Excellent Integrated System Limited

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Molex Connector Corporation
0347920080

For any questions, you can email us directly:
sales@integrated-circuit.com

PRODUCT SPECIFICATION

1.0 SCOPE

This product specification covers the 0.50 mm (0.0197 inch) terminal system on a 2.0mm (0.0787 inch) centerline (pitch) single row and dual row Mini 50 unsealed wire to board connection system terminated with 0.35mm^2 to 0.13mm^2 wire using crimp technology.

2.0 PRODUCT DESCRIPTION

2.1 PRODUCT NAME AND SERIES NUMBERS

2.2 ASSOCIATED TERMINALS

Product Name	Series
24 Way Right Angle Header Assembly	34826
20 Way Right Angle Header Assembly	34826
16 Way Right Angle Header Assembly	34826
12 Way Right Angle Header Assembly	34826
8 Way Right Angle Header Assembly	34793
4 Way Right Angle Header Assembly	34793
24 Way Vertical Header Assembly	34825
20 Way Vertical Header Assembly	34825
16 Way Vertical Header Assembly	34825
12 Way Vertical Header Assembly	34825
8 Way Vertical Header Assembly	34792
4 Way Vertical Header Assembly	34792
24 Way SMT Header Assembly	34897
20 Way SMT Header Assembly	34897
16 Way SMT Header Assembly	34897
12 Way SMT Header Assembly	34897
8 Way SMT Header Assembly	34912
4 Way SMT Header Assembly	34912
4 Way Receptacle Connector Assembly	34791
8 Way Receptacle Connector Assembly	34791
12 Way Receptacle Connector Assembly	34824

PRODUCT SPECIFICATION

Product Description	Vendor Part Number
Molex CTX 50 Small Grip Female Receptacle Terminal (.13mm^2)	560023-0421
Molex CTX 50 Medium Grip Female Receptacle Terminal (.22mm^2)	560023-0422
Molex CTX 50 Large Grip Female Receptacle Terminal (.35mm^2)	560023-0448

2.3 DIMENSIONS, MATERIALS, PLATINGS AND MARKINGS

Harness Housings: unfilled PBT
Header Housing: 30% glass fiber SPS
Pins: Copper alloy C26000
Tin Plating: Overall Tin with Nickel under-plate
CPA: 50% glass fiber PA66

2.4 SAFETY AGENCY APPROVALS

UL File Number	Not Applicable
CSA File Number	Not Applicable
TUV License number	Not Applicable

PRODUCT SPECIFICATION

3.0 APPLICABLE DOCUMENTS AND SPECIFICATIONS

Description	Document Number
4 & 8 way single row receptacle assembly sales drawing (charted)	SD-34791-001
12 way dual row receptacle assembly sales drawing (charted)	SD-34824-002
4 & 8 way vertical header assembly sales drawing (charted)	SD-34792-001
12 way vertical header assembly sales drawing (charted)	SD-34825-001
4 & 8 way right angle header assembly sales drawing (charted)	SD-34793-001
12 way right angle header assembly sales drawing (charted)	SD-34826-001
4 & 8 way SMT header assembly sales drawing (charted)	SD-34912-001
12 way SMT header assembly sales drawing (charted)	SD-34897-001
4 & 8 way harness sales drawing (charted)	DU5T-14489-CCA
12 way harness sales drawing (charted)	FU5T-14489-AA
Molex CTX 50 terminal sales drawing (charted)	SD-560023-002
Tray packaging specification (header only)	PK-31301-440
Tube packaging specification (header only)	PK-31301-688
Bulk packaging specification (receptacle assembly only)	PK-31301-538
Application specification	AS-34791-020

PRODUCT SPECIFICATION

4.0 RATINGS

4.1 VOLTAGE

500 VDC MAXIMUM; Per GMW3191, All measured isolation resistances shall be >100MΩ.
14 VDC MAXIMUM; Per NDS24012, An initial leak current of ≤ 10µA and a post endurance leak current of ≤ 1mA.

