
108-94874

10 DEC 2024 REV C1

Class 1

2 to 8 positions NextGen MCON 1.2 LL Sealed

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1. SCOPE

1.1. Contents

This specification covers the performance, tests, and quality requirements for the products of the following table.

Position nr.	Contact type	Drawing number	Variant	Description	Mating part drawing
2	MCON 1.2 LL Drawing nr.: 1418754	2378602	standard	2POS, NEXTGEN, MCON 1.2 LL REC, SLD	1703498
		2395642	180° turned receptacle housing	2POS, NEXTGEN, MCON 1.2 LL REC, SLD TURNED	1703498
		2441392	standard, with biomass-balanced material	2POS, NEXTGEN+, MCON 1.2 LL REC, SLD, SUSTAINABLE	1703498
3		2378603	standard	3POS, NEXTGEN, MCON 1.2, SLD	1703494
		2395643	180° turned receptacle housing	3POS, NEXTGEN, MCON 1.2, SLD, TURNED	1703494
		2441393	standard, with biomass-balanced material	3POS, NEXTGEN+, MCON 1.2 LL REC, SLD, SUSTAINABLE	1703494
4		2378604	standard	4POS, NEXTGEN, MCON 1.2 LL REC, SLD	1564559
5		2376805	standard	5POS, NEXTGEN, MCON 1.2 LL REC, SLD	2141524
6		2378606	standard	6POS, NEXTGEN, MCON 1.2 LL REC, SLD	2141320
8		2378608	standard	8POS, NEXTGEN, MCON 1.2 LL REC, SLD	1703506

Accessories							
Wire			Part numbers				
Type (DIN 76772)	Insulation diameter (mm) Ø	mm ²	MCON 1.2 LL	Single wire seal		Blind plug PN/Color	
FLR & ACW	1.2-1.4	0.35	7-1452665-X	Yellow	967067-2	967056-1	Blue
	1.4-1.6	0.50	7-1452668-X	Green	967067-1		
	1.7-1.9	0.75	7-1452668-X	Green	967067-1		
	1.9-2.1	1.00	7-1452671-X	Green	967067-1		
	2.2-2.4	1.50	7-1452671-X	Green	2287497-1		

1.2. Qualification

When tests are performed the following specified specifications and standards shall be used. All inspections shall be performed using the applicable inspection plan and product drawing.

2. APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein. In the events of conflict between the requirements of this specification and the product drawing or of conflict between the requirements of this specification and the referenced documents, this specification shall take precedence.

2.1. TE Documents

- General Requirements for Test Specifications
- Customer Drawings acc. to part no. on page 2 “Contents”
- MCON Contact System Product Specifications – 108-18782
- Application Specification for MCON Contact System – 114-18464
- Application Specification NextGen MCON connector - 114-94767 2-8 POS, NextGen MCON 1.2 LL REC., Sealed

2.2. Other documents

- DIN IEC 60512 Electromechanical components for electronic equipment; basic testing procedures and measuring methods - edition May 1994
- DIN 40050, part 9 Road vehicles; degrees of protection (IP-Code)
- 209-160012:2020-09 (formerly LV 214)
- SAE/USCAR-2 rev.8

2.3. Design and construction

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

2.4. Material

Descriptions of material are shown in the drawings.

2.5. Ratings

- Voltage up to 48V (pollution level 1) - DIN EN 60664-1
- Current carrying capability - see applicable current carrying capability **see page 7, 1. Figure**
- Temperature **-40°C to +130°C** *)
- Durability cycles acc. to contact specification – **See specification 108-18782**
- Degree of protection **X9K**

*) ambient temperature and heating up by current (see Figure 1.)

2.6. Performance and test description

The product is designed to meet the electrical, mechanical, and environmental performance requirements specified in Paragraph 2.7. All tests are performed at ambient environmental conditions per IEC 60512 unless otherwise specified.

2.7. Test requirements

A. 209-160012:2020-09

Test Description	Requirement	Procedure
Visual- and dimensional examination <i>TG0 / TG1</i>	Meets requirements of product-customer-drawing	Acc. DIN IEC 60512-2 Test 1a and 1b
ELECTRICAL INSPECTIONS		
Current-temperature capability	See TE - Specification 108-18782, MCON 1.2 LL Depending on the application, different results may occur. When a comparable example cannot be found, the application must be investigated and tested on an individual basis.	
Max. temperature rise of contacts		
Change of temperature rise at the end of lifetime		
Voltage proof <i>TG 0</i>	Value and nature of the test voltage: 500V~ No disruptive/breakdown	Acc. DIN IEC 60512-2, Test 4a Method to be used: C Time of testing: 60s
Insulation resistance <i>TG 0</i>	Insulation resistance > 100 MΩ	Acc. DIN IEC 60512-2, Test 3a Method to be used: C Time of testing: 60s Test voltage: 500V=

