

## enetSEAL+ Connector System

### 1. INTRODUCTION

#### 1.1. Purpose

Testing was performed on the TE Connectivity (TE) 2 Position 1.2 mm Sealed Ethernet Connector System to determine its conformance to the requirements of Product Specification 108-151045.

#### 1.2. Scope

This report covers the mechanical, electrical, and environmental sealing performance of the 2 Position 1.2 mm Sealed Ethernet Connector System. Testing was performed at the Winston-Salem Electrical Components Test Laboratory in 2016, 2017, 2018, 2019, 2020, 2021 and 2022. The test file numbers can be found in Figure 12. This documentation is on file at, and available from the Global Automotive Division Product Reliability Center.

#### 1.3. Conclusion

The 2 Position 1.2mm Sealed Ethernet Connectors listed in paragraph 1.4. conformed to the mechanical, electrical, and environmental sealing performance requirements given in Product Specification 108-151045.

#### 1.4. Test Specimens

Test specimens were representative of normal production lots. Specimen part numbers listed in Figure 1 were used for test.

PART NUMBER	DESCRIPTION
1534594-1	1.2 mm MCON CB Receptacle with 22 AWG (0.35 mm <sup>2</sup> ) wire
1642656-1	Mounting clip
1670144-1	1.2 mm MCON CB Receptacle with 18 AWG (0.75 mm <sup>2</sup> ) wire
1718348-1	1.2 mm MCON CB Tab with 22 AWG (0.35 mm <sup>2</sup> ) wire
1718350-1	1.2 mm MCON CB Tab with 18 AWG (0.75 mm <sup>2</sup> ) wire
1534594-2	1.2 mm MCON CB Receptacle with 22 AWG (0.35 mm <sup>2</sup> ) wire
1534594-3	1.2 mm MCON CB Receptacle with 22 AWG (0.35 mm <sup>2</sup> ) wire
1670144-2	1.2 mm MCON CB Receptacle with 18 AWG (0.75 mm <sup>2</sup> ) wire
1670144-3	1.2 mm MCON CB Receptacle with 18 AWG (0.75 mm <sup>2</sup> ) wire
2272168-1	Wire Dress Cover, straight
2292906-1	2-way sealed plug assembly, Key A
2292906-2	2-way sealed plug assembly, Key B
2292937-1	2-way sealed cap assembly, Key A
2292937-2	2-way sealed cap assembly, Key B
2325102-1	2POS, TAB1.2X0.6, HDR ASSY,180DEG, SLDR, Key A
2325102-7	2POS, TAB1.2X0.6, HDR ASSY,180DEG, SLDR, Key A
2325103-1	2POS, TAB1.2X0.6, HDR ASSY,180DEG, SLDR, Key A
2325103-7	2POS, TAB1.2X0.6, HDR ASSY,180DEG, SLDR, Key A

2325106-1	ADAPTER,2POS,1.2X0.6,PIN HSG ASSY
2325098-2	MNTG CLIP,ENETSEAL PLUS
2325098-4	MNTG CLIP,ENETSEAL PLUS
2325098-6	MNTG CLIP,ENETSEAL PLUS
2325098-7	MNTG CLIP,ENETSEAL PLUS
2325098-8	MNTG CLIP,ENETSEAL PLUS
2339032-1	100MB Ethernet Right Angle Header, Key A
2339032-2	100MB Ethernet Right Angle Header, Key B
2339032-7	100MB Ethernet Right Angle Header, Key A
2339032-8	100MB Ethernet Right Angle Header, Key B
2366735-1	4POS, HDR ASSY,180DEG, Solder tail
2366735-2	2POS, HDR ASSY,180DEG, Solder tail
2366735-3	4POS, HDR ASSY,180DEG, Press fit terminal
2366735-4	2POS, HDR ASSY,180DEG, Press fit terminal
2376612-1	enetSEAL+ Blind Cap

**Figure 1. Test Specimen Part Numbers and Description**

1.5. Environmental Conditions

Unless otherwise stated, the following environmental conditions prevailed during testing:

Temperature: 15° to 35°C.

Relative humidity (RH): 25 to 75%.

## 1.6. Qualification Test Sequences

TEST OR EXAMINATION	TEST GROUP (a)												
	1	2	3	4	5	6	7	8	9	10	11	12	
	TEST SEQUENCE (b)												
Visual inspection	1,5	1,8	1,4	1,6	1,3	1,3	1,4	1,3	1,3	1,3	1,3	1,3	1,5
Terminal-connector insertion	2												
Terminal-connector retention with primary latching	3												
Terminal-connector retention with primary and secondary latching, after moisture conditioning	4												
Terminal-connector retention with primary and secondary latching after cavity damage							3						
TPA engagement force, pre-set to lock		2											
TPA disengagement force, lock to pre-set		3											
TPA removal force, pre-set to off		4											
CPA engagement force, pre-set to lock		5											
CPA disengagement force, lock to pre-set		6											
CPA removal force, pre-set to off		7											
Connector-connector audible click			2										
Connector-connector audible click (moisture conditioned)			3										
Connector-connector mating force				2									2
Connector-connector retention force, primary lock engaged, CPA disengaged				3									3
Connector-connector un-mating force, primary lock disengaged/disabled				4									4
Primary lock deflection force				5									
Polarization feature effectiveness, mis-mated					2								
Connector drop						2							
Cavity damage susceptibility							2						
Connector mounting feature mechanical strength								2					
Header and Adapter Pin Retention (Moisture Conditioned)									2				
Misc. Component Engage/Disengage Force										2			
Connector Seal Retention- Unmated Connector												2	