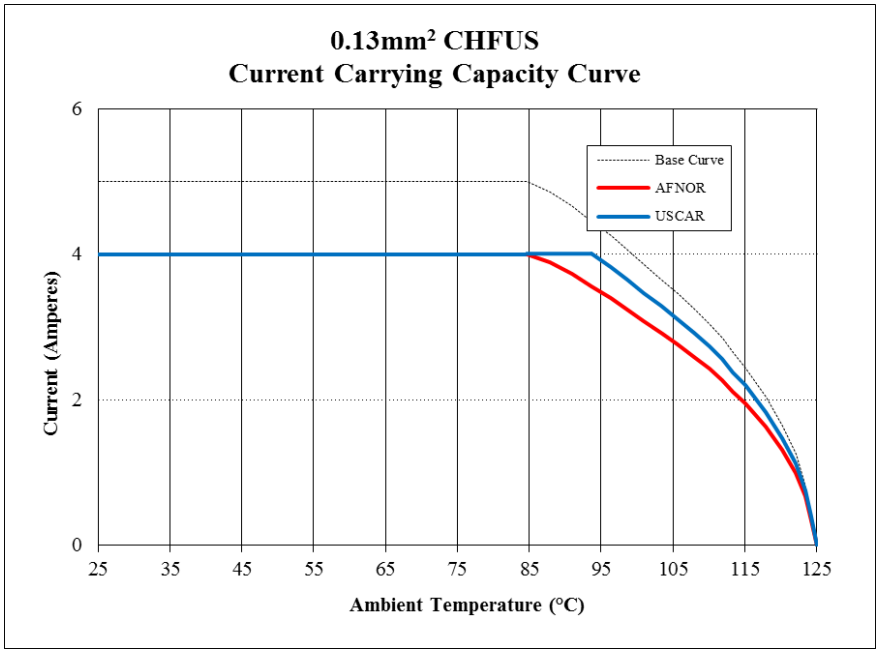
4.2 CURRENT AND APPLICABLE WIRES

Current is dependent on connector size, ambient temperature, blade size and related factors. Actual maximum current rating is application dependent and should be evaluated for each use.

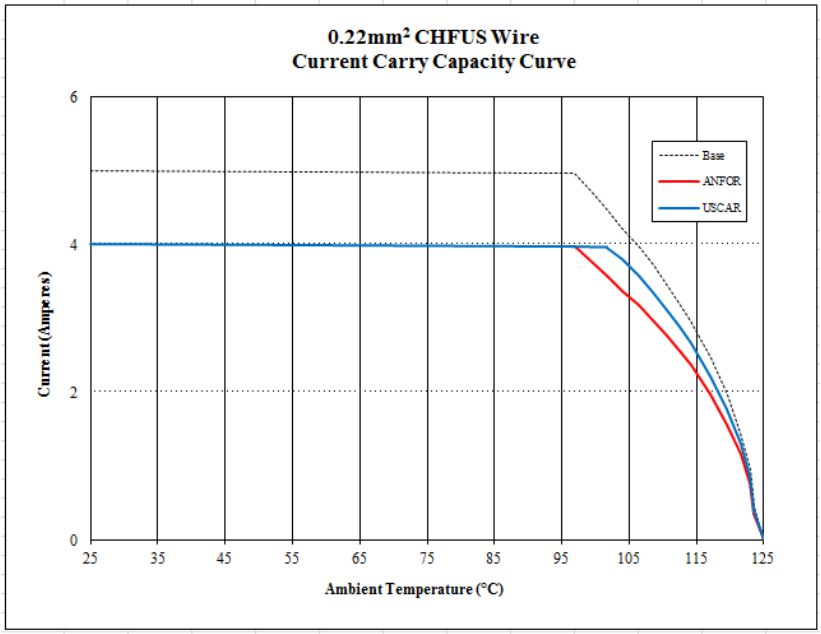
The current listed below is expected to cause a temperature rise in the ***terminal only, outside plastic.***