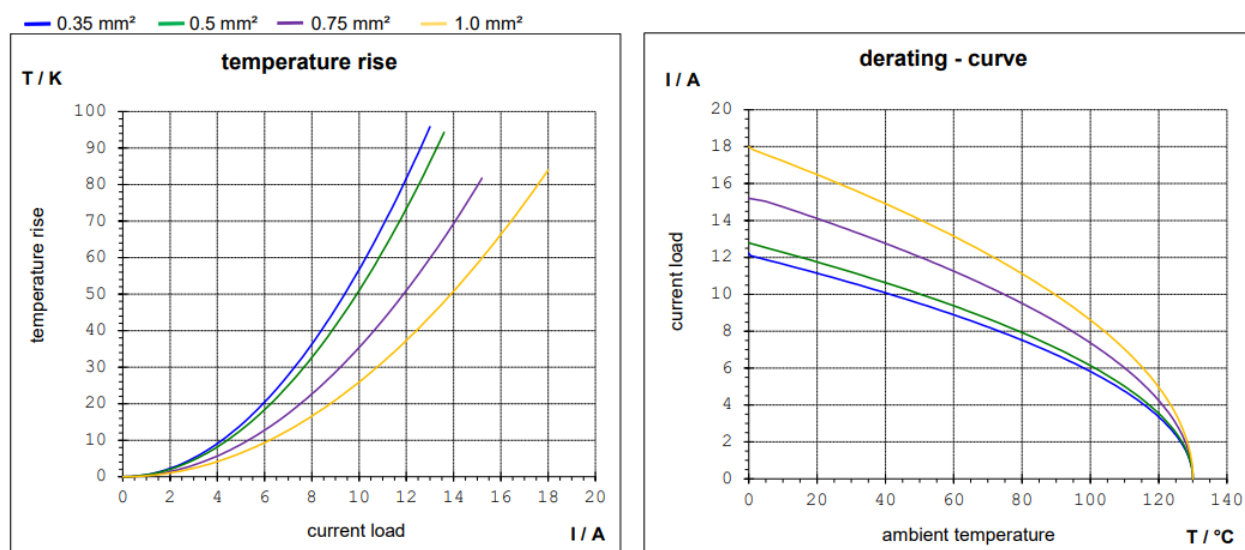
	MECHANICAL INSPECTIONS	
Test Description	Requirement	Procedure
Actuation forces for secondary lock, unequipped housing - TPA (Retainer) TG 6 E 6.4	Closing force (Pre-set → Lock) 2-3pos. Connectors: max.50N Opening force (Lock → Pre-set) (Without damage or deformation of the locking device) 2-3pos. Connectors $10 \leq F \leq 50 \text{ N}$ Drop test without damage	Suitable test apparatus with a constant speed of 50 mm/min
Keying and polarizing efficiency TG 7 E 7.1	Fully equipped housings for all positions 2-3pos. Connectors: min. 80N	Testing speed: 50mm/min
Draw-off strength of the housing with CPA closed TG 7 E 7.2	Retention force (without damage or deformation of the housing) 2-3pos. Connectors: min. 80N	Acc. DIN-IEC 60512-8 Permissible shift: 1,5mm Testing speed: 50 mm/min
Actuation forces of CPA TG 7 E 7.3	Closing force (Pre-set → Lock) 2-3pos. Connectors: $5 \text{ N} \leq F \leq 30 \text{ N}$ Opening force (Lock → Pre-set) 2-3pos. Connectors: $5 \text{ N} \leq F \leq 30 \text{ N}$ Closing force (Pre-set → Lock) – Without counterpart (without damage or deformation of the CPA) 2-3pos. Connectors: min. 80N	Suitable test apparatus with a constant speed of 50 mm/min
Mating force of connector TG 7 E 7.4	Fully equipped housings for all positions 2-3pos. Connectors: max. 75N	Acc. IEC 512-7, Test 13a Testing speed: 50 mm/min
Contact Insertion Force TG 8 E 8.1	Socket: max. 15N	Acc. DIN-IEC 60512-8, Test 15d Testing speed: 50 mm/min
Contact Retention Force TG 8 E 8.2.1 E 8.2.2	First locking device: min. 55N Secondary locking device: min. 55N The required retention forces are absolute values.	Acc. DIN-IEC 60512-8, Test 15a Permissible shift of contacts:1mm Testing speed: 50 mm/min

Vibration TG17	No physical damage No discontinuities greater than: $t > 1$ ms	Dynamic Load, Sinusoidal DIN EN 60068-2-6 Severity level: 4 Dynamic Load, random vibration DIN EN 60068-2-64 Severity level: 4 Interface used for severity level 4 is: 114-18679-3
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ENVIRONMENTAL INSPECTIONS		
Test Description	Requirement	Procedure
Climatic load of the housing TG20	It must be possible to open and re-close the connector even at -20 °C. Any film hinges and latch elements present must not break off or crack upon actuation	DIN EN 60068 Aging in dry heat 130 °C/120 h <ul style="list-style-type: none"> • Aging in damp heat, constant 40 °C / 10 d, relative humidity: 95 % • Low temperature aging -40 °C / 48 h • Extracting and inserting at -20 °C • Aging in dry heat 80 °C / 48 h Drop test in the unplugged state
Long-term temperature storage TG21 <i>Contact extraction forces for all contacts</i>	$F_{\max} > 55$ N	Temperature: $T = 130$ °C Duration time: 1000 h Contact extraction force.
Resistance to chemicals TG 22 A + B	No functionally significant structural or dimensional change	<ul style="list-style-type: none"> • Cold-cleaning agent/cockpit cleaning agent - Commercially available • Penetrating oil Commercially available • Undiluted washer fluid anti-freeze Commercially available • Isopropanol Commercially available • Grease High melting point grease • Brake fluid DOT 4/DOT 55 • FAM test fuel(gasoline/premium) Commercially available • Diesel DIN EN 590 • Biodiesel DIN EN • Diesel additive AdBlue DIN 70070 • Engine oil 5W-30 Fully synthetic • Power steering fluid According to requirement • Automatic transmission fluid Fully synthetic • Radiator antifreeze Stable to -40 °C • Diluted sulfuric acid; density 1,28 g/ml • Road salt solution Mixture PG18C
Locking noise TG28	Locking noise	Aging (24h at $T=RT$) Locking noise <ul style="list-style-type: none"> ▪ LA, peak ≥ 70 dB(A) in a distance of 600 mm \pm 50 mm

<p>Protection against solid foreign objects and water</p> <p>TG 23</p>	<p>No medium shall penetrate the connector. The functioning of latching and releasing elements must remain fully maintained.</p>	<p>1) Thermal shock test</p> <p>Air temperature: 130 °C Duration / 30 min. each</p> <p>Water temperature: 0 °C Duration / 15 min. each</p> <p>Cycles: 5 Medium: low-surface-tension, 5% NaCl solution</p> <p>2) Immersion at low air pressure</p> <p>Absolute pressure 900 mbar / test duration 5 min 500 mbar / test duration 5 min</p> <p>Pressure variation: 100 mbar/min</p> <p>Moving conductor with pressure in all 4 directions</p> <p>3) Pressure washer test</p> <p>Severity: IP X9K</p> <p>All three sides of the test specimen are to be subjected to the steam jet. The jet is to be directed especially to the sealing elements.</p> <p>Pressure: 80 bar</p> <p>Temperature: 80°C</p> <p>Duration: 15 sec 0°/ 30°/ 60° /90° - 3 cycles</p> <p>Distance between nozzles and specimen: 100 – 150 mm</p> <p>Acc.: DIN 40050 T9</p>
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TG 13 - Housing influence on the derating Temperature limit 130 °C



1. Figure

Qualification Test Sequence

Qualification Test Sequence – General Requirements

Test	PG	Test Group ¹⁾										
		A	B	C	D	E	F	G	H	I	J	K
		Test Sequencer ²⁾										
Visual- and dimensional examination	1	1, 4	1, 3	1, 3	1, 3	1, 3	1, 3	1, 5	1, 3	1, 3, 5	1, 3	1, 3
Voltage proof	0	2										
Insulation resistance	0	3						2, 4				
Contact retention in insert First locking device	8		2									
Contact retention in insert Second locking device	8			2								
Contact insertion force	8				2							
Mating forces of connector						2						
Draw-off strength of the housing with CPA	7						2					
Vibration	(17)							3				
Rapid change of temperature	19.1							3		2		
Long-term temperature storage	21										2	
Protection against solid foreign objects and water	23									4		
Engage- and disengage force of second locking device	7											2
Engage- and disengage force of the CPA	7								2			

1) See Para. 4.1 A

2) Numbers indicate sequence in which tests are performed.

