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SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1742

REV. DEC2005

Issued 1998-03
Revised 2005-12

Superseding J1742 MAR1998

(R) Connections for High Voltage On-Board Road Vehicle Electrical Wiring Harnesses— Test Methods and General Performance Requirements

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NOTE—No electrical connector, terminal, or related component may be represented as having met SAE specifications unless conformance to all applicable requirements of this specification have been verified and documented. All required verification and documentation must be done by the supplier of the part or parts. If testing is performed by another source, it does not relieve the primary supplier of responsibility for documentation of all test results and for verification that all samples tested met all applicable Acceptance Criteria. See Section 4.

1. Scope

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 in high power (20 V to 600 V and/or >80 amps) road vehicle applications. These procedures are applicable only to terminals used for In-Line, Header, and Device Connectors and for cable sizes up to 120 mm^2 (4/0).

In cases where power levels are mixed in the same connector, (i.e. sensing or normal 14.5 volt system circuits with High Power Contacts) the High Power Contacts must pass J1742 requirements, and all other contacts must pass SAE J2223-2 requirements. The connection system (housing and high power contacts) shall meet J1742 requirements.

The requirements and procedures in this document are not intended for connections internal to electrical/electronic modules or complete subassemblies.

This document does not contain a test for EMI/EMC since these parameters must be tested as a combination of cable and connector. These are considered system level requirements. Determination of the need and type of test must be considered at that level.

See Appendix C, Design Notes for further information.

IMPORTANT NOTICE: In any intended vehicle application, if the products covered by this specification are, or may be, subjected to conditions beyond those described in this document, they must pass special tests simulating the actual conditions to be encountered before they can be considered acceptable for actual vehicle application. By way only of example, this includes products that may be subjected to temperatures beyond the extremes of Class 5 in Table 2 of SAE J2223-2, or may be subjected to shock or vibration in the un-sprung portions of a vehicle, such as the wheel hub. Products certified by their supplier as having passed specific applicable portions of this specification are not to be used in applications where conditions may exceed those for which the product has been satisfactorily tested.

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The Authorized Person is the final authority as to what tests are to be performed on his or her parts and for what purpose these tests are required. He or she is also the final authority for resolving any questions related to testing to this specification and for authorizing any deviations to the equipment, procedures and/or acceptance requirements contained in this specification. Any such deviation must be documented and included in the final test report and on the part print. The following are examples of appropriate print notations:

Example 1: Test value per SAE J2223-2, Revision 1, paragraph 5.4.2 Connector Mating/Un-mating Force – mating force value = 85 N.

Example 2: SAE J2223-2, Revision 1, paragraph 5.4.9 Cavity Damage Susceptibility – not applicable to this design.

Agreement to waive or alter test procedures and Acceptance Criteria must be made between customer and supplier.

Guidance as to the recommended tests for selected purposes is given in the charts in Appendix A and B. In the absence of contrary direction from the Authorized Person in the test request/order, all electrical connectors and their associated terminals and other components are required to meet all applicable portions of this document with the following exception:

Specific tests that are not required or additional test requirements as specified in any document in the hierarchy of Section 2.

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1.1 Rationale

Numerous technological advances have been made since the original document was issued. USCAR and SAE have also cooperated on the development of more refined connector test methods and acceptance criteria. These changes are reflected in this revision of J1742.

2. References

2.1 Document Hierarchy

In the event there is a conflict between performance specifications, part drawings, and other related standards or specifications, the requirements shall be prioritized as follows:

1st – Applicable FMVSS requirements and other applicable state and Federal requirements
2nd – Applicable part drawings
3rd – Applicable product design specification(s)
4th – Automotive Industry Action Group (AIAG) Production Part Approval Process (PPAP)
5th – Applicable SAE performance specifications
6th – Other applicable standards and specifications

2.2 Part Drawing

See SAE J2223-2 for part drawing information.

2.3 Product Design Specification

See SAE J2223-2 for Product Design Specification information.

2.4 Test Request/Order

Refer to SAE J2223-2 for Test Request information.

2.5 Other Referenced Documents

2.5.1 SAE PUBLICATIONS

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J2223-2—Connections for On-Board Road Vehicle Electrical Wiring Harnesses
SAE J1127—Battery Cable
SAE J1128—Low Tension Primary Cable
SAE/USCAR-23—Road Vehicle—60 V and 600 V Single Core (ISO/Metric) Cables—Dimensions, Test Methods and Requirements

2.6 Related Publications

The following publications are provided for information purposes only and are not a required part of this document.

2.6.1 SAE PUBLICATIONS

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1654—High Voltage Primary Cable
SAE J1673—Recommended Practice for High Voltage Wiring Assemblies

3. Definitions and Abbreviations

3.1 Definitions

Terms defined in the definitions or abbreviations sections are capitalized (i.e. Room Temperature, PLR, etc.) See SAE J2223-2 for additional definitions applicable to this document.

3.1.1 BREAKDOWN

The failure of the dielectric of an insulation under the effect of an excessive electric field and/or by physical or chemical deterioration of the dielectric material.