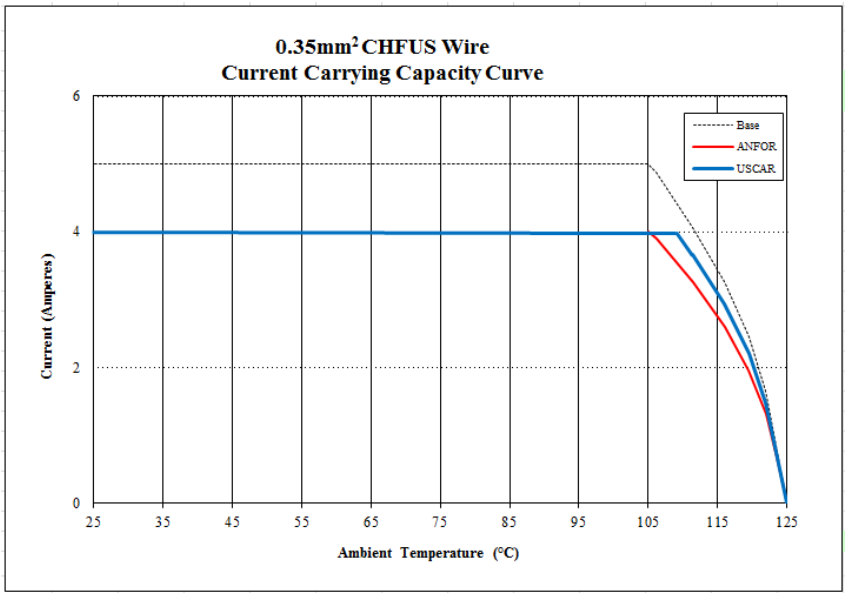
Wire section	Current	Wire range Insulation Diameter
.35 mm^2	see derating curve	1.4 mm MAX (0.055 inch)
.22 mm^2	see derating curve	1.2 mm MAX (0.047 inch)
.13 mm^2	see derating curve	1.05 mm MAX (0.041 inch)

Derating Curves



PRODUCT SPECIFICATION





TEMPERATURE

Operating:	- 40 Cº to + 105 Cº
Non-operating:	- 40 Cº to + 105 Cº

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DOCUMENT NUMBER:	CREATED / REVISED BY:	CHECKED BY:	APPROVED BY:
PS-34791-020	TREVOR MACHUGA	JAROD FISCHER	RON BAUMAN

PRODUCT SPECIFICATION

5.0 PERFORMANCE

5.1 ELECTRICAL PERFORMANCE

ITEM	DESCRIPTION	TEST CONDITION	REQUIREMENT
1	**Contact Resistance (Low Level)**	Mate teminal: apply maximum voltage of **20** mV and a max current of **100** mA.	**20** milliohms MAXIMUM
2	**Contact Resistance @ Rated Current (Voltage Drop)**	Mate terminal: apply **3** A of current with a 0.35mm^2 wire	**20** milliohms MAXIMUM
3	**Isolation Resistance**	Apply a voltage of **500** VDC between adjacent terminals and between terminals to ground.	**100** Meg ohms MINIMUM
4	**Dielectric Strength**	Apply an AC rms voltage of 1000V at 60 Hz across each adjacent cavity and between the terminals to ground	No dielectric breakdown or flash-over shall occur between cavities or between the cavities and the outside of a connector at any time during the test.
5	**Current Carrying Capability**	Mate terminal: Determine the heating curve by measuring the temperature after 1008 cycles (45 minutes ON and 15 minutes OFF per cycle).	**Temperature not to exceed 55° over ambient**
6	**Connector - Connector Overcurrent Loading**	Pass the following current for the specified time below through only one circuit that is arbitrarily selected: (20awg) Current (Amps) — Time **11.0** — **60 Minutes** **13.5** — **200 Seconds** **15.0** — **5 Seconds** **20.0** — **1 Second**	Housing shall not start burning
7	**Leak Current**	Apply 1000V AC with frequencies 50 to 60Hz, having wave-form close to a sinusoidal, between terminals and between housing and terminals. Conditioning consists of exposure to 60±5°C and 90-95% humidity for one hour in a thermo-static and humido-static tank.	**Initial Leak Current** **10** microAmp MAXIMUM **Post Conditioning** **1** milliAmp MAXIMUM

