

Qualification Results for Cryogenic Temperature Testing of EEE Components in the ESA ARIEL Science Mission

M. Sanchez (ALTER Technology Spain)
M. Morales (ALTER Technology Spain)

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Qualification Results for Cryogenic Temperature Testing of EEE Components in the ESA ARIEL Science Mission

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- Acknowledgements

ALTER INTRODUCTION

The Company

ALTER is a leading engineering company which provides reliable and agile solutions in engineering, procurement, assembly, and test to many of the world's most innovative technologies, such as semiconductors, electronic equipment and geospatial intelligence.

Space

Telecom

Medical

Railway

Defence

Aeronautical

Automotive



Figures, data, facts

ALTER at a glance (2025's figures)

91
Million Euros Revenues

505
Employees

40
Years in the market

8
sites

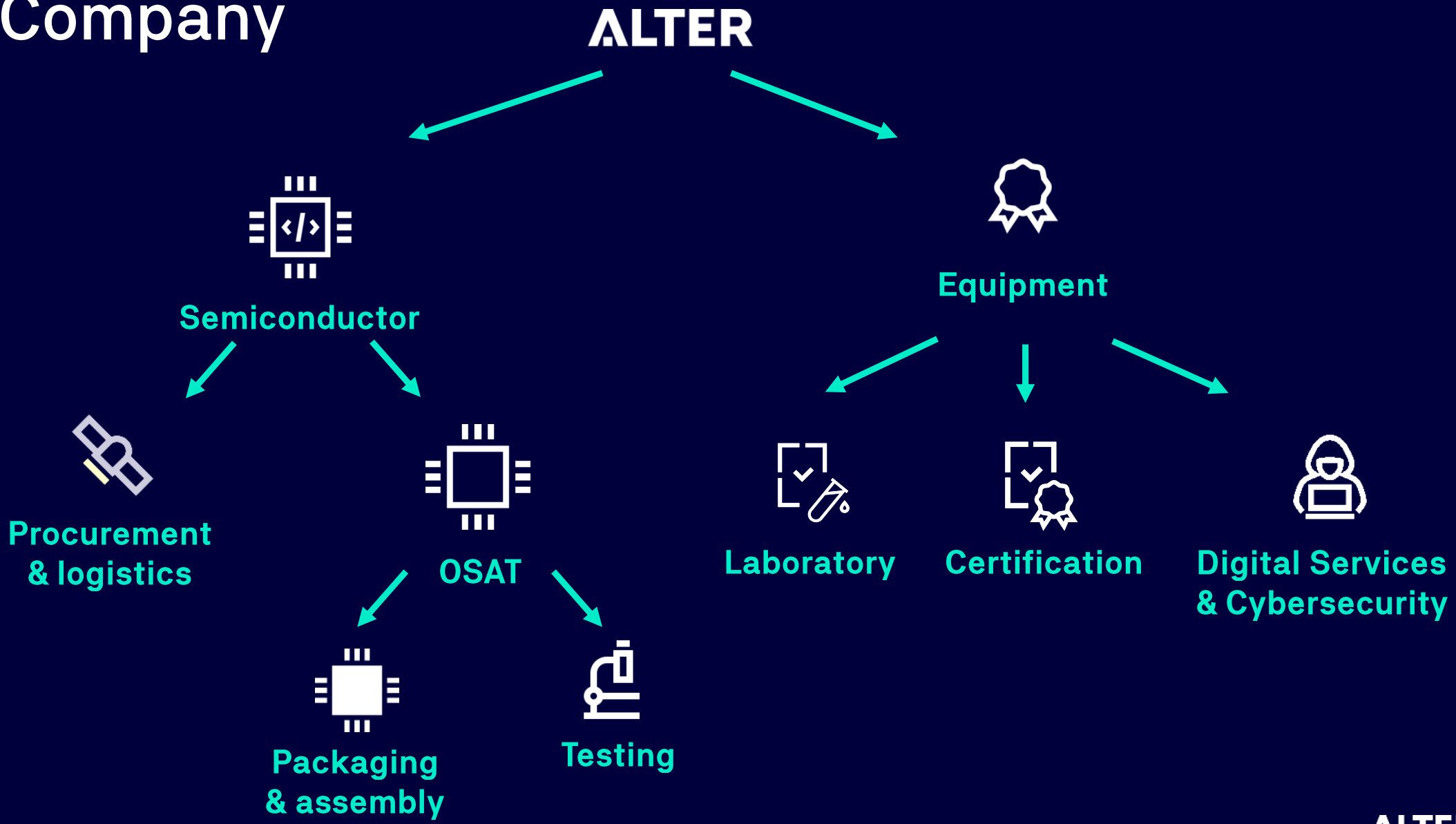
10,000
M2 laboratories

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- ALTER SPAIN
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- ALTER USA

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The Company



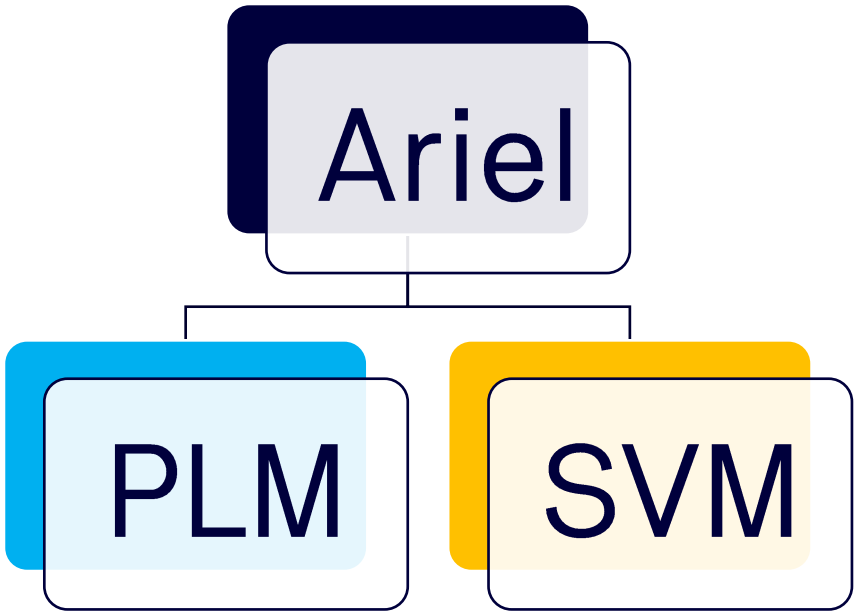
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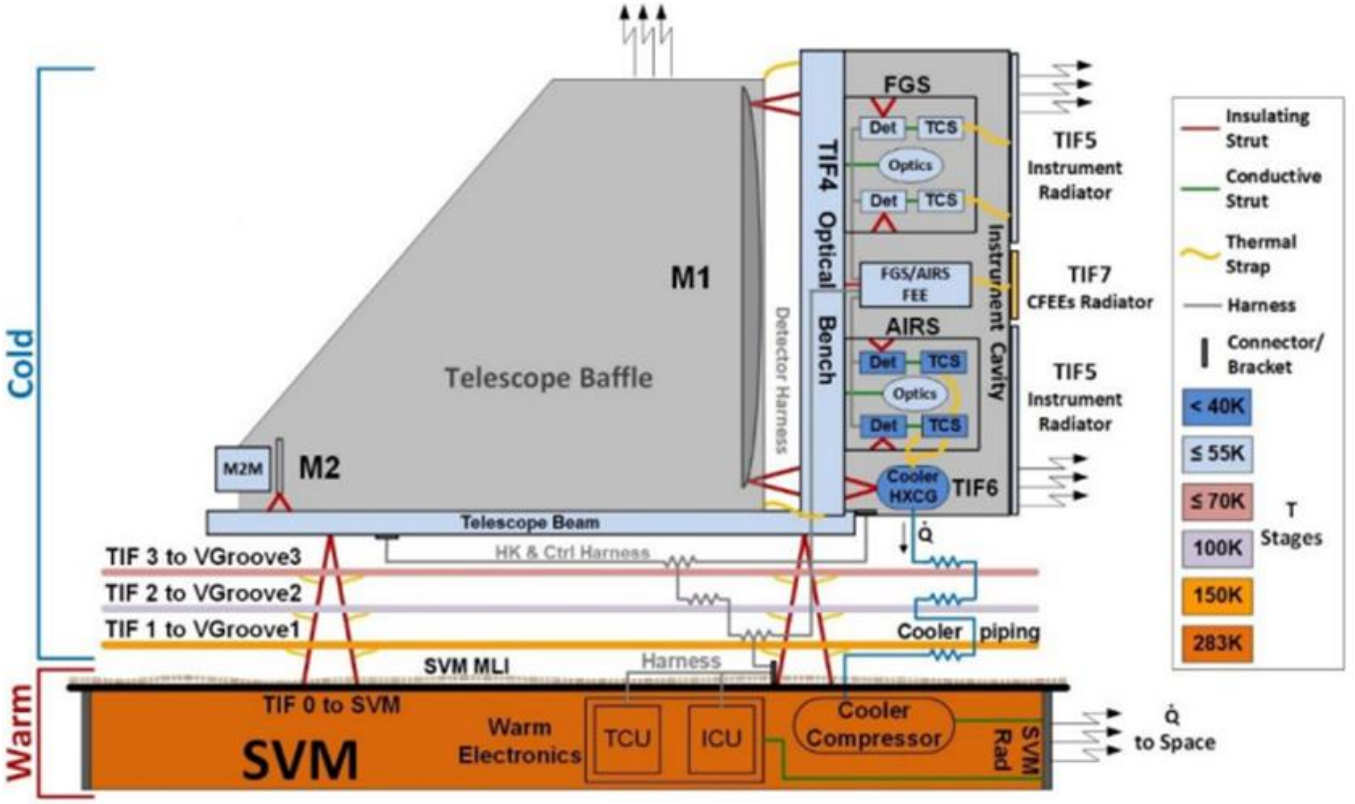
Mission background & Sub-systems involved

Mission background and Sub-systems involved

Ariel Mission (Atmospheric Remote-sensing Infrared Exoplanet Large-survey, ESA Cosmic Vision M4)



