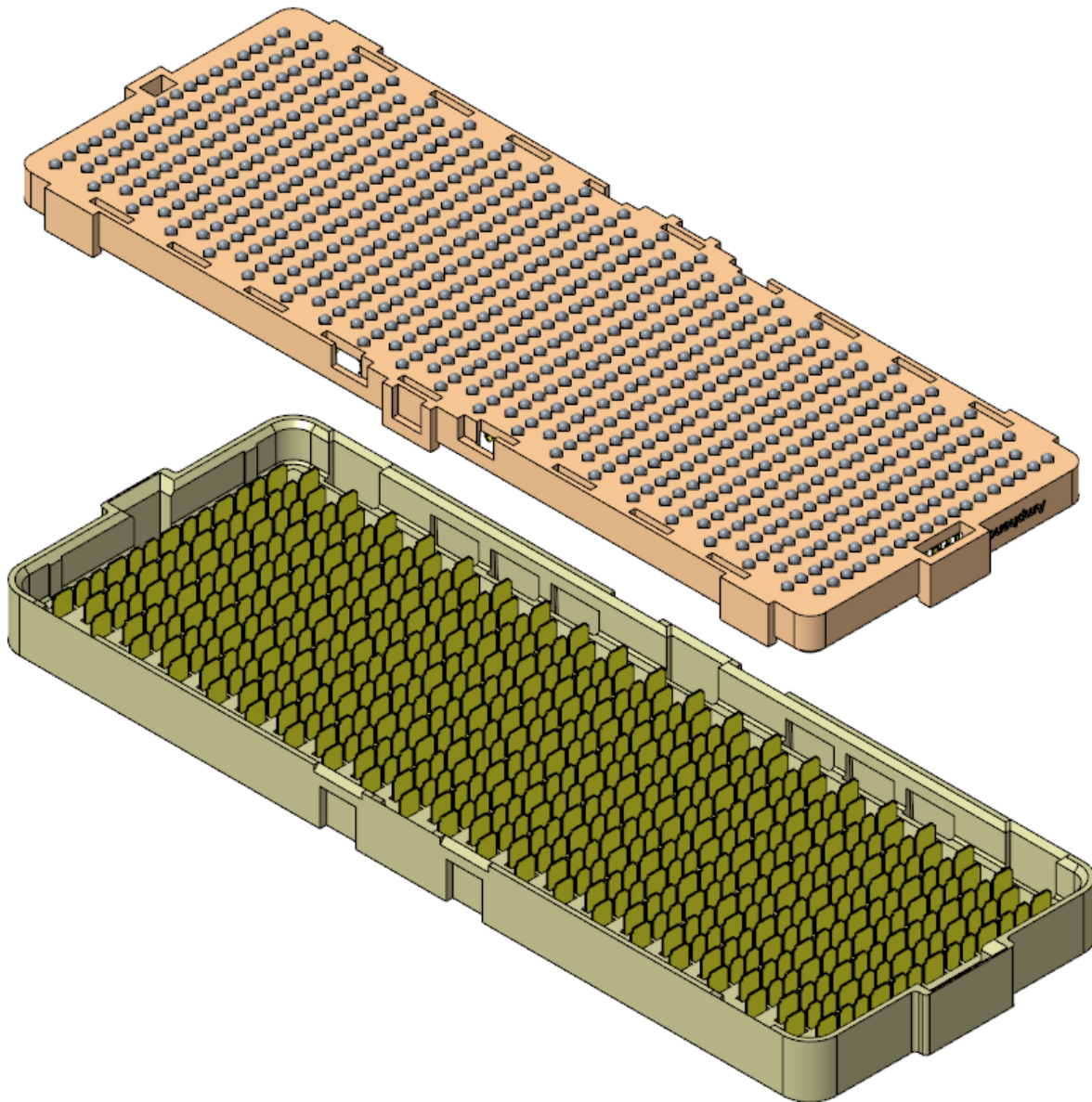


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M-Series™ Connector System



4 Pair, 40 Column, 5mm High Version Shown

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1.0 OBJECTIVE

This specification defines the performance, test, quality, and reliability requirements of the M-Series™ Connector System with BGA termination.