- (a) See Paragraph 1.4.
- (b) Numbers indicate sequence in which tests were performed.

**Figure 2. Mechanical Test Sequences**

TEST OR EXAMINATION	TEST GROUP (a)								
	1(c)	2(c)	3	4	5	6	7	8	9
	TEST SEQUENCE (b)								
Visual inspection	1,9	1,8	1,8	1,6	1,8	1,8	1,6	1,8	1,3
Connector cycling	2	2	2	2	2	2	2	2	
Dry circuit resistance	3,7	3,6	3,6		3,6	3,6		3,6	
Voltage drop	4,8	4,7	4,7		4,7	4,7		4,7	
Terminal-connector retention with primary and secondary latching after temperature humidity cycling or high temperature exposure			9	7	9				
Mechanical shock with continuity monitoring	5								
Vibration with continuity monitoring	6								
Insulation Resistance				3,5			3,5		
Thermal shock with continuity monitoring		5							
Temperature/humidity cycling			5	4		5	4		
High temperature exposure					5			5	
BROADR-REACH Channel Test									2

- (a) See Paragraph 1.4.
- (b) Numbers indicate sequence in which tests are performed.
- (c) Test specimens divided into two groups. The first group is used to measure dry circuit resistance. The second group is used to measure voltage drop and continuity monitoring.

**Figure 3. Electrical Test Sequences**

TEST OR EXAMINATION	TEST GROUP (a)							
	1	2(c)	3(c)	4(d,g)	5(c,e)	6(c,e)	7(c,g)	8(c,g)
	TEST SEQUENCE (b)							
Visual inspection	1,3	1,14	1,14	1,3	1,14	1,14	1,6,11,14, 17,20,21	1,6,11,14, 17,20,21
Connector cycling		2	2		2	2	2	2
Terminal-connector retention with primary and secondary latching after temperature humidity cycling or high temperature exposure		15	15					
Insulation Resistance		3,5,7,9, 11,13	3,5,7,9, 11,13		3,5,7,9, 11,13	3,5,7,9, 11,13	3,5,8,10, 13,16,19	3,5,8,10, 13,16,19
Temperature/humidity cycling		6			6		7	
High temperature exposure			6			6		7
Fluid Resistance	2							
Submersion		10	10		10(f)	10(f)	18	18
Pressure/Vacuum Leak		4,8	4,8		4(h),8(h)	4(h),8(h)	4(h),9(h)	4(h),9(h)
High Pressure Spray		12	12		12(f)	12(f)	15	15
IP6K7				2			12	12

- (a) See Paragraph 1.4.
- (b) Numbers indicate sequence in which tests were performed.
- (c) Test specimens divided into two groups. The first group contains the minimum wire size. The second group contains the maximum wire size.
- (d) This sequence was used to test the flange with mounting clip seal separate from the connector interface.
- (e) This sequence of testing does not include the flange seal.
- (f) High Pressure Spray was performed prior to Submersion in some of the test groups.
- (g) For assemblies which use a flange seal, a visual inspection was used to confirm there were no flange seal failures due to dust or fluid ingress.
- (h) The flange seal was tested separate from the peripheral and matte seal. Refer to 108-151045, Figure 1 for more detail.

**Figure 4. Environmental Sealing Test Sequences**

## 2. SUMMARY OF TESTING

### 2.1. Visual inspection

All specimens submitted for testing were representative of normal production lots. A Certificate of Conformance (C of C) was issued by Quality Engineering. Specimens were visually examined and no evidence of physical damage detrimental to product performance was observed.