PLM: Cold Payload Module
SVM: Warm Service Module



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SUB-SYSTEMS INVOLVED

Ariel PLM equipment and temperature ranges to be tested

	Non-Op (1)	Op (2)	Safe (3)	Decon (4)
ACS CHX (RAL Tech) *as for AIRS SCA*	[29K:323K]	[29K:45K]	[29K:63K]	[29K: 240K*]
AIRS CFEE (CEA)	[37K:323K]	[47K:73K]	[37K:73K]	[47:175K]
AIRS CU, excluding SCA and CFEE (CEA)	[37K:323K]	[47K:63K]	[37K:63K]	[47:175K]
FGS FOM, excluding SCA and SCE (CBK)	[37K:323K]	[47K:63K]	[37K:63K]	[47:175K]
Instrument Radiator (Admatis)	[37K:323K]	[47K:63K]	[37K:63K]	[47:175K]
M2M Mechanism (SENER)	[37K:323K]	[47K:63K]	[37K:63K]	[47:175K]
TA Baffle (Active Space)	[37K:323K]	[42K:63K]	[37K:63K]	[42:175K]
TOB & optics (Leonardo / INAF)	[37K:323K]	[47K:63K]	[37K:63K]	[47: 180K*]
VG3 (BG)	[41K:323K]	[47K:68K]	[41K:68K]	[41:135K]
VG2 (BG)	[70K:323K]	[75K:120K]	[70K:120K]	N/A
VG1 (BG)	[110K:323K]	[115K:175K]	[110K:175K]	N/A
PIP elements: DISC (RAL Tech) & connectors (ADS and CSA/ABB)	[223K:333K]	[233K: 303K]	N/A	N/A

PLM qualification temperature ranges extracted from ESA-ARIEL-PL-TN-003

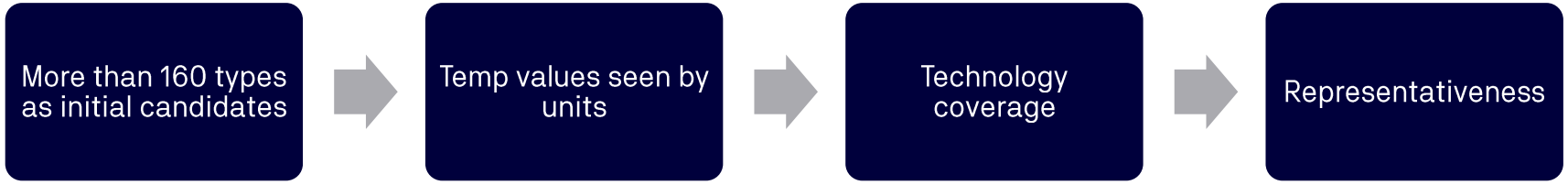
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Testing candidates and testing flow



“Winter is coming”

SELECTION AND SEQUENCE FOR CRYO TEST



Test Flow agreed to be performed on these components:

- The 12 cycles between maximum and minimum non-operating temperature range are intended to measure the thermal stress suffered by the component just by being at those temperatures, while the test is performed under no biasing conditions.
- The cryo life test is designed to measure the fatigue suffered by the parts by working biased at the minimum operating temperature conditions. 1000h is reduced to 500h for Thermistor, Connectors and Cables.
- Importance of dedicated calculations ESA-ARIEL-PL-TN-003 iss1

Cryogenic validation test flow
External Visual Inspection
Initial Electrical Measurements at room temperature (22 ±3°C)
Functional Characterization at Top min
Thermal Cryogenic Cycling from Tnop min Non-Operative during test. • 12 Cycles • Max temp: 323K • Min temp: Tnop min • Dwell time: 30min
Electrical Measurements at room temperature (22 ±3°C)
External visual inspection
Extended Cryogenic test at Top min Monitoring of selected parameters and biasing according to application • 500/1000h • Temp = Top min
Final Functional Characterization at Top min
Electrical Characterization at room temperature (22 ±3°C) Parameter drift calculation
External Visual Inspection

CANDIDATES FOR CRYOGENIC TESTING

Characteristics	Part type/Description	Component Number	Manufacturer	Number of samples	Thermal cycles	Extended Criogenic test
Microswitch	T6932 Microswitch	ESCC 370100302B	Petercem	3pcs	37K-323K	15000 cycles
Wires & Cables	- Junction cable x thermistors - Assembly of four ESCC 3901.019 silver plated copper, Variant 26 (P35862A), 1 Kapton KPT616 07/16 and 1 Kapton KPT01901/04 - CEH 2807 INOX wire, CELLOFLON (expanded PTFE), and polymide, AWG28 - Fluoropolymer Insulated, Low Frequency, 600V, -200 to + 200 degC, Based on Type CSWL variant 01	- ESCC 390101850 - P559699=P584717A+kapton noir - P541327A - ESCC 3901020401B	Axon	2 x 1m 1 x 2m 2 x 1m 3 x 1m	37K-323K	500h@37K
Heater	Heaters 30x20 mm, single layer, PSA, with cable 390101922 (26AWG) 1EFIST949001	ESCC 400900210R5789	Zoppas Industries (RICA)	3pcs	29K-323K	500h@29K
Nano D85	Nano-D 85 Titane FLEX Nano-D 85 FLEX Nano-D 85 CFEE	- NM-225-085-225-JC00-D55 + NK-2G5-085-135-TH00-D56 - NK-2G2-085-135-JC00-E1Q + NK-2F2-085-435-TH00-E1Q	Airborn	2sets 2sets	29K-323K	500h@29K
PHR2010 resistor PT1000 platinum sensor	PHR 2010 7K98 0,1% 500mW 25ppm/ºC Chip QP1K0.232.2L73.B.0300	ESCC 4001023047981B2 ESCC 400601508040300	Vishay Sfernice IST	5pcs 5pcs	29K-323K	500h@29K
Resistors and Capacitors	0805 2.2nF, NPO 10% 50V (A612) 0805 100nF, BME X7R, 10%, 100V TAJ 2.2uF, Tantal, 10%, 16V 100nF, CRX, 10% 25 V Cryo CHPHR0805 4.7R, 200 ppm/°C, 2%	ESCC 3009003062201KC ESCC 300904103104KE 301200102225KC SR1209CRX104Z1F ESCC 4001026024R70G6	AVX AVX AVX Presidio Vishay Sfernice	10pcs 10pcs 10pcs 5pcs 5pcs	37K-323K	1000h@42K
Sub-D & Micro-D Splice	MDM Solder Bucket 31S Space Splice HD Sub-D 26-pin Male and Female	- ESCC 340102902B31SFR164E + 340102902B31PFR164E - ESCC 340109701B - ESCC 340100202BDAMA26PNMB + 340100202BDAMA26SNMB	C&K	2 sets 2 sets 2 sets	29K-323K	500h-- >1000h@29K
ND2SA15P	NanoD 15S + NanoD 15P (ND2SA15)	P592367 + P592368	Axon	2sets	29K-323K	500h@29K
Modified heater	ESCC4009002 variant 10, Heaters 42x20 mm, single layer, PSA, Teflon FEP, with cable 390101911 (26AWG)	ESCC 400900210R6186	Zoppas Industries (RICA)	3pcs	29K-323K	500h@29K
Precision OpAmp	OPA2192ID SOIC-8	OPA2192ID	Texas Instruments	5pcs	37K-323K	1000h 47K

Planned in 2026-27

ALTER



Equipment used

EQUIPMENT USED

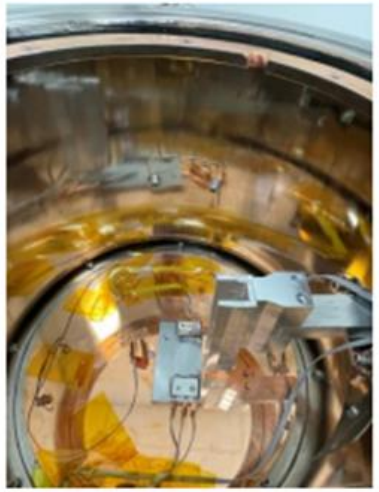
The testing at these low temperaturas are performed by means of TWO Helium closed-loop cryostat with pumping system and feedthrough.

- Temperature control on Big Cold Finger from 10K
- Load capacity 22cm diam, h=10cm
- Temp rate <2k/min
- Vacuum range 1E-4 to 1E-7mbar
- Temperature sensors for control and monitoring
- Feed-through for in-vacuum measurements
- Can operate inside ISO8 clean area