3.1.2 CONNECTOR

A component which terminates conductors for the purpose of providing connection and disconnection to a suitable mating component. Connectors are designed to be connected and disconnected in the de-energized state unless otherwise specified. See Appendix C.

3.1.3 CONNECTOR HOUSING

The part of a connector into which the insert and contacts are assembled.

3.1.4 CONTACT

Conductive element in a component that mates with a corresponding element to form an electrical path.

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3.1.5 HIGH POWER CONNECTOR

Any connector containing one or more High Power Contacts. Connectors fitting this description shall meet the requirements of SAE J1742.

3.1.6 HIGH POWER CONTACT

Terminal assembly contained within a connector that operates at between 20 V and 600 V and/or >80A for any portion of their duty cycle.

3.1.7 RATED VOLTAGE

Voltage level at which a device is designed to operate.

3.1.8 HIGH POWER CONTACT

Any connector contact designed to carry ≥20 Volts (AC rms or DC) and/or >80 amps.

3.2 Abbreviations

See SAE J2223-2 for abbreviations.

4. General Requirements

See SAE J2223-2 for General Requirements.

4.1 Equipment

Equipment is required per J2223-2. In addition, the items found in Table 1 are required for testing High Voltage Connection Systems.

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TABLE 1—EQUIPMENT

Item	Description	Requirements
1	High Potential Tester with load meter	⇒ AC 1000 V rms (50-60 Hz or DC 1600 V

5. Test and Acceptance Requirements

5.1 General

See SAE J2223-2 for General Test and Acceptance Requirements. All sections of J2223-2 apply to the testing and validation of high Power connections systems except as noted in this document. Certain additional testing as described herein shall also be conducted.

5.1.1 CIRCUIT CONTINUITY MONITORING

Where Continuity Monitoring is required, follow the Circuit Continuity Monitoring procedures in SAE J2223-2. No Circuit Continuity Monitoring is required during any conditioning procedure for contacts operating above 20 volts.

5.2 Terminal - Mechanical Tests

5.2.1 Terminal-to-Terminal Engage/Disengage Force

Conduct the Terminal-to-Terminal Engage/Disengage Force per SAE J2223-2.

5.2.2 Terminal Bend Resistance

Conduct the Terminal Bend Resistance Test per SAE J2223-2.

5.2.3 Terminal to Conductor Attachment (crimp) Pull-out Force

5.2.3.1 Purpose

This procedure details a standard method to measure the retention capability of crimped connections.

NOTE—Pull-out force test shall not be used to determine electrical performance of the crimp application. It is used only to determine the mechanical limits of the crimp application for handling purposes

5.2.3.2 Equipment

1. Measuring device capable of measuring crimp heights and widths.
2. De-crimping tool, or other suitable means of opening insulation crimps without damaging the cable conductor. (Note: it is acceptable to make the samples with the insulation crimp not crimped to avoid this step.)
3. Force Tester.
4. Cable strippers, long-nose pliers and/or side cutters.

5.2.4 Procedure

1. A minimum of 20 samples is required to be tested for each production crimp height. Data shall be obtained and recorded for minimum, maximum, and nominal production crimp heights.
2. Samples shall be applied to appropriate cable with overall length no less than 150 mm.
3. Pull-out force test shall be performed on leads with the insulation crimp wings open (not crimped).
4. Pull-out force test shall be performed on taut leads (i.e., remove slack in cable before performing pull-out test to prevent incorrect test results due to “jerking”).
5. Measure and record the conductor crimp and insulation crimp heights and widths in millimeters for each sample.
6. If the insulation crimp is not already open, open the insulation crimp with the de-crimper or other suitable tool so that the pull-out force will reflect only the conductor crimp connection.
7. Visually inspect the de-crimped area to ensure that none of the conductor strands have been damaged. Do not use any samples that have damaged conductor strands.
8. Measure and record pull-out forces in Newtons for each sample.
9. Apply an axial force at a rate between 50 and 250 mm/min (100 mm/min is recommended).
10. For double, triple, or multiple crimp setups with conductor sizes within one conductor size step, pull the smallest conductor. (e.g. for a .35/.50 double, pull the .35 mm^2 wire).

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11. For double, triple, or multiple crimp setups with conductor sizes more than one step apart, one of the smallest and one of the largest gage size cables must be tested. (e.g. for a .50/1.0 double, pull both wires individually, for a .50/1.0/2.0 triple, pull the .50 mm^2 and the 2.0 mm^2 wires, for a .50/.50/2.0 triple, pull one of the .50 mm^2 and the 2.0 mm^2 wires.) In this case, 20 samples per wire size tested will be required.
12. Report any observations from visual examination.

5.2.5 ACCEPTANCE CRITERIA

1. The minimum pull-out forces for cables up to 8.0 mm^2 are specified in Table 2. The pull-out forces for unlisted conductor sizes can be defined by linear interpolation, (i.e. read out from plotted values in Table 2).
2. For cable sizes >8.0 mm^2, the minimum pull-out value is 600 N.

