

**Product Specification for AMPSEAL 16 COAXIAL Housings**

A4	Test sequence and details as per USCAR2 Rev 7 added	21OCT2021	HPS	JB
A3	1P, Header Updates for Release to Market 4P Header Vibration Data Added	21SEP2021	DFS	JB
A2	1P, Cap Pin Assy, W2W Sealed Coaxial – Test details, sequence and sample description added. 4P, Cap Pin Assy, flange, Sealed COAX AS16 - Sample description added.	15SEP2021	HPS	JB
Rev	Description	Date	Drawn	Approved

1. SCOPE

1.1. Content

This specification defines the performance, tests, and quality requirements for the TE Connectivity (TE) AMPSEAL 16 COAXIAL Connector series.

1.2. Qualification

When tests are performed on the subject product line, procedures specified in Figure 1 shall be used. All inspections shall be performed using the applicable inspection plan and product drawing.

1.3. Qualification Test Results

Successful qualification testing on the subject product line was completed June 2021. The Qualification Test Report number for this testing is 501-94038.

2. APPLICABLE DOCUMENTS AND FORMS

The following documents and forms constitute a part of this specification to the extent specified herein. Unless otherwise indicated, the latest edition of the document applies. In the event of conflict between the requirements of this specification and the product drawing, the product drawing shall take precedence. In the event of conflict between the requirements of this specification and the referenced documents, this specification shall take precedence.

2.1. TE Documents

- 108-94515: Product Specification MATE-AX
 - Applicable Sections for Inline Connections:
 - I. 4.2.3 Electrical Data
 - II. 4.2.5 Materials
 - III. 4.2.6 Contact Platings
 - IV. 4.2.7 HF-Parameter
- 109-18379: Test Specification (MATE-AX cable assemblies)
 - Applicable in correlation with Product Specification Sections listed above.

2.2. Industry Documents

- SAE/USCAR-2 (Rev 7): Performance Specification for Automotive Electrical Connector Systems.
- ISO 20653: Tests and measurements- Road vehicles - Degrees of protection (IP-Code) - Protection of electrical equipment against foreign objects, water and access.
- SAE J2030: Performance Standard for Heavy-Duty Electrical Connector
- USCAR17: Performance Specification for Automotive RF Connector System.
- IEC 60512-25-7: Tests and measurements – Impedance, reflection coefficient, and voltage standing wave ratio (VSWR)
- IEC 60512-25-2: Tests and measurements – Attenuation (insertion loss)
- IEC 60512-25-5: Tests and measurements – Return loss
- IEC 60512-25-1: Tests and measurements – Crosstalk ratio
- EIA-364-02: Air Leakage Test Procedure for Electrical Connectors
- SAE J1455: Recommended Environmental Practices for Electronic Equipment
- GMSL2 Hardware Design Guide (Rev. 14.0)
- LV214: Motor Vehicle Connectors Test Specification

3. REQUIREMENTS

3.1. Design and Construction

Product shall be of the design, construction, materials, and physical dimensions specified on the applicable product drawing.

3.2. Materials

Materials used in the construction of this product shall be specified on the applicable product drawing.

3.3. Ratings

- Voltage: 60V DC.
- Temperature: -40 to +105°C

3.4. RF Connector Performance Requirements

- See Table 1 for RF Requirements
- See Table 1 for RF Test Descriptions.
- Characteristic Impedance: 50 ohms differential pair
- Frequency Range: 1 to 6 GHz

3.5. Test Requirements and Procedures Summary

Product is designed to meet the electrical, mechanical, and environmental performance requirements specified in Table 1. Unless otherwise specified, all tests shall be performed at ambient environmental conditions.

Table 1

TEST DESCRIPTION	REQUIREMENT	PROCEDURE
Visual inspection	No visual defects, torn seals, cracked plastic, or discoloration observed.	SAE J2030 6.1. Rev 2015 OR USCAR2 Visual inspection of product before (and after) un-mating connectors for conditions such as torn seals, cracked plastic, evidence of fluid or dust ingress in sealed connector systems, arcing, charring, melting, or anything that affects the performance or serviceability of the product as deemed by qualified Engineer.
MECHANICAL		
Mating Force and Un-mating Force	135N Max. Mating Force 135N Max. Un-mating Force	SAE J2030 6.9. and 6.10. Rev 2015 Measure force necessary to mate and un-mate specimens at a maximum rate of 50 mm per minute.
Terminal Insertion/Forward Stop	50N Max. Insertion 50N Min. Push Through	USCAR2 5.4.1.3 Rev 7 Insert the terminal at max rate of 50mm/min. Once the terminal has been snapped into place, continue applying force to the forward stop until at least 50N has been applied.
TPA engagement Pre-Set to Lock w/ terminals	60N Max.	USCAR2 5.4.5 Rev 7 50mm/min max head speed