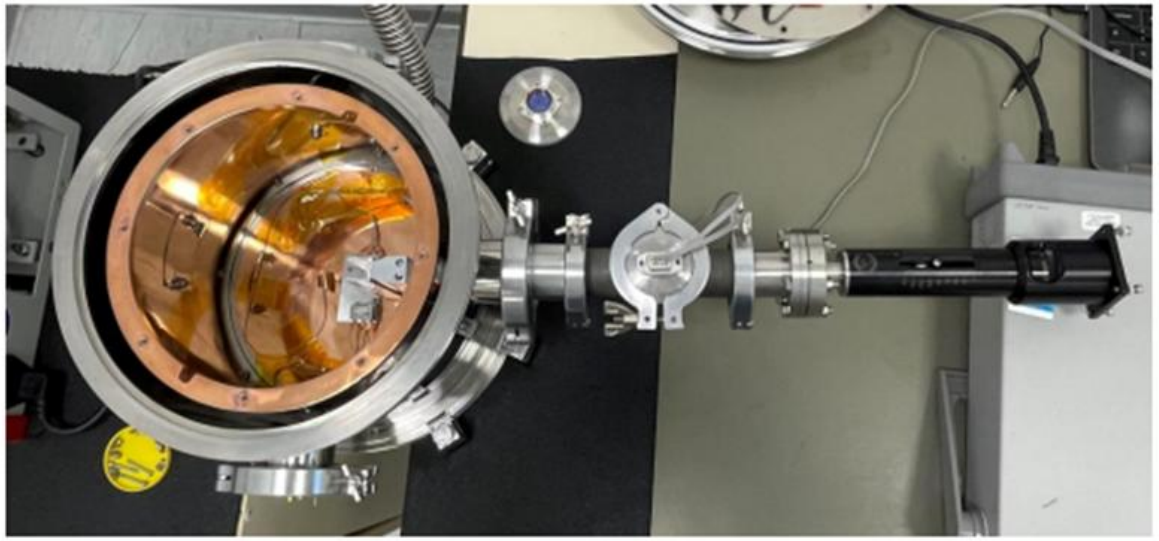


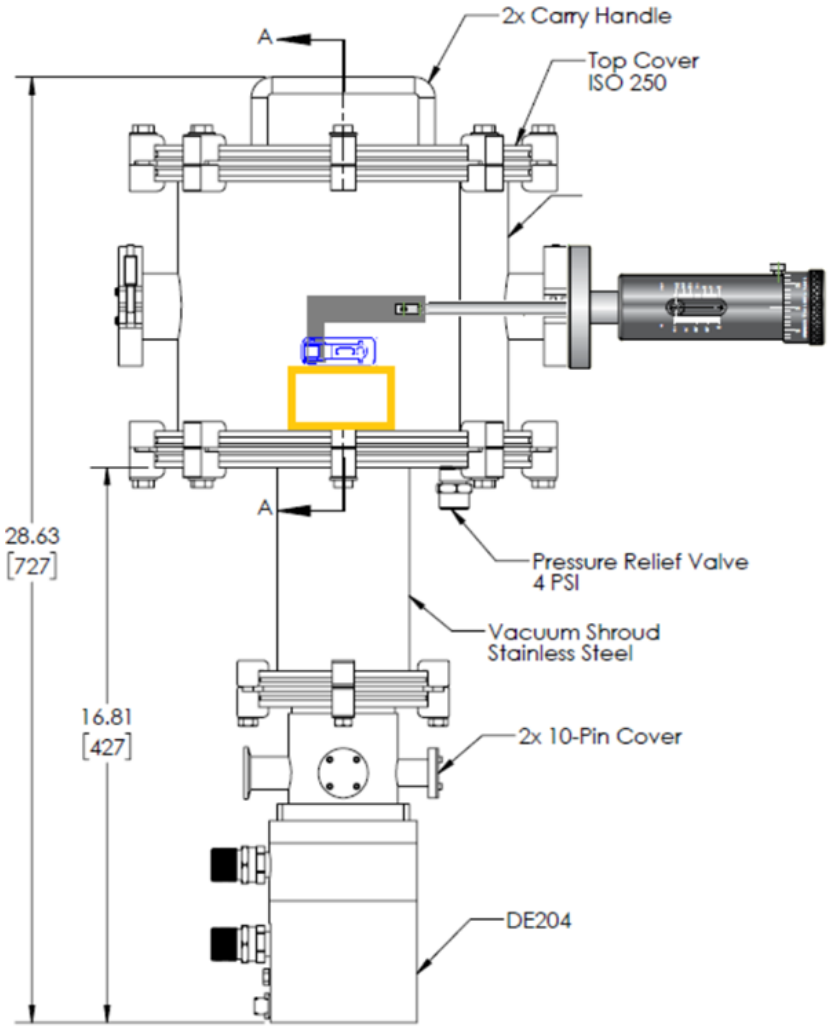
DEDICATED SUPPORT FROM ESA-ARIEL FOR DOUBLING THE CRYOGENIC CAPABILITIES TO MATCH PROJECT NEED-SCHEDULE

EQUIPMENT USED









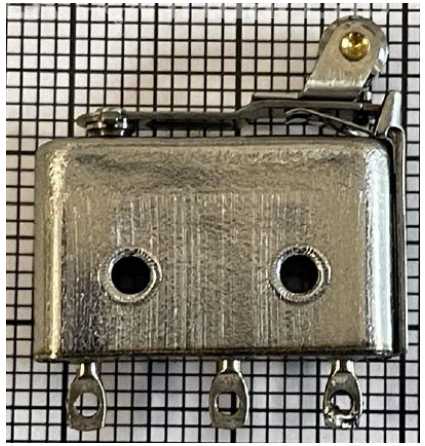
RESULTS



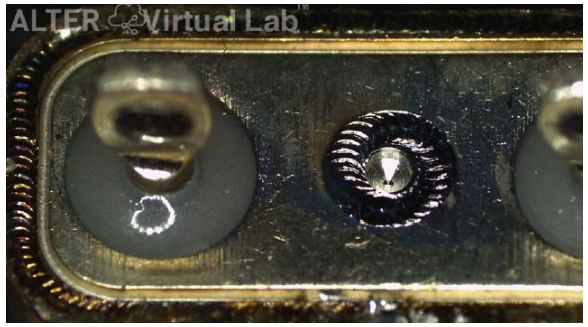
MicroSwitch T6932

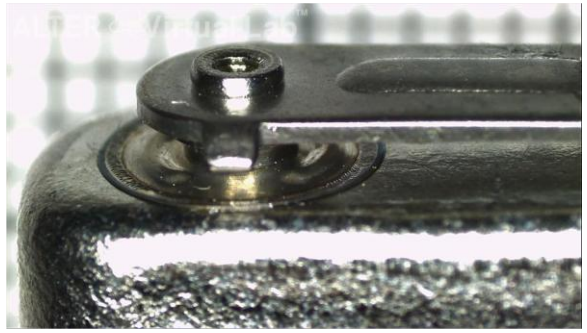
Characteristics	Part type/Description	Component Number	Manufacturer	Number of samples	Thermal cycles	Extended Criogenic test
Microswitch	T6932 Microswitch	ESCC 370100302B	Petercem	3pcs	37K-323K	15000 cycles

INITIAL PICTURES and SETUP:











A linear motion feed-through and an aluminum piece with a wedged were used to change switch status (move the pulser when displaced)

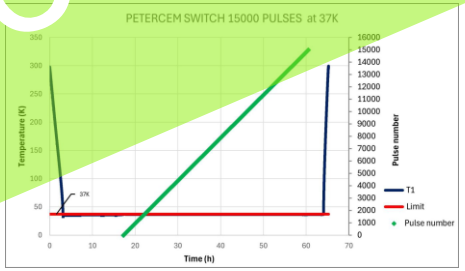
MicroSwitch T6932

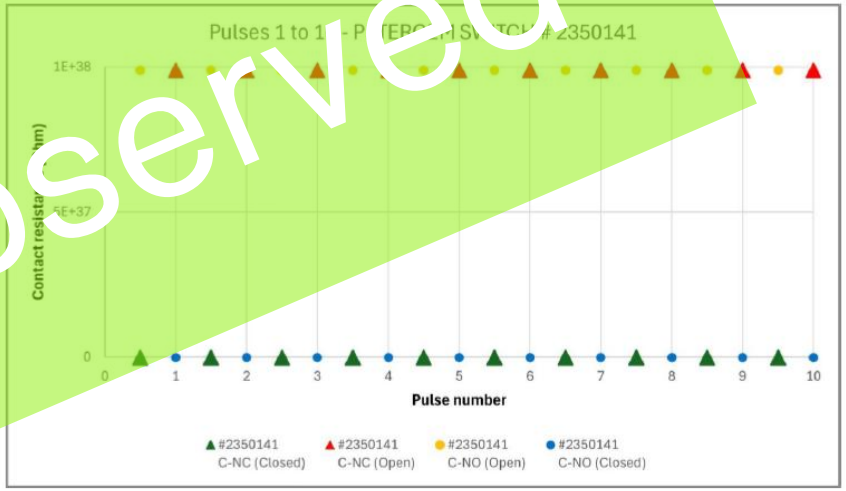
Electrical parameters at room temp.

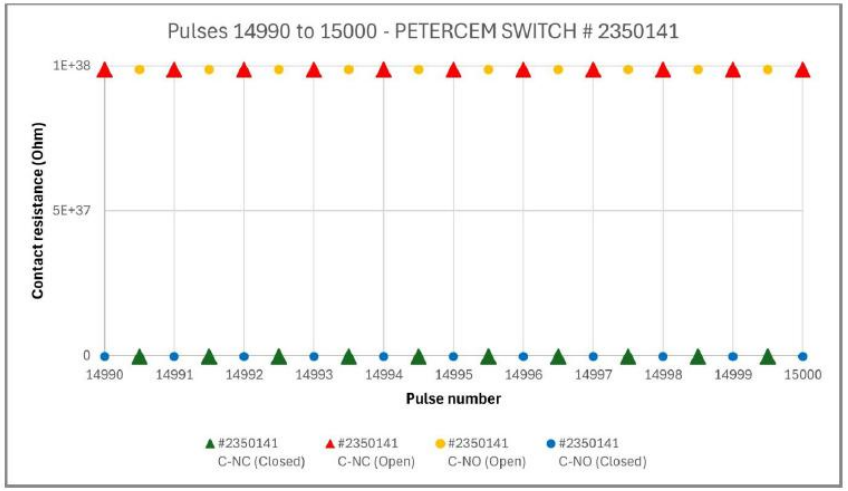
#	TEST	CONDITIONS	LIMITS		UNIT
			MIN	MAX	
1	Rc C-NO	I = 50mA	--	100	mOhm
2	Rc C-NC	I = 50mA	--	100	mOhm
3	Ri	VDC = 500V, t = 120s max	1000	--	MOhm

Cryo Life test conditions

#	CHARACTERISTICS	SYMBOL	CONDITIONS	UNIT
1	Step 1 (C-NC connected; C-NO open)	--	Not pulsed.	--
2	Step 2 (C-NC open; C-NO connected)	--	Pulsed	--
3	Pulses *	N	15000	--
4	Temperature	T	37	K







No anomalies observed

Wires & Cables

Characteristics	Part type/Description	Component Number	Manufacturer	Number of samples	Thermal cycles	Extended Criogenic test
Wires & Cables	- Junction cable x thermistors - Assembly of four ESCC 3901.019 silver plated copper, Variant 26 (P35862A), 1 Kapton KPT616 07/16 and 1 Kapton KPT01901/04 - CEH 2807 INOX wire, CELLOFLON (expanded PTFE), and polymide, AWG28 - Fluoropolymer Insulated, Low Frequency, 600V, -200 to + 200 degC, Based on Type CSWL variant 01	- ESCC 390101850 - P559699=P584717A+kapton noir - P541327A - ESCC 3901020401B	Axon	2 x 1m 1 x 2m 2 x 1m 3 x 1m	37K-323K	500h@37K

INITIAL PICTURES and SETUP:



390101850B



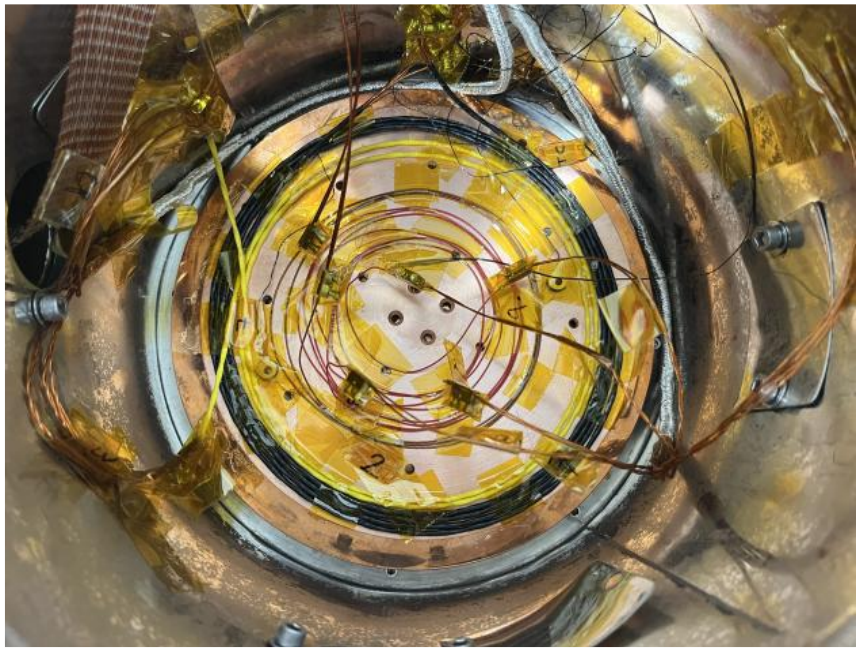
390102401B



P541327A



P559699



Cables were fixed to copper base plate using Kapton tape in several points. The copper plate was placed inside the helium cryostat.