TABLE 2—PULL-OUT FORCE REQUIREMENTS

Approx. (mm^2)	AWG	Minimum Pull-out Force (N)	Reference MinimumCable Break Strength (N)
0.22	24	40	
0.35	22	50 (Annealed Core)	58
0.35	22	70 (Hard Drawn Core)	
0.5	20	75	91
0.8	18	90	136
1.0	16	120	202
1.5		150	
2.0	14	180	331
2.5		210	
3.0	12	240	521
4.0		265	
5.0	10	290	833
6.0		320	
8.0	8	350	

5.3 Terminal - Electrical Tests

5.3.1 VOLTAGE DROP

5.3.1.1 Purpose

This test determines the voltage drop associated with the electrical resistance of the conductor crimp(s) and contact interface regions at nominal current conditions. This voltage drop is then used to calculate the Total Connection Resistance.

For terminals rated ≤80 amps, refer to SAE J2223-2 for completion of the Voltage Drop test.

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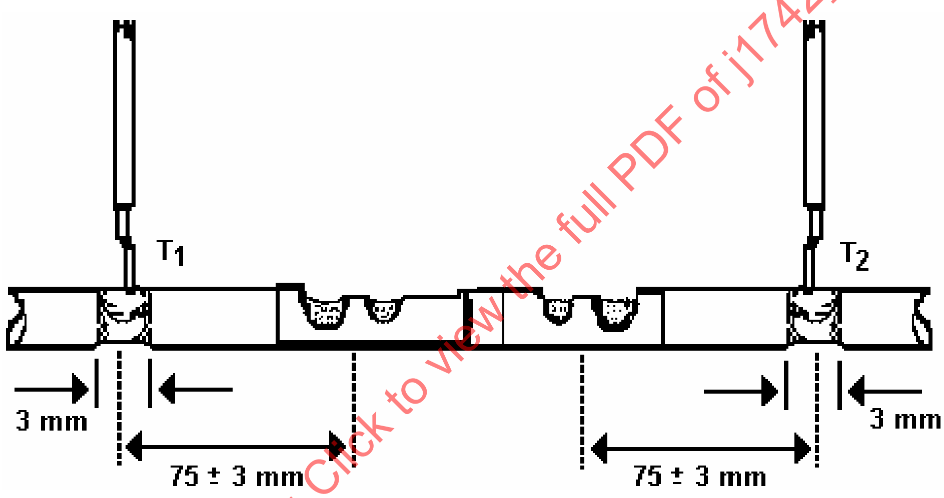
5.3.1.2 Equipment

⇒ Digital Multimeter (DMM)
⇒ AC or DC Power Supply (Voltage and current as required)
⇒ Current shunts

5.3.1.3 Procedure

1. Voltage Drop readings are taken at the maximum current rating of the terminal and cable combination as determined in Section 5.3.2, Maximum Current Test. Adjust the power supply to provide the required test current. Record the test current used. More than one terminal pair may be tested in series. Refer to Figure 1: Connection Resistance Millivolt Lead Locations, for placement of the millivolt test leads.



NOTE—Alternate locations for sense points T_1 and T_2 are acceptable as long as the effect of the cable is minimized and the proper resistance representing the cable bulk is deducted.

FIGURE 1—CONNECTION RESISTANCE MILLIVOLT LEAD LOCATIONS

2. Measure and record the millivolt drop across 150 mm of the conductor size and insulation type to be used during the test, using the test current determined in Step 1. For testing Header type connectors, refer to SAE J2223-2 “Testing Headers and Direct Connect Components” and measure the millivolt drop across only 75 mm of the conductor used.

NOTE—Alternate cable lengths are acceptable, but should be kept as short as possible. For attachment points exceeding 75 mm per side, the extra wire resistance shall be measured and subtracted per step 5.

3. Choose the preferred method of taking measurements (soldered sense lead or probe) and document the method chosen. In either case, the sense points T_1 and T_2 (Figure 1) must be soldered for all stranded cable. For Header type connectors, T_2 is attached to the Header terminal per SAE J2223-2 “Testing Headers and Direct Connect Components”. All millivolt leads must be no larger than 0.22 mm^2 (24 AWG).

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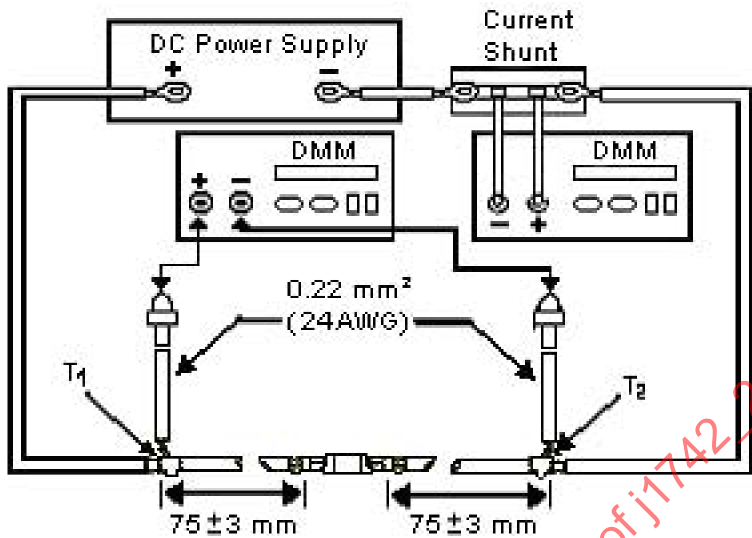