B. USCAR-2

MECHANICAL INSPECTIONS		
Test Description	Requirement	Procedure
Group D - Insertion/Extraction 5.4.1		
5.4.1 A Terminal - Connector insertion force, unloaded housings, initial parts, smaller / larger wire cross section.	Requirements: $F_{max} \leq 15 \text{ N}$	<p>Insertion/retention force tester with peak reading feature</p> <p>Temperature/humidity chamber capable of 95 to 98% RH at 40 °C</p> <p>Secure the terminal sample in the force tester by gripping the conductor a minimum of 20 mm behind the insulation grip.</p> <p>Test speed = 50 mm / min</p>
5.4.1 A Terminal - Connector Forward stop force, initial Parts	Requirements: $F_{max} > 50 \text{ N}$	<p>Test speed = 50 mm / min</p> <p>A force of $F_{max} > 50 \text{ N}$ was applied, the contacts could not be pushed through. No visible damage detected.</p>
5.4.1 B Terminal - connector retention force, primary lock only, housings fully equipped, initial parts.	Requirements: $F_{max} \geq 40 \text{ N}$	Pullout / test speed = 50 mm / min
5.4.1 B Terminal - connector retention force, primary lock + secondary lock, after moisture conditioning, housings fully equipped, initial parts.	Requirements: $F_{max} \geq 70 \text{ N}$	Pullout / test speed = 50 mm / min
Group E - Misc. Component Engage/Disengage 5.4.5		
5.4.5.2 A Pre-Staged TPA Engage Force, pre-set to lock, housings fully equipped, initial parts.	Requirements: $F_{max} \leq 60 \text{ N}$	<p>Engage each component to be tested, with its retaining mechanism in place at a rate not to exceed 50 mm/min. Test TPA, PLR, and ISL forces with terminals installed in all available cavities</p>
5.4.5.2 A Pre-Staged TPA Engage Force, pre-set to lock, housings unequipped, initial parts.	Requirements: $F_{max} \geq 15 \text{ N}$	<p>Engage each component to be tested, with its retaining mechanism in place at a rate not to exceed 50 mm/min. Test TPA, PLR, and ISL forces with terminals installed in all available cavities</p>

5.4.5.2 B Pre-Staged TPA Disengage Force, lock to pre-set, housings fully equipped, initial parts.	<p>Requirements:</p> <p>1st mate $F_{max} \leq 60 \text{ N}$</p> <p>2nd mate $F_{max} \geq 18 \text{ N}$</p> <p>Exemption:</p> <p>2 pos. Min: 7.7 N Max: 14.3 N</p> <p>3 pos. Min: 8.5 N Max: 14.2 N</p> <p><i>Note to 2nd mate: Drop test past. No risk of TPA opening during transportation or during harness manipulation</i></p>	With the component fully installed and properly fixtured, disengage the component at a rate not to exceed 50 mm/min.
5.4.5.2 A Pre-Staged CPA Engage Force, Mated Connector, pre-set to lock, initial parts.	<p>Requirements: $5 \text{ N} \leq F_{max} \leq 25 \text{ N}$ (acc. to UCSAR-23 rev. 3:2016-03)</p>	Engage each component to be tested, with its retaining mechanism in place at a rate not to exceed 50 mm/min. Test TPA, PLR, and ISL forces with terminals installed in all available cavities
5.4.5.2 A Pre-Staged CPA Engage Force, Unmated Connector, pre-set to lock, initial parts.	<p>Requirements: $F_{max} \geq 60 \text{ N}$</p> <p><i>Comment: Locking feature on tab housing removed to simulate an unmated connector.</i></p>	Engage each component to be tested, with its retaining mechanism in place at a rate not to exceed 50 mm/min. Test TPA, PLR, and ISL forces with terminals installed in all available cavities
5.4.5.2 B Pre-Staged CPA Disengage Force, Mated Connector, lock to pre-set, initial parts.	<p>Requirements: $10 \text{ N} \leq F_{max} \leq 30 \text{ N}$</p>	With the component fully installed and properly fixtured, disengage the component at a rate not to exceed 50 mm/min.
5.4.5.2 B Pre-Staged CPA Disengage Force, Unmated Connector, pre-set to removed, initial parts.	<p>Requirements: $F_{max} \geq 30 \text{ N}$</p>	With the component fully installed and properly fixtured, disengage the component at a rate not to exceed 50 mm/min.
Group F - Audible Click 5.4.7		
<p>5.4.7 Connector-to Connector Audible Click - Pre-Moisture Conditioning (step 1)</p> <p>5.4.7 Connector-to Connector Audible Click - Post Moisture Conditioning (step 2)</p>	<p>The ambient noise level must be between 30 and 50 dB</p>	<p>Measure and record the dB (A) level of the ambient sound within the test environment.</p> <p>Locate the sound measuring device or microphone 600 mm \pm 50 mm from the connector.</p> <p>Repeat steps 1 through 3 using the group 2 connectors, post moisture conditioning. Parts are brought to their practical limit of moisture content by exposing "dry as molded parts" to 95 to 98% Relative Humidity at 40 °C for 6 hours (minimum), then completing the test within 30 minutes.</p>
Group G - Connector to Connector Mating / Un-mating 5.4.2 & 5.4.3		
5.4.2 A Connector-connector mating force, housings fully loaded, initial parts.	<p>Requirements: $F_{max} \leq 45 \text{ N}$ (according to USCAR-25 Rev. 3:2015:03)</p>	Increase the mating force at a uniform rate of 50 mm/min \pm 10 mm/min until complete mating occurs.