Wires & Cables

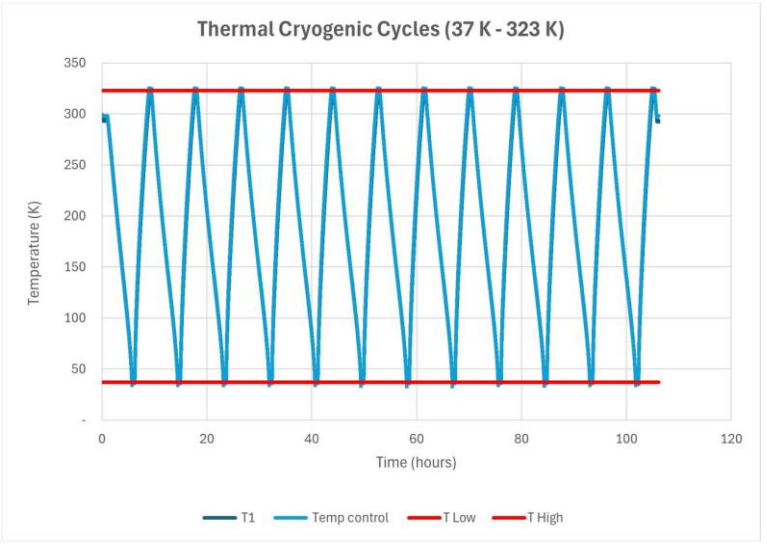
Electrical parameters at room temp:

#	TEST	CONDITIONS	LIMITS		UNIT	PASS	FAIL
			MIN	MAX			
1	R1-1	I = 50mA, t<1 min	--	0.244	Ohm	2	0
2	R1-2	I = 50mA, t<1 min	--	0.244	Ohm	2	0
3	R2-1	I = 10mA, t<1 min	--	0.516	Ohm	1	0
4	R2-2	I = 10mA, t<1 min	--	0.516	Ohm	1	0
5	R2-3	I = 10mA, t<1 min	--	0.516	Ohm	1	0
6	R2-4	I = 10mA, t<1 min	--	0.516	Ohm	1	0
7	R3	I = 1mA, t<1 min	--	--	Ohm	2	0
8	R4	I = 50mA, t<1 min	--	0.375	Ohm	3	0

Life test conditions

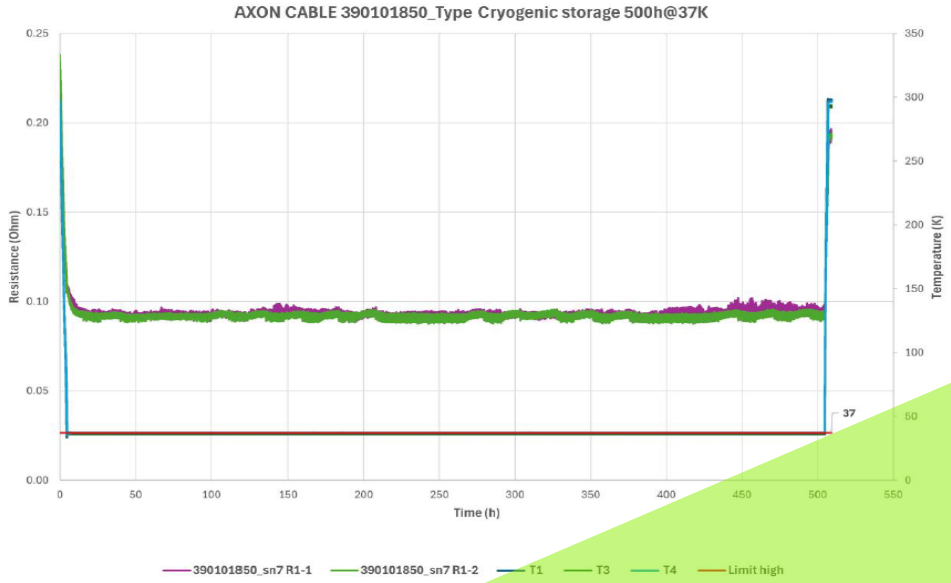
#	CHARACTERISTICS	SYMBOL	CONDITIONS	UNIT
1	Temperature	T	37	K
2	Time	t	500	h
3	Measurements	DC Resistance	4 wires auto ohm	Ohm

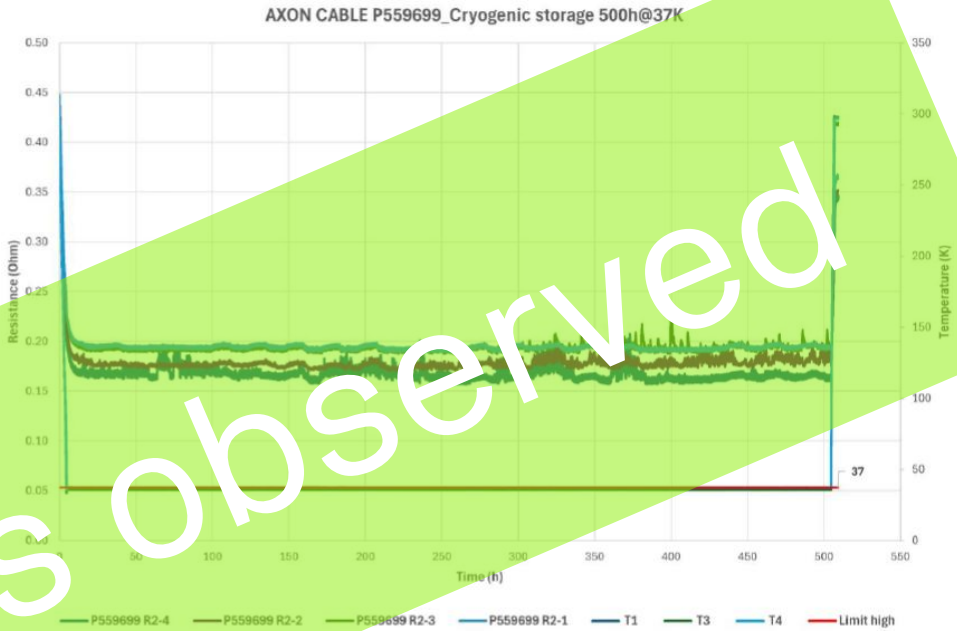
	NUMBER OF CYCLES: 12		
STEP	CHARACTERISTIC	TEST CONDITION	UNIT
1	Maximum temperature	323	K
2	Minimum temperature	37	K
3	Residence time	30	min
4	Pressure *	<10e-4	mbar



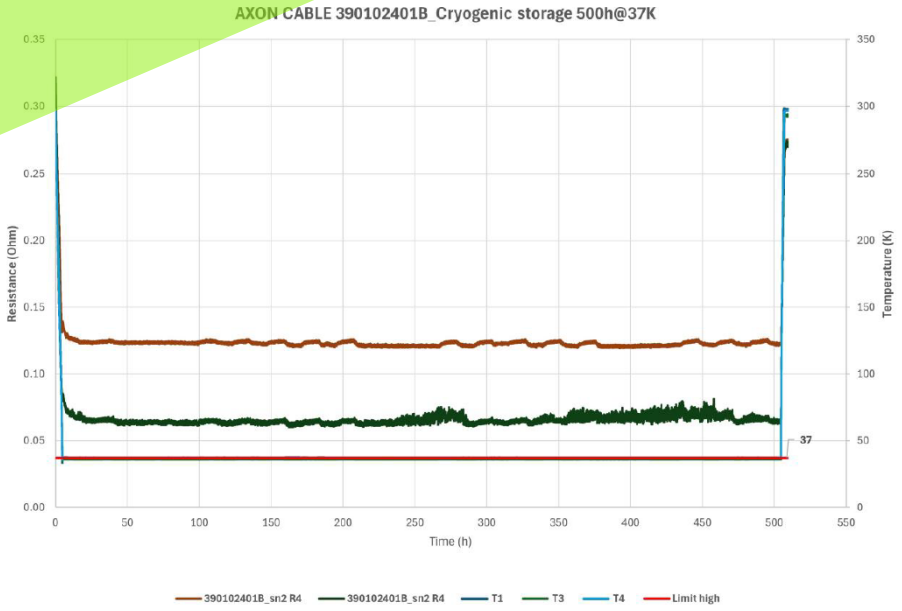
Profile for Thermal cycles

Wires & Cables









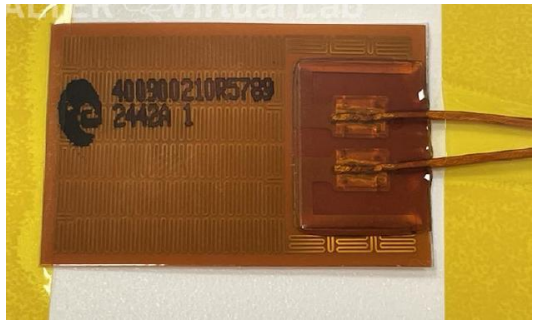
No anomalies observed

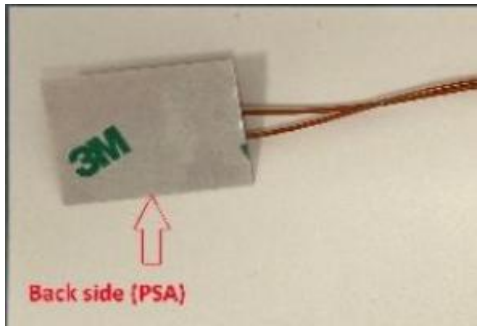
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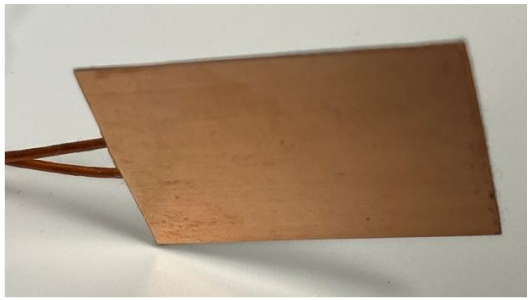
Heaters