FIGURE 2—CURRENT RESISTANCE TEST SET-UP

4. Set the power supply for the current determined in Step 1 and wait 30 minutes minimum to ensure that the test current stabilizes at the appropriate value. Allow sufficient time for all other test equipment to warm and stabilize per the manufacturer's recommendations.
5. Using the test current determined in Step 1, measure and record the millivolt drop (mVD) readings between test points T_1 and T_2. Use these values in the equation below to calculate the voltage drop across the entire connection, including the crimp(s) and terminal interface.

mVD Entire Connection = mVD (T_1 - T_2) – [mVD Conductor (Step 2)]

Total Connection Resistance = mVD Entire Connection ÷ Test Current

Use these results to verify conformance to the Acceptance Criteria of Section 5.3.1.4.

5.3.1.4 Acceptance Criteria

1. The measured temperature of the terminal must not exceed a 55 °C rise over ambient, or the maximum temperature recommended by the terminal manufacturer, whichever is lower.
2. The voltage drop shall not exceed 60 mV for Tin plated terminals and 80 mV for Silver plated terminals for any terminal/cable combination tested.
3. The change in voltage drop from before to after conditioning shall not exceed 20 mV.

5.3.2 MAXIMUM TEST CURRENT CAPABILITY

This test is used to determine the maximum test current at which a terminal system can operate in a Room Temperature environment before excessive thermal degradation and/or resistance begins to occur. Temperature Rise (Y axis) vs. Current (X axis) shall be plotted for each applicable conductor size. These graphs are NOT to be used for actual terminal application in a vehicle (see Appendix C – Design Notes). This test is conducted on terminals alone, thus eliminating the variation that may be introduced by the heat dissipating characteristics of differing connector housing designs and sizes.

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NOTE—A draft free environment is necessary to get accurate measurements.

5.3.2.1 Equipment

⇒ Digital Multimeter (DMM)
⇒ AC or DC Power Supply (Voltage and current as required)
⇒ Current shunts (Size as required, ± 1%)
⇒ Thermocouples (Type "J" or "T")
⇒ Data Logger (As required)

5.3.2.2 Procedure

1. Prepare 20 (at least 10 male and 10 female) terminal samples per section 5.1.6, Terminal Sample Preparation, of SAE J2223-2 using one of the conductor gage sizes and insulation thicknesses applicable to the design of the terminal to be tested.
2. Complete the Connector and/or Terminal Cycling procedure per section 5.1.7, SAE J2223-2 if not already performed on the sample set.
3. Measure and record the voltage drop across 150 mm of the conductor to be used for the test, using the expected Maximum Current Capability of the TUT in combination with that conductor size and insulation type. For testing Header type connectors, refer to Section 5.1.5 SAE J2223-2 and measure the millivolt drop across only 75 mm of the conductor used.

NOTE—Alternate cable lengths are acceptable, but should be kept as short as possible. For attachment points exceeding 75 mm per side, the extra wire resistance shall be measured and subtracted per step 5.

4. Assemble the circuit shown in Figure 3 in a draft free enclosure. Use at least 10 terminal pairs. Choose the preferred method of taking measurements (soldered sense lead or probe) and document the method chosen. In either case, the sense point T_1 (Figure 1) must be soldered for all stranded cable. Attach conductor ends of the terminal pairs to form one continuous series circuit and attach the thermocouples to each mated pair as shown in Figure 3. Attach the circuit to a non-conductive surface, such as wood or high temperature plastic, leaving a minimum of 50 mm between test samples.

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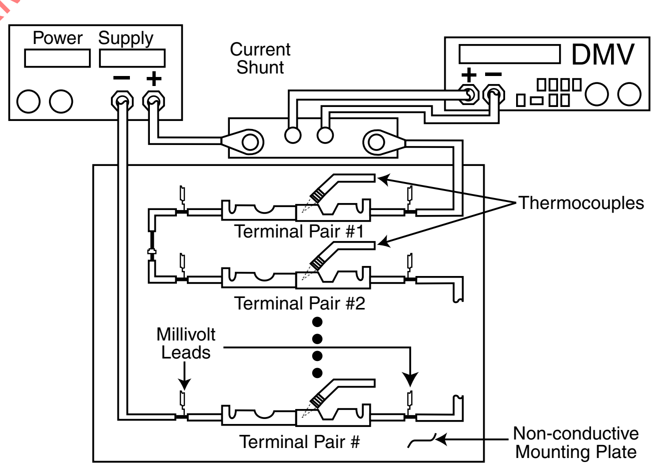