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5.2 MECHANICAL REQUIREMENTS

ITEM	DESCRIPTION	TEST CONDITION	REQUIREMENT
1	**Connector Mate/ Unmate Forces**	Mate and Unmate connector (male to female) at a rate of **50 ± 5** mm (**2 ± ¼** inch) per minute.	**Mate Force** 1.Housing: **20** Newtons MAXIMUM 2.Connector: a.Primary Lock Engaged **22** Newtons MAXIMUM (4 ckt) **35** Newtons MAXIMUM (8 ckt) **36** Newtons MAX (12 ckt) **38** Newtons MAX (16ckt) **47** Newtons MAX (20ckt) **57** Newtons MAX (24ckt) b. Primary Lock Disengaged **30** Newtons MAXIMUM 3.Terminal Partially Installed: **7** Newtons MINIMUM **Unmate Force** 1.Housing a. Primary Lock Disengaged **5** Newtons MAXIMUM b. Primary Lock engaged **110** Newtons MINIMUM 2.Connector a. Primary Lock Disengaged: (4 & 8 Ckt): **20** Newtons MAX Initial **25** Newtons MAX Post 10cycles (12 Ckt): **25** Newtons MAX Initial (16 Ckt): **34** Newtons MAX Initial (20 Ckt): **43** Newtons MAX Initial (24 Ckt): **55** Newtons MAX Initial b. Primary Lock Engaged With Wire Bundle Pull **75** Newtons MINIMUM
2	**Locking Device Strength (Primary Lock Engaged)**	After the 11th mating apply a force to the test sample with the locking device engaged and hold constant for 10+2 seconds.	The force should be **100** Newtons MINIMUM

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3	**Primary Lock Disengage Force (CPA Disengaged)**	Apply a force to push on the lock mechanism and attempt to unmate the connection	**30** Newtons MAXIMUM
4	**Terminal Retention Force (in Housing-Dry as Molded)**	Axial pullout force on the terminal in the housing at a rate of **50 ± 5** mm (**2 ± ¼** inch) per minute.	ISL in Pre-Lock **10** Newtons MINIMUM **5** Newtons MINIMUM Post Cycles
			ISL in Final-Lock **40** Newtons MINIMUM
5	**Terminal Insertion Force (into Housing)**	Apply an axial insertion force on the terminal at a rate of **50 ± 5** mm (**2 ± ¼** inch) per minute.	**5** Newtons MAXIMUM
6	**Forward Stop Force**	Apply an axial insertion force on the terminal at a rate of **50 ± 5** mm (**2 ± ¼** inch) per minute.	**50** Newtons Min.
7	**Terminal - Engagement Force with ISL in Final-Lock**	Apply an axial insertion force on the terminal at a rate of **50 ± 10** mm (**2 ± ¼** inch) per minute.	**30** Newtons Minimum
8	**Connector Audible**	The connector lock must provide audible feedback during connector mating by hand Ambient noise must be between 30 and 50 dB	4&8ckt: **45**dB over Ambient (C scale) 12ckt: **36**dB over Ambient
9	**Terminal/Cavity Polarization 180° Misoriented**	Connector and terminal must be polarized to prevent mating in improper direction	**10** Newtons MINIMUM
10	**Independent Secondary Lock (ISL) Engage Force**	The force to insert the ISL from the pre-lock position to the final-lock position at a rate of **50 ± 5** mm (**2 ± ¼** inch) per minute.	**ISL Insertion w/o terminals (pre to final lock):** **5** Newtons MINIMUM
			ISL Insertion with terminals (pre to final lock): **40** Newtons MAXIMUM
			ISL Insertion with terminal partially installed: **40** Newtons MINIMUM
11	**Independent Secondary Lock (ISL) Disengage Force**	The force to completely disengage the ISL from final-lock position at a rate of **50 ± 5** mm (**2 ± ¼** inch) per minute.	**60** Newtons MAXIMUM
12	**Header Pin Retention Force (in Vertical, Right Angle, &SMT Housing)**	Axial pushout force on the terminal in the housing at a rate of **50 ± 10** mm (**2 ± ¼** inch) per minute.	**15** Newtons MINIMUM