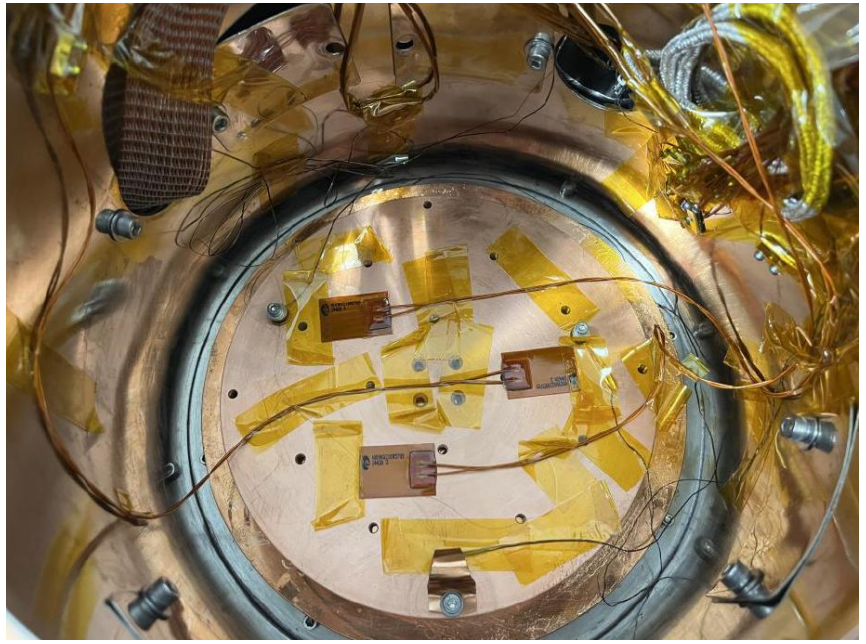
Characteristics	Part type/Description	Component Number	Manufacturer	Number of samples	Thermal cycles	Extended Criogenic test
Heater	Heaters 30x20 mm, single layer, PSA, with cable 390101922 (26AWG). 1EFIST949001	ESCC 400900210R5789	Zoppas Industries (RICA)	3pcs	29K-323K	500h@29K

INITIAL PICTURES and SETUP:









Heaters were mounted to thin copper plates using their own PSA.
For cryogenic tests, heaters were fixed to He cryostat base plate using Kapton tape

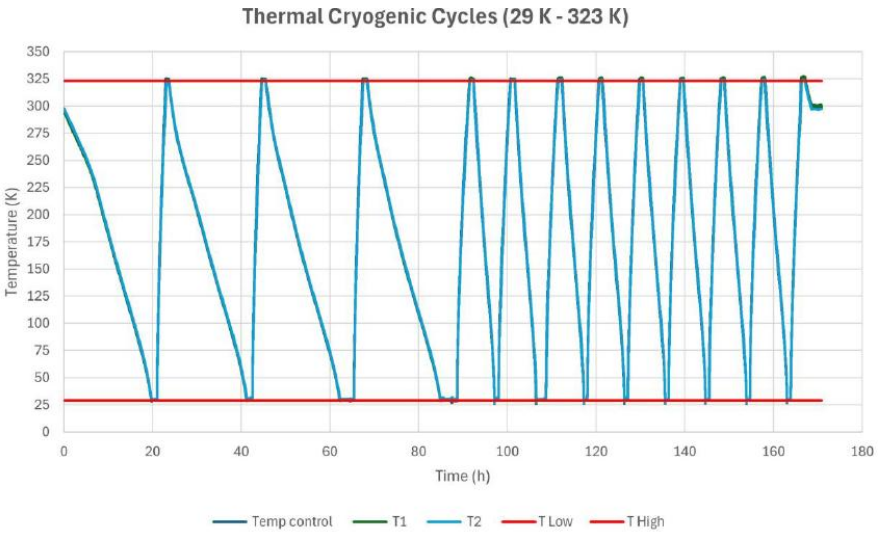


A thin vacuum grease layer (*) was applied between copper mounting plate and cryostat base plate. The heaters body and leads were secured with Kapton tape
(*): APIEZON® Hydrocarbon Vacuum Grease Type N, high Vacuum, down to 4K (-269°C)

Heaters

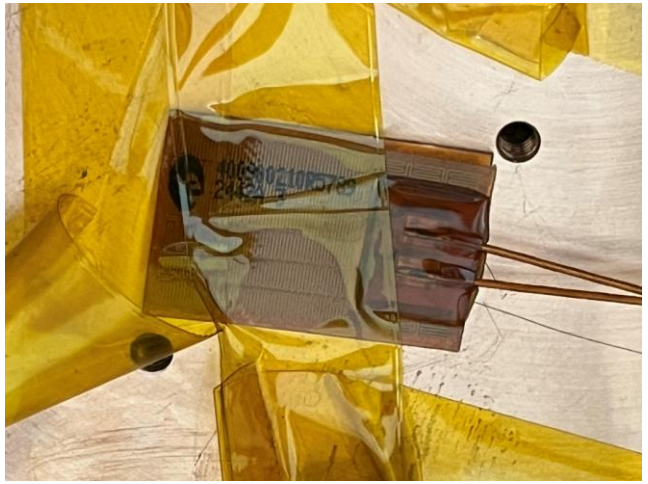
Electrical parameters at room temp:

#	TEST	CONDITIONS	LIMITS		UNIT	PASS	FAIL
			MIN	MAX			
1	R	V=1V	564.48	587.52	Ohm	4	0
2	IR	500 ± 50V; 60s	1000	--	MOhm	4	0
3	IL	500 Vrms, 60s	--	2	mA	4	0



Thermal Cycles:

- During first cycles, ramp down was slower due to decreased He pressure in the system. Anomaly was solved and cycles continued at nominal cooling rate.
- Heaters were powered ON at 21V (aprox 0.7Watt power) after 30 min stabilization time at 29K during each of the 12 cycles. No anomalies were observed.



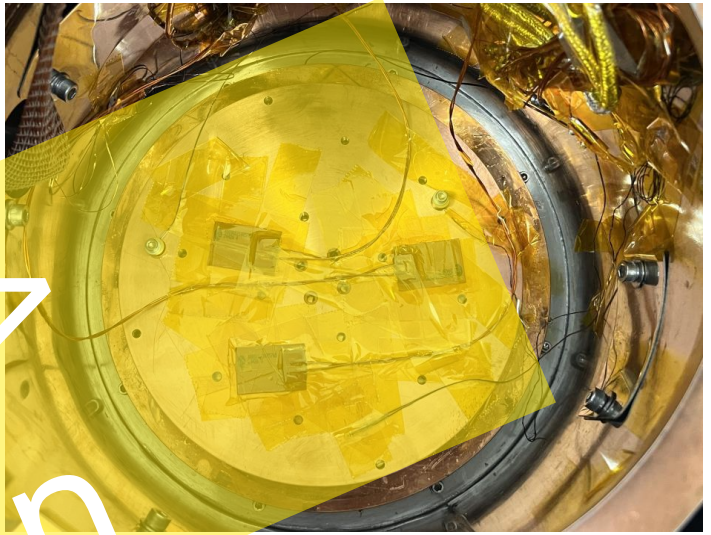
One Heater (SN3) detached from copper substrate
PSA adhesive failure→ To be managed by mechanical or other potting options to fix the heater
No other anomalies were observed

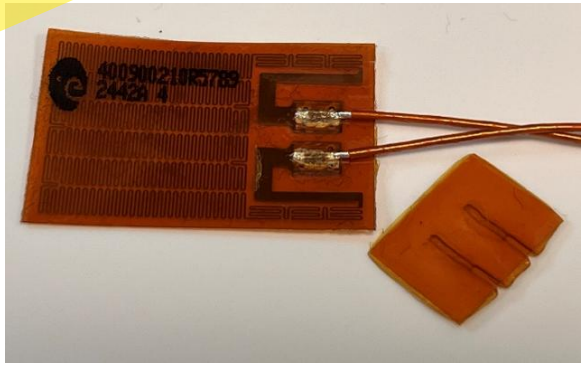
Heaters

Cryo Life test

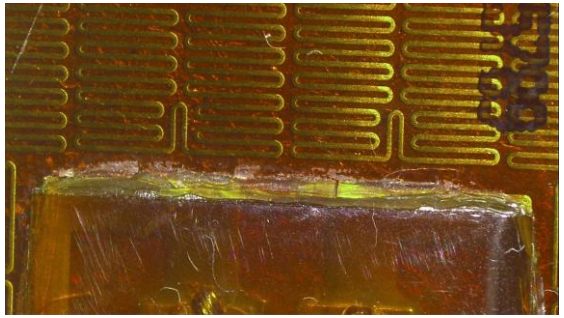
#	CHARACTERISTICS	SYMBOL	CONDITIONS	UNIT
1	Ambient temperature	Tamb	29	K
2	Time	t	500	hours

- Heater's resistance was monitored during the test, measurements were done by applying 1 Volt and measuring with 4 wires connection.
- A daily switch-on was done by applying 21 Volts for a short period of time. A total of 21 switches ON were done during test with no anomalies





- At the end of 500 hours of exposure to 29K the Helium cryostat was opened for final inspections and electrical measurements at room temperature. When removing the Kapton tape, sample SN4 leads insulation material was completely detached from the heater body. The soldered joints do not show any cracks.



- Detailed inspection on the other two samples (SN2&3) in test shows cracks and slight detachment on the peripheral sides of the insulation material.