FIGURE 3—SET-UP FOR MAXIMUM TEST CURRENT

5. Test the sample terminal pairs at 23 °C (Room Temperature). The ambient temperature sensor must be placed on the same plane as the test samples, 30 cm to 60 cm from the nearest sample.
6. Adjust the power supply to zero amps output and then turn on the supply and the DMM's.
7. Slowly increase the power supply output until it is providing 50% of the expected Maximum Current Capability of the TUT.
8. Wait at least 15 minutes for the circuit temperature to reach Steady State. Then record the ambient temperature, the temperature of each terminal pair interface, and the millivolt drop across each terminal pair (T_1 to T_2 in Figure 1, less the millivolt drop of the conductor as determined in Step 3). Then calculate the resistance of the terminal pair interface.
9. Increase the current by 10% of the expected Maximum Current Capability of the TUT and repeat Step 8.
10. Repeat Step 9 until 80% of the expected Maximum Current Capability of the TUT is met.
11. Continue to increase the current in increments of 5% of the expected Maximum Current Capability of the TUT, repeating Step 8 after each incremental increase.
12. For samples to be used in subsequent tests, repeat Step 11 until one of the following conditions occurs:
    a. The temperature of any terminal interface exceeds a 55 °C rise, or the maximum temperature recommended by the terminal manufacturer, whichever is lower.
    b. The voltage drop exceeds 60 mV for tin plated terminals and 80 mV for Silver plated terminals for any terminal/cable combination tested.
13. The maximum test current capability of the specific combination of the terminal and the conductor gage and insulation type used is then determined to be the current in the first increment in which either the condition described in a. or b. of Step 12 above was achieved, less 10% of that value.
14. As an optional step, at the discretion of the Authorized Person for samples that will not be used in subsequent tests, continue to increase the current in steps of 5% of the expected Maximum Current Capability of the TUT until the thermal stability of any one or more samples can no longer be achieved. Data from this test-to-failure step may be useful for statistical purposes or for estimating safety margins.
15. Repeat Steps 1 – 13 or 14 for each conductor size and insulation type applicable to the TUT.
16. Graph the data with temperature on the Y-axis and current (in amps) on the X-axis for all conductor sizes and insulation types tested.

NOTE—This data is NOT to be used as guidance for any actual application of the TUT, see section 11 of SAE J2223-2.

5.3.2.3 Acceptance Criteria

For the current determined to be the "Maximum Test Current":

1. The measured temperature of the terminal must not exceed a 55 °C rise over ambient, or the maximum temperature recommended by the terminal manufacturer, whichever is lower.
2. The Total Connection Voltage Drop of any sample must not exceed 60 mV for tin plated terminals and 80 mV for Silver plated terminals for any terminal/cable combination tested.

5.3.3 1008 HOUR CURRENT CYCLING

5.3.3.1 Equipment

AC or DC Power Supply (voltage and current as required).

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5.3.3.2 Procedure

Complete the 1008 Hour Current Cycling test per SAE J2223-2. Take one additional set of data at the end of cycle 24. The Acceptance Criteria are as follows:

1. The measured temperature of the terminal must not exceed a 55 °C rise over ambient, or the maximum temperature recommended by the terminal manufacturer, whichever is lower.
2. The voltage drop shall not exceed 60 mV for tin plated terminals and 80 mV for Silver plated terminal for any cable/terminal combination tested.
3. The change in voltage drop measured from cycle 24 to completion of the test shall not exceed 20 mV.

5.4 Connector - Mechanical Tests

5.4.1 TERMINAL - CONNECTOR INSERTION/EXTRACTION FORCE

5.4.1.1 Procedure

Complete the Terminal – Connector Insertion/Extraction Force test per SAE J2223-2. Acceptance Criteria are as follows:

Contact Insertion:

1. For terminal sizes ≤6.3 mm, use the acceptance criteria of SAE J2223-2. For all others, use the insertion force shown on the part print. In cases where no value is specified, the maximum insertion force is 30 N.
2. Neither the conductor nor the terminal may buckle during the test.
3. The forward stop must withstand a push-through force of 50 N or the column strength of the largest applicable conductor size, whichever is smaller.

Contact Extraction:

The minimum Extraction Force of a terminal from its cavity shall meet the values shown in the Table 6, SAE J2223-2 for terminal sizes ≤6.3. For terminal sizes >6.3, the values in Table 3 apply. Since pull test values are high for the larger cable sizes, the test may be set up to pull test to the required value rather than to failure.

TABLE 3–TERMINAL-CONNECTOR MINIMUM EXTRACTION FORCE

Cable Size (mm^2)	Primary Lock (Newtons)	Primary and Secondary Lock * (Newtons) per step 5.4.1.3.-B 9,10 of SAE J2223-2.		Primary and Secondary Lock (Newtons) after Temp/Humidity (Section 5.6.2, SAE J2223-2)
		Before Moisture Conditioning	After Moisture Conditioning	
≤ 5.0	80	110	110	50
>5.0 ≤8.0	125	175	175	75
> 8 and < 32	200	235	235	115
≥ 32	330	450	450	225

* includes connectors not designed for use with secondary lock.

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5.4.2 CONNECTOR-CONNECTOR MATING/UN-MATING FORCE (NON-MECHANICAL ASSIST CONNECTORS)

Complete the Connector-Connector Mating/Un-mating Force (Non-mechanical Assist Connectors) per SAE J2223-2.