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13	**Insertion / Removal Feeling**	Insert and remove the terminal or the connector, while checking the correctness of the insertion/removal feeling	Connector shall be free of detrimental cracking, rust, play, flaw, deformation, and other defects. Terminal shall be free of catching and / or other abnormality.
14	**Connector Repetitive Mating/Unmating (Single Row)**	Mate and Unmate connector (male to female) at a rate of about **100mm/min**	**After 5cycles** Mating force **20** Newtons Max (primary lock engaged) Unmating force **8** Newtons Min (primary lock disengaged) **After 50cycles** **Voltage Drop** **30** milliohms MAXIMUM Mating force **40** Newtons Max (primary lock engaged) Unmating force **10** Newtons Min (primary lock engaged)
15	**Connector Polarization Feature Effectiveness**	Connector must be polarized to prevent mating with similar connectors - **0° Misorientation for all possible header and receptacle configurations**	**240 Newton Minimum** PolA_recp - PolB_hdr **12Ckt** PolB_recp - PolA_hdr **12Ckt** **220 Newton Minimum** PolA_recp - PolB_hdr **4Ckt** PolB_recp - PolA_hdr **4Ckt** PolC_recp - PolD_hdr **4Ckt** PolD_recp - PolC_hdr **4Ckt** PolA_recp - PolB_hdr **8Ckt** PolB_recp - PolA_hdr **8Ckt** **200 Newton Minimum** **16-20Ckt** PolA_recp - PolB_hdr **190 Newton Minimum** **16-20Ckt** PolB_recp - PolA_hdr **115 Newton Minimum** PolA_recp - PolC_hdr **12Ckt** PolA_recp - PolC_hdr **12Ckt** **110 Newton Minimum** PolA_recp - PolC_hdr **4Ckt** PolA_recp - PolD_hdr **4Ckt** PolC_recp - PolB_hdr **4Ckt**

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			100 Newton Minimum PolC_recp - PolA_hdr **4Ckt** PolD_recp - PolB_hdr **4Ckt** PolB_recp - PolC_hdr **12Ckt**
			95 Newton Minimum PolA_recp - PolC_hdr **8Ckt**
			90 Newton Minimum PolB_recp - PolD_hdr **4Ckt** PolB_recp - PolC_hdr **8Ckt**
			80 Newton Minimum PolB_recp - PolC_hdr **4Ckt** PolD_recp - PolA_hdr **4Ckt**
16	**Pry Resistance**	A pair of connectors shall have one of them secured and the other inserted. Under these conditions, they shall be pried axially, rectangularity, front and rear and right and left around the top with a force of 78N After prying the connectors to two stages of fitting, pull them out. This is one cycle. Subject connectors to 10 cycles and Perform **Contact Resistance @ Rated Current (Voltage Drop)** and **Connector Mate/Unmate Forces** (Primary Lock Engaged),the mate/unmate speed shall be about 100 mm/min.	While being tested, the connectors shall not have any problem in being made electrically alive **Voltage Drop** **30** milliohms MAXIMUM Mate **20** Newtons MAXIMUM Unmate Primary Lock Engaged **20** Newtons MINIMUM
17	**Pry Resistance II**	Pull the female connector wire at a 45º angle in the direction which minimizes the male and female terminal contact at a speed of 5mm/min to 100N. Then decrease the pulling load at the same speed to 0N (No Force)	The waveform slope remained positive when increasing load during pulling and negative when decreasing load
18	**Connector Drop Test**	**System Assembly (Mated & Fully populated) –** Subject the assembly to a fall of 1 meter on each face, except for electrical wire side, onto a concrete floor	No damage or incipient rupture shall be observed.
		Connector Assembly (Unmated & Fully Populated) - Subject the assembly to a fall of 1 meter on each face, except for electrical wire side, onto a concrete floor	No damage or incipient rupture shall be observed.