- Final electrical measurements at room temperature are PASS with the note that Insulation resistance and Voltage proof were done only to heater area for SN4, without including leads area

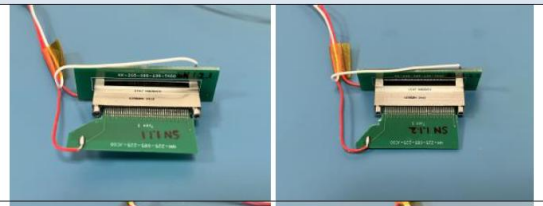
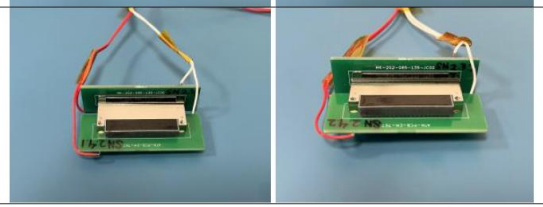
Lessons learnt-1
modified design

ALTER

Nano-Ds from Airborn

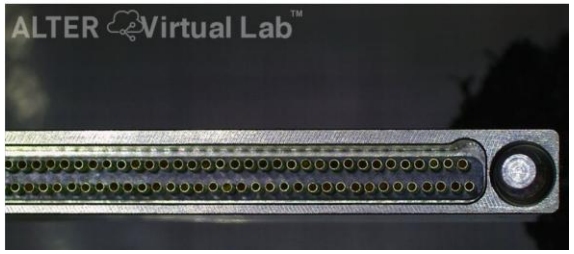
Characteristics	Part type/Description	Component Number	Manufacturer	Number of samples	Thermal cycles	Extended Criogenic test
Nano D85	Nano-D 85 Titane FLEX Nano-D 85 FLEX Nano-D 85 CFEE	- NM-225-085-225-JC00-D55 + NK-2G5-085-135-TH00-D56 - NK-2G2-085-135-JC00-E1Q + NK-2F2-085-435-TH00-E1Q	Airborn	2sets 2sets	29K-323K	500h@29K

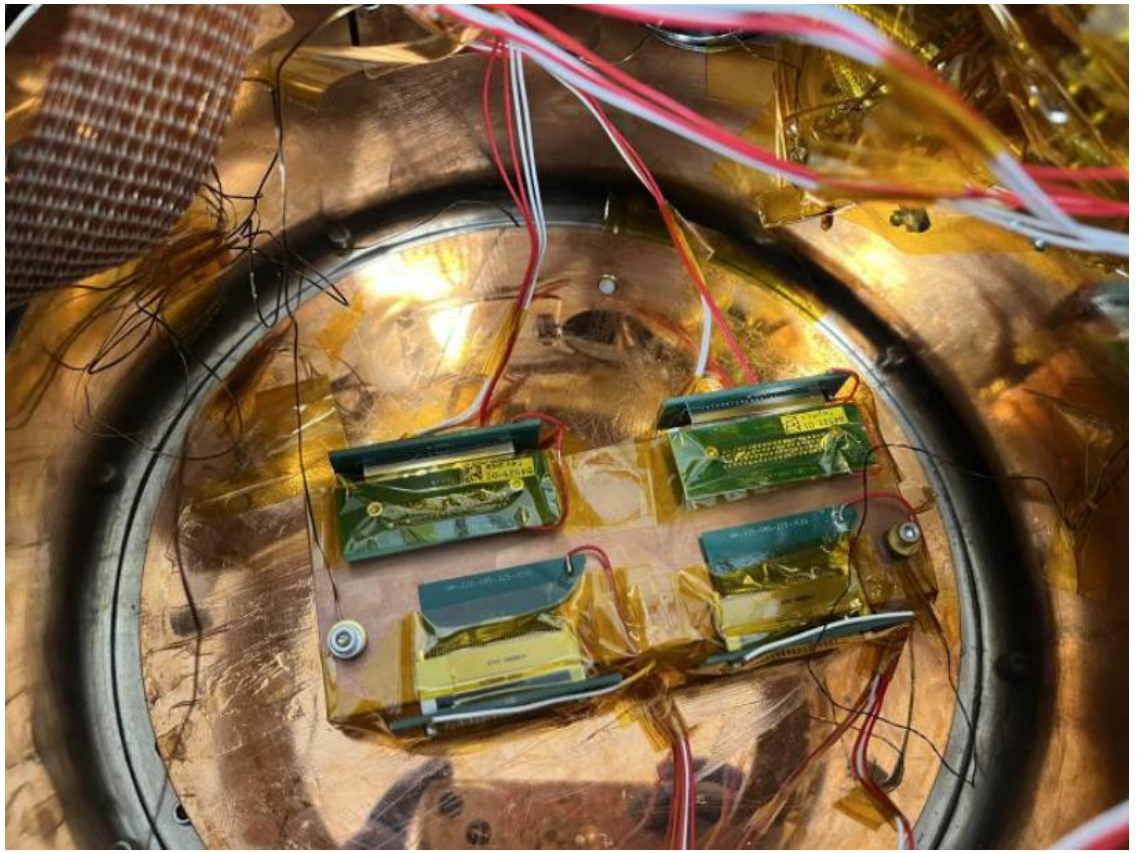
INITIAL PICTURES and SETUP:

	SERIALIZATION	ASSEMBLY
Pair type 1	NM-225-085-225-JC00-D55 Serialized: 1.1.1 and 1.1.2	
	NK-2G5-085-135-TH00-D56 Serialized: 1.2.1 and 1.2.2	
Pair type 2	NK-2G2-085-135-JC00-E1Q Serialized: 2.3.1 and 2.4.1	
	NK-2F2-085-435-TH00-E1Q Serialized: 2.3.2 and 2.4.2	

Connectors soldered on individual PCBs, mated in pairs and having the contacts connected in one chain. 20cm cables permit to measure chain resistance and insulation resistance to chassis







Nano-D from Airborn

Electrical parameters at room temp

#	TEST	CONDITIONS	LIMITS		UNIT	PASS	FAIL
			MIN	MAX			
1	R	I max = 1 Amp	--	--	Ohm	4	0
2	IR	100 VDC; 60s	1000	--	MOhm	4	0

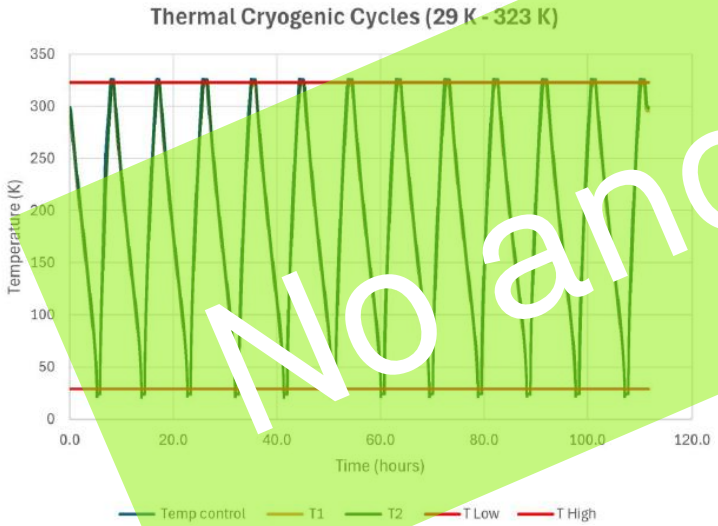
Insulation resistance measured between contacts chain and chassis. However, measurements of IR between chassis and contact chain at 29K were not reliable as connector chassis is placed in physical contact with cryostat metallic base plate

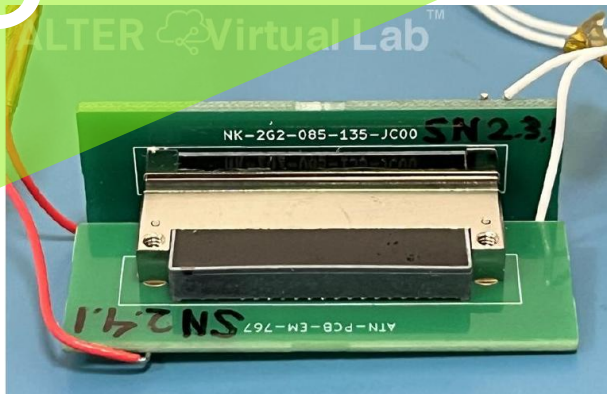
Cryo Life test

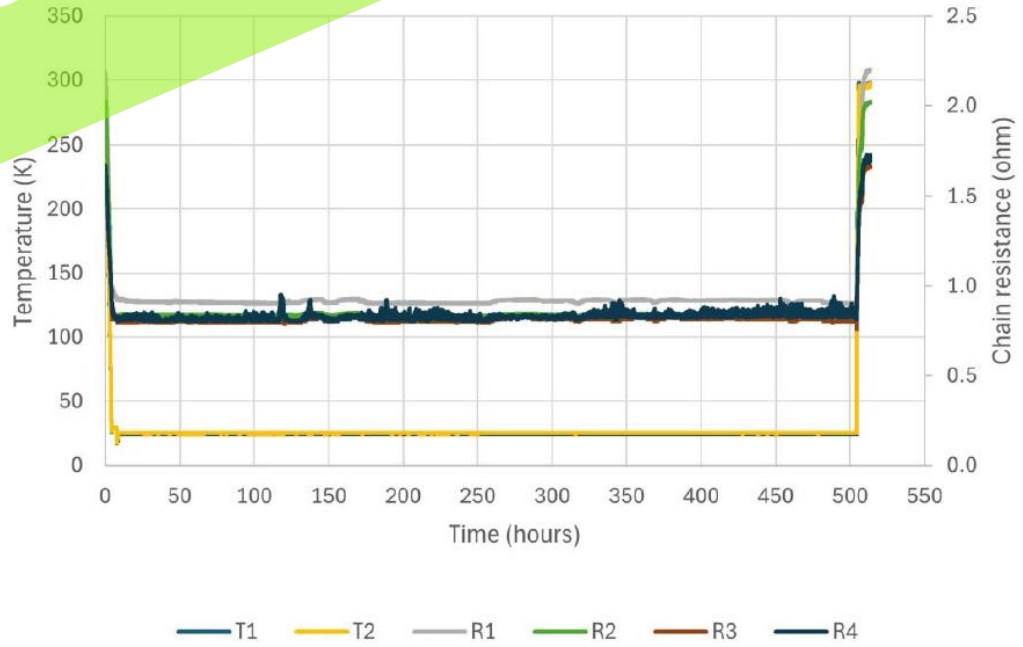
#	CHARACTERISTICS	SYMBOL	CONDITIONS	UNIT
1	Temperature	T	29 (+0 / -10)	K
2	Time	t	500	hours