5.4.2 B Connector-connector retention force, housings unequipped, CPA not engaged, initial parts.	Requirements: $F_{max} \geq 110 \text{ N}$	Increase the retention force at a uniform rate not to exceed 50 mm/min until complete separation occurs.
5.4.2 B Connector-connector unmating force with primary connector locking mechanism completely disabled, housings fully equipped, initial parts.	Requirements: $F_{max} \leq 75 \text{ N}$	Increase the retention force at a uniform rate not to exceed 50 mm/min until complete separation occurs.
5.4.2 C Lock deflection force, housings unequipped, CPA not engaged, initial parts	Requirements: $6 \text{ N} \leq F_{max} \leq 51 \text{ N}$ <i>Comment:</i> <i>The connector can be successfully unmated at the specified force.</i>	Gradually apply a force to the lock release button. Stop the force at 6 N and verify the lock mechanism remains locked using an applicable evaluation method. Continue force application up to 51 N, or until the lock mechanism has clearly moved far enough to avoid contact with the lock feature on the mating part if unmating is attempted
5.4.2 C Lock deflection force, CPA engaged, initial parts.	Requirements: Lock mechanism remains locked at $F = 70 \text{ N}$	If applicable, fully engage the CPA into the final lock position. Gradually apply a force of 70 N to the lock release button. Look to see if the lock mechanism clears the lock feature. Pull on connector to see if connector disengages.
Group H - Polarization Feature Effectiveness 5.4.4		
5.4.4 Correct orientation, but with the wrong index (coding), housings fully equipped, initial parts.	For 2 pos. Requirements: $F_{max} / t = 3 \times \text{mating force (21.9 N)} / 3 \text{ s} = 65.7 \text{ N} / 3 \text{ s}$ For 3 pos. Requirements: $F_{max} / t = 3 \times \text{mating force (27.1 N)} / 3 \text{ s} = 81.3 \text{ N} / 3 \text{ s}$	9 VDC continuity meter ranging from 50 to 500 Ω with audible alarm Attempt to engage the connector halves at a rate not to exceed 50 mm/min until a force of 3X the maximum value of a properly mated connector (with force being $\geq 60 \text{ N}$ and $\leq 150 \text{ N}$) is applied.
5.4.4 Incorrect orientation (Polarization), housings fully equipped, initial parts.	For 2 pos. Requirements: $F_{max} / t = 3 \times \text{mating force (21.9 N)} / 3 \text{ s} = 65.7 \text{ N} / 3 \text{ s}$ For 3 pos. Requirements: $F_{max} / t = 3 \times \text{mating force (27.1 N)} / 3 \text{ s} = 81.3 \text{ N} / 3 \text{ s}$	9 VDC continuity meter ranging from 50 to 500 Ω with audible alarm Attempt to engage the connector halves at a rate not to exceed 50 mm/min until a force of 3X the maximum value of a properly mated connector (with force being $\geq 60 \text{ N}$ and $\leq 150 \text{ N}$) is applied.
Group I - Connector Drop Test 5.4.8		
5.4.8 Connector drop test.	Requirements: - No Deteriorations, Cracks, deformities etc. that could affect functionality of the part	For each group, drop one sample at a time once and only once onto a horizontal concrete surface from a height of at least 1 m, orienting the samples in six groups corresponding to the six connector "faces" of a rectangular connector. Use one group for each orientation shown.

	- Components shall not be displaced from their intended shipping position	
Group J - Cavity Damage Susceptibility 5.4.9		
5.4.9 TPA/PLR Insertion with Partially Installed Terminal, housings selectively equipped, initial parts.	<p>For 2 pos. Requirements: $F_{max} > F$ (42.5 N) + 40 N = 82.5 N</p> <p>For 3 pos. Requirements: $F_{max} > F$ (51.1 N) + 40 N = 91.1 N</p>	Test speed = 10 mm / min
5.4.1 B Terminal - connector retention force, primary lock and secondary lock, after cavity damage, housings selectively equipped, initial parts.	Requirements: $F_{max} \geq 50$ N	Test speed = 50 mm / min
Group Y - Conn. Seal retention - Unmated Connector 5.4.13		
5.4.13 Conn. Seal retention - Unmated Connector	<p>Requirements: No defects.</p> <p>Seal shall be retained.</p>	<p>Rotate the table at a speed [rpm] to generate a minimum acceleration of 1960 m/s^2 for a minimum of 10 seconds. Test with the TPA in the open and closed position.</p> <p>2 pos. Test Speed: 1698 RPMs R = 62mm (0.062m)</p> <p>3 pos. Test Speed: 1379 RPMs R = 94mm (0.094m)</p>
Group Z - Conn. Seal retention - Mated Connector 5.4.14		
5.4.14 Connector Seal Retention - Mated Connector, housings fully equipped, initial parts.	Requirements: Seal shall remain on the connector and in its intended position	Test speed = 400 mm / min

ELECTRICAL INSPECTIONS		
Test Description	Requirement	Procedure
Group M - Vibration/Mechanical Shock 5.4.6		
5.3.1 Dry Circuit Resistance.	Max. Total Connection Resistance 10 milliohms (samples 1-5)	Test specification / revision: SAE/USCAR-2 Rev 6 Date testing was performed: 10/30/2023 to 11/6/2023. Equipment used: DX20 D5 Wire probe method: Voltage / Current Bundles Forward – reverse current: Yes Maximum Total Connection Resistance: 10mΩ Maximum current level: N/A Total resistance (raw data) includes: 1 crimp, terminal bulk, wire EWL wire size / length: 1.0mm2 / 6 ¾
5.4.6 Vibration/Mech Shock/Circuit Continuity Monitoring.	V3 profile, -40 to 130C – 2 to 5pos connectors Random profile 22 hours per axis, sine profile 22 hours per axis (total 44 hours per axis) No discontinuity > 7 ohms > 1 us (samples 6-10) V2 profile, -40 to +130°C – 6 and 8 pos connectors	Detailed information about procedure can be found in Appendix (B. Vibration specification - USCAR2-8)
Group N - Thermal Shock 5.6.1		
5.3.1 Dry Circuit Resistance.	2 pos. Requirements: Connection resistance: $R \leq 10 \text{ m}\Omega$ Voltage drop: $U \leq 50 \text{ mV}$ 3 pos. Requirements (Sample 1-5): Connection resistance: $R \leq 10 \text{ m}\Omega$ Voltage drop: $U \leq 50 \text{ mV}$ Requirements (Sample 6-10): Circuit Continuity Monitoring during thermal shock: No loss of electrical continuity > 7 Ω and ≥ 1μs	Test specification / revision: SAE/USCAR-2 Rev 8.
5.6.1 Thermal shock	Requirement: connector assembly should withstand extreme temperature cycles that cause expansion and contraction of the various materials used in the connector system.	-40°C / 125°C each 30 min, 100 cycles with circuit continuity monitoring
Group O - Temperature/Humidity Cycling 5.6.2		
5.3.1 Dry circuit resistance / 5.3.2 Voltage drop.	Requirements: Connection resistance: $R \leq 10 \text{ m}\Omega$ Voltage drop: $U \leq 50 \text{ mV}$	Test specification / revision: SAE/USCAR-2 Rev 8.