TEST DESCRIPTION	REQUIREMENT	PROCEDURE
Connector Cycling	See note	USCAR2 5.1.7 Rev 7 Mate and unmate each connector pair 10 times
Mating Force Un-mating Force & Retention Force(g)	Mating Force: 135N Max. Un-mating Force: 75N Max. Retention Force: ≥ 110 N	USCAR2 5.4.2 Rev 7
Terminal Retention(g)	60N Min. (Initial) 50N Min. (Final)	USCAR2 5.4.1.3 Rev 7
TPA disengagement Lock to Pre-Set w/ terminals(g)	60N Max.	USCAR2 5.4.5 Rev 7
Polarization Feature Effectiveness	USCAR2 5.4.4 Rev 7	USCAR2 5.4.4 Rev 7
Connector Drop Test	USCAR2 5.4.8 Rev 7	USCAR2 5.4.8 Rev 7
Cavity Damage Susceptibility	USCAR2 5.4.9 Rev 7	USCAR2 5.4.9 Rev 7
Mounting Feature Strength	USCAR 2 5.4.11 Rev 7	USCAR 2 5.4.11 Rev 7
Connector and/or Terminal Cycling	USCAR 2 5.1.7 Rev 7	USCAR 2 5.1.7 Rev 7
Misc. Component Engage/Disengage	USCAR 2 5.4.5 Rev 7	USCAR 2 5.4.5 Rev 7
Connector-Connector Audible Click	USCAR 2 5.4.7 Rev 7	USCAR 2 5.4.7 Rev 7
Connector-Connector Mating & Un- mating/Retention	USCAR 2 5.4.2 Rev 7	USCAR 2 5.4.2 Rev 7
Connector Seal Retention – Mated Connector	USCAR 2 5.4.14 Rev 7	USCAR 2 5.4.14 Rev 7

ELECTRICAL

Insulation resistance - SAE J2030	Insulation Resistance > 100 M Ω	SAE J2030 6.3 Rev 2015 U = 500 V (DC) t = 60s
Low Signal Termination Resistance	Outer Contacts mated connection: Initial: max 7.5 m Ω After test: max 40m Ω Inner Contacts mated connection: Initial: max 15 m Ω After test: max 40m Ω	SAE J2030 6.2. Rev 2015 Measure connection resistance across mated terminals and subtract bulk resistance of Equal Wire Lengths (EWL).

TEST DESCRIPTION	REQUIREMENT	PROCEDURE									
Voltage Drop – SAEJ2030	<table border="1"> <thead> <tr> <th data-bbox="527 254 672 327">Wire</th> <th data-bbox="672 254 789 327">Test current</th> <th data-bbox="789 254 920 327">Voltage Drop</th> </tr> </thead> <tbody> <tr> <td data-bbox="527 327 672 369">RG 174</td> <td data-bbox="672 327 789 369">1A</td> <td data-bbox="789 327 920 369">100 mV</td> </tr> <tr> <td data-bbox="527 369 672 432">RTK-031</td> <td data-bbox="672 369 789 432">3A</td> <td data-bbox="789 369 920 432">100 mV</td> </tr> </tbody> </table>	Wire	Test current	Voltage Drop	RG 174	1A	100 mV	RTK-031	3A	100 mV	<p>SAE J2030 6.4. Rev 2015</p> <p>Averaged measurements after 30 seconds, 15 minutes and 30 minutes of current being applied. EWL subtracted.</p> <p>Test current max 3A, dependent of the cable.</p>
Wire	Test current	Voltage Drop									
RG 174	1A	100 mV									
RTK-031	3A	100 mV									
Voltage Drop – USCAR2	<table border="1"> <thead> <tr> <th data-bbox="527 468 672 541">Wire</th> <th data-bbox="672 468 789 541">Test current</th> <th data-bbox="789 468 920 541">Voltage Drop</th> </tr> </thead> <tbody> <tr> <td data-bbox="527 541 672 583">RG 174</td> <td data-bbox="672 541 789 583">1A</td> <td data-bbox="789 541 920 583">50 mV</td> </tr> <tr> <td data-bbox="527 583 672 646">RTK-031</td> <td data-bbox="672 583 789 646">3A</td> <td data-bbox="789 583 920 646">50 mV</td> </tr> </tbody> </table>	Wire	Test current	Voltage Drop	RG 174	1A	50 mV	RTK-031	3A	50 mV	<p>USCAR2 5.3.2 Rev. 7</p>
Wire	Test current	Voltage Drop									
RG 174	1A	50 mV									
RTK-031	3A	50 mV									
Maximum Test Current Capability	<p>Data collected for information only. Derating Curves can be found in the appendix below.</p>	<p>USCAR2 5.3.3 Rev 7</p> <p>Ambient = 80 Deg C, Operating Temp = 105 Deg C, Max T-rise = 45 Deg C</p> <p>All inner conductors to be under current, outer contact to be return conductor</p>									
Contact Resistance	<p>Outer Contacts mated connection: 5mΩ max.</p> <p>Inner Contacts mated connection: 24mΩ max.</p>	<p>USCAR17-5, Section 4.3.1</p>									
Circuit Continuity Monitoring	<p>No discontinuities ≥7 ohms for more than 1 microsecond</p>	<p>USCAR2-7, Section 5.1.9</p>									
Current Cycling	<p>USCAR 2 5.3.4 Rev 7</p>	<p>USCAR 2 5.3.4 Rev 7</p>									
Dry Circuit Resistance	<p>USCAR 2 5.3.1 Rev 7</p>	<p>USCAR 2 5.3.1 Rev 7</p>									
Insulation resistance – USCAR2	<p>USCAR 2 5.5.1 Rev 7</p>	<p>USCAR 2 5.5.1 Rev 7</p>									
SIGNAL PROPAGATION											
Impedance	<p>Refer to 108-94515 Section 4.2.7 for RF performance requirements of Inline Connections.</p>	<p>Refer to 109-18379 Section 7.3.3 for information regarding the test procedure.</p>									
Crosstalk	<p>Refer to 108-94515 Section 4.2.7 for RF performance requirements of Inline Connections.</p>	<p>Refer to 109-18379 Section 7.3.6 for information regarding the test procedure.</p>									
Insertion Loss	<p>Refer to 108-94515 Section 4.2.7 for RF performance requirements of Inline Connections.</p>	<p>Refer to 109-18379 Section 7.3.4 for information regarding the test procedure.</p>									

