....	18
Figure 4: Retention of Slide in the Open Position	19
4.2.11 Mechanical Assist Integrity.	19
Figure 5: Side Force Strength	20
4.2.12 Connector Mounting Feature Mechanical Strength.	20
Figure 6: Connector Mounting Fixture Strength Example.....	21
Figure 7: Connector Mounting Fixture Strength Test Setup, 3-Dimensional View	21
Figure 8: Connector Mounting Fixture Strength Test Setup, End View	22
Figure 9: Connector Mounting Fixture Strength Test Setup, Side View	22
4.2.13 Connector Audible Feedback.	22
4.2.14 Connector Lock Mechanical Overstress.	23

4.2.15 Connector Position Assurance (CPA).....	23
4.2.16 Connector Seal Retention - Mated Connector.....	24
4.2.17 Connector Seal Retention - Unmated Connector.....	24
Figure 10: Unmated Connector Seal Test	25
4.2.18 Locked Connector Disengagement Force.....	25
Table 9: Locked Connector Disengage Force	25
4.2.19 Unlocked Connector Disengagement Force.....	25
4.2.20 Connector Polarization (Coding) Feature Effectiveness.....	26
4.2.21 Mechanical Shock.....	27
Figure 11: Series Circuit Monitoring.....	28
Figure 12: Vibration Mounting Fixture.....	29
Table 10: Mechanical Shock.....	29
Figure 13: Continuity Loss	30
Figure 14: Continuity Loss for SIR Connectors.....	30
4.3 Electrical Tests.....	30
4.3.1 Maximum Current Rating.....	30
Figure 15: Draft-Free Enclosure.....	31
Figure 16: Base Curve	32
Figure 17: Derating Curve.....	33
4.3.2 Dry Circuit Resistance.....	33
Figure 18: In-Line Circuit Lead Location	34
Table 11: Maximum Resistance Values.....	34
4.3.3 Voltage Drop.....	35
Figure 19 - Terminal Insertion.....	35
Figure 20: Current Resistance Test Setup.....	36
Figure 21: Typical Connection Resistance Millivolt Lead Locations	36
4.3.4 1008-Hour Current Cycling.....	37
4.3.5 Isolation Resistance.....	38
4.3.6 Dielectric Strength.....	38
4.4 Environmental Tests.....	39
4.4.1 Thermal Aging.....	39
4.4.2 Thermal Shock.....	40
4.4.3 Humid Heat Cyclic (HHC).....	41
Table 12: Cyclic Humidity Requirements	41
Figure 22: Cyclic Humidity Profile	42
Table 13: Cyclic Humidity Profile	43
4.4.4 Humid Heat Constant (HHCO).....	43
Table 14: Constant Humidity Requirements	44
4.4.5 Heavy Duty Test.....	44

4.4.6 Flammability	45
4.4.7 Corrosion.	45
4.4.8 Vibration with Thermal Cycling.	46
Figure 23: Thermal Cycle	47
Table 15: Thermal Cycle Requirements	47
Figure 24: Body (Sprung Masses) Random Vibration Schedule	47
Table 16: Body (Sprung Masses) Random Vibration Schedule	48
Figure 25: Engine Mounted Sinusoidal Vibration Cycle (based on ISO 16750-3).....	48
Table 17: Engine Mounted Sinusoidal Vibration Cycle (based on ISO 16750-3).....	48
Figure 26: Engine Mounted Random Vibration Cycle (based on ISO 16750-3).....	49
Table 18: Engine Mounted Random Vibration Cycle (based on ISO 16750-3).....	49
Figure 27: Wheel Random Vibration Cycle.....	50
Table 19: Wheel Random Vibration Cycle	50
Figure 28: Severe Applications Sinusoidal Vibration (based on ISO 16750-3)	51
Table 20: Severe Sinusoidal Vibration (based on ISO 16750-3).....	51
Figure 29: Severe Random Vibration Cycle (based on ISO 16750-3).....	52
Table 21: Severe Random Vibration Cycle (Severe Applications; based on ISO 16750-3).....	52
Table 22: Generic Vibration Profiles for Transmissions (12 to 20 000) Hz.....	53
4.4.9 Water Submersion.	53
Figure 30: Water Submersion Setup.....	54
4.4.10 Pressure/Vacuum Leak.	54
4.4.11 High Pressure Spray.....	56
Figure 31: Nozzle and Jet Dimensions	57
Table 23: Spray Pattern	57
Figure 32: High Pressure Spray Test Arrangement.....	58
4.4.12 Fluid Resistance.	58
Table 24: Fluids.....	60
4.5 Miscellaneous Tests.....	60
4.5.1 Resistance of Short Circuit Devices.	60
Figure 33: Electrical Resistance of Shorting Bars.....	61
4.5.2 Terminal Push-out Force.	61
Table 25: Push-out Force.....	62
4.6 Further Requirements.....	62
4.6.1 Test Sequences.....	62
Table 26: Terminal Mechanical Tests	63
Table 27: Terminal Electrical Tests.....	64
Table 27: Terminal Electrical Tests (continued).....	65
Table 28: Connector Mechanical Tests	66
Table 28: Connector Mechanical Tests (continued)	67

Table 28: Connector Mechanical Tests (continued)	68
Table 28: Connector Mechanical Tests (continued)	69
Table 29: Sealed Connector Environmental Tests	70
Table 29: Sealed Connector Environmental Tests (continued)	71
Table 30: Unsealed Connector Environmental Tests	72
Table 31: Connector Validation Test Matrix	73
5 Provisions for Shipping	75
6 Notes	75
6.1 Glossary. Not applicable.....	75
6.2 Acronyms, Abbreviations, and Symbols.....	75
7 Additional Paragraphs	76
7.1 All parts or systems supplied to this standard	76
8 Coding System	76
9 Release and Revisions	76
Appendix A	77
Data Sheet A1: Electrical Connection System – Test Summary	77

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Scope. This standard defines the requirements, functional tests, and durability tests for low voltage automotive single and multiple-pole electrical connectors, terminals, and related components. Procedures included within this specification are intended to cover performance testing at all phases of development, production, and field analysis of electrical terminals, connectors, and components that constitute the electrical connection systems.

1.2 Mission/Theme. Define test and validation requirements including test sequences for electrical connection systems.

1.3 Classification. Not applicable.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ASTM IRM-902	EN 590	ISO/TS16949	USCAR23
ASTM IRM-903	EN 60068-2-6	SAE J1127	USCAR25
ASTM Reference Fuel C	EN 60068-2-64	SAE J1128	USCAR38
ASTM Service Fluid 104	IEC 60068-2-38	SAE RM66-04	
Citgo #33123	IEC 60068-2-78	USCAR21	

2.2 GM Standards/Specifications.

B 040 0900	B 040 2012	GMW3172
B 040 1065	L 000 0102	GMW3232
B 040 1073	GMW3059	GMW14914

2.3 Additional References.

ISO/TS16949 Certification

3 Test Preparation and Evaluation

3.1 Resources.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label. (As required by ISO/TS16949.)

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.1.3 Facilities. All facilities and test equipment shall be ISO/TS16949 certified.

3.1.4 Equipment. Test equipment shall be capable of measuring the physical and electrical parameters as specified.

All meters and gauges used in measurements of the test sample shall be capable of measuring to one significant digit less than the specified value.

