# Modular, High Density, RF Connection System

## 1. INTRODUCTION

### 1.1. Purpose

Testing was performed on the TE Connectivity (TE) Modular, High Density, RF Connection System with 1-piece and 2-piece backplane modules to determine their conformance to the requirements of Product Specification 108-2443 Revision B.

### 1.2. Scope

This report covers the electrical, mechanical, and environmental performance of the Modular, High Density, RF Connection System. Testing on the 1-piece backplane module connector system, with the exception of corrosion resistance, was performed at the Harrisburg Electrical Components Test Laboratory between 22Dec10 and 25Apr11. Corrosion resistance testing was performed at NTS, Boxborough MA between 02Apr11 and 07Apr11. The test file number for this testing is EA20101091T Rev C. Additional testing was performed on the Modular, High Density, RF Connection System with 2-piece backplane module. Testing, with the exception of corrosion resistance, was performed at the Harrisburg Electrical Components Test Laboratory between 31May11 and 07Jan12. Corrosion resistance testing was performed at NTS, Boxborough MA between 16Dec11 and 20Dec11. The test file number for this testing is EA20110416T Rev A. This documentation is on file at and available from the Harrisburg Electrical Components Test Laboratory.

### 1.3. Conclusion

The Modular, High Density, RF Connection System listed in paragraph 1.4., conformed to the electrical, mechanical, and environmental performance requirements of Product Specification 108-2443 Revision B.

## 1.4. Test Specimens

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

| Test Group | Quantity | Part Number | Rev | Description | Cable |
|---|---|---|---|---|---|
| 1 | 3 | 1996884-1 | D | 4 position RF module backplane, 1-piece stainless steel shell. Au plated RF contacts | Daughter card only (20) 3 inch single end on flexible cable. |
| | 3 | 1996883-3 | E | 4 position RF module daughter card, stainless steel shell | |
| | 1 | 1996706-1 | C | 8 position RF module backplane, 1-piece stainless steel shell. Au plated RF contacts | |
| | 1 | 1996705-4 | H | 8 position RF module daughter card, stainless steel shell | |
| | 20 | 1996390-1 | K | SMPM straight cable jack (flexible) floating panel mount, Au plated contacts | |
| 1 | 3 | 2157192-1 | 4 | 8 position RF module backplane, 2-piece aluminum shell with trivalent chromate finish | Daughter card and backplane (24 each) 12 inch single end on flexible cable. |
| | 3 | 2101780-5 | J | 8 position RF module daughter card, stainless steel shell | |
| | 24 | 2101012-1 | D | SMPM straight cable plug (M) snap-in panel mount, Au plated, backplane, RF contacts | |
| | 24 | 1996390-1 | K | SMPM straight cable jack (F) floating panel mount, Au plated, daughter card, RF contacts | |
| 2 | 3 | 1996706-1 | C | 8 position RF module backplane, 1-piece stainless steel shell. Au plated RF contacts | Daughter card and backplane (24 each) 24 inch single end on flexible cable. |
| | 3 | 1996705-4 | H | 8 position RF module daughter card, stainless steel shell | |
| | 24 | 1996390-1 | K | SMPM straight cable jack (flexible) floating panel mount, Au plated contacts | |
| 3 | 3 | 1996706-1 | C | 8 position RF module backplane, 1-piece stainless steel shell. Au plated RF contacts | Daughter card (24) 3 inch single end on flexible cable.<br>Daughter card and backplane (24 each) 3 inch single end on flexible cable, environmental cables used. |
| | 3 | 1996705-4 | H | 8 position RF module daughter card, stainless steel shell | |
| | 48 | 1996390-1 | K | SMPM straight cable jack (flexible) floating panel mount, Au plated contacts | |
| 3 | 3 | 2157192-1 | 4 | 8 position RF module backplane, 2-piece aluminum shell with trivalent chromate finish | Daughter card and backplane (24 each) 12 inch single end on flexible cable. |
| | 3 | 2101780-5 | J | 8 position RF module daughter card, stainless steel shell | |
| | 24 | 2101012-1 | D | SMPM straight cable plug (M) snap-in panel mount, Au plated, backplane, RF contacts | |
| | 24 | 1996390-1 | K | SMPM straight cable jack (F) floating panel mount, Au plated, daughter card, RF contacts | |
| 4 | 2 | 1996706-1 | C | 8 position RF module backplane, 1-piece stainless steel shell. Au plated RF contacts | Daughter card and backplane (8 each) 12 inch double end on flexible cable, 2.9 mm on equipment side.<br>Daughter card and backplane (8 each) 12 inch double end semi-rigid cable, 2.9 mm on equipment side. |
| | 2 | 1996705-4 | H | 8 position RF module daughter card, stainless steel shell | |
| | 16 | 1996390-1 | K | SMPM straight cable jack (flexible) floating panel mount, Au plated contacts | |
| 4 | 1 | 2157192-1 | 4 | 8 position RF module backplane, 2-piece aluminum shell with trivalent chromate finish | Daughter card and backplane (8 each) 3 inch double end on flexible cable, 2.9 mm on equipment side. |
| | 1 | 2101780-5 | J | 8 position RF module daughter card, stainless steel shell | |
| | 8 | 2101012-1 | D | SMPM straight cable plug (M) snap-in panel mount, Au plated, backplane, RF contacts | |
| | 8 | 1996390-1 | K | SMPM straight cable jack (F) floating panel mount, Au plated, daughter card, RF contacts | |