TEST DESCRIPTION	REQUIREMENT	PROCEDURE
Return Loss	Refer to 108-94515 Section 4.2.7 for RF performance requirements of Inline Connections.	Refer to 109-18379 Section 7.3.5 for information regarding the test procedure.
GMSL2 Channel Test: Insertion Loss	GMSL2 Per Section: <i>Single-Ended Insertion Loss Specification: 6Gbps/187Mbps and 6Gbps/1.5Gbps</i> for 10MHz – 3.5GHz	GMSL2 Hardware Design Guide (Rev. 14.0)
GMSL2 Channel Test: Insertion Loss to Return Loss Ratio (IRR)	GMSL2 Per Section: <i>Differential/Single-Ended IRR Specification: 6Gbps Forward/1.5Gbps Reverse</i> for 10MHz – 3.5GHz	GMSL2 Hardware Design Guide (Rev. 14.0)
RF Channel Cross Talk	Cross talk \geq 60dB for 10MHz – 3.5GHz	Refer to 109-18379 Section 7.3.6 for information regarding the test procedure.

ENVIRONMENTAL

Water Immersion IPX7	Water shall not penetrate in a quantity causing harmful effects or impair performance if the enclosure is immersed in water temporarily under specified pressure and time conditions	ISO 20653 Immersion depth: 1.0 m Duration 30 min
Dust Test IP6KX	Dust shall not penetrate in a quantity causing harmful effects or impair performance if the enclosure is exposed to dust per the standard.	ISO 20653
Thermal Shock – SAE J2030	See note	SAE J2030 6.13 Rev 2015 Subject specimens to 10 cycles between -40 and 105°C with 1-hour dwells at temperature extremes.
Vibration	See note	USCAR2 Vibration test acc. to USCAR2 Class V2
Vibration/Mechanical Shock	See note	USCAR2 Vibration/Mechanical Shock test acc. to USCAR2 Class V2
Header Terminal Solderability	95% coverage of center contact and shield solder tines	TEC-109-11-10; Method B
Header Terminal Wave Solderability	No defects	TEC-109-202; Cond B

TEST DESCRIPTION	REQUIREMENT	PROCEDURE
Thermal shock – USCAR2	USCAR 2 5.6.1 Rev 7	USCAR 2 5.6.1 Rev 7
High Temperature Exposure	USCAR 2 5.6.3 Rev 7	USCAR 2 5.6.3 Rev 7
Fluid Resistance	USCAR 2 5.6.4 Rev 7	USCAR 2 5.6.4 Rev 7
Temperature/Humidity Cycling	USCAR 2 5.6.2 Rev 7	USCAR 2 5.6.2 Rev 7
Submersion	USCAR 2 5.6.5 Rev 7	USCAR 2 5.6.5 Rev 7
Pressure/Vacuum Leak	USCAR 2 5.6.6 Rev 7	USCAR 2 5.6.6 Rev 7
High Pressure Spray	USCAR 2 5.6.7 Rev 7	USCAR 2 5.6.7 Rev 7