5.3 ENVIROMENTAL REQUIREMENTS

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ITEM	DESCRIPTION	TEST CONDITION	REQUIREMENT
1	**Durability**	Mate connectors up to **10** cycles prior to environmental tests.	**10** milliohms MAXIMUM
2	**Thermal Shock (Electrical)**	Mate connectors per durability; expose to **300** cycles of: Temperature Cº / Duration (Minutes) **-40 +0/-3** **30** **+105 +3/-0** **30** Perform **Contact Resistance (Low Level)**	**Dry Circuit Resistance** **20** milliohms MAXIMUM & Discontinuity < **1** microsecond
3	**Thermal Shock (Physical)**	Mate connectors per durability; expose to **300** cycles of: Temperature Cº / Duration (Minutes) **-40 +0/-3** **30** **+105 +3/-0** **30** Apply a voltage of **500** VDC per Isolation Resistance	**100** Meg ohms MINIMUM
		Apply an AC rms voltage of 1000V at 60 Hz per Dielectric Strength	No dielectric breakdown or flash-over shall occur between cavities or between the cavities and the outside of a connector at any time during the test.
4	**Thermal Shock (Mechanical)**	Mate connectors per durability; expose to **1000** cycles of: Temperature Cº / Duration (Minutes) **-40 +0/-3** **30** **+105 +3/-0** **30** Unmate connector per Connector Mate/ Unmate Forces	Unmate w/latch **100** Newtons MINIMUM w/o terminals
		Mate connectors per durability; expose to **1000** cycles of: Temperature Cº / Duration (Minutes) **-40 +0/-3** **30** **+105 +3/-0** **30** Extract terminal from housing per Terminal Retention Force (in Housing)	TPA in Final-Lock **30** Newtons MINIMUM
5	**Temperature/ Humidity Cycling (Electrical)**	Mate connectors per durability. Subject connector system to **10** cycles of: **60%** RH **4** hours @ **23** C°; **97%** RH **10** hours @ **55** C°, **2** hour @ **-40** C°; **2** hours @ **105** C° Perform **Contact Resistance (Low Level)** Perform **Contact Resistance @ Rated Current (Voltage Drop)**	**Dry Circuit Resistance** **20** milliohms MAXIMUM **Voltage Drop** **20** milliohms MAXIMUM