**Figure 1 (cont)**

| Test Group | Quantity | Part Number | Rev | Description | Cable |
|---|---|---|---|---|---|
| 5 | 1 | 1996706-1 | C | 8 position RF module backplane, 1-piece stainless steel shell. Au plated RF contacts | Daughter card and backplane (8 each) 24 inch double end flexible cable, 2.9 mm on equipment side. |
| | 1 | 1996705-4 | H | 8 position RF module daughter card, stainless steel shell | |
| | 8 | 1996390-1 | K | SMPM straight cable jack (flexible) floating panel mount, Au plated contacts | |
| 6 | 6 | 1996884-1 | D | 4 position RF module backplane, 1-piece stainless steel shell. Au plated RF contacts | Daughter card (6) line under test double end flexible cable BNC, backplane shorted contact daughter card (7) 3 inch single end flexible cable non-test. |
| | 6 | 1996883-3 | E | 4 position RF module daughter card, stainless steel shell | |
| | 24 | 1996390-1 | K | SMPM straight cable jack (flexible) floating panel mount, Au plated contacts | |
| 6 | 3 | 2157192-1 | 4 | 8 position RF module backplane, 2-piece aluminum shell with trivalent chromate finish | Daughter card (3) line under test, double end flexible cable, BNC on equipment side. 12 inch single end flexible cable (21) non-test. Backplane (3) 3 inch single end shorted contact. 12 inch single end flexible cable (21) non-test. |
| | 3 | 2101780-5 | J | 8 position RF module daughter card, stainless steel shell | |
| | 24 | 2101012-1 | D | SMPM straight cable plug (M) snap-in panel mount, Au plated, backplane, RF contacts | |
| | 24 | 1996390-1 | K | SMPM straight cable jack (F) floating panel mount, Au plated, daughter card, RF contacts | |
| 7 | 1 | 1996706-1 | C | 8 position RF module backplane, 1-piece stainless steel shell. Au plated RF contacts | Daughter card and backplane (8 each) 24 inch double end leads, 2.9 mm on equipment side. |
| | 1 | 1996705-4 | H | 8 position RF module daughter card, stainless steel shell | |
| | 8 | 1996390-1 | K | SMPM straight cable jack (flexible) floating panel mount, Au plated contacts | |
| 8 | 2 | 1996706-1 | C | 8 position RF module backplane, 1-piece stainless steel shell. Au plated RF contacts | Daughter card and backplane (7 each) 4 inch double end flexible cable, 2.9 mm on equipment side. Daughter card and backplane (7 each) 4 inch double end semi-rigid cable, 2.9 mm on equipment side. |
| | 2 | 1996705-4 | H | 8 position RF module daughter card, stainless steel shell | |
| | 14 | 1996390-1 | K | SMPM straight cable jack (flexible) floating panel mount, Au plated contacts | |
| 8 | 1 | 2157192-1 | 4 | 8 position RF module backplane, 2-piece aluminum shell with trivalent chromate finish | Daughter card and backplane (8 each) 3 inch double end flexible cable, 2.9 mm on equipment side. |
| | 1 | 2101780-5 | J | 8 position RF module daughter card, stainless steel shell | |
| | 8 | 2101012-1 | D | SMPM straight cable plug (M) snap-in panel mount, Au plated, backplane, RF contacts | |
| | 8 | 1996390-1 | K | SMPM straight cable jack (F) floating panel mount, Au plated, daughter card, RF contacts | |