- 
- 2.2. Terminal-connector insertion  
All terminal-connector insertion measurements were less than 30 N for a single terminal and less than 60 N when two terminals were inserted simultaneously.
  - 2.3. Terminal-connector retention with primary latching  
All terminal-connector extraction with primary latching measurements were greater than 25 N for 1.2 mm receptacle terminals in the plug connector, and greater than 40 N for 1.2 mm tab terminals in the cap connector.
  - 2.4. Terminal-connector retention with primary and secondary latching, after moisture conditioning  
All terminal-connector retention with primary and secondary latching measurements after moisture conditioning were greater than 70 N for 1.2 mm receptacle terminals in the plug connector, and greater than 60 N for the 1.2 mm tab terminals in the cap connector.
  - 2.5. Terminal-connector retention with primary and secondary latching, after cavity damage  
All terminal-connector retention with primary and secondary latching measurements after cavity damage were greater than 60 N for the 1.2 mm tab terminals in the cap connector.
  - 2.6. Terminal-connector retention with primary and secondary latching, after temperature/humidity cycling or high temperature exposure  
All terminal-connector retention with primary and secondary latching measurements after temperature/humidity cycling or high temperature exposure were greater than 50 N.
  - 2.7. TPA engagement force, pre-set to lock  
All TPA engagement force measurements were greater than 7 N without terminals and less than 60 N with terminals installed.
  - 2.8. TPA disengagement force, lock to pre-set  
All TPA disengagement forces were less than 60 N for the first cycle. After two cycles, the disengagement force was greater than 15 N for the plug connector and greater than 10 N for the cap connector.
  - 2.9. TPA removal force, pre-set to off  
The TPA removal force for the plug connector was greater than 25 N. The TPA removal force for the cap connector was greater than 7 N.
  - 2.10. CPA engagement force, pre-set to lock  
All CPA engagement force measurements were less than 60 N when un-mated and less than 22 N with properly mated connectors.
  - 2.11. CPA disengagement force, lock to pre-set  
All CPA disengagement force measurements were between 9 N and 30 N.
  - 2.12. CPA removal force, pre-set to off  
All CPA removal force measurements were greater than 30 N with un-mated plug connectors.
  - 2.13. Connector-connector audible click  
All connector-connector audible click measurements were greater than 7 dB above ambient.
  - 2.14. Connector-connector audible click after moisture conditioning  
All connector-connector audible click measurements after moisture conditioning were greater than 5 dB above ambient.

- 
- 2.15. Connector-connector mating force  
All connector-connector mating force measurements were less than 45 N.
- 2.16. Connector-connector retention force, primary lock engaged, CPA disengaged  
All connector-connector retention force measurements were greater than 110 N with primary lock engaged and CPA disengaged.
- 2.17. Connector-connector un-mating force, primary lock disengaged/disabled  
All connector-connector un-mating force measurements with primary lock disengaged were less than 75 N.
- 2.18. Primary lock deflection force  
All force measurements to disengage the primary connector lock were between 6 N and 51 N.
- 2.19. Polarization feature effectiveness, mis-mated  
Mis-mated specimens could not be mated and did not have electrical contact when subjected to a force of 135 N for 3 seconds. This included correct orientation with wrong key as well as incorrect orientation with correct key.
- 2.20. Connector drop  
No evidence of physical damage was visible as a result of drop testing.
- 2.21. Cavity damage susceptibility  
The cap TPA could not fully seat with a load of 60 N applied when a terminal was partially seated.
- 2.22. Connector mounting feature mechanical strength  
The connector mounting feature was not damaged from a 50 N load in directions F1 to F5. The connector mounting feature withstood a force of 110 N in the F6 direction without damage.
- 2.23. Connector cycling  
No physical damage occurred as a result of manually mating and un-mating the specimens 10 times.
- 2.24. Dry circuit resistance  
All dry circuit resistance measurements were less than 15 milliohms after subtracting the bulk resistance of equal wire length. The test specimens were subjected to a 20 millivolt maximum open circuit voltage and current not exceeding 100 milliamperes.
- 2.25. Voltage drop  
All voltage drop measurements were less than 50 millivolts and the total connection resistance was less than 15 milliohms after subtracting the bulk resistance of equal length wire. Test specimens were energized at 4.0 amperes for 18 AWG wire or 1.75 amperes for 22 AWG wire.
- 2.26. Mechanical shock with continuity monitoring  
No discontinuities were detected during mechanical shock testing. Following mechanical shock testing, no cracks, breaks, or loose parts on the specimens were visible.
- 2.27. Vibration with continuity monitoring  
No discontinuities were detected during vibration testing. Following mechanical shock testing, no cracks, breaks, or loose parts on the specimens were visible.
- 2.28. Insulation resistance  
All insulation resistance measurements were greater than 100 megaohms at 500 volts direct current.