Airborn connectors - Cryogenic storage 500h @29K

Standard profile for Thermal cycles





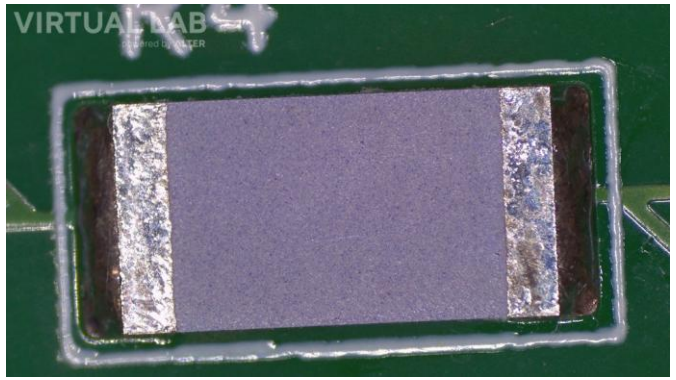


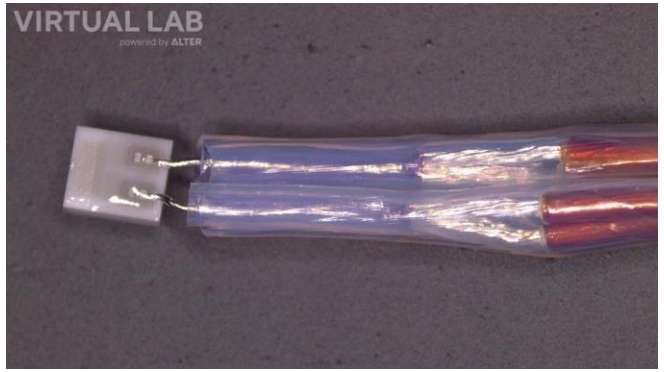
No anomalies observed

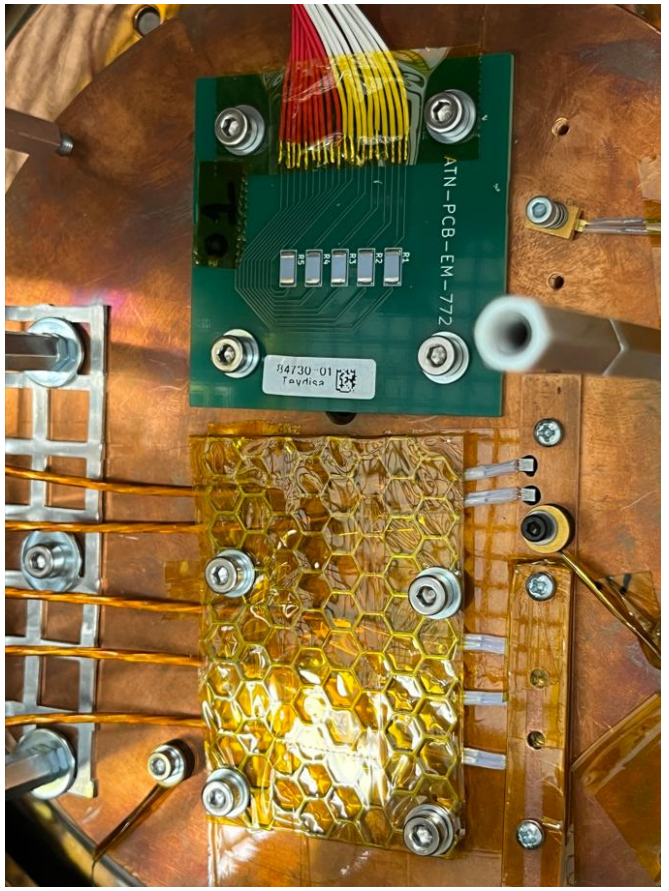
PHR2010 and Pt Sensor

Characteristics	Part type/Description	Component Number	Manufacturer	Number of samples	Thermal cycles	Extended Criogenic test
PHR2010 resistor PT1000 platinum sensor	PHR 2010 7K98 0,1% 500mW 25ppm/ºC Chip QP1K0.232.2L73.B.0300	ESCC 4001023047981B2 ESCC 400601508040300	Vishay Sfernice IST	5pcs 5pcs	29K-323K	500h@29K

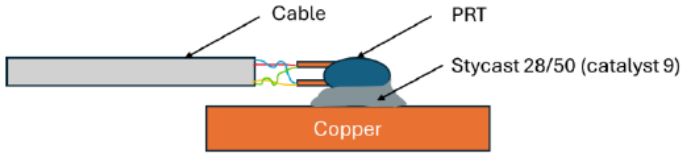
INITIAL PICTURES and SETUP:







- Thermistors will be mounted to a thin copper interface of 1mm as follows:
  - 2 samples will be fixed using Stycast adhesive.



  - 3 samples will be in direct contact with the copper plate using Kapton tape and vacuum grease.

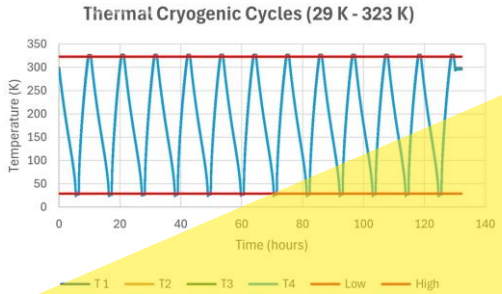
Then the copper interface carrying the samples will be screwed to Helium Cryostat base. Vacuum grease can be added to improve thermal conductivity between copper plate and chamber base plate.

PHR2010 and Pt Sensor

Electrical parameters at room temp

#	Test	CONDITIONS	LIMITS		UNIT	ACCEPT	REJECT
			Min	Max			
1	RA	4 wires auto-ohm	7972.02	-	Ohm	6	0
2	RZ	IOP max = 0.3 mA	998.82	1001.17	Ohm	6	0
3	IR	Voltage = 100 V (+/-10%)	100	-	Mohm	6	0

Thermal cycles

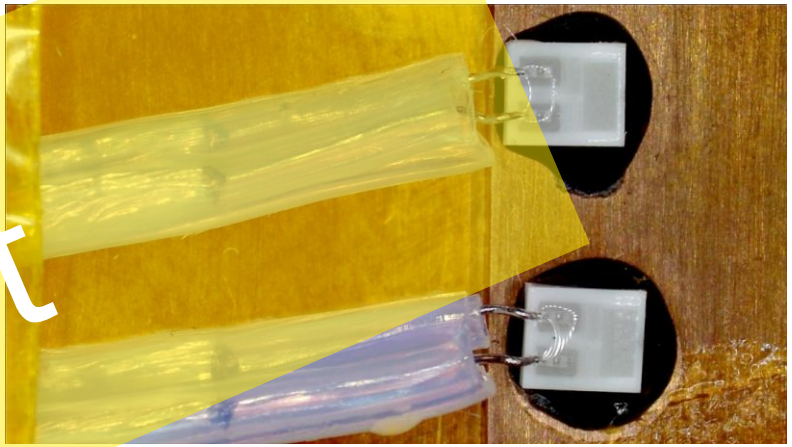


Cryo Life test

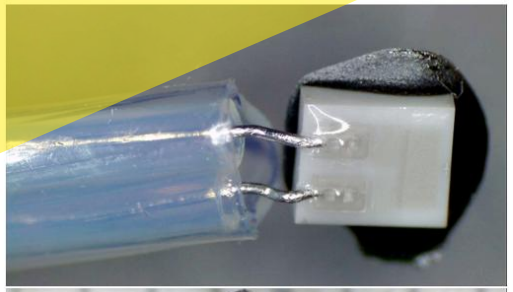
#	CHARACTERISTICS	SYMBOL	CONDITIONS	UNIT
1	Temperature	T	29 (+0 / -10)	K
2	Time	t	500	hours

Visual inspection after cryo life test



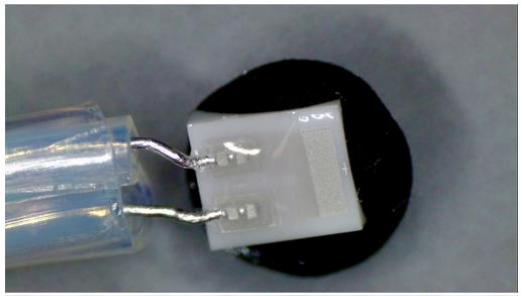


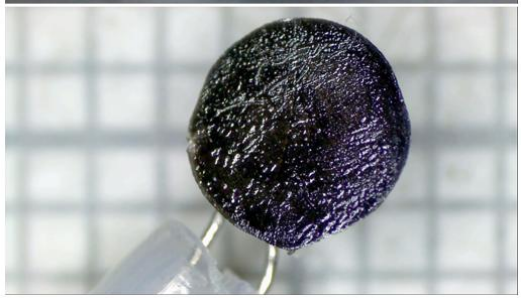
EVI – SN 01 after life test





EVI – SN 02 after life test





Lessons learnt

After Life test, during visual inspection and after cleaning with IPA, lack of adhesion on the parts using Stycast mounting

ALTER

Resistors and capacitors

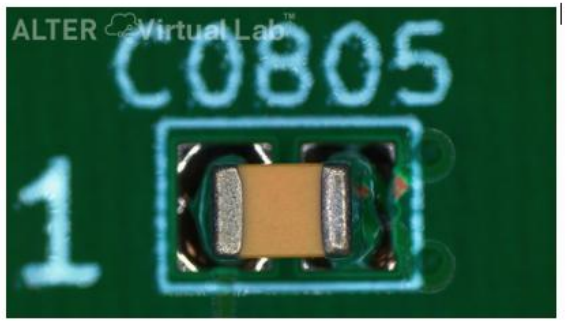
Characteristics	Part type/Description	Component Number	Manufacturer	Number of samples	Thermal cycles	Extended Criogenic test
Resistors and Capacitors	0805 2.2nF, NPO 10% 50V (A612) 0805 100nF, BME X7R, 10%, 100V TAJ 2.2uF, Tantal, 10%, 16V 100nF, CRX, 10% 25 V Cryo CHPHR0805 4.7R, 200 ppm/°C, 2%	ESCC 3009003062201KC ESCC 300904103104KE ESCC 301200102225KC SR1209CRX104Z1F (CRX) ESCC 4001026024R70G6	AVX AVX AVX Presidio Vishay Sfernice	10pcs 10pcs 10pcs 5pcs 5pcs	37K-323K	1000h@42K

INITIAL PICTURES:

General external top view.

Part type: 0805 2.2nF, NPO 10% 50V (A612CE0350KNC) Component number: 3009003062201KC.

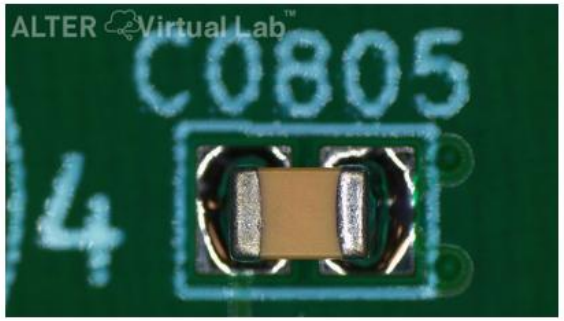
S/N: C1-1



General external top view.

Part type: 0805 100nF, BME X7R, 10%, 100VComponent number: 300904103104KE.

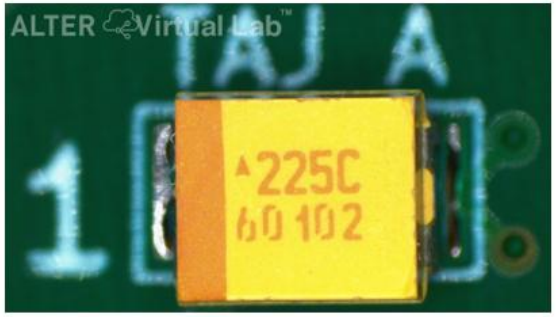
S/N: C2-9



General external top view.