**Figure 1 (end)**

1.5. Environmental Conditions

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

- Temperature: 15 to 35°C
- Relative Humidity: 20 to 80%

1.6. Qualification Test Sequence

| Test or Examination | Test Group (a) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3(b) | 4 | 5 | 6 | 7 | 8 |
| | Test Sequence (c) | | | | | | | |
| Initial examination of product | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Low Level Contact Resistance (LLCR) | 2,8 | | 2,4 | | | | | |
| Voltage Standing Wave Ratio (VSWR) | | | | 2 | | | | |
| Insulation resistance | | 2,6 | | | | | | |
| Withstanding voltage | | 3,7 | | | | | | |
| Insertion loss | | | | | | | | 2 |
| Frequency response | | | | | | | | 3 |
| Isolation | | | | | | | | 4 |
| Power handling | | | | | | | 2 | |
| Vibration, Class V3 | | | | | | 2 | | |
| Mechanical shock, Class OS2 | | | | | | 3 | | |
| Durability | 5 | | | | | | | |
| Mating force | 3,6 | | | | | | | |
| Unmating force | 4,7 | | | | | | | |
| Thermal shock (non-operating) | | 4 | | | | | | |
| Operating temperature | | | | | 2 | | | |
| Corrosion resistance | | | 3 | | | | | |
| Humidity | | 5 | | | | | | |
| Final examination of product | 9 | 8 | 5 | 3 | 3 | 4 | 3 | 5 |

***NOTE***

*(a) See paragraph 1.4.*

*(b) For 1-piece backplane module connector system only: Two sets of cables were used on the backplane for this test group. One set of cables was prepared and used for LLCR measurements. A separate environmental set was prepared and used for corrosion exposure only. Following corrosion exposure, the environmental cables were replaced with the original measurement cables in the same positions as originally installed and were used for the final measurement.*

*(c) Numbers indicate sequence in which tests were performed.*

**Figure 2**

## 2. SUMMARY OF TESTING

2.1. Initial Examination of Product - All Test Groups

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

2.2. LLCR - Test Groups 1 and 3

All LLCR measurements, taken at 100 milliamperes maximum and 20 millivolts maximum open circuit voltage were less than 8 milliohms initially for center contacts, less than 2 milliohms initially for outer contacts, and had a change in resistance (ΔR) of less than 5 milliohms after testing.

A. Connector System with 1-Piece Backplane Module

*Equal Wire Length (EWL) bulk wire measurements were subtracted from all tabulated data.*

*Test Group 1: center contact bulk = 25.87 milliohms, outer contact bulk = 1.96 milliohms.*

*Test Group 3: center contact bulk = 23.78 milliohms, outer contact bulk = 1.46 milliohms.*