3.1.5 Test Vehicle/Test Piece. Electrical connectors used for testing shall be manufactured according to the values and the tolerances that are shown on the drawings or the releases. Materials shall conform to all specifications shown on the respective drawings. Specific sample quantity requirements are detailed in each test procedure. See test sequences in Section 4.6 to determine which tests are required. Should a test failure occur, consult with the responsible GM engineer to determine if the test is to be continued to gain additional product experience or if testing shall be terminated.

3.1.5.1 Terminal Attachment. Terminals shall be affixed to the cable using production intent processes per USCAR21 mechanical crimp or USCAR38 ultrasonic weld specifications.

3.1.5.2 Disposition of Samples. Test samples shall be retained for examination and further analysis and shall not be disposed of without permission of the responsible GM connector and validation engineers.

3.1.6 Test Time. Not applicable.

3.1.7 Test Required Information. Not applicable.

3.1.8 Personnel/Skills. Not applicable.

3.2 Preparation.

3.2.1 Conditioning. The following conditioning shall be performed as defined on connectors and terminals prior to the test procedures specified in this specification:

- Attach wires of appropriate gauge size to terminals.
- Insert terminated leads into the specific connector housings undergoing testing, if required.
- For tests that do not require connector housings, mate and unmate the female terminal with the corresponding male terminal 10 times being careful not to cause overstress to the contact spring.
- For tests on connection/terminal assemblies, mate and unmate the connectors with terminals 10 times with the corresponding connector or header interface, **except** when performing Section 4.2.8, which requires unmated virgin test samples.
- For tests on connection/terminal assemblies with terminals sizes 2.8 mm and smaller, stress terminals by inserting a male terminal or equivalent test pin into the female terminal. The male terminal or test pin shall correspond in size to the female terminal being tested. Insert the test pin and apply a force of 0.5 N in each direction as shown in Figure 1 for 10 seconds.

Note: A terminal shall be stressed in only one direction, thus for another axis stress another terminal. Thus it takes four separate terminals to stress in each of the four directions.

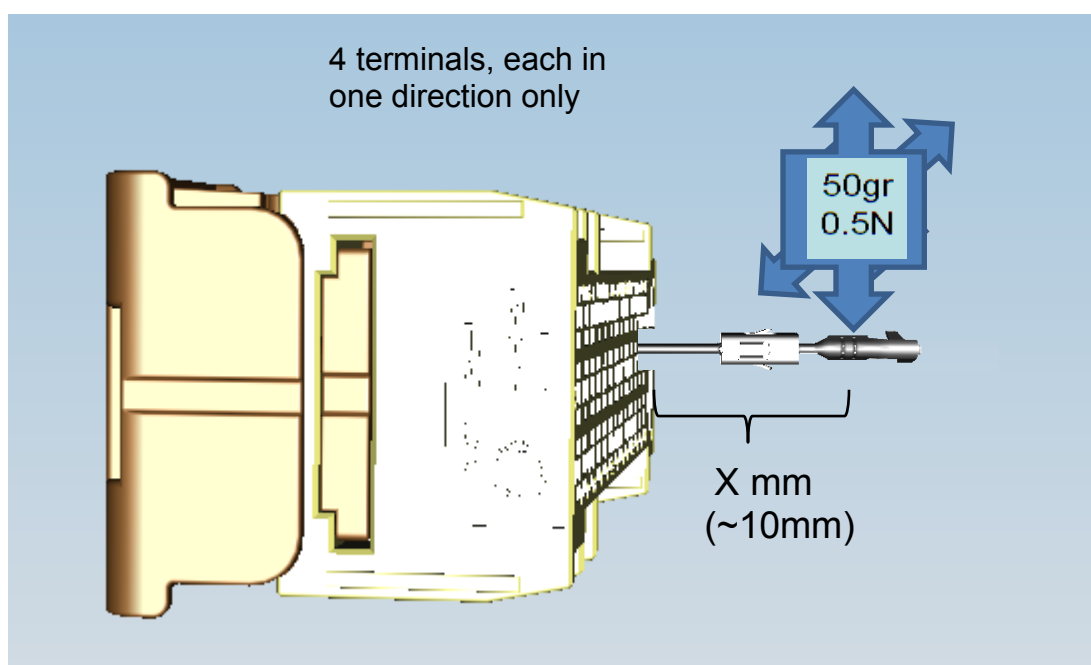


Figure 1: Terminal Conditioning

- Connector housings without terminals shall be aged for a minimum of 24 hours at $(+40 \pm 3)^\circ\text{C}$ and a relative humidity of 95% to 98% prior to performing any connector mechanical testing.
- Store test samples at an ambient temperature of $(+23 \pm 5)^\circ\text{C}$ for at least 24 hours prior to performing any electrical testing regardless of connector housing material.

3.3 Conditions.

3.3.1 Environmental Conditions. Not applicable.

3.3.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

3.4 Instructions.

3.4.1 Visual Examination.

3.4.1.1 Purpose. Assure parts used for testing are free of damage and obvious defects.

3.4.1.2 Equipment. Normal lighting, photographic equipment, a device with at least 10× magnification as required.

3.4.1.3 Sample Preparation. All test samples shall be conditioned per 3.2.1.

3.4.1.4 Procedure. Not applicable.

3.4.1.5 Pre-Test Visual Examination. Visually examine each test specimen before testing and/or conditioning. The test specimens shall not exhibit any evidence of deterioration, cracks and/or other deformities that could affect performance, function and/or appearance. A control sample shall be retained. Photographs and/or video recordings of the samples being tested shall be taken.

3.4.1.6 Post-Test Visual Examination. After testing, re-examine each test sample and note in detail any observable changes, such as swelling, corrosion, discoloration, physical distortions, cracks, etc. Compare the tested samples to the following items, noting any differences:

- Control samples
- Videos
- Photographs

3.4.1.7 Acceptance Criteria. There shall be no corrosion, discoloration, cracks, etc., which could affect the functionality of the part. Swelling or physical distortion shall not exceed the tolerances specified on the part drawing.

3.5 Data. Not applicable.

3.6 Safety. This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

3.7 Documentation. Samples of components or material released to this standard shall be tested for conformity with the requirements of this standard and approved by the responsible GM department prior to the start of delivery of production level components or materials.

Any change to the component or material, e.g., design, function, properties, manufacturing process and/or location of manufacture requires a new release of the product. It is the sole responsibility of the supplier to provide the customer, unsolicited, with documentation of any change or modification to the product/process, and to apply for a new release.

If not otherwise agreed to, the entire verification test shall be repeated and documented by the supplier prior to start of delivery of the modified or changed product. In some cases, a shorter test can be agreed to between the responsible GM department and the supplier.

The supplier shall maintain adequate records of all tests performed and their results as specified by TS16949. Documentation shall include a copy of the test facility certification.

A minimum of 5 fully assembled samples from the same batch as the tested sample shall accompany the initial test report. The sample connectors shall be fully assembled with terminals, cables, and seals. Terminals with crimped on wire seals shall be fully assembled with cables and seals.

The supplier shall inform the GM Connector Design Release Engineer (DRE) of all adjustments, modifications of parts and/or processes required to comply with Production Part Approval Process (PPAP).

3.7.1 Test Results. Test results shall be reported in a detailed format as defined in Appendix A, with one summary per test sequence. Each sequence and its specific results shall be reported. Any failures shall be documented and include the requirement that was not met. Additional documentation may be attached (e.g.,

pictures, charts of measurements). The summary test form is contained in Appendix A. Raw test data shall be provided when requested.

3.7.2 Deviations from Test Procedure. Deviations from this test procedure shall be approved by the GM Connector DRE and documented before beginning any testing. Such deviations shall be specified on component drawings, test certificates, reports, etc.