- 
- 2.29. Thermal shock with continuity monitoring  
No discontinuities were detected during thermal shock testing. Following thermal shock testing, no cracks, breaks, or loose parts on the specimens were visible.
- 2.30. Temperature/humidity cycling  
No evidence of physical damage was visible as a result of temperature/humidity cycling.
- 2.31. High temperature exposure  
No evidence of physical damage was visible as a result of exposure to high temperature.
- 2.32. Fluid resistance  
No evidence of physical damage was visible as a result of exposure to fluids.
- 2.33. Submersion  
No evidence of leakage or water ingress was detected as a result of exposure to submersion.
- 2.34. Pressure/Vacuum leak, initial  
No evidence of air bubbles, leaks, or water ingress from 7 psi internal air pressure or 7 psi vacuum.  
\*Flange seals were tested with the following acceptance criteria:  
No evidence of air bubbles, leaks, or water ingress from 4 psi internal air pressure or 4 psi vacuum.  
See Figure 4 for more information.
- 2.35. Pressure/Vacuum leak, after temperature/humidity cycling or high temperature exposure  
No evidence of air bubbles, leaks, or water ingress from 4 psi internal air pressure or 4 psi vacuum.  
\*Flange seals were tested with the following acceptance criteria:  
No evidence of air bubbles, leaks, or water ingress from 2 psi internal air pressure or 2 psi vacuum.  
See Figure 4 for more information.
- 2.36. High pressure spray  
No evidence of water ingress or physical damage was visible as a result of high pressure spray.
- 2.37. Header and Adapter Pin Retention (Moisture Conditioned)  
All force measurements to displace the stitched terminals 0.2mm in either direction were above 50N.
- 2.38. Misc. Component Engage/Disengage Force  
All force measurements to engage the mounting clip were below 85N.  
All force measurements to disengage the mounting clip were below 60N.  
\*If the mating plug has been assembled to the adapter or header, the mounting clip cannot disengage.
- 2.39. Connector Seal Retention- Unmated Connector  
The flange seal retained position and mating of connector and seal function were not diminished.
- 2.40. IP6K7  
No evidence of leakage, water ingress, or dust ingress was detected as a result of exposure to submersion.
- 2.41. BROAD R-REACH Channel Test  
All tested channels are within the limits per the specification.



---

### 3. TEST METHODS

#### 3.1. Visual Inspection

A Certificate of Conformance (C of C) was issued stating that all specimens in this test package were produced, inspected, and accepted as conforming to product drawing requirements, and were manufactured using the same core manufacturing processes and technologies as production parts.

#### 3.2. Terminal-connector insertion

The force to insert a terminal into the connector was measured using a tensile/compression device with a rate of travel of 50 mm per minute. The peak insertion force was recorded.

#### 3.3. Terminal-connector retention with primary latching

The force required to remove a terminal from the connector with only the primary latching engaged was measured using a tensile/compression device with a rate of travel of 50 mm per minute. The peak retention force was recorded.

#### 3.4. Terminal-connector retention with primary and secondary latching, after moisture conditioning

Prior to testing, specimens were subjected to 40°C and 95-98% RH for 6 hours. After conditioning, the force required to remove a terminal from the connector with primary and secondary latching engaged was measured using a tensile/compression device with a rate of travel of 50 mm per minute. The peak retention force was recorded.

#### 3.5. Terminal-connector retention with primary and secondary latching, after cavity damage

Prior to testing, specimens were subjected to cavity damage susceptibility. After cavity damage, the force required to remove a terminal from the connector with primary and secondary latching engaged was measured using a tensile/compression device with a rate of travel of 50 mm per minute. The peak retention force was recorded.

#### 3.6. Terminal-connector retention with primary and secondary latching, after temperature/humidity cycling or high temperature exposure

Prior to testing, specimens were subjected to temperature/humidity cycling or high temperature exposure. After temperature/humidity cycling or high temperature exposure, the force required to remove a terminal from the connector with primary and secondary latching engaged was measured using a tensile/compression device with a rate of travel of 50 mm per minute. The peak retention force was recorded.

#### 3.7. TPA engagement force, pre-set to lock

The force required to push the TPA to the lock position was measured using a tensile/compression device with a rate of travel of 50 mm per minute. The peak engagement force was recorded.

#### 3.8. TPA disengagement force, lock to pre-set

The force required to pull the TPA to the pre-set position was measured using a tensile/compression device with a rate of travel of 50 mm per minute. The peak disengagement force was recorded.

#### 3.9. TPA removal force, pre-set to off

The force required to pull the TPA to the off position was measured using a tensile/compression device with a rate of travel of 50 mm per minute. The peak removal force was recorded.

#### 3.10. CPA engagement force, pre-set to lock

The force required to push the CPA to the lock position was measured using a tensile/compression device with a rate of travel of 50 mm per minute. The test was performed on un-mated plugs as well as properly mated connectors. The peak engagement force was recorded.

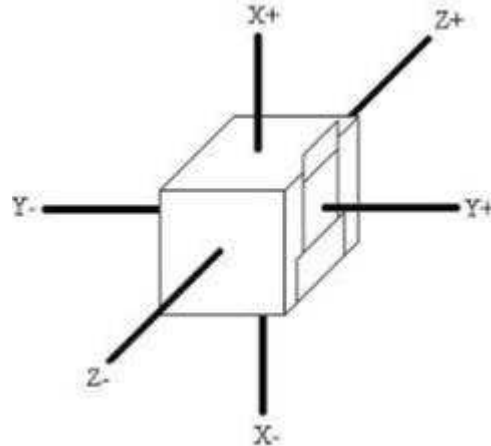
#### 3.11. CPA disengagement force, lock to pre-set

The force required to pull the CPA to the pre-set position was measured using a tensile/compression device with a rate of travel of 50 mm per minute. The peak disengagement force was recorded.