| Test Group | Specimen Number | Specimen Size | Number of Data Points | Condition | LLCR (milliohms) | | |
|---|---|---|---|---|---|---|---|
| | | | | | Minimum | Maximum | Average |
| Center Contact | | | | | | | |
| 1 | 1 | 4 position | 4 | Initial | 6.01 | 6.44 | 6.23 |
| | | | | Final (ΔR) | -0.10 | 0.39 | 0.10 |
| | 2 | | | Initial | 6.04 | 6.24 | 6.14 |
| | | | | Final (ΔR) | -0.43 | -0.04 | -0.23 |
| | 3 | | | Initial | 5.24 | 6.15 | 5.67 |
| | | | | Final (ΔR) | -0.27 | 0.28 | -0.01 |
| | 4 | 8 position | 8 | Initial | 4.78 | 6.25 | 5.82 |
| | | | | Final (ΔR) | -0.30 | 0.21 | 0.00 |
| 3 | 1 | 8 position | 8 | Initial | 2.41 | 3.67 | 3.09 |
| | | | | Final (ΔR) | 0.61 | 2.63 | 1.25 |
| | 2 | | | Initial | 2.44 | 3.40 | 2.91 |
| | | | | Final (ΔR) | 0.68 | 1.66 | 1.12 |
| | 3 | | | Initial | 2.75 | 3.71 | 3.06 |
| | | | | Final (ΔR) | 0.65 | 2.04 | 1.04 |
| Outer Contact | | | | | | | |
| 1 | 1 | 4 position | 4 | Initial | 0.41 | 0.71 | 0.60 |
| | | | | Final (ΔR) | -0.45 | -0.04 | -0.17 |
| | 2 | | | Initial | 0.37 | 0.50 | 0.43 |
| | | | | Final (ΔR) | 0.06 | 0.15 | 0.09 |
| | 3 | | | Initial | 0.36 | 0.65 | 0.51 |
| | | | | Final (ΔR) | -0.12 | 0.04 | -0.04 |
| | 4 | 8 position | 8 | Initial | 0.13 | 0.70 | 0.42 |
| | | | | Final (ΔR) | -0.13 | 0.12 | 0.02 |
| 3 | 1 | 8 position | 8 | Initial | 0.18 | 0.34 | 0.24 |
| | | | | Final (ΔR) | 0.12 | 0.30 | 0.19 |
| | 2 | | | Initial | 0.23 | 0.36 | 0.30 |
| | | | | Final (ΔR) | 0.03 | 0.52 | 0.20 |
| | 3 | | | Initial | 0.26 | 0.39 | 0.31 |
| | | | | Final (ΔR) | -0.07 | 0.46 | 0.16 |

**Figure 3**

B. Connector System with 2-Piece Backplane Module

*Equal Wire Length (EWL) bulk wire measurements were subtracted from all tabulated data.*

*Test Group 1: center contact bulk = 113.43 milliohms, outer contact bulk = 14.28 milliohms.*

*Test Group 3: center contact bulk = 116.44 milliohms, outer contact bulk = 11.83 milliohms.*

| Test Group | Specimen Quantity | Specimen Size | Number of Data Points | Condition | LLCR (milliohms) | | |
|---|---|---|---|---|---|---|---|
| | | | | | Minimum | Maximum | Average |
| Center Contact | | | | | | | |
| 1 | 3 | 8 position | 24 | Initial | 5.84 | 7.32 | 6.40 |
| | | | | Final (ΔR) | -1.54 | 0.43 | -0.26 |
| 3 | 3 | 8 position | 24 | Initial | 2.69 | 4.52 | 3.21 |
| | | | | Final (ΔR) | 0.94 | 4.22 | 2.80 |
| Outer Contact | | | | | | | |
| 1 | 3 | 8 position | 24 | Initial | -2.05 | -1.36 | -1.79 |
| | | | | Final (ΔR) | -0.29 | 0.20 | -0.06 |
| 3 | 3 | 8 position | 24 | Initial | 0.40 | 1.38 | 0.67 |
| | | | | Final (ΔR) | 0.12 | 1.51 | 0.70 |

**Figure 4**

2.3. VSWR - Test Group 4

VSWR was less than 1.5:1 to 26.5 GHz for semi-rigid cable, and less than 1.5:1 to 20 GHz for flexible cable.

2.4. Insulation Resistance - Test Group 2

All insulation resistance measurements were greater than 10,000 megohms initially and 5,000 megohms after testing.

2.5. Withstanding Voltage - Test Group 2

No dielectric breakdown or flashover occurred; leakage current was less than 5 milliamperes.

2.6. Insertion Loss - Test Group 8

Insertion loss measurements were less than -0.12 sqrt f (GHz) dB from 1.0 to 26.5 GHz for semi-rigid cable, and less than -0.12 sqrt f (GHz) dB from 1.0 to 20.0 GHz for flexible cable.

2.7. Frequency Response - Test Group 8

Frequency response was less than ±1.0 dB from 1.0 to 26.5 GHz for semi-rigid cable, and less than ±1.0 dB from 1.0 to 20.0 GHz for flexible cable.

2.8. Isolation - Test Group 8

Isolation measurements were greater than 140 dB from 3.0 to 30 MHz, greater than 120 dB from 30 MHz to 3.0 GHz, and greater than 100 dB from 3.0 to 26.5 GHz.

2.9. Power Handling - Test Group 7

VSWR was less than 1.5 at 3.0 to 30 MHz and 30 dBm, and less than 1.5 at 30 MHz to 26.5 GHz and 20 dBm.

