# AMPSEAL 16* High Temperature Connector System

## 1. INTRODUCTION

### 1.1. Purpose

Testing was performed on the AMPSEAL 16* High Temperature Connector System to determine its conformance to the requirements of Product Specification 108-32602 Revision A.

### 1.2. Scope

This report covers the electrical, mechanical, and environmental performance of the AMPSEAL 16 High Temperature Connector System. Testing was performed at the Product Reliability Center Global Automotive Division Laboratory in 2019. The test file numbers for this testing are 20190453ACL (Test Groups 1,2,3), and 20191068ACL (Test Group 4) and 20190614ACL (Test Group 5). This documentation is on file and available from the Product Reliability Center Global Automotive Division Laboratory.

### 1.3. Conclusion

The AMPSEAL 16 High Temperature Connector System listed in paragraph 1.4. conformed to the electrical, mechanical, and environmental performance requirements of Product Specification 108-32602 Revision A.

### 1.4. Test Specimens

Test specimens were representative of normal production lots. Specimens identified with the following part numbers were used for testing:

| Part Number | Description |
|---|---|
| 638078-1 | Pin contacts, 14-18 AWG, Au |
| 2098251-1 | Socket contacts, 14-18 AWG, Au |
| 638112-1 | Pin contacts, 14-18 AWG, Au |
| 776491-1 | Socket contacts, 14-18 AWG, Au |
| 1924463-1 | Pin contacts, 18-20 AWG, Au |
| 1924464-1 | Socket contacts, 18-20 AWG, Au |
| 2320914-2 | 3 position cap assembly, SDWS, Key 2 |
| 2320921-2 | 3 position plug assembly, SDWS, Key 2 |
| 2320918-1 | 12 position cap assembly, SDWS, Key 1 |
| 2320925-1 | 12 position plug assembly, SDWS, Key 1 |
| 2320927-2 | 3 position cap assembly, RDWS, Key 2 |
| 2320933-2 | 3 position plug assembly, RDWS, Key 2 |
| 2320931-1 | 12 position cap assembly, RDWS, Key 1 |
| 2320937-1 | 12 position plug assembly, RDWS, Key 1 |

Figure 1

### 1.5. Environmental Conditions

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

- Temperature: 15 to 35°C
- Relative Humidity: 25 to 75%



* Trademark
| Indicates change

1.6. Qualification Test Sequence

| Test or Examination | Test Group (a) | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| | Test Sequence (b) | | | | |
| Visual inspection | 1,10 | 1,13 | 1,6 | 1,11 | 1,8 |
| Low signal termination resistance | | | | 2,5,8 | |
| Voltage drop | | | | 3,6,9 | |
| Insulation resistance | 2,4,7,9 | 2,4,7,9,11 | 4 | | |
| Random vibration | | | | 7 | |
| Durability | | | | | 7 |
| Terminal retention, axial | | | | | 3 |
| Mating/unmating force | | | | | 4,5 |
| Maintenance aging | | | | 10 | 6 |
| Temperature life | 5 | | | | |
| Thermal shock | | 5 | 2 | 4 | 2 |
| Sealing pressure, pre-test | 3 | 3 | | | |
| Sealing pressure, post-test | 6 | 6 | | | |
| Pressure washing | | 10 | | | |
| Chemical exposure | | 12 | | | |
| Salt exposure | | | 3 | | |
| Steam cleaning | | 8 | | | |
| Water Immersion | 8 | | | | |
| Dust Test | | | 5 | | |

**NOTE**

*(a) See paragraph 1.4.*

*(b) Numbers indicate sequence in which tests are performed.*

Figure 2

## 2 SUMMARY OF TESTING

2.1. Visual Inspection - All Test Groups

Specimens were visually inspected and no evidence of physical damage detrimental to product performance was observed.

2.2. Low Signal Termination Resistance - Test Group 4

All low signal termination resistance measurements were less than 6 milliohms for 14 and 16 AWG wire and less than 9 milliohms for 18 AWG wire.

2.3. Voltage Drop - Test Group 4

All voltage drop measurements were less than 100 millivolts.