2.0 SCOPE

This specification is applicable to the termination characteristics of the M-Series™ Connector System which provides for parallel interconnection of printed wiring boards in low power applications. It covers product offerings of Lead Free BGA that meets the requirements of the European Union Directive of Restrictions for Hazardous Substances (Directive 2002/95/EC). On the contact interface end, it covers precious metal plating thicknesses of 0.76 microns (30µ”).

3.0 APPLICABLE DOCUMENTS

3.1 AICC Specifications

- Applicable AICC product customer drawings
- AICC Application Specification GS-20-0553 (M-Series™ BGA Connectors)
- GS-15-0111: Nickel Plating
- GS-15-011: GXT Plating
- GS-15-012: Gold Plating
- GES-14-455: Packaging of MEG-Array® Product
- BUS-19-124: Solderball to Terminal Tensile Test Procedure
- BUS-19-125: MEG-Array® Conn. 3 Point Bend Test Procedure
- BUS-03-601: Current Rating

3.2 Other Standards and Specifications

- UL-94V-0: Test for Flammability of plastic Materials in Devices and Appliances
- EIA 364: Electrical Connector/Socket Test Procedures Including Environmental Classifications
- GR-1217-CORE: Telcordia Specification “Generic Requirements for Separable Electric Connectors”
- IPC-9701: “Performance Test Methods and Qualification Requirements for Surface Mount Solder Attachments”
- IEC 60512: Connectors for Electronic Equipment – Tests and Measurement
- ASTM B888: Copper-Iron-Phosphorus Alloy
- ASTM B422: Copper-Nickel-Cobalt-Silicon
- ASTM D5138: Std Specification for Liquid Crystal Polymers
- ANSI/J-STD-005: Requirements for Soldering Pastes
- ANSI/J-STD-004: Requirements for Soldering Fluxes
- IEC 68-2-60 Ke: Flowing mixed gas Corrosion Test
- ANSI-J-002: Solderability Tests for Component Leads, Terminations, Lugs, Terminals & Wires (paragraph 3.4.2 Steam Aging)
- EIA-638 - Surface Mount Solderability Test
- UL 1977: Standard for Component Connectors for Use in Data, Signal, Control and Power Applications

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3.3 AICC Product Qualification Reports

- EL-2019-05-007 (Product qualification test report, M-Series™ Connector System, 12 column, 5mm stack height)
- EL-2022-09-003 (Product qualification test report, M-Series™ Connector System, 24 column, 4mm stack height)
- EL-2023-01-042 (Product qualification test report, M-Series™ Connector System, 40 column, 11mm stack height)

4.0 REQUIREMENTS

4.1 Qualification

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

4.2 Materials

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

- Terminals: Copper alloy.
- Plating: 0.76 µm GXT or Au over 1.27 µm Ni.
- Housings: High temperature thermoplastic, UL 94V-0 compliant.
- Vacuum caps: High temperature thermoplastic, UL 94V-0 compliant.
- Solder spheres: Tin lead, or lead free alloy.

4.3 Design and Construction

The connector shall be a multi-piece assembly having an array of contacts with solder balls attached, for installation on surface mount printed wiring boards or flexible circuits.

- Mating: The connector shall be capable of mating and un-mating manually without the use of special tools.

4.4 Visual inspection

Visual inspections shall be performed using 10x magnification. Parts should be free from blistering, discoloration, cracks, etc.

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5.0 ELECTRICAL CHARACTERISTICS

5.1 Contact Resistance, Low Level (LLCR)

Measurements shall be performed using a four wire method per EIA 364-23. The initial low level contact resistance shall not exceed 20mΩ (5mm stack height). After environmental exposure, the increase in LLCR shall not exceed 10mΩ. The following details shall apply:

- Test Voltage: 20 mV DC maximum open circuit
- Test Current: 100 mA maximum
- Number of readings: 500 minimum

5.2 Current Rating

5.2.1 General Criteria

The following details shall apply:

- Test Specification: EIA 364-70 or IEC 60512-5-1 or IEC 60512-5-2
- Ambient Temperature: 25°C
- Airflow: None (still-air)
- Reference – BUS-03-601

5.2.2 General Application

- Measure temperature versus applied current.
- 12 columns powered.
- Thermocouple location: Mechanically attached to the base of a terminal located approximately in the center of the pin field. See Figure 2.
- Plug and receptacle connectors are to be soldered to standard continuity test boards.
- The temperature-rise above ambient shall not exceed 30°C at 0.5A per contact.