2.10. Vibration, Class V3 - Test Group 6

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

2.11. Mechanical Shock, Class OS2 - Test Group 6

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

2.12. Durability - Test Group 1

No evidence of physical damage was visible as a result of mating and unmating the specimens 500 times.

2.13. Mating Force - Test Group 1

All mating force measurements were less than 75 N for 4 position specimens, and less than 145 N for 8 position specimens.

2.14. Unmating Force - Test Group 1

All unmating force measurements were greater than 13 N for 4 position specimens, and greater than 25 N for 8 position specimens.

2.15. Thermal Shock (non-operating) - Test Group 2

No evidence of physical damage was visible as a result of thermal shock testing.

2.16. Operating Temperature - Test Group 5

VSWR was less than 1.5.1 to 20 GHz at temperatures between -40 and 85°C.

2.17. Corrosion Resistance - Test Group 3

Specimens were able to mate and unmate, and met all LLCR requirements after exposure to a corrosive atmosphere.

2.18. Humidity - Test Group 2

No evidence of physical damage was visible as a result of exposure to a moisture laden atmosphere.

2.19. Final Examination of Product - All Test Groups

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

## 3. TEST METHODS

3.1. Initial Examination of Product

A Certificate of Conformance 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. LLCR

LLCR 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.

3.3. VSWR

VSWR was measured on mated specimens using a network analyzer with a sweep range of 1.0 to 26.5 GHz. Eight cables were measured.

3.4. Insulation Resistance

Insulation resistance was measured between each single contact to all other contacts and between the shell and all the contacts of mated specimens. A test voltage of 500 volts DC was applied for a maximum of 2 minutes before the resistance was measured.

3.5. Withstanding Voltage

A test potential of 325 volts rms was applied between adjacent contacts of mated specimens for 1 minute and then returned to zero.

3.6. Insertion Loss

A full Two-Port Calibration was performed using a network analyzer, the insertion loss, $S_{21}$, of the specimen was measured.

3.7. Frequency Response

Frequency response data was extracted from insertion loss data (see paragraph 3.6).

3.8. Isolation

Sinusoidal frequencies of 3.0 MHz to 26.5 GHz were applied to 1 end of the "driven line". The "quiet line" was monitored using a spectrum or network analyzer to measure any crosstalk signals.

3.9. Power Handling

VSWR measurements were taken at an operating temperature of 105°C at 3.0 to 30 MHz and 30 dBm, and at 30 MHz to 26.5 GHz and 20 dBm. Mated specimens were held at 105°C for 1 hour before performing VSWR.

3.10. Vibration, Class V3

Mated specimens were subjected to a random vibration test. The parameters of this test condition were specified by a random vibration spectrum with excitation frequency bounds of 5 and 2000 Hz. The Power Spectral Density (PSD) at 5 Hz was 0.005 $G^2$/Hz. The spectrum sloped up at 3 dB per octave to a PSD of 0.1 $G^2$/Hz at 100 Hz. The spectrum remained flat at 0.1 $G^2$/Hz from 100 to 1000 Hz. The spectrum sloped down at 6 dB per octave to a PSD of 0.025 $G^2$/Hz at the upper bound frequency of 2000 Hz. The root-mean square amplitude of the excitation was 12.0 GRMS. Specimens were subjected to this test for 1 hour in each of the 3 mutually perpendicular axes for a total test time of 3 hours per specimen. Cables on the specimens were secured to the vibrating surface no more than 25.4 mm from the module. Specimens were monitored for discontinuities of 10 nanoseconds or greater using an energizing current of 100 milliamperes.

3.11. Mechanical Shock, Class OS2

Mated specimens were subjected to a saw-tooth waveform with an acceleration amplitude of 40 gravity units (g's peak) and a duration of 11 milliseconds. Three shocks in each direction were applied along the 3 mutually perpendicular axes for a total of 18 shocks. Cables on the specimens were secured to the vibrating surface no more than 25.4 mm from the module. Specimens were monitored for discontinuities of 10 nanoseconds or greater using an energizing current of 100 milliamperes.

3.12. Durability

Specimens were mated and unmated 500 times at a maximum rate of 600 cycles per hour.