3.8 Test Tolerances.

3.8.1 Default Tolerances. Unless stated otherwise, Table 1 shall define the test environment parameters and tolerances to be used for all validation testing.

Table 1: Parameters and Tolerances ^{Note 1}

Requirement	Tolerance
Ambient Temperature	As Specified, $\pm 3^{\circ}\text{C}$
Room Temperature	$(+23 \pm 5)^{\circ}\text{C}$
Room Ambient Relative Humidity	30% to 70%
Chamber Humidity	As Specified, $\pm 5\%$
Voltage	As Specified, $\pm 0.1\%$
Current	As Specified, $\pm 1\%$
Resistance	As Specified, $\pm 1\%$
Random Acceleration (G_{RMS})	As Specified, $\pm 20\%$ ^{Note 2}
Acceleration (Mechanical Shock, G)	As Specified, $\pm 20\%$
Length	As Specified, $\pm 1\%$
Test Time	As Specified, $\pm 0.5\%$
Force	As Specified, $\pm 5\%$
Frequency	As Specified, $\pm 1\%$
Distance (Excluding Dimensional Check)	As Specified, $\pm 1\%$
Flow Rate	As Specified, $\pm 5\%$
Relative Velocity	As Specified, 50 ± 10 mm/minute

Note 1: Not to be used for performance-dependent variables.

Note 2: PSD deviations from applicable tables are not permitted without GM approval.

G = Gravity

G_{RMS} = G Root Mean Square

4 Requirements and Procedure

4.1 Classification. Electrical connectors are classified by temperature class, vibration class, sealing class and mating force class.

4.1.1 Temperature Class. Table 2 defines the general temperature classes for electrical connection systems within the vehicle.

Table 2: Temperature Class (T)

Class	Ambient Operating Temperature	Typical Installation Position
1	(-40 to +85) °C	Passenger compartment or trunk
2	(-40 to +105) °C	Underhood, chassis
3	(-40 to +125) °C	On engine, transmission
4	(-40 to +150) °C	On engine (hot locations)
5	Per connector CTS	Per CTS

CTS = Component Technical Specification

4.1.2 Vibration Class. Table 3 defines the general vibration classes for electrical connection systems within the vehicle.

Table 3: Vibration Class (V)

Class	Typical Installation Position
1	On body or chassis
2	On engine
3	On wheel, Unsprung Mass
4	Severe applications (e.g., ECU, Throttle Body, EGR)
5	Transmission (internal and external)

ECU = Engine Control Unit, EGR = Exhaust Gas Recirculation

Note: As defined in GMW3172, the traditional target life of 160 000 km (100 000 mi) shall be classified as Target Life 1. When Target Life is expected to exceed this, the classification shall be labeled as the multiple of this traditional target life, i.e., 240 000 km (150 000 mi) shall be labeled as Target Life 1.5 and 320 000 km (200 000 mi) as Target Life 2. Unless otherwise specified, connectors will be validated to Target Life.

4.1.3 Sealing Class. Table 4 defines the general sealing classes for electrical connections systems within the vehicle.

Table 4: Sealing Class (S)

Class	Description	Typical Installation Position
1	Unsealed	Passenger compartment or trunk
2	Submersion Sealed	Underhood or exposed areas, including door
3	High Pressure Spray Protected	Exposed areas where high pressure spray is expected

4.1.4 Connector Mating Force Class. Table 5 defines the general connector mating force classes for electrical connections systems within the vehicle.

Refer to USCAR25 for specific design and performance requirements.

Table 5: Connector Mating Force Class (M)

Class	Maximum Allowable Mating Force
1	22 N
2	45 N
3	75 N

4.1.5 Test Procedures and Sequences. The supplier shall follow all of the procedures defined under each test section. The supplier shall follow the test sequences defined in Section 4.6.

4.2 Mechanical Tests.

4.2.1 Crack Corrosion.

4.2.1.1 Purpose. This test is used to determine the susceptibility to stress-corrosion of any portion of terminals made from un-plated copper-zinc alloys.

This test is carried out by exposing test sample components to suitable corrosive media under controlled conditions for specified time periods and then examining for induced cracking. This test shall be run on any terminal that has any unplated copper/zinc (copper content less than or equal to 70%) based section.

4.2.1.2 Equipment.

- Glass test vessel of suitable size (≈ 150 mm high) to contain test samples and requisite volume of test medium. The test vessel shall be fitted with a gas tight glass lid and suitable glass grid or frame to allow suspension of the test piece above the test medium.
- Magnification equipment to provide at least 10 $\times$ magnification

4.2.1.3 Sample Preparation.

4.2.1.3.1 Test Samples. Finished terminals crimped to wires.

4.2.1.3.2 Number of Test Samples. Three (3) minimum.

4.2.1.4 Procedure.

1. Clean contacts or material to be tested by degreasing in a suitable alkaline cleaner or organic solvent. If necessary, immerse parts for approximately 30 seconds in either sulfuric acid (10% by mass) or nitric acid (30% by mass) and then rinse in clean running water to remove any surface oxides. Dry the parts thoroughly.
2. Prepare the test media using commercial grade reagents and distilled or de-ionized water. Composition of test medium: Ammonia solution (25% by mass) diluted with water to a ratio of 1 to 1 (density at +20 °C: 0.946 g/cm³ to 0.950 g/cm³).
3. Unless otherwise specified, the test shall be performed at an ambient temperature of (+23 $\pm$ 5) °C.
4. Fill the test vessel with the ammonia solution to a depth of ≈ 30 mm. Suspend the cleaned test samples at a height of 50 mm above the surface of the ammonia solution and seal the test vessel. Expose the samples for (24 $\pm$ 1) hours.

Note: Deviations from the continuous time requirement shall be noted on the test report. If it is necessary to interrupt the test, test samples may be removed from the vessel and stored in de-ionized water for up to 16 hours, dried and then re-exposed to the ammonia medium for the remainder of the time required.

5. Following the 24 hour ammonia exposure, submerge the samples in either sulfuric acid (10% by mass) or nitric acid (30% by mass) at (+23 $\pm$ 5) °C for 30 seconds to 60 seconds.
6. Examine the parts using at least 10 $\times$ magnification. Observe and note any cracks.

4.2.1.5 Acceptance Criteria. The surface shall be free of cracks.

4.2.2 Crimp/Weld Integrity.

4.2.2.1 Purpose. The purpose of this procedure is to verify cable attachment integrity and conformance to performance requirements. All cable to terminal attachment configurations shall be verified.

4.2.2.2 Sample Preparation. Crimp terminals used for testing connectors shall be crimped to the requirements defined in USCAR 21, "Performance Specification for Cable to Terminal Electrical Crimps". Ultrasonically welded terminals used for testing connectors shall be welded to the requirements defined in USCAR38, "Performance Specification for Ultrasonically Welded Wire/Cable Termination".

Use the appropriate cable seal as applicable.

4.2.2.3 Procedure.

4.2.2.3.1 Cable to Terminal Crimps. Cable to terminal crimps shall be validated per USCAR21. Refer to USCAR21 for test procedure. Terminal crimps for all wire sizes specified for the terminal shall be completed.

4.2.2.3.2 Cable to Terminal Welds and Welded Splices. Cable to Terminal Welds and Welded Splices shall be validated per USCAR38. Refer to USCAR38 for test procedure. Cable Terminals Welds and Welded Splices for all wire sizes specified for the terminal shall be completed.