5.4.3 CONNECTOR TO CONNECTOR MATING AND UN-MATING FORCES (CONNECTORS WITH MECHANICAL ASSIST)

Complete the Connector-to-Connector Mating and Un-mating Force (Connectors with Mechanical Assist) per SAE J2223-2.

5.4.4 POLARIZATION FEATURE EFFECTIVENESS

Complete the Polarization Feature Effectiveness test per SAE J2223-2.

5.4.5 MISCELLANEOUS COMPONENT ENGAGE/DISENGAGE FORCE

Complete the Miscellaneous Component Engage/Disengage Force test per SAE J2223-2.

5.4.6 VIBRATION/MECHANICAL SHOCK

Complete the Vibration/Mechanical Shock test per SAE J2223-2. Circuit monitoring and Dry Circuit testing are not required unless the connector contains terminals intended to operate below 20 V. See paragraph 5.1.

5.4.7 CONNECTOR-TO-CONNECTOR AUDIBLE CLICK

Conduct the Connector-to-Connector Audible Click test per SAE J2223-2.

5.4.8 CONNECTOR DROP TEST

Conduct the Connector Drop Test per SAE J2223-2.

5.4.9 CAVITY DAMAGE SUSCEPTIBILITY

Conduct the Cavity Damage Susceptibility test per SAE J2223-2.

5.5 Connector - Electrical Tests

5.5.1 ISOLATION RESISTANCE

Conduct the Isolation Resistance Test as specified in SAE J2223-2 except set the Megohmeter to 1000 VDC. The acceptance requirement is as follows:

The resistance between every combination of two adjacent terminals in the CUT shall exceed 100 MΩ at 1000 VDC. This includes terminals that may be separated by one or more vacant terminal cavities.

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5.5.2 Dielectric Withstand Voltage

5.5.2.1 Purpose

This test is used to determine the potential for break-down of the insulating materials between adjacent circuits in the connector.

5.5.2.2 Equipment

⇒ High Potential Tester with load meter. As required – see Table 4.

5.5.2.3 Procedure

1. Prepare 10 mated pair connector samples per section 5.1.6, SAE J2223-2, Terminal Sample Preparation, using the largest wire gage size appropriate to the design.

NOTE—When conducting this test as part of a sequence as in section 5.9:
For sealed connector pairs, all Dielectric Tests shall be started within one hour and completed within three hours of any environmental conditioning.
For unsealed connector pairs, condition all parts for ≥3 hours in laboratory ambient environment prior to conducting Dielectric Strength measurements.

2. Select the voltage to be applied to the samples from Table 4. Either AC or DC voltage may be used.

TABLE 4—DIELECTRIC WITHSTAND VOLTAGE

Connector Rated Voltage	AC Applied Voltage	DC Applied Voltage
50-100	1000	1600
110-300	1600	2500
300-600	1000+ 2X (where X is the connector rated voltage	1600+ 3.2X (where X is the connector rated voltage)

3. Connect the circuits in the connector as shown in Figure 4 and apply the voltage chosen in step 2 to the adjacent contacts for ≥60 seconds. Record leakage current.
4. Connect all circuits together and apply a foil wrap to the outside of the connector. Apply the voltage between the foil and circuit array for one minute. Record results.

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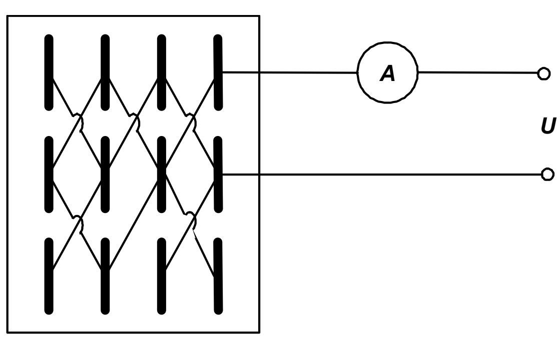

FIGURE 4—METHOD OF CONNECTING LEADS FOR ISOLATION RESISTANCE TEST

5.5.2.4 Acceptance Requirements

There shall be no dielectric break-down or flash-over between individual cavities or between cavities and the outside of the connector at any time during the test.

5.6 Connector Environmental Tests

5.6.1 THERMAL SHOCK

Conduct the Thermal Shock test per SAE J2223-2. Circuit Monitoring and Dry Circuit measurements are not required unless the design being tested contains circuits operating at less than 20 V.

5.6.2 TEMPERATURE/HUMIDITY CYCLING

Complete the Temperature/Humidity Cycling test per SAE J2223-2. Dry Circuit measurements are not required unless the design being tested contains circuits intended to operate at less than 20 V. Take measurements only on those contacts if present.

5.6.3 HIGH TEMPERATURE EXPOSURE

Conduct the High Temperature Exposure test per SAE J2223-2. Dry Circuit testing is not required unless the design contains circuits intended to operate at less than 20 V. Take measurements only on those contacts if present.

5.6.4 FLUID RESISTANCE

Conduct the Fluid Resistance test per SAE J2223-2.