NOTE: *Shall meet visual requirements, show no physical damage, and meet requirements of additional tests as specified in the Product Qualification and Requalification Test Sequence shown in Figure 1*

3.6. Product Qualification and Requalification Test Sequence

TEST OR EXAMINATION	Test Group (a)																	
	1(d)	2	3	4	5	6	7	8(d)(f)	9	10	11	12	13	14	15	16	17	18
	Test Sequence (b)																	
Visual inspection	1, 10(c)	1,4	1,7	1, 3(c)	1,3	1,3	1,5	1,7	1,3	1,3	1,7	1,7	1,7	1,6	1,3	1,3	1,3	1,3
Mating Force and Un-mating Force		3																
Terminal Insertion/Forward Stop					2						2,5							
TPA engagement Pre-Set to Lock w/ terminals				2								2,5						
Vibration	7																	
Insulation resistance			2,4,6															
Low Signal Termination Resistance	2,5,8																	
Voltage drop – SAEJ2030	3,6,9																	
Maximum Test Current Capability						2												
Water Immersion ISO 20653 IPX7			3											2,5				
Thermal Shock	4	2																
Dust Test ISO 20653 IP6KX			5															
GMSL2 Channel Test: Insertion Loss							2											
GMSL2 Channel Test: Insertion Loss to Return Loss Ratio (IRR)							3											
RF Channel Cross Talk							4											
Connector Cycling								2										
Dry Circuit Resistance								3,5										
Vibration/Mechanical Shock								4(e)										
Circuit Continuity Monitoring								4(e)										
Voltage Drop - USCAR2								6										
Header Terminal Solderability									2									
Header Terminal Wave Solderability										2								
Connector Mating & Un-mating Force (g)													2,5					
Connector Retention Force(g)														3,6				
Terminal Retention(g)											3,6							
TPA disengagement Lock to Pre-Set w/ terminals(g)												3,6						
Polarization Feature Effectiveness(g)															2			
Connector Drop Test(g)																2		
Cavity Damage Susceptibility(g)																	2	
Mounting Feature Strength(g)																		2
Dry Heat (LV214 B.19.3 105° for 120hrs) (g)											4	4	4	3				
Temperature shock (LV 214 B 19.1) (g)														4				

- (a) See Paragraph 4.1.A
- (b) Numbers indicate sequence in which tests were performed.
- (c) Final visual inspection of cap assemblies failed due to testing performed outside of this sequence.
- (d) Test specimens divided into two groups. The first group is used to measure low signal termination resistance. The second group is used to measure voltage drop and continuity monitoring.
- (e) Circuit Continuity Monitoring is performed during [simultaneously with] the scheduled conditioning per the Test Sequence step number.
- (f) Test results pending completion; refer to Table 2 for detail regarding tested samples and quantities.
- (g) Tests only specific for 1P Coax Cap Pin Assy connector

Figure 1. Test Sequences

3.7. Product Qualification and Requalification Test Sequence – USCAR2 Rev 7

TEST OR EXAMINATION	Test Group (c)																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Test Sequence (d)																
Test sequence ID	C	D	E	F	G	H	I	J	L	M	N	P	Q	O	Z	TU AB	RSA A
General	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Connector and/or Terminal Cycling	3									3	3	3		3		3	3
Visual Inspection	2,6	2,4	2,4	2,4	2,4	2,4	2,4	2,4	2,4	2,8	2,8	2,8	2,4	2,9	2,4	2,16	2,16
Maximum test current capability	4																
Current cycling	5																
Terminal - Connector Insertion/retention force		3															
Terminal-Connector Retention												9		10		17	17
Misc. Component Engage/Disengage			3														
Connector-Connector Audible Click				3													
Connector Mating & Un-mating					3												
Polarization Feature Effectiveness						3											
Connector Drop Test							3										
Cavity Damage Susceptibility								3									
Mounting Feature Strength									3								
Dry Circuit Resistance										4,6	4,6	4,6		4,6			
Voltage Drop - USCAR2										7	7	7		7			
Circuit Continuity Monitoring										5	5						
Vibration/mechanical shock										5							
Thermal shock											5						
High Temperature Exposure												5				6	
Fluid Resistance													3				
Temperature/Humidity Cycling														5			6
Insulation Resistance														8		4,7,9,11,13,15	4,7,9,11,13,15
Submersion																10	10
Pressure/Vacuum Leak																5,8	5,8
High Pressure Spray																12,14	12,14
Connector Seal Retention – Mated Connector															3		

Figure 6. Test Sequences – USCAR2 Rev 7

4. QUALITY ASSURANCE PROVISIONS

4.1. Qualification Testing

A. Specimen Selection

Specimens shall be prepared in accordance with applicable Instruction Sheets and shall be selected at random from current production.