5.5.1 Insulation resistance	Requirement IR > 100 MΩ connection type as follows: All contacts against aluminum foil, wrapped around the housing. Between adjacent contacts.	Performed with 5 samples at U = 500 VDC and t = 60 s
5.4.1 Contact extraction forces	Requirements: Fmax > 50 N	Test speed: 50 mm / min
ENVIROMENTAL INSPECTIONS		
Test Description	Requirement	Procedure
Group Q - Fluid Resistance 5.6.4		
5.6.4 Fluid Resistance	Requirement: Resistance to chemicals.	Submerge sample for 30 minutes. Dry heat 168 h / 50 °C • Engine oil • Power steering fluid • Automatic transmission fluid • Engine coolant • Brake fluid Storage 168 h / RT • Gasoline • Diesel fuel • Ethanol • AdBlue
Group RSAA - Combined R+S+AA (5.6.2 / 5.6.5 / 5.6.6 / 5.6.7)		
5.1.8 Visual inspection	Requirement: no evidence of deterioration, cracks, deformities, etc.	Inspect naked eye for deviations.
5.1.7 Connector and/or Terminal Cycling	Requirement: 10 mate/unmate cycles.	Completely mate and unmate each connector or terminal pair ten times.
5.5.1 Insulation resistance	Resistance between every combination of two adjacent terminals must exceed 100MΩ at 500 VDC.	IR > 100 MΩ at U = 500 VDC, until stabilize.
5.6.6 Pressure / Vacuum leak test	Sealing capability of sealed (S2, S2.5, and S3 sealing classification) connector systems should not change under pressure.	Initial: • Submersion of the samples in saltwater solution (20 °C). • Air Pressure Test up to 48 kPa (0.48 bar). • Observe samples for 15 seconds and verify that there are no air bubbles. • Vacuum Test 48 kPa / 15s. After aging: • Submersion of the samples in saltwater solution (20 °C). • Air Pressure Test up to 28 kPa (0.28 bar). Observe samples for 15 seconds and verify that there are no air bubbles. • Vacuum Test 28 kPa / 15s.
5.6.2 Temperature / Humidity cycling	Conditioning Step	Class 3 -40 °C / 125 °C / 320 h / 95 % R.H.

5.6.5 Submersion test	Conditioning Step	<ul style="list-style-type: none"> • Submersion of the samples within 30 s after removing from the heat chamber in 5 % salt water with liquid washing soap (0 °C) to a depth of 30 – 40 cm for 30 minutes. • After 30 min remove samples from saltwater solution, then carefully dry the exterior surfaces of the samples. Repeat the Steps 4 more times.
5.6.7 High Pressure Spray	Conditioning Step	<ul style="list-style-type: none"> • Pressure /- Temperature: 80 bar / 80 °C. • Test duration per angle: 15 s for 0°, 30°, 60°, 90°. • Rotation: speed (5 ± 1) r / min. • Distance between nozzle and specimen: 100-150 mm. • Test is performed: 3 times. • Samples were opened after test, no visible water ingress.
5.4.1 Terminal-Connector Retention Force, housings fully equipped, primary and secondary lock active (After High Temperature Exposure).	Requirements: $F_{max} \geq 50 \text{ N}$	Test speed = 50 mm / min.
Group TUAB - Combined T+U+AB (5.6.3 / 5.6.5 / 5.6.6 / 5.6.7)		
5.1.8 Visual inspection initial	Requirement: no evidence of deterioration, cracks, deformities, etc.	Inspect naked eye for deviations.
5.1.7 Connector and/or Terminal Cycling	Requirement: 10 mate/unmate cycles.	Completely mate and unmate each connector or terminal pair ten times.
5.5.1 Insulation resistance	Resistance between every combination of two adjacent terminals must exceed 100MΩ at 500 VDC.	IR > 100 MΩ at U = 500 VDC, until stabilize.
5.6.6 Pressure / Vacuum leak test	Sealing capability of sealed (S2, S2.5, and S3 sealing classification) connector systems should not change under pressure.	<p>Initial:</p> <ul style="list-style-type: none"> • Submersion of the samples in saltwater solution (20 °C). • Air Pressure Test up to 48 kPa (0.48 bar). • Observe samples for 15 seconds and verify that there are no air bubbles. • Vacuum Test 48 kPa / 15s. <p>After aging:</p> <ul style="list-style-type: none"> • Submersion of the samples in saltwater solution (20 °C). • Air Pressure Test up to 28 kPa (0.28 bar). • Observe samples for 15 seconds and verify that there are no air bubbles. • Vacuum Test 28 kPa / 15s.
5.6.3 High Temperature Exposure	Conditioning Step	Class 3 -40 °C / 125 °C / 1008 h

5.6.5 Submersion test	Conditioning Step	<ul style="list-style-type: none"> • Submersion of the samples within 30s after removing from the heat chamber in 5% salt water with liquid washing soap (0 °C) to a depth of 30 – 40 cm for 30 minutes. • After 30min remove samples from saltwater solution, then carefully dry the exterior surfaces of the samples. Repeat the Steps 4 more times.
5.6.7 High Pressure Spray	Conditioning Step	<ul style="list-style-type: none"> • Pressure /- Temperature: 80 bar / 80 °C. • Test duration per angle: 15 s for 0°, 30°, 60°, 90°. • Rotation: speed (5 ± 1) r / min. • Distance between nozzle and specimen: 100-150 mm. • Test is performed: 3 times. • Samples were opened after test, no visible water ingress.
5.4.1 Terminal-Connector Retention Force, housings fully equipped, primary and secondary lock active (After High Temperature Exposure).	Requirements: $F_{max} \geq 50 \text{ N}$	Test speed = 50 mm / min