5.6.5 SUBMERSION

Conduct the Submersion test per SAE J2223-2.

5.6.6 PRESSURE/VACUUM LEAK

Conduct the Pressure/Vacuum Leak test per SAE J2223-2.

5.7 Special Tests

5.7.1 HEADER PIN RETENTION

Conduct the Header Pin Retention test per SAE J2223-2. Acceptance requirements are shown in Table 5.

TABLE 5—MINIMUM HEADER PIN DISPLACEMENT FORCE

Terminal Blade Width	Minimum Displacement Force
0.64	15 N
≥1.5	50 N

NOTE—Values for terminal sizes falling between table values 0.64 and 1.5 are calculated by interpolation (15 N to 50 N). Use the nominal blade width (0.64, 0.8, 1.2, etc.) for these calculations.

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5.7.2 CONNECTOR MOUNTING FEATURE MECHANICAL STRENGTH

Conduct the Mounting Feature Mechanical Strength test per SAE J2223-2.

5.8 Severe Duty Tests

Conduct the severe duty tests when required per SAE J2223-2.

5.8.1 HIGH PRESSURE SPRAY

Conduct the High Pressure Spray test per SAE J2223-2. This test is required for all sealed High Power Connectors. Complete 72 hours of heat age at class temperature prior to the High Pressure Spray test.

5.8.2 SEVERE VIBRATION

Conduct the Severe Vibration test when required per SAE J2223-2.

5.9 Test Sequence

5.9.1 GENERAL NOTES

1. The test sequences in this section represent the order in which tests are performed. The sequence should be logical and interrelated in order to accurately establish the performance characteristics of the component or assembly.
2. Numbers in the body of Sections 5.9.3-5.9.8 indicate the order in which the tests or conditioning procedures are performed. Where there are duplicate numbers in the same column, the procedures are performed concurrently.
3. Destructive tests should be performed only on samples that are not intended for use in further test sequences.
4. The Dry Circuit Resistance test per SAE J2223-2, when required, should always be performed before any other electrical test and prior to sample movement. Dry Circuit Resistance testing is not required for contacts operating above 20 volts.
5. Fixtures and test set-ups should be reviewed by the Authorized Person prior to the start of testing.
6. The sequential test tables in this section are base sequences and may be altered at the discretion of the Authorized Person.
7. The total number of test samples needed for sequential tests is shown at the top of each column. It is important to note that, where parallel test paths are shown, a separate set of samples is required for each path. The same set of samples is never run through one path and then used again for a parallel test path unless specifically required in the test request/order. Exceptions are noted in each flow chart.

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5.9.2 GENERAL TEST FLOW CHART