B. Test Sequence

Qualification inspection shall be verified by testing specimens as specified in Table 2

Table 2: Description of Samples

Test Group(a)	Primary Assembly	Mating Assembly	Wire Size	Sample Size
1	2338212-1	2338211-1	RTK031	4
	2338212-1	2338211-1	RG174	4
2	2338212-1	2338211-1	RTK031	10
	2338212-1	2338211-1	RG174	10
	2338212-1	2356408-1	RTK031	10
	2338212-1	2356408-1	RG174	10
	2355843-1	2355844-1	RTK031	10
3	2338212-1	2338211-1	RTK031	4
	2338212-1	2338211-1	RG174	10
	2338212-1	2356408-1	N/A	10
	2338212-1	2339729-1	RTK031	10
	2355843-1	2355844-1	RG174	10
	2355843-1	2374559-1	RG174	10
	2339729-1	2338212-1	RTK031	20
4	2338212-1	-	RTK031	10
	2338211-1	-	RTK031	10
5	2338212-1	-	RTK031	10
	2338212-1	-	RG174	10
	2338211-1	-	RTK031	10
	2338211-1	-	RG174	10
6	2338212-1	2338211-1	RTK031	3
	2338212-1	2338211-1	RG174	3
	2338212-1	2356408-1	RTK031	3
	2338212-1	2356408-1	RG174	3
	2356413-1	2298488-1	RTK031	3
	2356413-1	2298510-1	RG174	3
7	2338212-1	2338211-1 2356408-1	RTK031	1 Channel as Described in the GMSL2 Specification
8	2355843-1 (a)	2355844-1 (a)	RTK031 (a)	4
	2355843-1 (a)	2355844-1 (a)	RG174 (a)	4
9	2356413-1	NA	NA	5
10	2356413-1	NA	NA	5
11	2374559-1	NA	RTK031	8
	2374559-1	NA	RG174	8
12	2374559-1	NA	RTK031	8
	2374559-1	NA	RG174	7
13	2374559-1	2355843-1	RTK031	8
	2374559-1	2355843-1	RG174	8
14	2374559-1	2355843-1	RTK031	4
	2374559-1	2355843-1	RG174	4
15	2374559-1	2355843-1	RTK031	5
	2374559-1	2355843-1	RG174	5
16	2374559-1	NA	NA	18
17	2374559-1	NA	RTK031	3
	2374559-1	NA	RG174	2
18	2374559-1	NA	NA	30

(a) Test results pending completion

Test Group(c)	Primary Assembly	Mating Assembly	Wire Size	Sample Size
10	2339729-1	2338212-1	RTK031	12
11	2339729-1	2338212-1	RTK031	20
12	2339729-1	2338212-1	RTK031	10
14	2339729-1	2338212-1	RTK031	10
16	2339729-1	2338212-1	RTK031	10
17	2339729-1	2338212-1	RTK031	10

4.2. Requalification Testing

If changes significantly affecting form, fit or function are made to the product or manufacturing process, product assurance shall coordinate requalification testing, consisting of all or part of the original testing sequences as determined by development/product, quality and reliability engineering.

4.3. Acceptance

Acceptance is based on verification that the product meets the requirements of Figure 1. Failures attributed to equipment, test setup or operator deficiencies shall not disqualify the product. When product failure occurs, corrective action shall be taken, and specimens resubmitted for qualification. Testing to confirm corrective action is required before resubmittal.

4.4. Quality Conformance Inspection

The applicable quality inspection plan shall specify the sampling acceptable quality level to be used. Dimensional and functional requirements shall be in accordance with the applicable product drawing and this specification.

5. APPENDIX

5.1. Four Position Inline Coaxial Derating Curves

A. The first group (Figure 2, Curve 1) consisted of the following test samples:

- (a). 2338211-1 → 4 Position Cap Assembly
- (b). 2338212-1 → 4 Position Plug Assembly
- (c). 2298488-1 → Female Contact Kit with RTK031 Cable
- (d). 2298490-1 → Male Contact Kit with RTK031 Cable

B. The first group (Figure 2, Curve 2) consisted of the following test samples:

- (a). 2338211-1 → 4 Position Cap Assembly
- (b). 2338212-1 → 4 Position Plug Assembly
- (c). 2298510-1 → Female Contact Kit with RG174 Cable
- (d). 2298511-1 → Male Contact Kit with RG174 Cable