Test Sequence (USCAR-2 Rev.8)

Terminal (Mechanical and Electrical) and Connector (Mechanical) Test Sequences (part 1)										
Test Name		Term. - Term. Engage/Disengage	Terminal Bend Resistance	Maximum Current/Current Cycling	Term. - Conn. Insertion/Retention	Misc. Component Engage/Disengage	Audible Click	Conn. Conn Mating/Unmating	Polarization Effectiveness	Drop
Test Sequence ID		A	B	C	D	E	F	G	H	I
Sample Size minimum (See individual procedures)		10	15/ 30	10	10	10(1)	16	15	(2)	3
Applicable Cable Size		Any	All	All	(3)	Any	/	Any	Any	/
5.1	General	1	1	1	1	1	1	1	1	1
5.1.7	Connector and/or Terminal Cycling			3						
5.1.8	Visual Inspection	2, 4	2, 4	2, 6	2, 4	2, 4	2, 4	2, 4	2, 4	2, 4
5.2.1	Terminal to Terminal Engage/Disengage	3								
5.2.2	Terminal Bend Resistance		3							
5.3.1	Dry Circuit Resistance									
5.3.3	Maximum Test Current Capability			4						
5.3.4	Current Cycling			5						
5.4.1	Terminal - Connector Insertion/retention force				3					
5.4.2	Mating/Unmating Force (Non-mech. Assist)							3		
5.4.3	Mating and Unmating Force (Mech. Assist)							3		
5.4.4	Polarization Feature Effectiveness								3	
5.4.5	Miscellaneous Component					3				
5.4.7	Connector-to-Connector Audible Click						3			
5.4.8	Connector Drop Test									3
5.4.9	Cavity Damage									
5.4.10	Terminal/Cavity Polarization									
5.7.1	Header Pin Retention									
5.4.11	Connector Mounting Feature Mechanical									
5.4.12	Mechanical Assist Integrity									
5.4.13	Connector Seal Retention - Unmated									
5.4.14	Connector Seal Retention - Mated Connector									
5.4.16	Bolted Connector Function									
	USCAR-49 Return loss (4.2)				5 (4)					

NOTES:

- (1) Ten samples for each applicable misc. component engage/disengage force test.
- (2) Sample size for polarization effectiveness is determined by the procedure.
- (3) See individual procedure for appropriate applicable cable size.
- (4) Applies to coaxial circuits only to confirm that RL is still within limits.

Terminal (Mechanical and Electrical) and Connector (Mechanical) Test Sequences (part 2)								
Test Name		Cavity Damage	Terminal/Cavity Polarization	Header Pin Retention	Mounting Feature Strength	Mechanical Assist Integrity	Conn. Seal Retention - Unmated	Conn. Seal Retention - Mated
Test Sequence ID		J	AE	K	L	X	Y	Z
Sample Size minimum (See individual procedures)		5	3	10	20	5	10	10
Applicable Cable Size		Lg	Lg	/	/	/	/	/
5.1	General	1	1	1	1	1	1	1
5.1.7	Connector and/or Terminal Cycling							
5.1.8	Visual Inspection	2, 4	2, 4	2, 4	2, 4	2, 4	2, 4	2, 4
5.2.1	Terminal to Terminal Engage/Disengage							
5.2.2	Terminal Bend Resistance							
5.3.1	Dry Circuit Resistance							
5.3.3	Maximum Test Current Capability							
5.3.4	Current Cycling							
5.4.1	Terminal - Connector Insertion/retention force							
5.4.2	Mating/Unmating Force (Non-mech. Assist)							
5.4.3	Mating and Unmating Force (Mech. Assist)							
5.4.4	Polarization Feature Effectiveness							
5.4.5	Miscellaneous Component							
5.4.7	Connector-to-Connector Audible Click							
5.4.8	Connector Drop Test							
5.4.9	Cavity Damage	3						
5.4.10	Terminal/Cavity Polarization		3					
5.7.1	Header Pin Retention			3				
5.4.11	Connector Mounting Feature Mechanical				3			
5.4.12	Mechanical Assist Integrity					3		
5.4.13	Connector Seal Retention - Unmated						3	
5.4.14	Connector Seal Retention - Mated Connector							3
5.4.16	Bolted Connector Function							3
	USCAR-49 Return loss (4.2)							
NOTES: (1) Ten samples for each applicable misc. component engage/disengage force test. (2) Sample size for polarization effectiveness is determined by the procedure. (3) See individual procedure for appropriate applicable cable size. (4) Applies to coaxial circuits only to confirm that RL is still within limits.								

Connector (Electrical) Test Sequences					
Test Name		Vibration / Mechanical Shock	Thermal Shock	Temp/Humidity Cycling	High Temp. Exposure
Test Sequence ID		M	N	O	P
Sample Size minimum (5) (See individual procedures)	Connector	10	10	10	10
	Terminal	10	10	10	10
Applicable Cable Size		Largest	Largest	Largest	Largest
5.1	General	1	1	1	1
5.1.8	Visual Inspection	2, 8	2, 8	2, 8	2, 8
5.1.7	Connector and/or Terminal Cycling	3	3	3	3
5.1.9	Circuit Continuity Monitoring (6)	5 (4)	5 (4)		
5.3.1	Dry Circuit Resistance (3)	4(6), 6(6)	4(6), 6(6)	4(2, 6), 6(2, 6)	4(6), 6(6)
5.3.2	Voltage Drop (8)	7	7	7(2)	7
5.4.1	Terminal-Connector retention force			9	9
5.4.6	Vibration/Mechanical Shock	5 (4)			
5.5.1	Insulation Resistance			7(2)	
5.6.1	Thermal Shock		5(4)		
5.6.2	Temperature/Humidity Cycling			5	
5.6.3	High Temperature Exposure				5
5.4.16	Bolted connector function	9(7)	9(7)	10(7)	10(7)
NOTES: (2) If IR is not tested in any other test path (typically in unsealed connectors), divide the sample set equally into two groups: "Dry Circuit Resistance and Voltage Drop but no Insulation resistance" and "Insulation Resistance but no Dry Circuit Resistance or Voltage Drop." This is needed due to differences in sample preparation methods. (3) Divide the sample set equally into two groups: "Dry Circuit Resistance and Voltage Drop but no Circuit Continuity Monitoring" and "Circuit Continuity Monitoring but no DCR/VD." This is needed due to differences in sample preparation methods. (4) Circuit continuity monitoring (5.1.9) is performed during (simultaneously with) the scheduled conditioning per the Test Sequence step number. (5) The samples size minimum indicates the minimum number of samples required. More samples may be required in order to test a fully populated connector and/or per each measurement item (dry circuit resistance, voltage drop, etc.). More details are in the individual procedures. (6) Omit dry circuit testing if testing for terminals larger than 2.8 mm. Use Voltage Drop test as a replacement Step 4. (7) Applies to bolt-mated connectors only. (8) Do not perform voltage drop (5.3.2) on coax circuits).					