4.2.2.4 Acceptance Criteria. The terminals shall meet the acceptance criteria defined in USCAR21 and USCAR38 specifications.

4.2.3 Terminal-to-Terminal Engagement Force.

4.2.3.1 Purpose. Quantify the force required to insert a male terminal into a female terminal.

4.2.3.2 Equipment. Insertion/Extraction tester with peak force reading feature.

4.2.3.3 Sample Preparation.

4.2.3.3.1 Test Samples. Male and female terminals with attached wire leads.

4.2.3.3.2 Number of Test Samples. Ten (10) terminal pairs, minimum.

4.2.3.4 Procedure.

1. Secure terminals to be tested onto fixtures.
2. Mate terminals at a uniform rate of (50 ± 10) mm/minute until fully engaged.
3. Record peak force and graph force versus distance from initial terminal to terminal contact to the fully engaged position.

4.2.3.5 Acceptance Criteria. Documentation purposes only.

4.2.4 Terminal-to-Connector Engagement Force.

4.2.4.1 Purpose. The purpose of this test is to quantify the force required to insert a terminal with an attached wire lead into an appropriate connector body.

4.2.4.2 Equipment. Insertion/Extraction tester with a peak force reading feature.

4.2.4.3 Sample Preparation.

4.2.4.3.1 Test Samples. Terminated leads, including appropriate wire seals (if applicable) and suitable connector bodies.

4.2.4.3.2 Number of Test Samples. Minimum of 10 terminals and an appropriate number of connector bodies.

Note: Terminated leads shall be constructed from the smallest and largest wire size specified for the respective terminals as listed below.

4.2.4.4 Procedure.

4.2.4.4.1 Terminal Position Assurance (TPA) in Open Position.

1. Mount the connector with the TPA in the Open position into a fixture.
2. Secure a terminated lead into a suitable fixture approximately 20 mm from the back of the terminal or seal. Take special care when securing the terminated lead so that the lead fixture does not interfere with full terminal insertion during the test.
3. Insert terminal into connector at a uniform rate of (50 ± 10) mm/minute until fully seated and locked.
4. Record peak force and graph force versus distance from initial contact of terminal to connector body to final engaged position.

4.2.4.4.2 TPA in Fully Seated Position.

1. Mount a connector with a fully seated TPA into a fixture.

2. Secure a terminated lead into a suitable fixture approximately 20 mm from the back of the terminal or seal. Take special care when securing the terminated lead so that the lead fixture does not interfere with full terminal insertion during the test.
3. Insert the terminal into the connector at a uniform rate of (50 ± 10) mm/minute until it is either fully seated and locked into the cavity or all forward motion of the terminal ceases due to interference between the terminal and the TPA or the maximum test insertion force reaches 75 N.
4. Record peak force and graph force versus distance from initial contact of terminal to connector body to final engaged position.

4.2.4.5 Acceptance Criteria.

4.2.4.5.1 TPA in Open Position.

1. For terminals with less than 1.0 mm^2 wire, the maximum engagement force to fully seat and lock the terminal shall be less than 15 N.
2. For terminals with 1.0 mm^2 or larger wire, the maximum engagement force to fully seat and lock the terminal shall be less than 30 N.
3. The forward stop shall withstand a push-through force of 25 N or the column strength of the largest applicable conductor size, whichever is smallest.

4.2.4.5.2 TPA in Fully Seated Position.

1. For terminals with less than 1.0 mm^2 wire, the minimum engagement force to fully seat and lock the terminal shall be 30 N or the terminal shall not be capable of being seated and locked due to interference between the TPA and the terminal.
2. For terminals with 1.0 mm^2 wire, the minimum engagement force to fully seat and lock the terminal shall be 40 N or the terminal shall not be capable of being seated and locked due to interference between the TPA and the terminal.
3. For terminals with greater than 1.0 mm^2 wire, the minimum engagement force to fully seat and lock the terminal shall be 60 N or the terminal shall not be capable of being seated and locked due to interference between the TPA and the terminal.

4.2.5 Terminal-from-Connector Extraction Force.

4.2.5.1 Purpose. Quantify the force required to remove a terminated lead from the connector body.

4.2.5.2 Equipment.

- Pull tester with peak force reading feature.
- Climatic chamber capable of 95% to 98% Relative Humidity at $+40^\circ\text{C}$.

4.2.5.3 Sample Preparation.

4.2.5.3.1 Test Samples. Terminals crimped to the maximum wire size specified for the respective terminal and compatible connectors.

4.2.5.3.2 Number of Test Samples. Fifty (50) terminated leads and a sufficient number of connectors to support the 50 terminals.

Note: All cavities of a connector shall be tested.

4.2.5.4 Procedure.

1. Assemble connectors and 10 of the terminals including all seals and other necessary components but without the TPAs. Designs using pre-staged TPAs shall have the TPA in the pre-staged position.
2. Secure the connector into a fixture.
3. Attach the lead to the pull tester at a point less than 100 mm behind the rear of the terminal.
4. Pull the lead at a uniform rate of (50 ± 10) mm/minute until pull-out occurs. Note the pull-out value and failure mode.
5. Record peak force required to pull the terminal out of the connector cavity. If the conductor breaks or pulls out of the terminal before the terminal pulls out of the cavity, record this force and note the failure mode.
6. Using new test samples repeat Steps 1 thru Step 5, but with all TPAs fully seated.

7. Using new test samples and fully seated TPAs, repeat Steps 1 thru Step 5 using connectors that are moisture conditioned by being exposing to 95% to 98% Relative Humidity at +40 °C for 6 hours. The pull test shall be performed immediately following removal of the connectors from the temperature/humidity chamber.
8. Using new test samples and fully seated TPAs, repeat Steps 1 thru Step 5 immediately after 4.4.1.
9. Using new test samples and fully seated TPAs, repeat Steps 1 thru Step 5 immediately after 4.4.3.

4.2.5.5 Acceptance Criteria. The terminal extraction force shall meet the requirements specified in Table 6.

Table 6: Minimum Extraction Force – Terminal from Connector Cavity

Terminal Size	Primary Lock Only	Primary Lock and TPA/PLR and Post-Moisture Conditioning per Section 4.2.5.4, Item 8	Post Thermal Aging Section 4.4.1 and Post Humid Heat Cyclic (HHC) Section 4.4.3
0.50 mm	20 N	60 N	50 N
0.64 mm	30 N	60 N	50 N
≤ 1.5 mm	50 N	80 N	70 N
≤ 2.8 mm	60 N	100 N	90 N
≤ 6.3 mm	90 N	120 N	110 N
≤ 9.5 mm	100 N	150 N	140 N
> 9.5 mm	100 N	200 N	190 N

PLR = Primary Lock Retention

4.2.6 Terminal Cavity Polarization.

4.2.6.1 Purpose. This test is conducted to ensure that the design of the cavity and the terminal polarization features will prevent insertion of a terminal in an improper orientation.

Note: This procedure is **not** required for terminal designs that are designed to plug and lock in any orientation.

Note: If surrogate data is used to fulfill the requirements of this test, the design of the cavity, terminal, cable, cavity wall thicknesses and all materials (except terminal plating) shall be identical. The responsible Connector Engineer shall determine the need for individual testing in cases where all terminal and cavity criteria are not identical.

4.2.6.2 Equipment.

- Insertion Force Tester with peak reading feature and all necessary fixtures or jigs.
- Sufficient number of connectors to test each incorrect terminal orientation ten (10) times, using a new cavity for each trial.