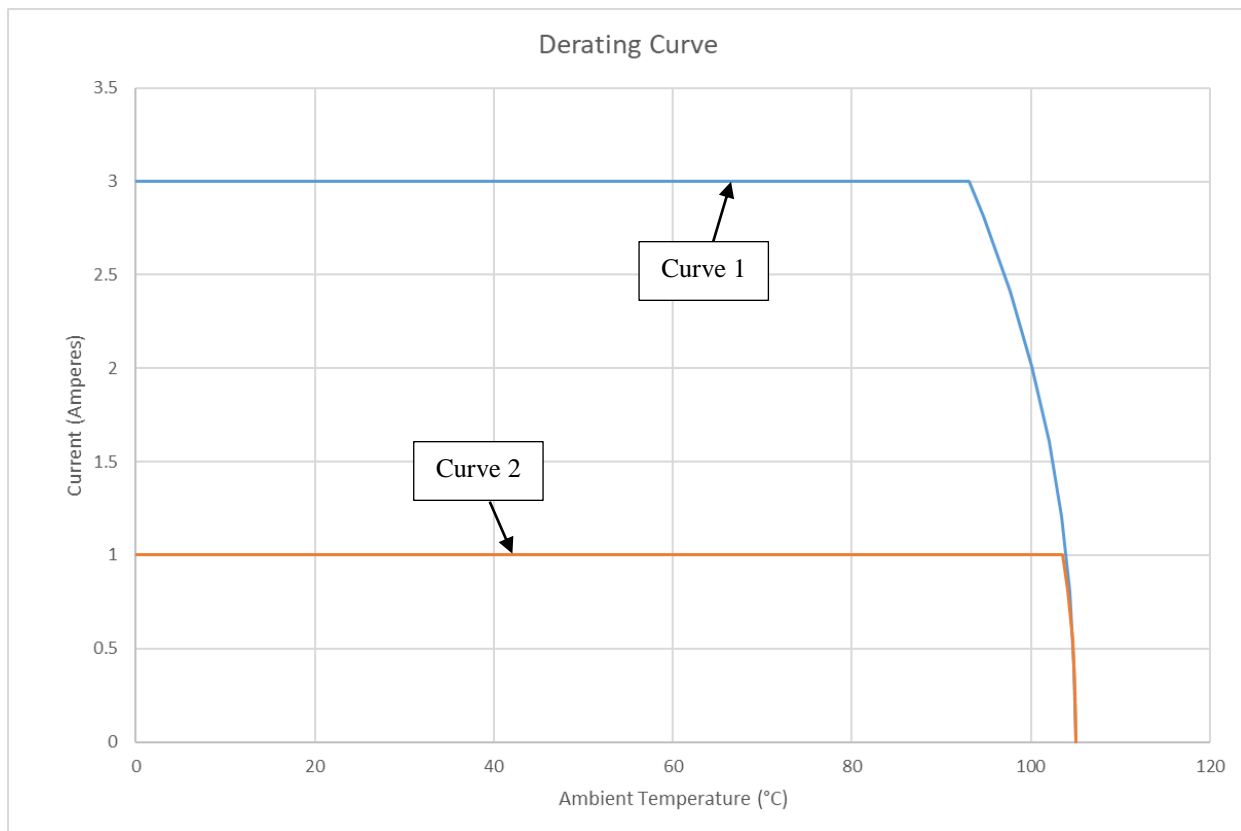


Figure 2: Derating Curves 4 Position Inline Plug and Cap

5.2 Four Position Vertical Header Derating Curves

A. The first group (Figure 3, Curve 1) consisted of the following test samples:

- (a). 2338212-1 → 4 Position Plug Assembly
- (b). 2356408-1 → 4 Position Vertical Header
- (c). 2298488-1 → Female Contact Kit with RTK031 Cable

B. The first group (Figure 3, Curve 2) consisted of the following test samples:

- (a). 2338212-1 → 4 Position Plug Assembly
- (b). 2356408-1 → 4 Position Vertical Header
- (c). 2298510-1 → Female Contact Kit with RG174 Cable