- 
- 3.12. CPA removal force, pre-set to off  
The force required to pull the CPA to the off position was measured using a tensile/compression device with a rate of travel of 50 mm per minute. The peak removal force was recorded.
- 3.13. Connector-connector audible click  
Specimens were manually mated 600 mm from the end of a sound meter probe. The dB level generated as the lock of the specimens engaged was recorded
- 3.14. Connector-connector audible click after moisture conditioning  
Prior to testing, specimens were subjected to 40°C and 95-98% RH for 6 hours. After conditioning, specimens were manually mated 600 mm from the end of a sound meter probe. The dB level generated as the lock of the specimens engaged was recorded
- 3.15. Connector-connector mating force  
The force required to fully mate the specimens was measured using a tensile/compression device with a rate of travel of 50 mm per minute. The peak mating force was recorded.
- 3.16. Connector-connector retention force, primary lock engaged, CPA disengaged  
Prior to testing, specimens were subjected to 40°C and 95-98% RH for 6 hours. After conditioning, the force required to pull apart mated connectors with the CPA disengaged was measured using a tensile/compression device with a rate of travel of 50 mm per minute. The peak retention force was recorded.
- 3.17. Connector-connector un-mating force, primary lock disengaged/disabled  
The force required to fully un-mate the specimens with the primary lock disengaged/disabled was measured using a tensile/compression device with a rate of travel of 50 mm per minute. The peak un-mating force was recorded.
- 3.18. Primary lock deflection force  
The force required to completely disengage the primary lock was measured using a tensile/compression device with a rate of travel of 50 mm per minute. The peak deflection force was recorded.
- 3.19. Polarization feature effectiveness, mis-mated  
A 135 N load was applied to specimens for 3 seconds oriented 180 degrees from their normal position in an attempt to mis-mate connectors. The test was repeated with specimens oriented in their normal position except they had wrong keying. Electrical contact was monitored during this test. Header and
- 3.20. Header and Adapter Pin Retention (Moisture Conditioned)  
The force required to displace the stitched terminal a maximum of 0.2mm was measured using a tensile/compression device with a maximum rate of travel of 25 mm per minute. The retention forces in the stitching direction and opposite the stitching direction were recorded.
- 3.21. Misc. Component Engage/Disengage Force  
The force required to fully mate and un-mate the specimens was measured using a tensile/compression device with a rate of travel of 50 mm per minute. The peak mating and un-mating force was recorded.
- 3.22. Connector Seal Retention- Unmated Connector  
The test specimen was rotated at 1960m/s<sup>2</sup> for 10 sec. The flange seal retains position and mating of connector and seal function are not diminished.
- 3.23. IP6K7  
No evidence of leakage, water ingress, or dust ingress was detected as a result of exposure to submersion.

### 3.24. Connector drop

Unmated specimens were subjected to drops from a height of 1 meter onto a concrete surface. Specimens were oriented prior to each release in the direction of the primary X, Y, and Z axes as shown in Figure 5.



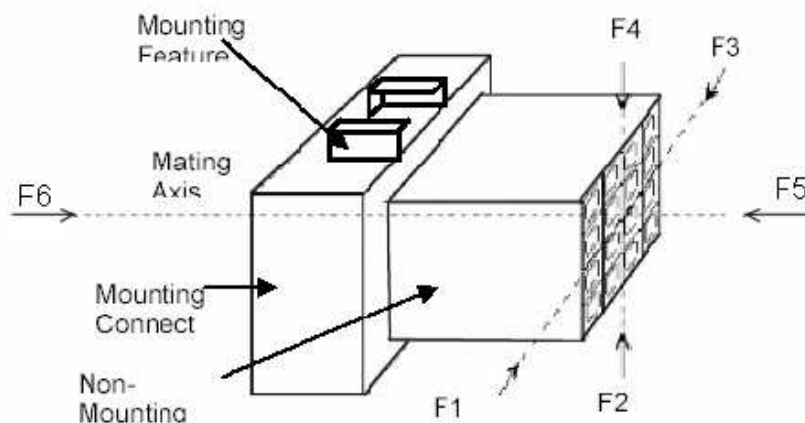
**Figure 5. Connector drop orientations**

### 3.25. Cavity damage susceptibility

Tab terminals were inserted into cap housings to the point just short of locking into position. A force was applied to the TPAs using a tensile/compression device at a rate of 50 mm per minute. It was recorded whether the TPA moved to the locked position or not.

### 3.26. Connector mounting feature mechanical strength

Cap connectors with mounting clips installed were mounted to a bracket and subjected to a mounting feature mechanical strength test with a tensile/compression device at a rate of 50 mm per minute. A 50 N load was applied in directions F1-F5 and a 110 N load was applied in direction F5 as shown in Figure 6.



**Figure 6. Mounting feature load orientations**

### 3.27. Connector cycling

Specimens were manually mated and unmated 10 times.