4.2.6.3 Procedure.

1. By analyzing the cavity and terminal design, choose the incorrect terminal orientations to be tested. At a minimum, each incorrect orientation in increments of 90° shall be tested. Rectangular designs where improper insertion at 90° from horizontal is clearly not possible do not need to be tested. It is permissible to test these designs in 180° increments. The responsible GM Connector Engineer is the final authority for determining the positions to be tested.
2. Prepare leads using the largest size conductor and insulation thickness applicable to the design.
3. Secure the connector housing in an appropriate fixture that will not distort the natural state, shape, or geometry of the connector or the terminal cavities.
4. Secure the terminal sample in the force tester by gripping the conductor a minimum of 20 mm behind the insulation grip.

5. Adjust the connector holder and force tester to insert the terminal in one of the “incorrect” orientations chosen in Step 1.
6. Push the terminal into the connector at a uniform rate of 50 mm/minute until the test force is 1.5 times the maximum force recorded in Section 4.3.1, Terminal to Connector Engagement Force, or 15 N, whichever is greater.
7. Record results:, i.e., terminal seated in cavity, terminal inserted but did not seat and to what approximate depth, terminal did not enter cavity, cable buckled, etc.
8. Repeat Steps 4 thru Step 9 using new terminals, cavities or connectors until all orientations determined in Step 1 have been tested.
9. Complete the visual examination of the terminals and connectors per Section 3.4.1.7.

4.2.6.4 Acceptance Criteria. Terminals inserted in any incorrect orientation shall not fit or lock into a connector cavity at a force 1.5 times the normal insertion force, 15 N, or the column strength of the largest applicable wire size, whichever is greater.

There shall be no visible damage to either the terminal or connector that would prevent subsequent correct insertion and function following any attempt at incorrect insertion per this procedure.

4.2.7 Terminal Bend Resistance.

4.2.7.1 Purpose. This test checks for a minimum level of terminal strength to resist bending or breakage during crimping, assembly, or service. Actual bending force values in each of three directions are recorded.

4.2.7.2 Equipment.

- Special steel mounting fixture(s) appropriate to the terminal(s) under test.
- Linear Force Tester with peak reading feature or weights per Table 7.

4.2.7.3 Procedure.

1. Using Figure 2, determine which design style most closely resembles the terminal under test.
2. Prepare terminal samples per Section 3.2, Test Samples using the smallest size conductor with the thinnest insulation specified for the terminal to be tested.
3. Repeat Step 2 except use the largest conductor size with the thickest insulation specified for the terminal to be tested.
4. Number each terminal.
5. Mount the terminal in a fixture taking care that location “1” is positioned as shown in Figure 3.
6. Apply the force specified in Table 7 on the insulation crimp wing to the sample as shown in Figure 3 for 15 seconds and release.
7. Inspect the area around the bend using at least 10× magnification. Note in the test report any signs of metal cracking or tearing.
8. Straighten the terminal to its original position and re-inspect the terminal for signs of metal cracking or tearing. Note in the test report any signs of metal cracking or tearing.
9. Select a new batch of at least 5 samples and mount them in a test fixture with the terminal rotated 180° from the position shown in Figure 3. Repeat Steps 4 thru Step 8.
10. Select a new batch of at least 5 samples and mount them in the test fixture with the terminal rotated 90° from the position shown in Figure 3. Repeat Steps 4 thru Step 8.

Note: Since terminals are typically symmetrical in this “side to side” direction, it is not necessary to test both directions. If the terminal is not symmetrical both directions shall be tested. Consult the GM Connector DRE for guidance in this regard.

11. For terminal style “B” designs in Figure 2, repeat Steps 4 thru Step 10 with each terminal mounted such that location “2” is firmly retained at the edge of the fixture.

4.2.7.4 Acceptance Criteria. The terminal shall not tear or crack when subjected to the applied force for 15 seconds. If the terminal bends from its original position during the test, it shall not tear or crack when straightened to its original position.

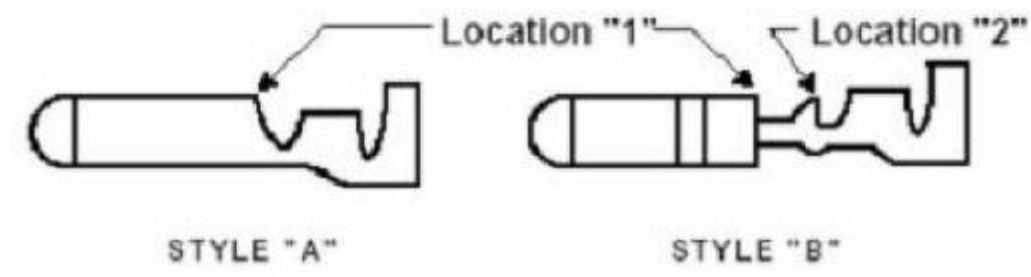
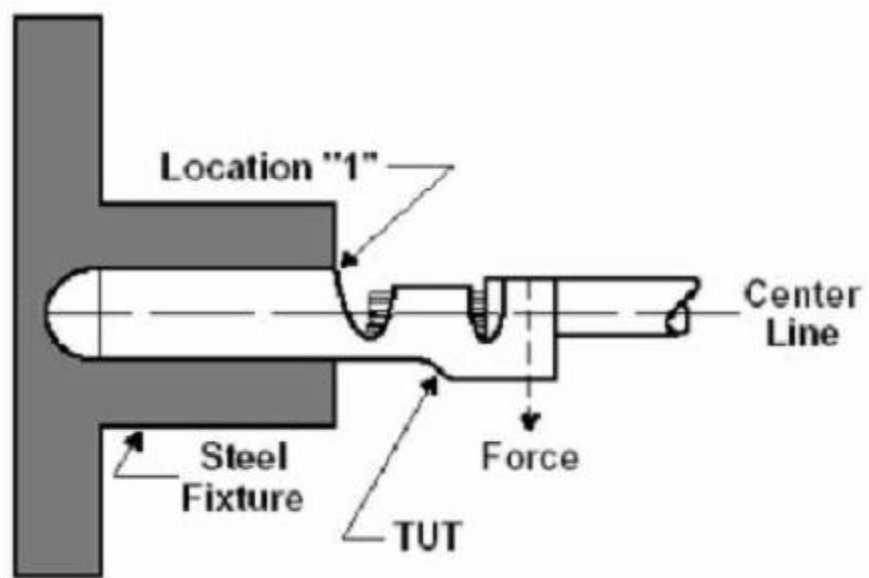


Figure 2: Terminal Design Style



TUT = Terminal Under Test

Figure 3: Terminal Bend Test

Table 7: Terminal Size and Applied Bending Force

Terminal Size	Applied Force
0.5 mm	3.0 N
0.64 mm to 1.5 mm	4.0 N
1.5 mm to 2.8 mm	7.0 N
2.8 mm to 6.3 mm	10.0 N
6.3 mm to 9.5 mm	15.0 N
≥ 9.5 mm	20.0 N

4.2.8 Connector-to-Connector Engagement Force.

4.2.8.1 Purpose. This test quantifies the force required to engage fully populated female and male connectors to each other. Note that this test shall also be used for connectors with manually operated mating assist devices such as slides, levers or cam locks. In this case, the force required to manually operate the

mechanical assist in mating and unmating the fully populated connector is measured. This also applies to pre-staging of connectors having bolts, slide locks, or other locking assist devices.

4.2.8.2 Acceptance Criteria. Refer to USCAR25 for Procedure and Acceptance Criteria of Connector to Connector Engagement Requirements.