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PS-34791-020	**TREVOR MACHUGA**	**JAROD FISCHER**	**RON BAUMAN**

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6	**Temperature/ Humidity Cycling (Physical)**	Mate connectors per durability. Subject connector system to **10** cycles of: **60%** RH **4** hours @ **23** C°; **97%** RH **10** hours @ **55** C°, **2** hour @ -**40** C°; **2** hours @ **105** C° Apply a voltage of **500VDC** per Isolation Resistance	**100** Meg ohms MINIMUM
		Apply an AC rms voltage of 1000V at 60 Hz per Dielectric Strength	No dielectric breakdown or flash-over shall occur between cavities or between the cavities and the outside of a connector at any time during the test.
7	**Temperature/ Humidity Cycling (Mechanical)**	Mate connectors per durability. Subject connector system to **10** cycles of: **60%** RH **4** hours @ **23** C°; **97%** RH **10** hours @ **55** C°, **2** hour @ -**40** C°; **2** hours @ **105** C° Unmate connector per Connector Mate/ Unmate Forces (Connector Holding)	Unmate w/latch **100** Newtons MINIMUM w/o terminals
		Mate connectors per durability. Subject connector system to **10** cycles of: **60%** RH **4** hours @ **23** C°; **97%** RH **10** hours @ **55** C°, **2** hour @ -**40** C°; **2** hours @ **105** C° Extract terminal from housing per Terminal Retention Force (in Housing)	TPA in Final-Lock **30** Newtons MINIMUM
8	**High Temperature Exposure (Electrical)**	Mate connectors per durability. Subject connector system to **105** Cº for **1008** hours. Perform **Contact Resistance (Low Level)** Perform **Contact Resistance @ Rated Current (Voltage Drop)**	**Dry Circuit Resistance** **20** milliohms MAXIMUM **Voltage Drop** **20** milliohms MAXIMUM
9	**High Temperature Exposure (Physical)**	Mate connectors per durability. Subject connector system to **105** Cº for **1008** hours. Apply a voltage of **500DC** per Isolation Resistance post 1008 hours	**100** Meg ohms MINIMUM
		Apply an AC rms voltage of 1000V at 60 Hz per Dielectric Strength	No dielectric breakdown or flash-over shall occur between cavities or between the cavities and the outside of a connector at any time during the test.

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<table>
<tr><td rowspan="2">10</td><td rowspan="2">High Temperature Exposure (Mechanical)</td><td>Mate connectors per durability. Subject connector system to 105 Cº for 1008 hours. Apply a force to wire bundle and pull on wire bundle in the following directions: Straight, +45° Vertical, -45° Vertical, +45° Horizontal, & -45° Horizontal</td><td>No breakage or electrical discontinuities at 60N or less</td></tr>
<tr><td>Mate connectors per durability. Subject connector system to 105 Cº for 1008 hours. Extract terminal from housing per Terminal Retention Force (in Housing)</td><td>TPA in Final-Lock
30 Newtons MINIMUM</td></tr>
<tr><td>10b</td><td>High Temperature Exposure (Mechanical) GM</td><td>Subject connector system to 105 Cº for 1008 hours. Extract Terminal from housing post test..</td><td>TPA in Final-Lock
40 Newtons MINIMUM</td></tr>
<tr><td>11</td><td>Chemical Resistance (Electrical)</td><td>Perform Contact Resistance (Low Level).

Expose connectors to the following fluids for the specified duration of soak and dry time:
<table>
<tr><td>Resistance To Fluids:</td><td>Time / Temp. in Fluid</td><td>Time / Temp. Drying</td></tr>
<tr><td>Automatic Transmission Oil:</td><td>15 Seconds @ 23°C</td><td>24 Hours @ 105°C</td></tr>
<tr><td>Zinc Chloride:</td><td>15 Seconds @ 23°C</td><td>24 Hours @ 23°C</td></tr>
<tr><td>Fuel:</td><td>7 Days @ 23°C</td><td>7 Days @ 23°C</td></tr>
<tr><td>Engine Coolant:</td><td>5 Minutes @ 23°C</td><td>48 Hours @ 50°C</td></tr>
<tr><td>Windshield Washer Fluid:</td><td>5 Minutes @ 23°C</td><td>48 Hours @ 50°C</td></tr>
</table>
Perform Contact Resistance (Low Level) and Contact Resistance @ Rated Current (Voltage Drop).</td><td>No deformation or cracks shall be observed in connector

<u>Delta Dry Circuit Resistance</u>
20 milliohms MAXIMUM
<u>Voltage Drop</u>
20 milliohms MAXIMUM</td></tr>
</table>