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5.2.3 Power Application

- Measure temperature versus applied current.
- Powered contact configurations to be qualified are represented in the supporting table.
- Thermocouple attachment: Mechanically attached to the base of the receptacle mating beams.
- Thermocouple location: One thermocouple in a central position of each column tested. Columns with thermocouples are noted in the supporting table.
- Plug and receptacle connectors are to be soldered to T-Rise test boards. Power is applied to connectors through wires screwed to input/output pads of test boards.
- The temperature-rise above ambient shall not exceed 30°C at the current levels noted in the supporting table. Actual output curves shall be plotted up to 50°C T-rise.

TEST CONFIGURATIONS 5mm Stack Height		Total Number of Columns in Test Sample: 12 Number of Powered Contacts within each Column: 13	
Columns Fully Powered	Columns with Thermocouples	Current Rating per Contact	Current Rating per Column
#6 & #7	Between #6 & #7	2.6A	33.8A
#1 thru #12	Between #6 & #7	1.5A	19.5A

Current-rating per contact drops as the number of adjacent powered columns increase. This is due to the cumulative heating effect of multiple columns powered in still-air test conditions.

5.3 Insulation Resistance

The insulation resistance of mated connectors shall not be less than 1000 MΩ after environmental exposure when measured in accordance with EIA 364-21. The following details shall apply:

- Test Voltage: 500 volts DC.
- Electrification Time: 60 seconds, unless otherwise specified.
- Points of Measurement: between adjacent and opposing contacts.
- Number of measurements: 30 (10 readings per loose piece connector set)

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5.4 Dielectric Withstanding Voltage (DWV)

There shall be no evidence of arc-over, insulation breakdown, or excessive current leakage (> 1.0 mA) when mated connectors are tested in accordance with EIA 364-20. The following details shall apply:

- Test Voltage: 500 volts (DC or AC RMS).
- Test Duration: 60 seconds.
- Test Condition – 1 (760 Torr – sea level).
- Voltage application rate: 500 V per second
- Points of Measurement: between adjacent and opposing contacts.
- Number of measurements: 30 (10 readings per loose piece connector set)

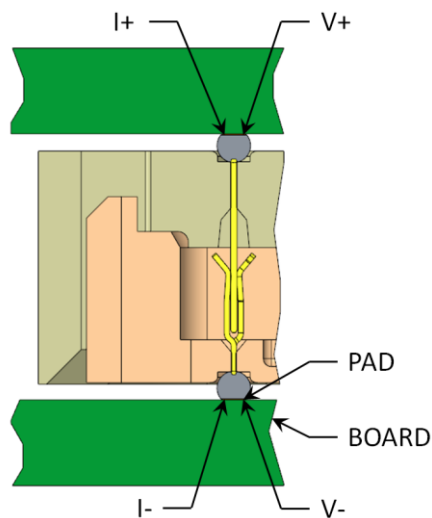


FIGURE 1

Termination Resistance Measurement Points

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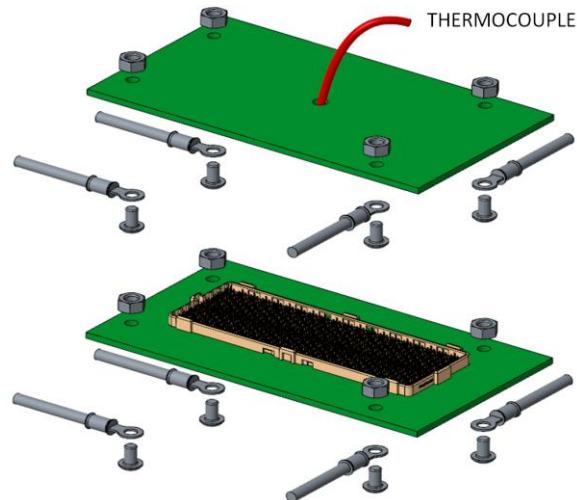