4.2.9 Terminal Position Assurance (TPA).

4.2.9.1 Purpose. This test is used to determine the mechanical function of the TPA. The purpose of this test is to prevent intermittent electrical function caused by an incompletely/improperly inserted terminal.

4.2.9.2 Equipment.

- Insertion/Extraction tester with peak reading feature.

4.2.9.3 Sample Preparation. Obtain a minimum of ten (10) samples of connectors and components to be tested. No special sample preparation is required.

4.2.9.4 Procedure.

4.2.9.4.1 TPA Retention Capability (Pre-lock Position to TAP Removal from Connector Force and Pre-lock Position to TPA Lock Position Force) without Terminals.

Note: This applies to connectors with pre-assembled TPAs only.

1. Using a suitable fixture, orient the connector with orientations specified by the design engineer as most likely to defeat the retaining feature.
2. Pull the TPA from the connector at a uniform rate (50 ± 10) mm/minute. Record peak force and graph force versus distance from initial position of TPA to connector body to final disengaged position.
3. Push the TPA into the connector at a uniform rate (50 ± 10) mm/minute. Record peak force and graph force versus distance from initial position of TPA to connector body to final locked position.

4.2.9.4.2 TPA Pre-lock to Lock Closing Force with Properly Assembled Terminals.

1. Insert terminals into all cavities of the connector.
2. Secure connector body and TPA into a holding fixture.
3. Insert TPA into connector body at a uniform rate of (50 ± 10) mm/minute.
4. Record peak force and graph force versus distance from initial position of TPA to connector body to final engaged position.

4.2.9.4.3 TPA Pre-lock to Lock Closing Force with One Improperly Assembled Terminal.

1. Study the design of the terminal and TPA and determine the position of the terminal where it is most likely that the TPA is possible to close with the lowest force and still provide terminal electrical contact.
2. Randomly select one cavity of each terminal size/type.
3. Secure connector body to fixture.
4. Partially insert the terminal into that position so that it is just short of locking into position. Secure/hold the terminal in that position.
5. Insert TPA into connector body at a uniform rate of (50 ± 10) mm/minute.
6. Record the peak force and whether or not the TPA seated and locked.
7. Properly assemble/insert the out of position terminal into the connector body.
8. Extract the terminal from the connector per the procedure specified in Section 4.3.2.

Note: Additional Moisture Conditioning is not required.

9. Remove terminal and inspect for physical damage.

4.2.9.4.4 Retention Force of Seated TPA.

1. Seat the TPA in its fully seated position in a fully populated connector.
2. Pull TPA at a uniform rate of (50 ± 10) mm/minute from the fully seated position to the pre-staged position. Record the force.

4.2.9.5 Acceptance Criteria. Refer to Table 8.**Table 8: TPA Removal Force Table**

Row	Procedure	Unprotected TPA ^{Note 1}	Protected TPA
1	TPA Removal from Connector ^{Note 2}	20 N minimum	20 N minimum
2	Pre-lock to Lock Position without Terminals	30 N minimum 45 N maximum	20 N minimum 45 N maximum
3	Pre-lock to Lock Position with Properly Seated Terminals	30 N minimum 45 N maximum	20 N minimum 45 N maximum
4	Pre-lock to Lock Position with One Incorrectly Seated Terminal ^{Note 2}	60 N or 2 × the measured value of Row 3, whichever is larger.	60 N or 2 × the measured value of Row 3, whichever is larger.
5	TPA Locked to Pre-locked Position	25 N minimum 45 N maximum	20 N minimum 45 N maximum

Note 1: An unprotected TPA is one that shows proud of the connector body.

Note 2: Without damage to the TPA, connector, or terminal.

4.2.10 Lever and Slide Open Position Retention.

4.2.10.1 Purpose. This test is used to verify that the retention force of the slide or lever is high enough to prevent it from separating from the connector body and remaining in the pre-lock position.

4.2.10.2 Equipment.

- Insertion/Extraction tester with peak force reading feature.

4.2.10.3 Sample Preparation.

4.2.10.3.1 Minimum sample size is five (5).

4.2.10.3.2 No special sample preparation is required.

4.2.10.4 Procedure.

1. Make a fixture that will secure the connectors to be tested without distorting any of the parts.
2. Mount the samples in the fixture with the slide or lever in the open position.
3. Apply a 50 N force in direction "F", as shown in Figure 4, at the rate of (50 ± 10) mm/minute.
4. Mount new connectors in the fixture maintaining the slide or lever in the as-delivered pre-lock position.
5. Apply a 150 N force to close the slide or lever at the rate of (50 ± 10) mm/minute.
6. Mount new connectors in the fixture maintaining the slide or lever in the as-delivered pre-lock position.
7. Apply an increasing force to the slide or lever at the rate of (50 ± 10) mm/minute until the pre-lock position is defeated. Record the force.

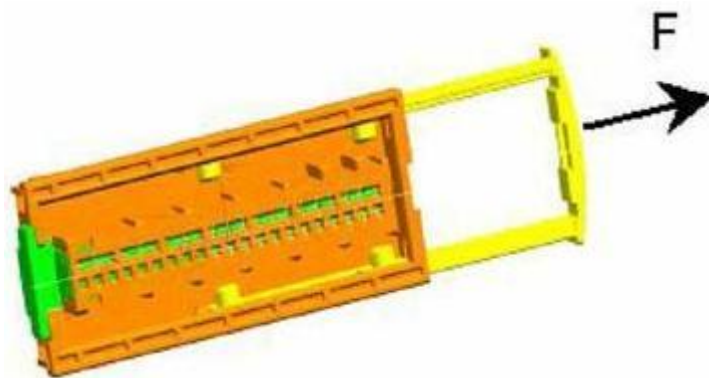


Figure 4: Retention of Slide in the Open Position

4.2.10.5 Acceptance Criteria.

1. The slide or lever shall withstand a 50 N force without separation or damage.
2. The slide or lever pre-lock position shall withstand a 150 N force without inadvertent closure.
3. The slide/lever and the connector body shall withstand the force to defeat the pre-lock position without permanent damage or deformation.

4.2.11 Mechanical Assist Integrity.

4.2.11.1 Purpose. This test is used to ensure that a lever or slide will withstand the handling of the connector and wire harness.

4.2.11.2 Equipment.

- Insertion/Extraction tester, with peak force reading feature.

4.2.11.3 Sample Preparation.

4.2.11.3.1 Minimum sample size is five (5).

4.2.11.3.2 No special sample preparation is required.

4.2.11.4 Procedure.

1. Make a fixture that will secure the connectors to be tested without distorting any of the parts.
2. Mount the samples in the fixture.
3. Apply a 100 N force in direction “F”, as shown in Figure 2, at the rate of (50 ± 10) mm/minute with the lever or slide in both the open and closed positions.
4. Apply a 100 N force in the direction opposite to direction “F” at the rate of (50 ± 10) mm/minute with the lever or slide in the open and closed positions.
5. Position the slide or lever in a position approximately half way between the open and closed positions. Apply a 60 N force in direction “F”, as shown in Figure 4, at the rate of (50 ± 10) mm/minute.
6. Position the slide or lever in a position approximately half way between the open and closed positions. Apply a 60 N force in the direction opposite to direction “F”, as shown in Figure 5, at the rate of (50 ± 10) mm/minute.