PRODUCT SPECIFICATION

<table>
<tr>
<td>12</td>
<td>Chemical Resistance (Mechanical)</td>
<td>Expose connectors to the following fluids for the specified duration of soak and dry time:
<table>
<tr><td>Resistance To Fluids:</td><td>Time / Temp. in Fluid</td><td>Time / Temp. Drying</td></tr>
<tr><td>Automatic Transmission Oil:</td><td>15 Seconds @ 23°C</td><td>24 Hours @ 105°C</td></tr>
<tr><td>Zinc Chloride:</td><td>15 Seconds @ 23°C</td><td>24 Hours @ 23°C</td></tr>
<tr><td>Fuel:</td><td>7 Days @ 23°C</td><td>7 Days @ 23°C</td></tr>
<tr><td>Engine Coolant:</td><td>5 Minutes @ 23°C</td><td>48 Hours @ 50°C</td></tr>
<tr><td>Windshield Washer Fluid:</td><td>5 Minutes @ 23°C</td><td>48 Hours @ 50°C</td></tr>
</table>
Un-mate connector per Connector Mate/ Un-mate Forces. (Hand Evaluation) Extract terminal from housing per Terminal Retention Force (in Housing)</td>
<td>No deformation or cracks shall be observed in connector

Unmate w/latch (hand evaluation) shall show no signs of functional degradation.

TPA in Final-Lock
30 Newtons MINIMUM</td>
</tr>
<tr>
<td rowspan="2">13</td>
<td rowspan="2">Chemical Resistance (Physical)</td>
<td>Expose connectors to the following fluids for the specified duration of soak and dry time:
<table>
<tr><td>Resistance To Fluids:</td><td>Time / Temp. in Fluid</td><td>Time / Temp. Drying</td></tr>
<tr><td>Automatic Transmission Oil:</td><td>15 Seconds @ 23°C</td><td>24 Hours @ 105°C</td></tr>
<tr><td>Zinc Chloride 50%:</td><td>15 Seconds @ 23°C</td><td>24 Hours @ 23°C</td></tr>
<tr><td>Engine Coolant:</td><td>5 Minutes @ 23°C</td><td>48 Hours @ 50°C</td></tr>
</table>
Apply a voltage of 500 VDC per Isolation Resistance post 1008 hours</td>
<td>No deformation or cracks shall be observed in connector

100 Meg ohms MINIMUM</td>
</tr>
<tr>
<td>Apply an AC RMS voltage of 1000V at 60 Hz per Dielectric Strength</td>
<td>No dielectric breakdown or flash-over shall occur between cavities or between the cavities and the outside of a connector at any time during the test.</td>
</tr>
</table>

PRODUCT SPECIFICATION

14	**Solderability**	Steam-age samples for 8 hours (Category 3), set at ambient for at least one hour, and its pins were dipped in ROL0 flux and lead-free solder per **SMES-152 (**Paragraph 5.3.4 Dip Coated) with an agitation of 10mm forward and backward. The solder temperature was **255ºC** per Molex BP5155. Criteria: SMES-152 Rev E Paragraph 5.4.1.	Solder coverage: **95**% MINIMUM (per **SMES-152**)
15	**IR Process Soldering**	Molex IR Profile: **ES-40000-5013** Maximum Temperature: **260ºC**	Dimensional: Conformance to Sales Drawing requirements & Visual: No Damage

6.0 PACKAGING

Parts shall be packaged to protect against damage during handling, transit and storage.

7.0 GAGES AND FIXTURES

All applicable gages and fixtures are referenced in the appropriate control plans.

8.0 OTHER INFORMATION

Products conform to the following environmental ratings:

Temperature: 105ºC
Vibration: On-Body (not coupled to engine)
Sealing: Un-Sealed

To ensure compliance with our product validation, it is imperative that our product meet the print dimensions. Any non-conformance with the true position of the PCB pins or mating interface will create performance failures that include; PCB installation, increased mate/unmate forces and electrical discontinuities.