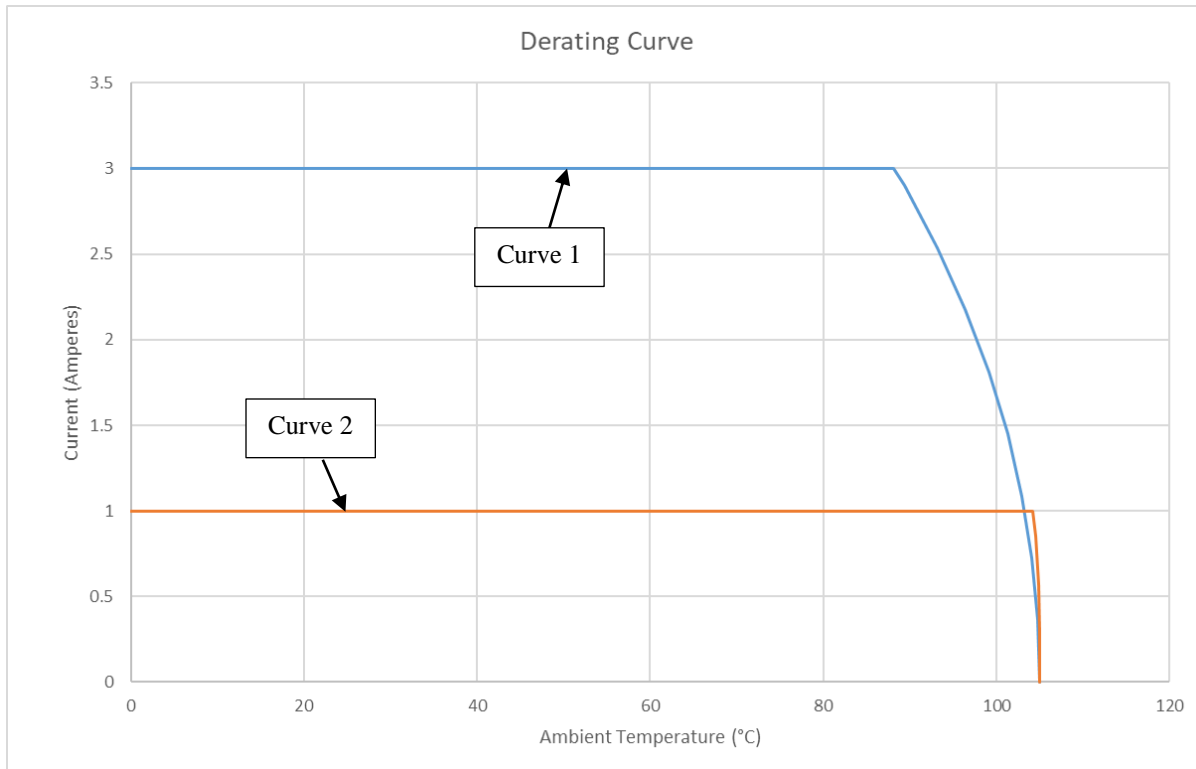


Figure 3: Derating Curves 4 Position Plug and Vertical Header

5.3. Header Terminal Assembly Derating Curves

- A. The first group (Figure 4, Curve 1) consisted of the following test samples:
- (a). 2356413 → AS16 Coax Vertical Header Terminal
 - (b). 2298488-1 → Female Contact Kit with RTK031 Cable
- B. The first group (Figure 4, Curve 2) consisted of the following test samples:
- (a). 2356413 → AS16 Coax Vertical Header Terminal
 - (b). 2298510-1 → Female Contact Kit with RG174 Cable