2.4. Insulation Resistance - Test Groups 1, 2 and 3

All insulation resistance measurements were greater than 20 megohms.

2.5. Random Vibration - Test Group 4

No discontinuities were detected during vibration testing. Following vibration testing, no cracks, breaks, or loose parts on the specimens were visible.

2.6. Durability - Test Group 5

No physical damage occurred because of manually mating and unmating the specimens 50 times.

2.7. Terminal Retention, Axial - Test Group 5

No contacts dislodged more than 0.8 mm when subjected to an axial load of 111 N for 10 seconds.

2.8. Mating/Unmating Force - Test Group 5

All mating and unmating force measurements were less than 135 N.

2.9. Maintenance Aging - Test Groups 4 and 5

No evidence of physical damage was visible because of removing and replacing 20% of the terminals 8 times.

2.10. Temperature Life - Test Group 1

No evidence of physical damage was visible because of temperature life testing.

2.11. Thermal Shock - Test Groups 2, 3, 4 and 5

No evidence of physical damage was visible because of thermal shock testing.

2.12. Sealing Pressure, Pre-test - Test Groups 1 and 2

No evidence of physical damage or bubbles were visible when specimens were subjected to a pressure of 35 kPa for 30 minutes.

2.13. Sealing Pressure, Post-test - Test Groups 1 and 2

No evidence of physical damage or bubbles were visible when specimens were subjected to a pressure of 35 kPa for 30 minutes.

2.14. Pressure Washing - Test Group 2

No evidence of physical damage was visible because of pressure washing.

2.15. Chemical Exposure - Test Group 2

No evidence of physical damage was visible because of exposure to chemicals.

2.16. Salt Exposure - Test Group 3

No evidence of physical damage was visible because of exposure to a salt-laden atmosphere.

2.17. Steam Cleaning - Test Group 2

No evidence of physical damage was visible because of steam cleaning.

2.18. Water Immersion – Test Group 1

No evidence of physical damage was visible because of steam cleaning.

2.19. Dust Test – Test Group 3

No evidence of physical damage was visible because of dust testing.

## 3. TEST METHODS

3.1. Initial Examination of Product

Specimens were visually inspected before and after unmating connectors for conditions such as torn seals, cracked plastic, evidence of fluid or dust ingress in sealed connector systems, arcing, charring, melting, or any other defect that could affect the performance or serviceability of the product.

3.2. Low Signal Termination Resistance

Low signal termination resistance measurements were made using a 4 terminal measuring technique. The test current was maintained at 100 milliamperes maximum with a 20-millivolt maximum open circuit voltage. The raw data recorded consisted of 8 inches of wire, the crimp resistance of the pin, the bulk resistance of the socket, the mating resistance of the pin/socket, and their bulk resistance. The resistance of the Equal W ire Lengths (EWLs) were subtracted out so that the reported data only included the crimps and interface.

3.3. Voltage Drop

Specimens were energized at 13 amperes for 14 AWG wire, 10 amperes for 16 AWG wire and 8 amperes for 18 AWG wire. Specimens were read after 30 seconds, 15 minutes, and 30 minutes and the average recorded. EWLs were subtracted out so that the reported data only included the crimps and interface.

3.4. Insulation Resistance

Insulation resistance was measured between adjacent contacts. A test voltage of 1000 volts DC was applied for 1 minute before the resistance was measured.

3.5. Random Vibration

Mated specimens were subjected to a random vibration test, specified by a random vibration spectrum, with excitation frequency bounds of 25 and 2000 Hz. The root-mean square amplitude of the excitation was 21 $G_{RMS}$. This was performed for 20 hours in each of 3 mutually perpendicular planes for a total vibration time of 60 hours. Specimens were monitored for discontinuities of 1 microsecond or greater using a current of 100 milliamperes DC.

3.6. Durability

Specimens were manually mated and unmated 50 times.

3.7. Terminal Retention, Axial

The plug and cap of each specimen were held in an L-vise attached to the base of an Instron machine. A pin held in a Jacobs chuck attached to the cross head of the Instron machine was used to apply a force of 111 N at a maximum rate of 10 N per second. The force was held for 10 seconds.