FIGURE 2
Maximum Current Set-up

6.0 MECHANICAL CHARACTERISTICS

6.1 Mating / Un-mating Force

Perform in accordance with EIA 364-13. The force to mate two compatible connectors shall not exceed 0.31 N per contact. The un-mating force shall not be less than 0.09 N per contact. The following details shall apply:

- Cross head speed: 5mm per minute.
- No lubrication.
- Utilize free floating fixtures
- Number of mating / un-mating cycles: 3

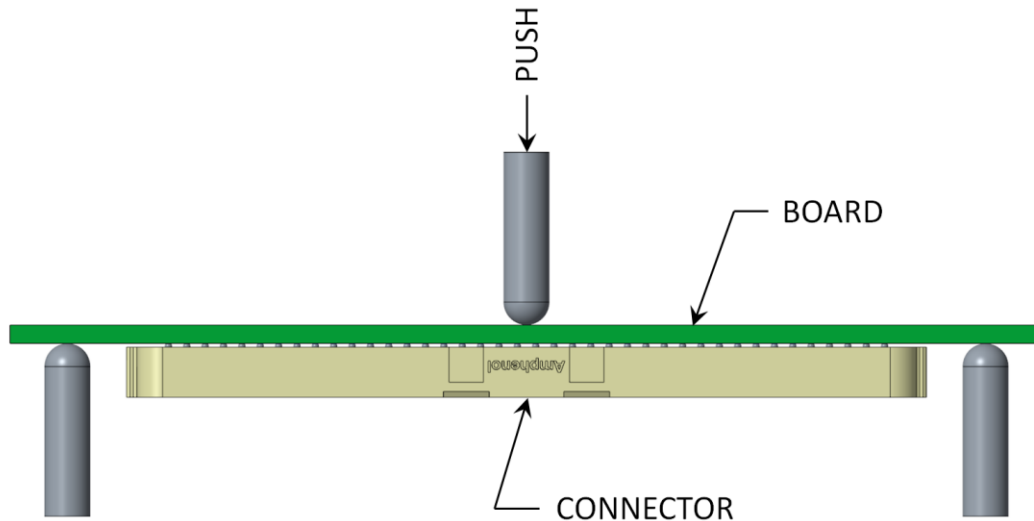
6.2 Solderball Pull Strength of Signal Contacts

The solderball pull strength in "Z" axis shall not be less than 750gms per contact when tested in accordance with BUS-19-124. Connectors are not soldered onto board. The housing is held in a fixture while each terminal is gripped in a vise and pulled vertically out of the housing. The terminal is stripped out of the ball, leaving the ball on the housing bottom. 10 contacts per sample shall be tested in this method.

6.3 Three Point Bend Test

The connectors are to be soldered onto test boards and flexed as shown in the figure below. The test board is to be deflected to a distance of 0.51mm per 25.4mm (20mils/inch) of board support distance. Dye penetrant is applied to solder joints and dried. Connector is pried off board and solder joints are visually inspected for cracks that occurred during bending. Per BUS-19-125 3-Point Bend Procedure.

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7.0 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 sections 5.0 & 6.0 as specified in the Table 1 test sequences. Unless specified otherwise, the products shall be mated during exposure.

7.1 Mechanical Shock

Perform in accordance with EIA-364-27, condition H. The following details shall apply:

- Amplitude: half sine 30G
- Duration: 11 milliseconds
- Number of shocks: 3 shocks along each of three orthogonal axis (18 shocks total)
- Mounting: rigidly mounted assemblies
- Monitor contacts in series, no discontinuities greater than 1 microsecond
- After completion of test in all three axes, connector shall meet post environmental LLCR requirement

7.2 Vibration

Perform in accordance with EIA-364-28, condition 2. The following details shall apply:

- Vibration amplitude: 1.5 mm (0.06 inch) double amplitude or 10G acceleration
- Frequency range: 10 to 500 to 10 Hz
- Sweep time: 15 minutes per cycle
- Duration: 2 hours along each of three orthogonal axes (6 hours total)

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- Mounting: rigidly mounted assemblies
- Monitor contacts in series, no discontinuities greater than 1 microsecond

7.3 Temperature Cycling

Perform in accordance with EIA-364-32 and IPC-9701. The following details shall apply:

- Prior to testing, test chamber must be characterized per VGLAB-016
- Temperature range: Between 0 +0/-10°C and 100 +10/-0 °C; Temperature shall be measured and recorded using a thermocouple mounted on the test board, as close to the center of the BGA pattern as possible.
- Heat transfer rate (at the sample-mounted thermocouple): less than 20 °C per minute
- Dwell time at each temperature extreme (at the sample-mounted thermocouple): 10 minutes.
- Number of cycles: 1000 cycles.
- Duration of each cycle: approximately 46 minutes (31 cycles per day)
- Sample resistance shall be monitored during test. An event is defined as a 100% increase in resistance or an electrical open. A failure is defined as 10 consecutive events.