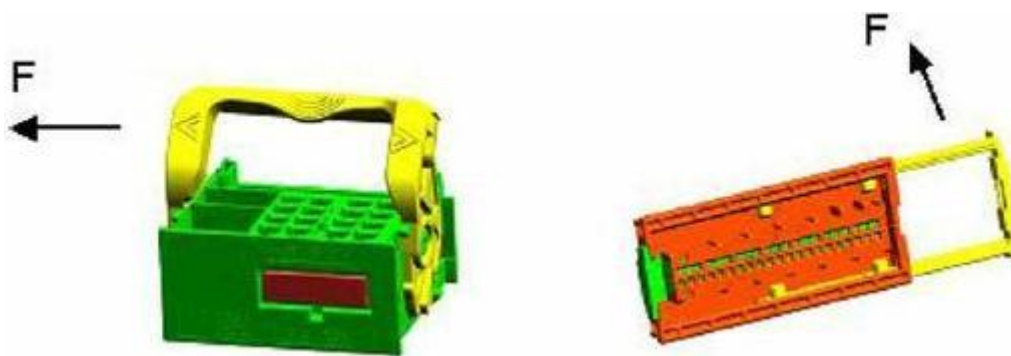


Figure 5: Side Force Strength

4.2.11.5 Acceptance Criteria.

1. The lever/slide shall withstand a 100 N force in the open and closed positions without separation or damage.
2. The lever/slide shall withstand a 60 N force in the midpoint position without separation or damage.

4.2.12 Connector Mounting Feature Mechanical Strength.

4.2.12.1 Purpose. This test is designed to test the mechanical strength of clip slots and other designed-in mounting features for electrical connectors. Such features shall withstand mechanical stresses (pulling, pushing, etc.) expected in the vehicle including vehicle assembly, service and repair without functional damage to the housing.

4.2.12.2 Equipment.

- Insertion/Extraction tester with peak force reading feature.

4.2.12.3 Sample Preparation. Obtain a minimum of thirty (30) samples of connectors to be tested. No special sample preparation is required. Manufacture a mounting feature with the correct dimensions to fit the connectors on test.

4.2.12.4 Procedure.

Note: The same samples may be used for testing various force directions if not damaged.

1. Test a minimum of thirty (30) connectors; five (5) in each direction.
2. One non-mounting (mating) connector may be used to test all connectors.
3. Secure a new connector with the designed-in mounting feature to a bracket with a fixture simulating the coordinating mounting feature. See Figure 6.

Note: No additional reinforcement of the connector slot is permitted.

4. With the connector assembly attached to the bracket, apply a downward force at a rate of (50 ± 10) mm/minute to the non-mounted mating connector in direction F1 until breakage of the mounting feature or until the force specified in the Acceptance Criteria of Section 4.2.12.5 is reached. The force shall be applied 5 mm from the rear and side of the connector to affect the greatest moment arm. See Figure 7, Figure 8, and Figure 9.
5. Remove the connector from the fixture.
6. Repeat Steps 2 thru Step 5 with four additional connectors.
7. Repeat Steps 2 thru Step 6 in the other three directions (F2, F3, and F4, 90° apart, and each perpendicular to the direction of mating of the mounting feature).
8. Secure a new connector with the designed-in mounting feature to a bracket with a fixture simulating the coordinating mounting feature. See Figure 6.
9. With the connector assembly attached to the bracket, apply a push force connector with a probe (at a rate of (50 ± 10) mm/minute) at the centerline of the connector in direction F5 until breakage of the mounting feature or until the force specified in the Acceptance Criteria of Section 4.2.12.5 is reached. See Figure 7.

10. Remove the connector from the fixture.
11. Repeat Steps 8 thru Step 10 with four additional connectors.
12. Repeat Steps 8 thru Step 11 in the other direction (F6).

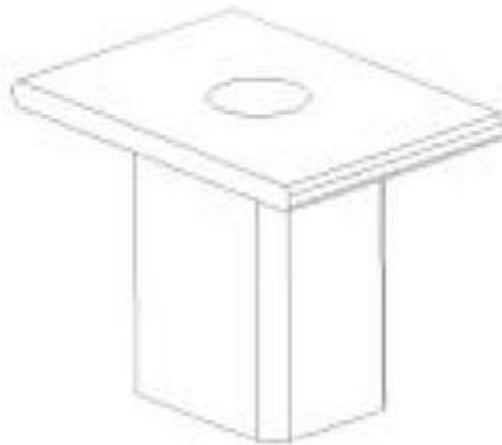
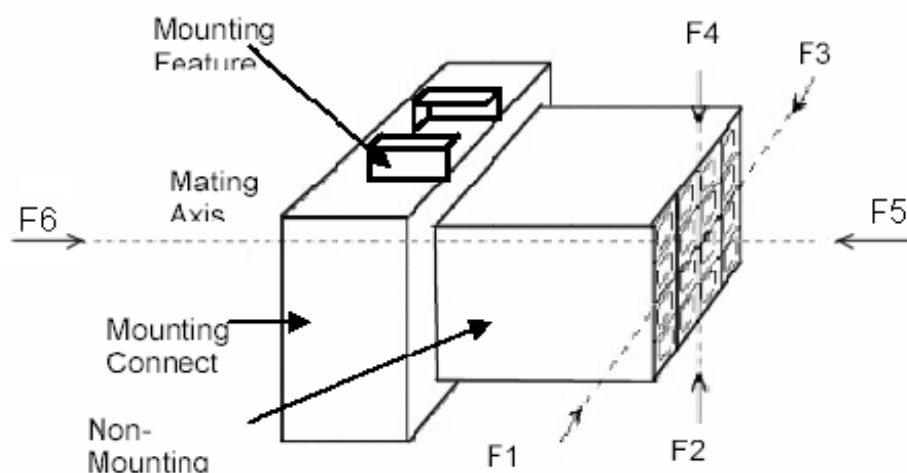


Figure 6: Connector Mounting Fixture Strength Example



Note: Arrows indicate direction of applied force, not location of probe.