3.28. Dry circuit resistance

Mated specimens were subjected to 20 millivolts maximum open circuit voltage and current not exceeding 100 milliamperes. Measurements were taken on a data acquisition system using voltage and current probe bundles (4-wire probe method). The overall resistance measurement includes a specified wire length, crimp, bulk terminal, and terminal interface. The equivalent wire length was subtracted out of the reported data.

3.29. Voltage drop

Test specimens on 18 AWG wire were energized at 4.0 amperes. Test specimens on 22 AWG wire were energized at 1.75 amperes. All specimens were allowed to reach thermal stability before measurements were taken. The overall resistance measurement includes a specified wire length, crimp, bulk terminal, and terminal interface. The equivalent wire length was subtracted out of the reported data.

3.30. Mechanical shock with continuity monitoring

Specimens were subjected to 10 half-sine wave impulses for 10 milliseconds duration at 35Gs in each of 3 mutually perpendicular planes. During mechanical shock, some specimens were checked for discontinuities by monitoring instances where the resistance was greater than 7 ohms for greater than 1 microsecond using a current of 100 milliamperes DC. Mechanical shock and vibration tested were completed in sequence for each axis before proceeding to the next axis.

3.31. Vibration with continuity monitoring

Mated specimens were subjected to the USCAR-2 V2-Random Engine Profile, with excitation frequency bounds of 60 and 1200 Hz as shown in Figure 7. The overall acceleration was 12.1 Grms. This test consisted of 8 hour runs in each of 3 mutually perpendicular planes for a total vibration time of 24 hours. During vibration, some specimens were checked for discontinuities by monitoring instances where the resistance was greater than 7 ohms for greater than 1 microsecond using a current of 100 milliamperes DC. Mechanical shock and vibration tested were completed in sequence for each axis before proceeding to the next axis. See Figure 8 for the setup.

FREQUENCY (Hz)	POWER SPECTRAL DENSITY (PSD) (g <sup>2</sup> /Hz)
60	0.00100
200	1.50000
210	0.10000
1200	0.10000

Figure 7. Random Vibration Profile (Reference)

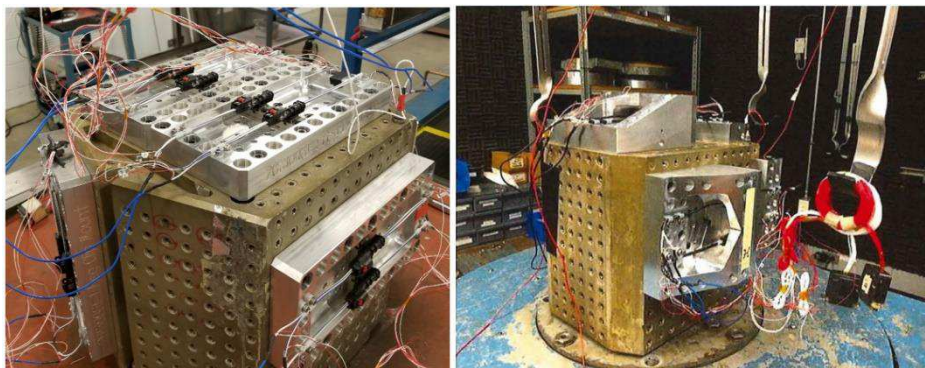


Figure 8. Random Vibration Setup

3.32. Insulation resistance

Insulation resistance was measured between adjacent terminals. A test voltage of 500 volts DC was applied for 15 seconds before the resistance was measured.

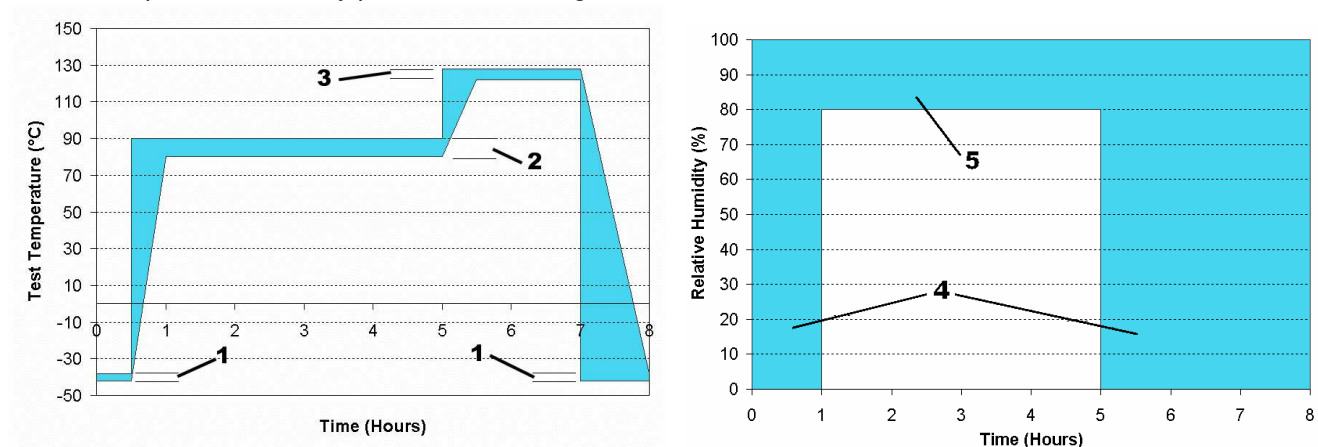
\*Adapter samples (2325106-1) from Environmental Test Group 4 were tested at 1000 volts DC.