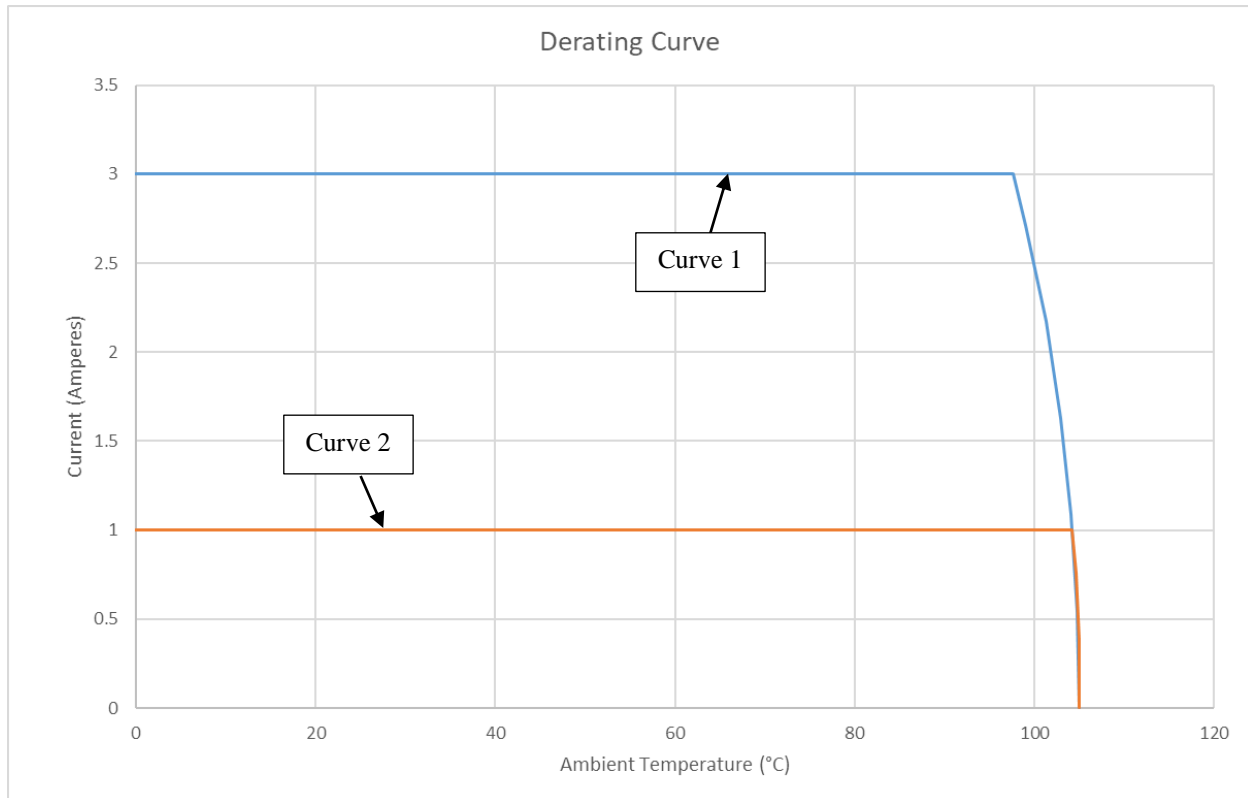


Figure 4: Derating Curves Header Terminal and Female Terminal in Free Air

5.4. 1 Position Vertical Header Derating Curves

A. The first group (Figure 5, Curve 1) consisted of the following test samples:

- (a). 2355843-1 → 1 Position Plug Assembly
- (b). 2355844-1 → 1 Position Vertical Header
- (c). 2298488-1 → Female Contact Kit with RTK031 Cable

B. The first group (Figure 5, Curve 2) consisted of the following test samples:

- (a). 2355843-1 → 1 Position Plug Assembly
- (b). 2355844-1 → 1 Position Vertical Header
- (c). 2298510-1 → Female Contact Kit with RG174 Cable

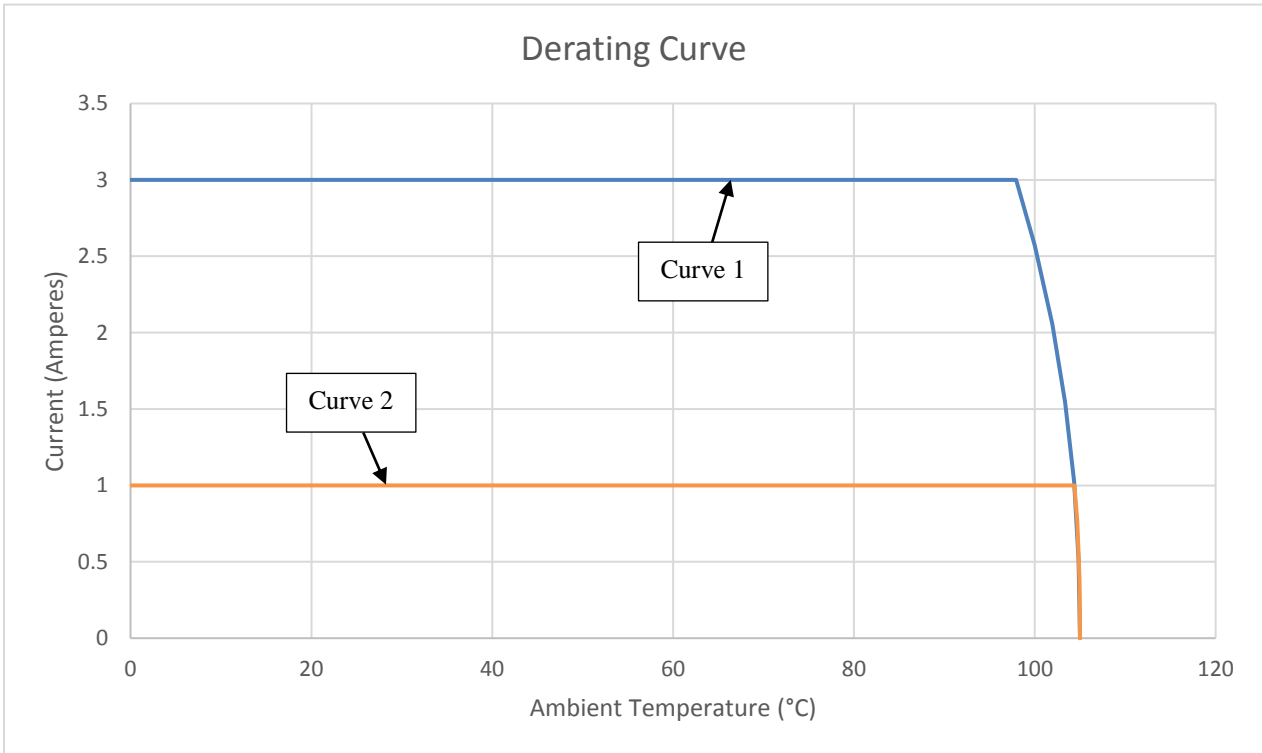


Figure 5: Derating Curves 1 Position Plug and Vertical Header