Figure 7: Connector Mounting Fixture Strength Test Setup, 3-Dimensional View

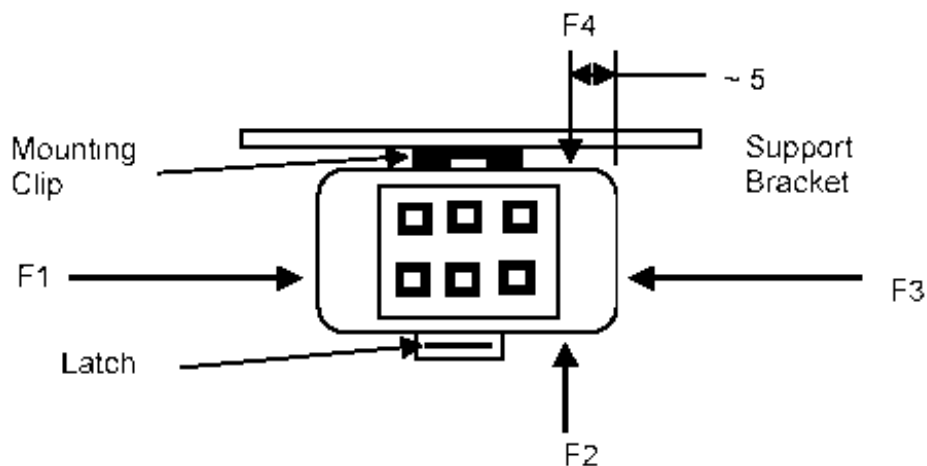


Figure 8: Connector Mounting Fixture Strength Test Setup, End View

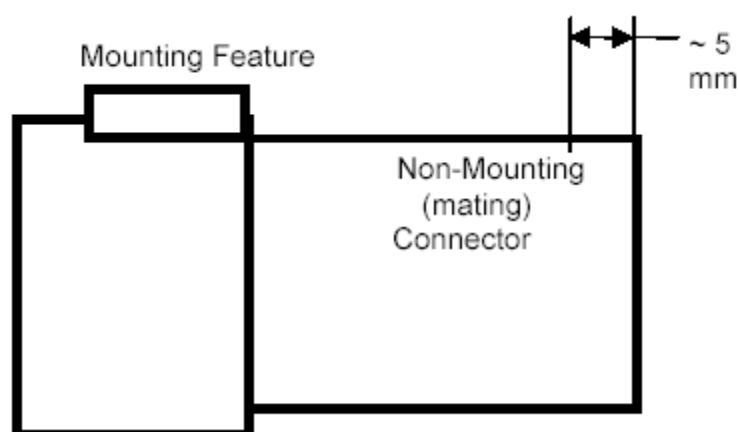


Figure 9: Connector Mounting Fixture Strength Test Setup, Side View

4.2.12.5 Acceptance Criteria.

4.2.12.5.1 The minimum force required to break the mounting feature or separate the clip from the mounting feature in directions F1 to F5 shall be > 50 N.

4.2.12.5.2 The minimum force required to break the mounting feature or separate the clip from the mounting feature in direction F6 shall be > 110 N.

4.2.13 Connector Audible Feedback.

4.2.13.1 Purpose. This test measures the level of noise generated when two connectors are mated. Connectors shall be mated by hand for this test rather than being clamped into a fixture which could dampen or amplify the sound.

4.2.13.2 Equipment.

- Sound Pressure (decibel (dB)) Meter

4.2.13.3 Procedure. Eight (8) sample pairs are required. Samples are to be production intent. All connector cavities shall be filled with wires and terminals of any size appropriate to the connector under test (CUT). Include all TPAs, seals, stuffers, and auxiliary pieces as applicable.

1. Measure and record the sound pressure level in decibels C-weighted scale (dB (C)), of the ambient sound within the test environment. The ambient noise level shall be 60 dB (C) minimum.
2. Locate the sound measuring device or microphone (600 ± 50) mm from the connector.
3. Mate the connectors by hand and measure the dB (C) level of the sound generated as the lock engages. Do not bias the connectors toward or away from the latch as they are engaged.
4. Repeat Steps 1 thru Step 3 using moisture conditioned parts. Parts are brought to their practical limit of moisture content by exposing "dry as molded parts" to 95% to 98% Relative Humidity at 40 °C for 6 hours (minimum), then completing the test within 30 minutes.
5. The minimum sound level required shall be as specified on the part drawing. If no value is specified, the requirement is 7 dB above the recorded ambient for un-conditioned parts and 5 dB for conditioned parts.

4.2.13.4 Acceptance Criteria. Data from this test is for engineering evaluation purposes only.

4.2.14 Connector Lock Mechanical Overstress.

4.2.14.1 Purpose. This test is to determine that the connector lock mechanism can withstand overstress applied to the lock.

4.2.14.2 Equipment.

- Pull tester with peak force reading feature.

4.2.14.3 Sample Preparation.

4.2.14.3.1 Minimum sample size = Ten (10).

4.2.14.3.2 No special sample preparation is needed.

4.2.14.4 Procedure. Wrap a 0.33 mm^2 (22 ga) wire around the connector lock assembly. Pull with 150 N on the wire against the lock in both horizontal and vertical directions.

4.2.14.5 Acceptance Criteria. There shall be no damage to the connector lock assembly after the force is applied.

4.2.15 Connector Position Assurance (CPA).

4.2.15.1 Purpose. This test is used to ensure that the CPA will function properly and verify the robustness to inadvertent closure and separation.

4.2.15.2 Equipment.

- Insertion/Extraction tester with peak force reading feature.

4.2.15.3 Sample Preparation.

4.2.15.3.1 Minimum sample size = Ten (10).

4.2.15.3.2 No special sample preparation is needed.

4.2.15.4 Procedure.

4.2.15.4.1 CPA Lock and Unlock Force.

1. Using a mated connector pair, close the CPA at a uniform rate of (50 ± 10) mm/minute until fully seated and locked. Record the peak force.
2. Open the CPA at a uniform rate of (50 ± 10) mm/minute until fully opened. Record the peak force.

4.2.15.4.2 CPA Closing Force at Connectors. Using an unmated connector, close the CPA at a uniform rate of (50 ± 10) mm/minute until fully seated and locked. Record the peak force.

4.2.15.4.3 CPA Extraction Force. Using an unmated connector, apply a force to the CPA in the opposite direction to the normal closing direction at a uniform rate of (50 ± 10) mm/minute until fully detached. Record the peak force.

4.2.15.5 Acceptance Criteria.

- The CPA pre-stage to lock force shall be 22 N maximum.
- The CPA lock to pre stage force shall be between 10 N and 30 N without the use of special tools.

4.2.15.5.1 CPA Closing Force on Unmated Connectors. The closing force for non-mated connector shall be greater than 80 N, or twice the mating force of the connection, whichever is greater.

4.2.15.5.2 CPA Extraction Force from Connector. The extraction force of the CPA shall be 60 N minimum.

4.2.16 Connector Seal Retention - Mated Connector.

4.2.16.1 Purpose. This test is used to determine that the connector seal will retain during mating and unmating of the connector assembly.

4.2.16.2 Sample Preparation.

4.2.16.2.1 Minimum sample size: Ten (10) female housings with radial seals for each test sequence.

4.2.16.2.2 Remove connector lock/slider/lever from connector housing.

4.2.16.3 Procedure.

1. Mate connector to device.
2. Remove connector from the device by using the wires when possible or by grasping the connector housing. Connector shall be fully separated within one second.

4.2.16.4 Acceptance Criteria. Seal shall remain on the connector and in its intended position.

4.2.17 Connector Seal Retention - Unmated Connector.

4.2.17.1 Purpose. This test is to ensure that connector seals will be sufficiently retained during shipping and handling prior to being mated or assembled.

4.2.17.2 Equipment.

- Variable speed motor with rotating table.

4.2.17.3 Sample Preparation.

Test samples: Ten (10) connector samples fully assembled. (Terminals are not required.)

Note: If the design uses a Pre-Staged Secondary component that interacts or aids in the retention of the connector seal, then conduct the test with this component in both its Pre-Staged and Final positions. If the design uses a Loose-Piece Secondary component, then conduct the test with and without this component.

4.2.17.4 Procedure.

1. Properly secure the sample under test per Figure 10, and ensure that only the connector seal is free to move.
2. Rotate the table at a speed (measure in rpm) to generate a minimum acceleration of 1960 m/s^2 ($\approx 200\text{G}$), for a minimum of 10 seconds.
 - a. Using Equation 1, calculate the required rotational speed (in rpm).
 - b. **Where:**
 - a** = Acceleration in meters per second squared (m/s^2)
 - R** = The distance (in meters) from the center of rotation to the nearest edge of the connector seal.

$$\text{Equation 1: } N = [(\text{sqrt}(a / R)) \times 60] / (2 \times \pi)$$

$$\text{Example: } a = 1960 \text{ m/s}^2 \text{ and } R = 0.2 \text{ m}$$

$$N = [(\text{sqrt}(1960 \text{ m/s}^2 / 0.2 \text{ m})) \times 60\text{s}] / (2 \times \pi)$$

$$N = 945.33 \text{ rpm}$$

3. Record and document [photograph] the position of the connector seal.