Sealed Connector System Environmental Test Sequences										
Test Name		Fluid Resistance	Temp/Humidity-Submersion	Temp/Humidity- PV Leak	Temp/Humidity High Press. Spray	Temp/Humidity- PV Leak, Submersion, High Press. Spray	High Temp Exposure- Submersion,	High Temp Exposure- PV Leak	High Temp Exposure- High Press. Spray	High Temp Exposure- PV Leak, Submersion, High Press. Spray
Test Sequence ID		Q	R	S	AA	RSAA	T	U	AB	TUAB
Sample Size minimum (2)	Connector	9	10	10	10	10	10	10	10	10
	Terminal	See Note 1								
Applicable Cable Size		Sm	Sm	Sm	Sm	Sm	Sm	Sm	Sm	Sm
5.1	General	1 ⁽³⁾	1	1	1	1	1	1	1	1
5.1.8	Visual Inspection	2, 4	2, 8	2, 10	2, 8	2, 16	2, 8	2, 9	2, 8	2, 16
5.1.7	Connector and/or Terminal Cycling		3	3	3	3	3	3	3	3
5.1.9	Circuit Continuity Monitoring									
5.3.1	Dry Circuit Resistance									
5.3.2	Voltage Drop									
5.4.1	Terminal-Connector retention force		9	11	11	17	9	10	#	17
5.4.6	Vibration/Mechanical Shock									
5.5.1	Insulation Resistance		4, 6	4 7 ⁽⁴⁾ 9 ⁽⁴⁾	4, 6 ⁽⁴⁾ 8 ⁽⁴⁾ 10 ⁽⁴⁾	4, 7 ⁽⁴⁾ 9 ⁽⁴⁾ 11 ⁽⁴⁾ 13 ⁽⁴⁾ 15 ⁽⁴⁾	4, 6	4, 7	4, 6 ⁽⁴⁾ 8 ⁽⁴⁾ 10 ⁽⁴⁾	4, 7 ⁽⁴⁾ 9 ⁽⁴⁾ 11 ⁽⁴⁾ 13 ⁽⁴⁾ 15 ⁽⁴⁾
5.6.1	Thermal Shock									
5.6.2	Temperature/Humidity Cycling		5	6	5	6				
5.6.3	High Temperature Exposure						5	6	5	6
5.6.4	Fluid Resistance	3								
5.6.5	Submersion		7			10	7			10
5.6.6	Pressure/Vacuum Leak			5, 8		5, 8		5, 8		5, 8
5.6.7	High Pressure Spray				7 ⁽⁵⁾ 9 ^(4,6)	12 ⁽⁵⁾ 14 ^(4,6)			7 ⁽⁵⁾ 9 ^(4,6)	12 ⁽⁵⁾ 14 ^(4,6)
NOTES: (1) The number of terminals is determined by the number required to fully populate the total number of connector samples. (2) Connectors with multi-cavity (mat) conductor seals require one additional set of ten CUTs per multi-cavity (mat) conductor seals sample preparation (5.1.10) making a total of 2 sets required. This applies to all 5.9.7 tests except Test Path Q (fluid resistance). (3) Surrogate validations for fluid resistance are allowed using results for an identical material in another connector. (4) Step is called-out in environmental test procedure. Do not repeat. step is only shown in table for easier understanding of sequence. (5) Use S2.5 spray level per Table 5.6.7.3-1. Omit step if customer does not request S2.5 spray level testing. (6) Use S3 spray level per Table 5.6.7.3-1. Omit step if customer does not request S3 spray level testing.										

3. QUALITY ASSURANCE PROVISIONS

3.1. Qualification Testing

A. A Sample Selection

The samples shall be prepared in accordance with product drawings. They shall be selected at random from current production.

Test Groups consist of: Samples prepared according to the 209-160012 and USCAR-2 automotive spec. test matrix.

B. Test Sequence

Qualification inspection shall be verified by testing samples as specified in paragraph 2.7.1.

3.2. Requalification testing

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

3.3. Acceptance

Acceptance is based on verification that the product meets the requirements of paragraph 2.7. Failures attributed to equipment, test setup, or operator deficiencies shall not disqualify the product. When product failure occurs, corrective action shall be taken and samples resubmitted for qualification. Testing to confirm corrective action is required before resubmittal.

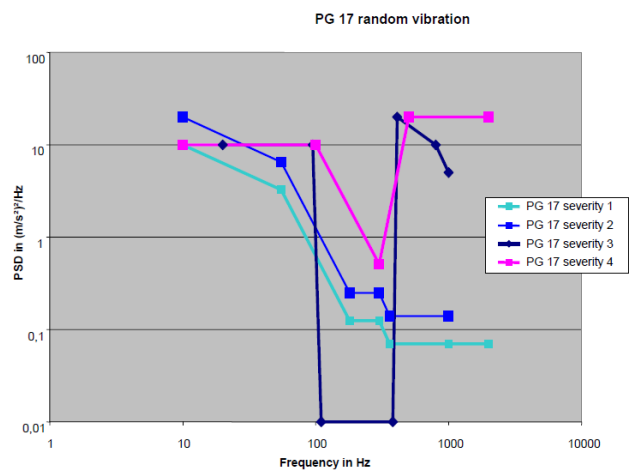
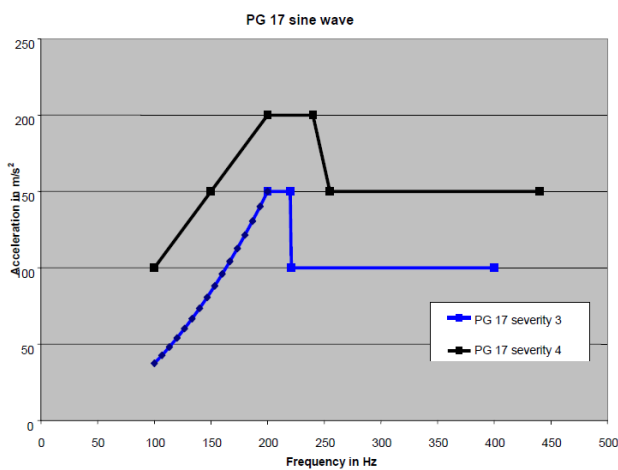
3.4. Quality conformance inspection

The applicable quality inspection plan will 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.