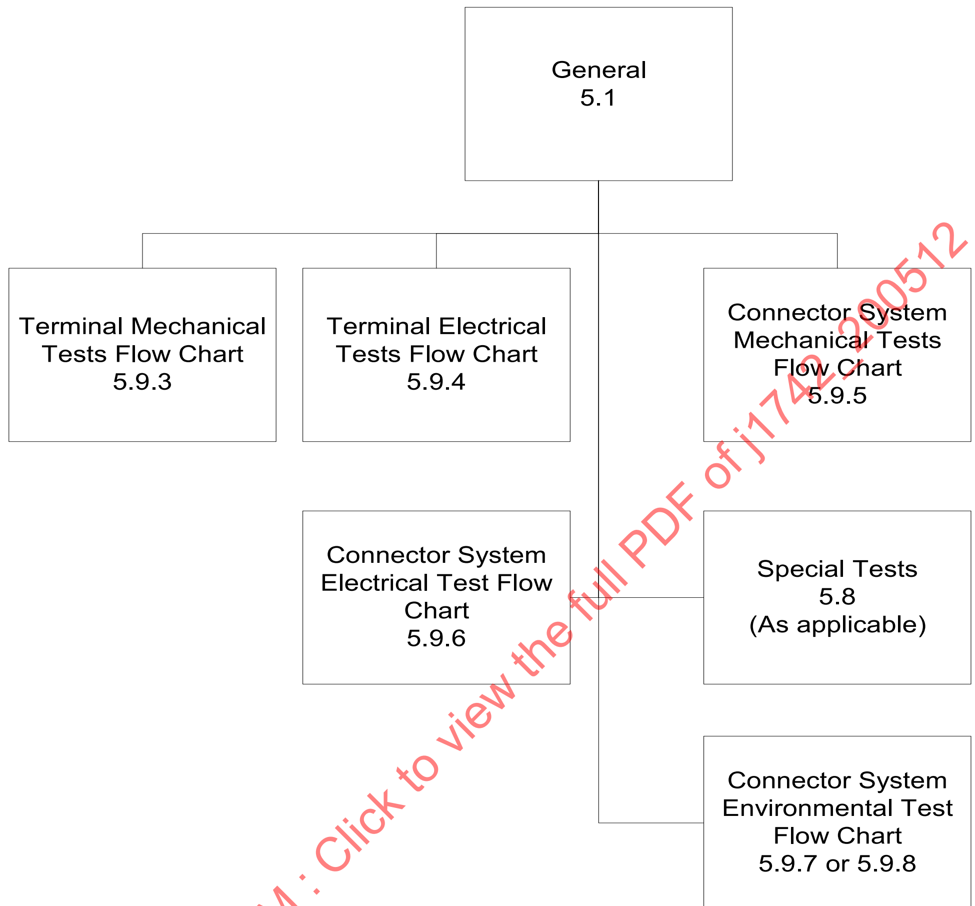

FIGURE 5—GENERAL TEST FLOW CHART

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TABLE 5—SECTIONS 5.9.3 TERMINAL MECHANICAL, 5.9.4 TERMINAL ELECTRICAL, AND 5.9.5 CONNECTOR SYSTEM MECHANICAL TEST SEQUENCES

Section	Flow Chart	5.9.3			5.9.4	5.9.5								
	Test	Term. - Term. Engage/Disengage Force	Terminal Bend Resistance	Terminal to Conductor Attachment (crimp) Pull-out Force	Maximum Current/Current Cycling	Term.-Conn. Insertion/Extraction	Misc. Component Engage/Disengage	Audible Click	Conn. Conn Mating/Un-mating	Polarization Effectiveness	Drop	Cavity Damage	Header Pin Retention	Mounting Feature Mech Strength
	Sequence ID	**A**	**B**	**M**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
	Sample Size (Refer to individual procedures)	10	15/30	20	10/30	10	10(1)	8	15	(2)	3	5	20	20
5.1	General	1	1	1	1	1	1	1	1	1	1	1	1	1
5.1.8	Visual Inspection	2, 4	2, 4	2	2, 5	2, 4	2, 4	2, 4	2, 4	2, 4	2, 4	2, 4	2, 4	2, 4
5.2.1	Terminal to Terminal Engage/Disengage Force	3												
5.2.2	Terminal Bend Resistance		3											
	Terminal/Conductor Attachment			3										
5.3.3	Maximum Test Current Capability				3									
5.3.4	1008 Hour Current Cycling				4									
5.4.1	Terminal - Connector Insertion/Extraction Force					3								
5.4.2	Connector-Connector Mating/Unmating Force (Non-mechanical Assist Connectors)								3					
5.4.3	Connector to Connector Mating and Unmating forces (Connectors with Mechanical Assist								3					
5.4.4	Polarization Feature Effectiveness									3				
5.4.5	Miscellaneous Component Engage/Disengage Force						3							
5.4.7	Connector-to-Connector Audible Click							3						
5.4.8	Connector Drop Test										3			
5.4.9	Cavity Damage											3		
5.7.1	Header Pin Retention												3	
5.7.2	Connector Mounting Feature Mechanical Strength													3

1. 10 samples for each applicable Misc. Component Engage/Disengage Force test.
2. Sample size for Polarization Effectiveness is determined by the procedure.

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TABLE 6—SECTIONS 5.9.6 CONNECTOR SYSTEM ELECTRICAL, 5.9.7 SEALED CONNECTOR SYSTEM ENVIRONMENTAL, AND 5.9.8 UN-SEALED CONNECTOR SYSTEM ENVIRONMENTAL TEST SEQUENCES

Section	Flow Chart	5.9.6[2]				5.9.8[4]					5.9.7		
	Test	Vibration	Thermal Shock	Temp./Humidity	High Temp Exposure	Fluid Resistance	Temp/Humidity-Submersion	Temp/Humidity-PV Leak	High Temp Exposure-Submersion	High Temp Exposure- PV Leak	Temp/Humidity(10)	Pressure\Vacuum Stand Alone	High Pressure Spray
	Sequence ID	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**	**X**
	Sample Size (Refer to individual procedures)	10	10	10	10	8	10	10	10	10	10	10	10
5.1	General	1	1	1	1	1	1	1	1	1	1	1	1
5.1.8	Visual Inspection	2, 8	2, 8	2, 10	2, 8	2, 7	2, 10	2,10	2, 10	2, 10	2,8	2,6	2, 8
5.1.7	Connector Cycling	3	3	3	3		3	3	3	3			3
5.1.9	Circuit Continuity Monitoring	5	5										
5.3.2	Voltage Drop	7	7	7[10]	7								
5.4.1	Terminal-Connector Extraction Force			9							7		
5.4.6	Vibration/Mechanical Shock	5											
5.5.1	Isolation Resistance			8[3, 10]		3, 5	4, 6, 8	4, 6, 8	4, 6, 8	4, 6, 8	3,5[3]		4,6
5.5.2	Dielectric Break-down					6	9	9	9	9	6		7
5.6.1	Thermal Shock		5									5	
5.6.2	Temperature/Humidity Cycling			5			5[8,7]	5[8,7]					
5.6.3	High Temperature Exposure				5				5[8,7]	5[8,7]			
5.6.4	Fluid Resistance					4							
5.6.5	Submersion						7[6,8,9]		7[6,8,9]				
5.6.6	Pressure/Vacuum Leak							7[5,8,9]		7[5,8,9]			
5.8.1	High Pressure Spray												5

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