3.13. Mating Force

The force required to mate individual specimens was measured using a tensile/compression device with a free floating fixture and a rate of travel of 12.7 mm per minute.

3.14. Unmating Force

The force required to unmate individual specimens was measured using a tensile/compression device with a free floating fixture and a rate of travel of 12.7 mm per minute.

3.15. Thermal Shock (non-operating)

Mated specimens were subjected to 5 cycles of thermal shock. One cycle consisted of the following:

| Step | Test Condition | |
|---|---|---|
| | Temperature (°C) | Time (minutes) |
| 1 | +0 | 60 |
| | -55 | |
| | -3 | |
| 2 | +10 | 5 (maximum) |
| | 25 | |
| | -5 | |
| 3 | +3 | 60 |
| | 125 | |
| | -0 | |
| 4 | +10 | 5 (maximum) |
| | 25 | |
| | -5 | |

**Figure 5**

3.16. Operating Temperature

Mated specimens were exposed to temperatures between -40 and 105°C. VSWR measurements were taken at 22, -40 and 105°C. Eight cables were measured, 2 modules with 4 cables per module.

3.17. Corrosion Resistance

Mated specimens were exposed to a 48 hour salt fog environment with periodic $SO_2$ injections. Specimens with a 2-piece backplane module were mounted in an optional enclosure with drain holes. Upon completion, specimens were rinsed and then dried for a minimum of 24 hours at 40°C.

3.18. Humidity

Mated specimens were exposed to 10 humidity/temperature cycles. Each cycle lasted 24 hours and consisted of cycling the temperature between 30 and 60°C while maintaining 95 percent humidity at all times except during descending temperature periods when the relative humidity may drop as low as 85% (Figure 6).

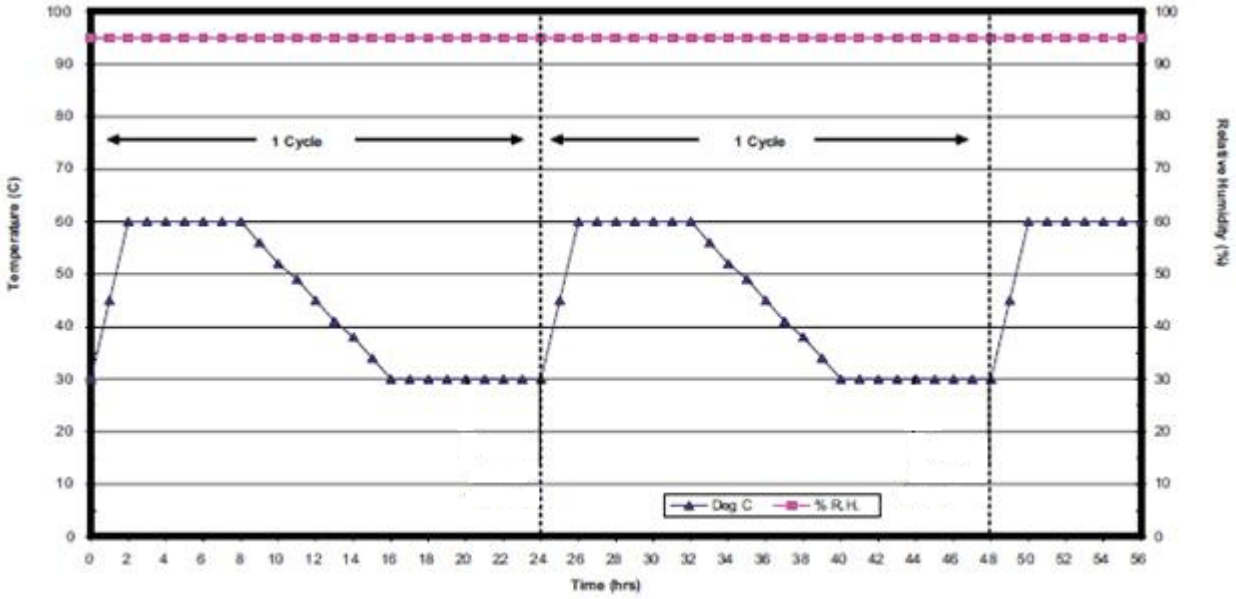


**Figure 6**

3.19. Final Examination of Product

Specimens were visually examined for evidence of physical damage detrimental to product performance.