3.8. Mating/unmating Force

The force required to mate and unmate individual specimens was measured using a tensile/compression device with a free-floating fixture and a rate of travel of 50 mm per minute.

3.9. Maintenance Aging

The TPA and 2 terminal positions of each plug and cap assembly, of each connector system, were manually extracted and reinserted 8 times at room temperature. This procedure was repeated, on the same terminal positions, after the specimens were exposed to 0°C for 1 hour, and then a third time after being exposed to 0°C for another hour. All positions cycled retained their corresponding terminal.

3.10. Temperature Life

Specimens were exposed to a temperature of 150 ± 3°C for 500 hours.

3.11. Thermal Shock

Specimens were subjected to 10 cycles of thermal shock with each cycle consisting of 1-hour dwells at -40 and 150°C.

3.12. Sealing Pressure, Pre-test

Specimens were placed inside a sealed pressure chamber with 1 end of a vent tube inserted into 1 empty cavity of the test specimen and the other end of the vent tube exiting the chamber. Thirty-five kPa was applied, from a dry compressed air source, to the chamber and maintained for 10 minutes. The free end of the vent tube was then immersed in a beaker of water no more than 20 mm and observed for 30 minutes for any air bubbles exiting the vent tube.

3.13. Sealing Pressure, Post-test

Specimens were placed inside a sealed pressure chamber with 1 end of a vent tube inserted into 1 empty cavity of the test specimen and the other end of the vent tube exiting the chamber. Thirty-five kPa was applied, from a dry compressed air source, to the chamber and maintained for 10 minutes. The free end of the vent tube was then immersed in a beaker of water no more than 20 mm and observed for 30 minutes for any air bubbles exiting the vent tube.

3.14. Pressure Washing

Specimens were subjected to 375 cycles of spray for 3 seconds of a 6 second period consisting of a volume of 9.46 liters per minute at a pressure of 7000 kPa and a temperature of 40°C from a distance of 20 to 30 cm. No detergent.

3.15. Chemical Exposure

Specimens were exposed to the chemicals listed in Figure 3 after each chemical had stabilized at the specified temperature. No specimen was exposed to more than 1 chemical. On day "1" each specimen was dipped in its designated chemical for 5 seconds, removed and allowed to drip dry for 1 hour at the prescribed chamber temperature. This immersion procedure was repeated 4 more days for a total exposure time of 5 consecutive days. Chemical levels were monitored daily to compensate for evaporation.

| Fluids | Temperature (°C) |
|---|---|
| Diesel fuel (1E0337) | 60 ± 3 |
| Engine oil (1E176) | 100 ± 3 |
| Transmission Drive Train Oil (TDTO) | 100 ± 3 |
| Final Drive Axle Oil (FDAO) | 100 ± 3 |
| Ethylene glycol (50%) - Water (50%) | 100 ± 3 |
| Propylene glycol (50%) - Water (50%) | 100 ± 3 |
| Brake fluid (1E0479) | 25 ± 3 |

Figure 3

3.16. Salt Exposure

Specimens were exposed to a 5% salt fog atmosphere at 35°C for 96 hours. After exposure, specimens remained mated until after final electrical measurements were taken. Specimens were then examined for material deterioration, seal integrity, and oxidation of metals.

3.17. Steam Cleaning

Specimens were subjected to 375 cycles lasting 18.75 minutes of pressure washing at 85°C consisting of a volume of 9.46 liters per minute at a pressure of 1400 kPa from 20 to 30 cm. No detergent.

3.18. Water Immersion

Specimens were subjected to 125°C for 1 hour. Then immediately place them in water with a 5% salt solution and 0.1 g/L wetting agent, to a depth of 1 m for 4 h. Water temperature is to be 23 °C ± 3 °C.

3.19. Dust Test

Specimens were subjected to 24 hours in a Dust Chamber containing the equivalent of air cleaner fine dust (particle size as defined by SAE J726). Maintaining a minimum suspended concentration of 0.88 g/m$^3$.