3.33. Thermal shock with continuity monitoring

Test specimens were subjected to 100 cycles of thermal shock. Each cycle consisted of 30-minute dwells at -40°C and 125°C with a 30 second maximum transition time. During thermal shock, some specimens were checked for discontinuities by monitoring instances where the resistance was greater than 7 ohms for greater than 1 microsecond using a current of 100 milliamperes DC.

3.34. Temperature/humidity cycling

Specimens were subjected to 40 8-hour cycles (320 hours total) of the USCAR-2, Revision 6, Class T3 temperature/humidity profile shown in Figure 9.



Key:

- 1. -40°C
- 2. 85±5°C
- 3. 125±3°C
- 4. Relative humidity, uncontrolled. Do not vent chamber at hour 5
- 5. 80-100% relative humidity

**Figure 9. Temperature/humidity cycling schedule**

3.35. High temperature exposure

Specimens were subjected to 125±3°C for 1008 hours.

### 3.36. Fluid resistance

One specimen was placed into each of the fluids listed in Figure 10 for 30 minutes at the temperatures indicated. No specimen was exposed to more than 1 fluid. After conclusion of the 30-minute exposure, the specimens were stored under a fume hood for 7 days in ambient conditions. Concluding the storage period, the specimens were visually examined for any defects.

FLUID	TEMPERATURE (°C)
Gasoline	23
Diesel Fuel	23
Engine Oil	50
Ethanol	23
Power Steering Fluid	50
ATF	50
Engine Coolant	50
Brake Fluid	50
Diesel Exhaust Fluid (DEF)	23
Roundup Original (7.5% Concentration)	23
Gear Oil 90wt	85

**Figure 10. Fluids used for fluid resistance test**

### 3.37. Submersion

All specimens were placed into a thermal chamber and heat soaked for a minimum of 2 hours at 125°C. The specimens were removed from the thermal chamber and within 30 seconds, were submersed into a 0°C salt water solution with ultraviolet dye, to a depth of 30-40 cm for a period of 30-minutes. At the end of the 30-minute submersion, all specimens were removed from the salt water solution, excess solution was shaken off, and the exterior surfaces of the specimens were dried. Insulation resistance testing was conducted immediately after the specimens were dried.

### 3.38. Pressure/Vacuum leak, initial

A tube was attached to an air adapter secured to each specimen. The other end of the tube was connected to a regulated pressure source. Specimens were submerged in a salt water solution. The air pressure was slowly increased until the gage read 48 kPa (7 psig). The specimens were observed for 15 seconds to verify that there were no air bubbles. The regulated source was switched from pressure to vacuum and 48 kPa (7psig) of vacuum was slowly applied to the specimens and held for 15 seconds. The specimens were then removed from the salt water solution, the excess fluid was shaken off, and all exterior surfaces were carefully dried.

\*Flange seals were tested to 28 kPa (4psig) pressure and vacuum.

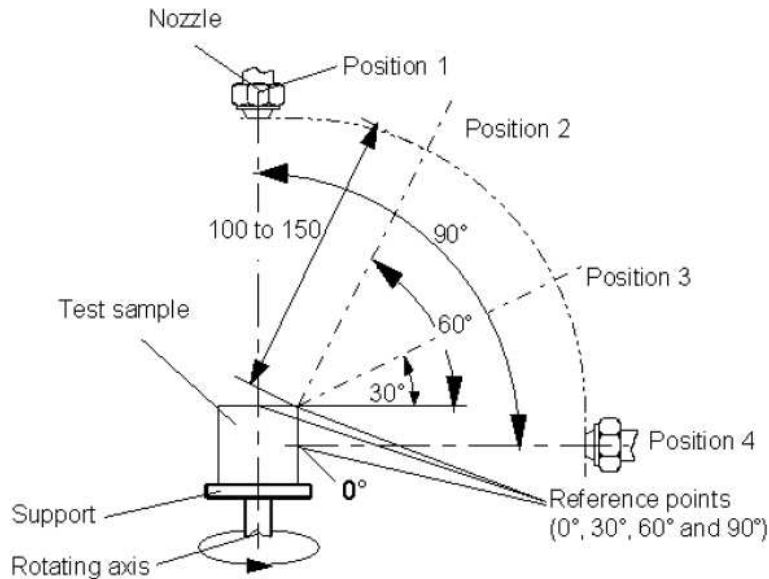
### 3.39. Pressure/Vacuum leak, after temperature/humidity cycling or high temperature exposure

A tube was attached to an air adapter secured to each specimen. The other end of the tube was connected to a regulated pressure source. Specimens were submerged in a salt water solution. The air pressure was slowly increased until the gage read 28 kPa (4 psig). The specimens were observed for 15 seconds to verify that there were no air bubbles. The regulated source was switched from pressure to vacuum and 28 kPa (4psig) of vacuum was slowly applied to the specimens and held for 15 seconds. The specimens were then removed from the salt water solution, the excess fluid was shaken off, and all exterior surfaces were carefully dried.