7.4 High Temperature Life

Perform in accordance with IEC 60512-11-4 or EIA-364-17. Connectors shall be mated without any electrical load. The following details shall apply:

- Test Temperature – 105 °C±5°C
- Test Duration – 500 hours

7.5 Thermal Shock

Perform in accordance with IEC 60512-11-4 or EIA-364-32, Method A, Condition 1. Connectors shall be mated without any electrical load. The following details shall apply:

- Number cycles: 5
- Temperature range: -55°C to +85°C
- Temperature dwell: 30 minutes
- Temperature transfer rate: 30 seconds maximum
- 1µsecond event detection

7.6 Steady State Humidity

Perform in accordance with EIA-364-31, Method II: Connectors shall be tested at accelerated humidity. Upon completion of exposure period, they shall be conditioned at room ambient for a period of four hours. The following details shall apply:

- Relative Humidity 95%
- Temperature 40°C
- Test Condition A (96 hours)

7.7 Industrial Mixed Flowing Gas (class IIA, 4 gas)

Samples shall be exposed to a gas mixture per Telcordia GR-1217-CORE, section 9.1.3. The header sample set shall be placed into the gas chamber, in an un-mated state, for a total of 10 days. Upon completion of those 10days, the exposed samples shall be mated with the receptacle sample set and placed back into the gas chamber mated for an additional 10 days. Details are as follows:

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- Temperature: 30° C
- Relative humidity: 70%
- Gas composition (central office): 200 ppb NO₂, 10 ppb H₂S, 10 ppb Cl₂, 100 ppb SO₂

7.8 Durability

Perform in accordance with IEC 60512-9-1 or EIA 364-09. The following details shall apply:

- The connector halves shall be mated/unmated the following number of cycles according to the plating thickness being tested:

0.76µm (30µ") thick Au or GXT	200 cycles (total)
-------------------------------	--------------------

- After cycling, the contacts shall meet the requirements of paragraphs 5.1.1 and or 5.1.2 of this specification. The test shall be performed with plug & receptacle soldered to board.
- Cycling rate: 50mm±5mm (2 inches) per minute

7.9 Dust

Perform in accordance with EIA-364-91. Samples shall be exposed for one hour to a benign dust composition as per table A.1 of the EIA specification.

- Only the header connector assemblies shall be subjected to dust exposure

7.10 Thermal Disturb

Perform in accordance with EIA 364-110, Condition A (+15°C to +85°C 10 cycles)

8.0 QUALITY ASSURANCE PROVISIONS

8.1 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.

8.2 Inspection Conditions

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

- Temperature: 25 ± 5° C.
- Relative Humidity: 20% to 60%
- Barometric pressure: Local ambient

8.3 Sample Quantity and Description

Samples used for qualification testing shall be samples that were manufactured using standard production equipment and procedures. The quantity of samples needed for each test sequence is shown in Tables 3 & 4.

8.4 Acceptance

Electrical and mechanical requirements placed on test samples as indicated in the sections of this specification 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.

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Failures attributed to equipment, test set-up or operator error shall not disqualify the product. If product failure occurs, corrective action shall be taken and samples resubmitted for qualification.

8.5 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, components and assemblies produced to latest print revision, verification of plating composition and thickness, etc.

8.6 Re-qualification testing

If any of the following conditions occur, the responsible Product Engineer shall initiate re-qualification testing consisting of all applicable parts of the qualification test matrix.