4. APPENDIX

A. Vibration specification (LV 214)

Severity	TC (Temperature cycle)	Random vibration with TC		Sine wave with TC		No. Of shock			
Lvl. 3 Applications close to power-train	0 min/20°C	22h/axis RMS value of acceleration: 105,5 m/s2		22h/axis		N/A			
	60 min/-40°C								
	90 min/-40°C								
	240 min/120°C								
	420 min/120°C								
	480 min/20°C								
	Hz						(m/s²)²/Hz	Hz	(m/s²)²/Hz
	20						10	100	0,095
	95	10	Hz	m/s²					
110	0,01	200	150						
380	0,01	220	150						
410	20	221	100						
800	10	400	100						
1500	5								
Lvl. 4 Engine-mounted parts	0 min/20°C	22h/axis RMS value of acceleration: 181 m/s2		22h/axis		N/A			
	60 min/-40°C								
	90 min/-40°C								
	240 min/130°C								
	420 min/130°C								
	480 min/20°C								
	Hz						(m/s²)²/Hz	Hz	(m/s²)²/Hz
	10						10	100	100
	100	10	150	150					
300	0,51	200	200						
500	20	240	200						
2000	20	255	150						
		440	150						



Vibration specification (USCAR 2-8)

Vibration/Mech Shock/Circuit Continuity Monitoring

Random Vibration	
Test specification / revision	USCAR-2 Rev8
Date testing was performed	11/3/2023 to 11/10/2023
Equipment used	(V7) UD Vibration System.
Base & DUT Fixture	7 x 9 ¾ in 6 Position, from Germany
First wire clamping point	100mm
Vibration and temperature class	V3 / T3 (max. 130°C)
Vibration frequency range	10Hz to 2000Hz
Acceleration in G's or m/s ²	18.41 GRMS
Vibration axes	X, Y, Z
Vibration duration / Vibration Runs	22 Hrs.
Number of control accelerometers used	1
Samples powered during vibration	N/A
Samples monitored during vibration	N/A
Discontinuities monitored at 100mA	Yes, No discontinuities detected.
Temperature cycled during vibration	-40C to 130°C
Notes	Samples 6-10 were monitored for discontinuity.

Frequency in Hz	Acceleration in m/s ²	Acceleration in G's
10		0.104
100		0.104
300		0.0051
500		0.208
2000		0.208
Total Acceleration (GRMS)		18.41

Sine Vibration	
Test specification / revision	USCAR V4 Sine
Date testing was performed	11/3/2023 to 11/10/2023
Equipment used	(V7) UD Vibration System.
Base Fixture and DUT Vibration Fixture	7 x 9 ¾ in 6 Position, from Germany
First wire clamping point	100mm
Vibration and temperature class	V3 / T3
Vibration frequency range	100Hz to 440Hz
Acceleration in G's or m/s ²	20.40 G's
Vibration axes	X, Y, Z
Sine sweep time: Min./ Sweep or Oct. / Min.	2min 7sec per sweep
Total number of sweeps per axis	624
Number of control accelerometers used	1
Samples powered during vibration	N/A
Samples monitored during vibration	N/A
Discontinuities monitored at 100mA	No discontinuities detected.
Temperature cycled during vibration	-40 to 130 C°
Notes	Samples 6-10 were monitored for discontinuity.

Frequency in Hz	Acceleration in m/s ²	Acceleration in G's	Displacement
100		10.20	0.5066mm p-p
150		15.30	0.3377mm p-p
200		20.40	0.2534mm p-p
240		20.40	0.1760mm p-p
255		15.30	0.1169mm p-p
440		15.30	0.0393mm p-p

100G Shock	
Test specification / revision	USCAR-2 Rev 8
Date testing was performed	11/17/2023
Equipment used	(V5) UD Vibration System.
Base & DUT Fixture	7 x 9 ¾ in 6 Position, from Germany
First wire clamping point	100mm
(AVCO) Pressure / Height	N/A
(AVCO) Generator	N/A
Shock class	V3
Type of mechanical shock	Half Sine
Acceleration in G's or m/s ²	100G
Pulse duration	11ms
Axes of the mechanical shock	+/-X,+/-Y,+/-Z
Number of mechanical shocks in each axis	6 (3 each direction)
Total number of mechanical shocks	18
Samples powered during shock	N/A
Samples monitored during shock	N/A
Discontinuities monitored at 100mA	No discontinuities detected.
Notes	Samples 6-10 were monitored for discontinuity.

25G shock	
Test specification / revision	USCAR-2 Rev 8
Date testing was performed	11/17/2023
Equipment used	(V5) UD Vibration System.
Base & DUT Fixture	7 x 9 ¾ in 6 Position, from Germany
First wire clamping point	100mm
(AVCO) Pressure / Height	N/A
(AVCO) Generator	N/A
Shock class	V3
Type of mechanical shock	Half Sine
Acceleration in G's or m/s ²	25G
Pulse duration	15ms
Axes of the mechanical shock	+/-X,+/-Y,+/-Z
Number of mechanical shocks in each axis	264 (132 each direction)
Total number of mechanical shocks	792
Samples powered during shock	N/A
Samples monitored during shock	N/A
Discontinuities monitored at 100mA	No discontinuities detected.
Notes	Samples 6-10 were monitored for discontinuity.

<u>LTR</u>	<u>REVISION RECORD</u>	<u>DWN</u>	<u>APP</u>	<u>DATE</u>
A	Initial revision	Székely Lehel	-	2023.03.01.
B	4-8pos added and BMB variants added	Székely Lehel	-	2024.05.08.
C	USCAR-2 rev.8 Inspection sequences added	Rusznák György	-	2024.08.01.
C1	Wording correction	Székely Lehel	-	2024.12.10.