\*Flange seals were tested to 14 kPa (2psig) pressure and vacuum.

### 3.40. High pressure spray

The specimens were secured to a rotating table with a rotation speed of 5 rpm. The specimens were sprayed with a flat fan type nozzle for 30 seconds per position from a distance of approximately 5 inches (127 mm) while rotating. This procedure was performed with the spray nozzle positioned at 0°, 30°, 60°, and 90°, see Figure 11. The water temperature was approximately 80°C. The water flow rate was measured at approximately 3.8 gal/min (14.5 L/min) and the water pressure was measured at approximately 1200 psi (8300 kPa).



**Figure 11. High pressure spray nozzle and table arrangement**

### 3.41. BROADR-REACH Channel Testing

The test specimens were assembled into a 15m channel (2 headers, 4 adapters) and soldered to test PCBs. Products were then connected to a network analyzer to collect the data.

**4. TEST SEQUENCE-TO-TEST NUMBER CROSS-REFERENCE**

TEST SEQUENCE		TEST NUMBER	
Test Sequence	Test Group	Test Number	Test Group
Mechanical (Refer to Figure 2)	1	20170697ACL	1
	2	20170697ACL	2
	3	20170698ACL	9
		20190125ACL	2
	4	20170697ACL	3
	5	20170697ACL	4
	6	20170698ACL	10
	7	20180066ACL	5
	8	20160205ACL	10
	9	20190250ACL	2
		20190253ACL	2
		20200162	1
	10	20190310ACL	1
		20190434ACL	1
		20190125ACL	1
	11	20190125ACL	5
	12	20190125ACL	3
		20190250ACL	1
20190253ACL		1	
20191287ACL		1	
Electrical (Refer to Figure 3)	1	20170699ACL	14
		20190126ACL	7d,7e,7f
		20190251ACL	4a,4b
		20190254ACL	4a,4b
		20190382ACL	1a,1b,1c,1d
		20190384ACL	1a,1b
		20201439	M
		20201436	M
		WE-20220016	M(a)
		WE-20220016	M(b)
		WE-20220019	M(a)
		WE-20220019	M(b)
		WE-20201629	2(a)
		WE-20201629	2(b)
WE-20211245	2(a)		
WE-20211245	2(b)		



	2	20170700ACL	15
		20190252ACL	5
		20190496ACL	1
		20201440	N
		20201437	N
		WE-20220014	3a
		WE-20220014	3b
		WE-20220017	3a
		WE-20220017	3b
		WE-20220021	3a
		WE-20220021	3b
		WE-20211244	3a
		WE-20211244	3b
		3	20170700ACL
	20201440		O1
	20201437		O1
	WE-20220014		4
	WE-20220017		4
	WE-20220021		4
	WE-20211244		4
	4	20170700ACL	17
		20201440	O2
		20201437	O2
	5	20170700ACL	18
		20201440	P
		20201437	P
		WE-20220014	5
WE-20220017		5	
WE-20220021		5	
WE-20211244		5	
6	20190300ACL	9	
	20201440	6	
	20201437	6	
7	20190300ACL	10	
	20190252ACL	7	
8	20190300ACL	11	
	20190252ACL	8	
9	20191025ACL	1	
	1	20160207ACL	17

Environmental (Refer to Figure 4)		20190301ACL	12
		20191179ACL	1,2,3
		EA20190365T	Q
		WE-20220020	6
		WE-20211415	1
		WE-20211246	6
	2	20170700ACL	19
		WE-20220015	7
		WE-20220018	7
		WE-20220020	7
		WE-20201630	1
		WE-20211244	7
	3	20180067ACL	20
		20201440	TUAB
		WE-20220015	8
		WE-20220018	8
		WE-20220020	8
		WE-20211244	8
	4	20190687ACL	1,2,3
		20190383ACL	2a,2b,3a,3b
	5	20190308ACL	1
		20190888ACL	1
	6	20190308ACL	2
		20190888ACL	2
		20201440	RSAA
	7	20190385ACL	2
		20190383ACL	2a,2b
		20190497ACL	1
		20190498ACL	1
	8	20190385ACL	3
20190497ACL		2	
20190498ACL		2	
20190383ACL		3a,3b	

**Figure 12. Test Number Cross-Reference**