- 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.
- A significant change is made to the manufacturing process, which impacts the product form, fit or function.
- 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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8.7 Qualification Testing Sequences

8.7.1 Table 1: Qualification Test Matrix, General Application

TEST GROUP ID ▶		1	2	3	4	5	6	7	8	9
TEST DESCRIPTION	SECTION	Current Rating	IR & DWV	Solderball Pull	3 Point Bend	Mech. Shock & Vibration	Temp Cycling	Temp Life	Thermal Shock & Humidity	MFG
VISUAL INSPECTION	4.4	1,3	1,4,8,12	1,3	1,3	1,13	1,3	1,7	1,13	1,13
ELECTRICAL:										
CONTACT RESISTANCE, LOW LEVEL	5.1.1					2,4,6,8,10,12		2,5	2,4,6,8,10,12	2,4,6,8,10,12
CURRENT RATING	5.2	2								
INSULATION RESISTANCE	5.3		2,6,10							
DIELECTRIC WITHSTANDING VOLTAGE	5.4		3,7,11							
MECHANICAL:										
MATING / UNMATING FORCE	6.1								See note 4	
SOLDERBALL PULL STRENGTH	6.2			2						
3 POINT BEND TEST	6.3				2					
ENVIRONMENTAL:										
MECHANICAL SHOCK	7.1					9				
VIBRATION	7.2					7				
TEMPERATURE CYCLING	7.3						2			
HIGH TEMPERATURE LIFE	7.4							4		
THERMAL SHOCK	7.5		5						3	
STEADY STATE HUMIDITY & TEMPERATURE	7.6		9						9	
MFG, UN-MATED, 10 DAYS	7.7									5 ³
MFG, MATED, 10 DAYS	7.7									7
DURABILTY	7.8					3 ¹ , 11 ²		3,6	5 ¹ , 11 ²	3 ¹ , 11 ²
DUST	7.9					5			7	
THERMAL DISTURB	7.10									9

NOTES:

1. Perform half of the specified number of durability cycles. (subtract out any number of cycles needed to perform measurements and other test sequences)
2. Perform second half of the specified number of durability cycles. (subtract out any number of cycles needed to perform measurements and other test sequences)
3. Only expose header samples for this sequence to this step.
4. Record mating and un-mating forces on first three cycles of durability.

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8.7.2 Table 2: Qualification Test Matrix, Power Application

TEST GROUP ID ►		1
TEST DESCRIPTION	SECTION	Current Rating
VISUAL EXAMINATION	4.4	1,3
ELECTRICAL:		
CONTACT RESISTANCE, SPECIFIED CURRENT	5.1.2	
CURRENT RATING	5.2	2
INSULATION RESISTANCE	5.3	
DIELECTRIC WITHSTANDING VOLTAGE	5.4	
MECHANICAL:		
MATING / UNMATING FORCE	6.1	
ENVIRONMENTAL:		
MECHANICAL SHOCK	7.1	
VIBRATION	7.2	
HIGH TEMPERATURE LIFE	7.4	
THERMAL SHOCK	7.5	
STEADY STATE HUMIDITY & TEMPERATURE	7.6	
MFG, UN-MATED, 10 DAYS	7.7	
MFG, MATED, 10 DAYS	7.7	
DURABILITY	7.8	
DUST	7.9	
THERMAL DISTURB	7.10	

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8.7.3 Table 3: Qualification Sample Requirements, General Application

TEST GROUP ID ►	1	2	3	4	5	6	7	8	9
SAMPLE DESCRIPTION	Current Rating	IR & DWV	Solderball Pull	3 Point Bend	Mech. Shock & Vibration	Temp Cycling	Temp Life	Thermal Shock & Humidity	MFG
CONNECTOR PAIRS	1	3	3	3	6	30	3	3	3
LLCR TEST BOARD SETS					3		3	3	3
CONTINUITY TEST BOARD SETS	1			3	3	30			

8.7.4 Table 4: Qualification Sample Requirements, Power Application

TEST GROUP ID ►	1
SAMPLE DESCRIPTION	Current Rating
CONNECTOR PAIRS	1
T-RISE TEST BOARD SETS	1

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9.0 REVISION RECORD

REV	PAGE	DESCRIPTION	EC #	DATE
A	All	Initial Release	-	2019-12-11
B	All	All references of M-Series™ 56 revised to M-Series™ Added AICC Product Qualification Report numbers to section 3.3	V-48591	2023-06-26