Part type TAJ 2.2uF, Tantal, 10%, 16V (TAJA225K016ESA) Component number 301200102225KC.

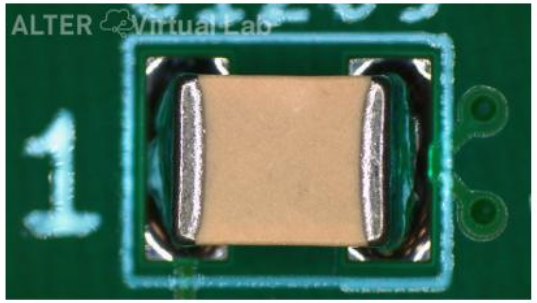
S/N: C4-1



General external top view.

Part type 100nF, CRX, 10% 25 V Cryo Component number SR1209CRX104Z1F.

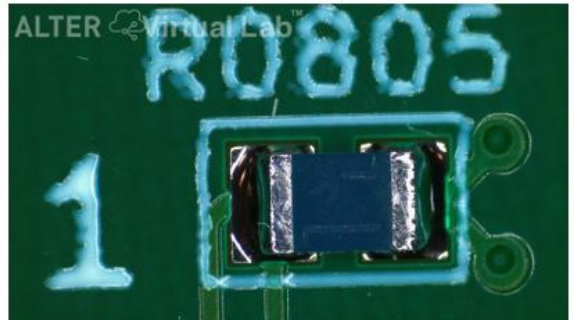
S/N: C3-1



General external top view.

Part type CHPHR0805 4.7R, 200 ppm/°C, 2% thick film (CHPHR 0805 L 4R70 G B) Component number 4001026024R70G6.

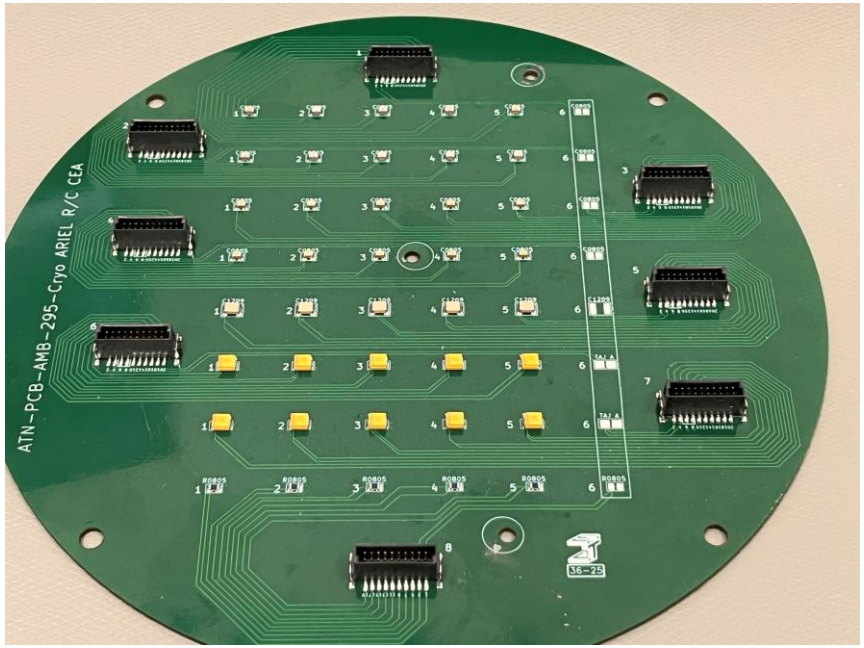
S/N: R-1

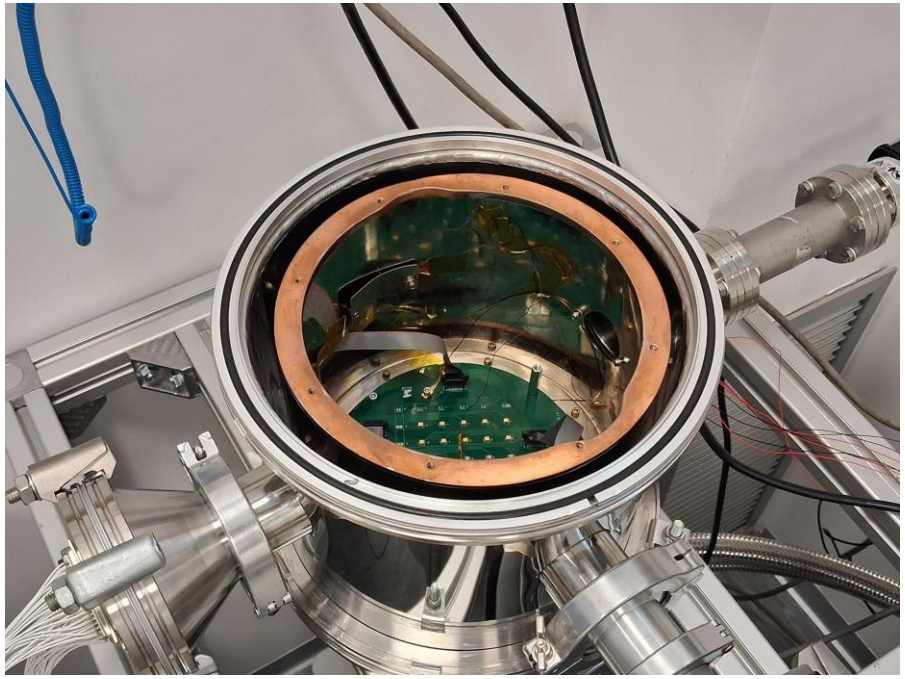


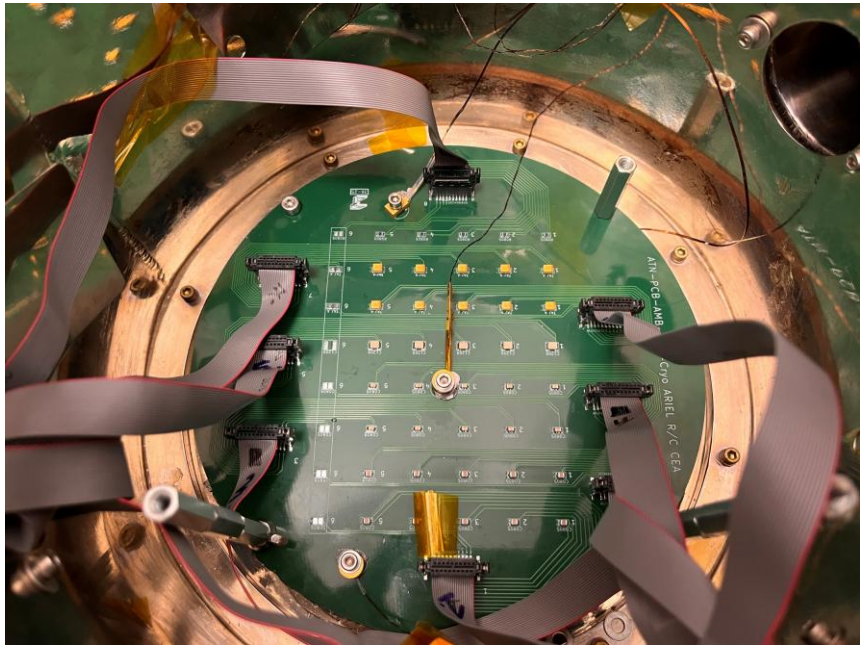
Resistors and capacitors

SETUP:

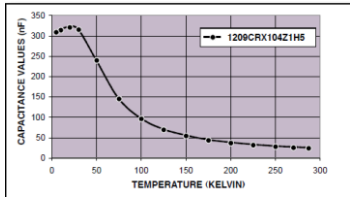
- Complex design for testing with 40pcs
- Utmost importance of using same materials and representative process than users
- Iterations with users to understand soldering materials
- Use of an ECSS-Q-ST-70-61C qualified assembly house







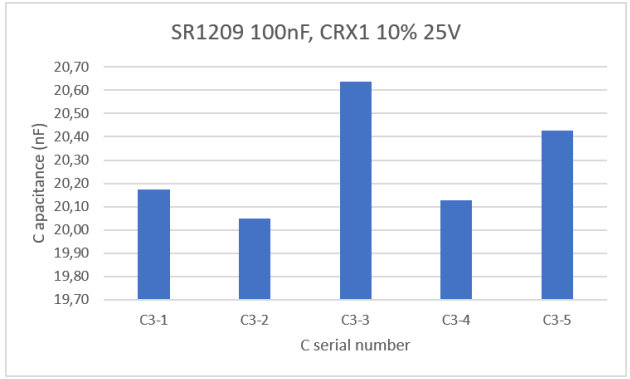
Resistors and capacitors



Electrical parameters at room temp

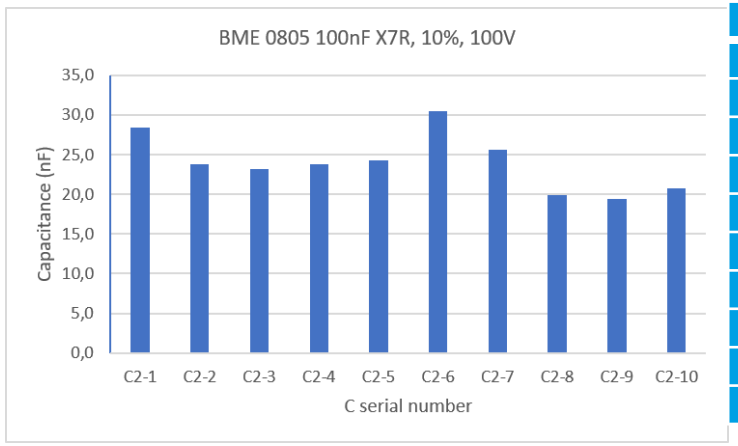
#	TEST	CONDITIONS	LIMITS		UNIT	PASS	FAIL
			MIN	MAX			
1	C1	f= 1kHz, Vrms=1V (Note 1)	1.98	2.42	nF	11	0
2	IR 1	Vmax=50Vdc; t=1min (Note 1)	100	--	GOhm	11	0
3	C2	f= 1kHz, Vrms=1V (Note 1)	90	110	nF	11	0
4	IR 2	Vmax=100Vdc; t=1min (Note 1)	100	--	GOhm	11	0
5	C3	f= 100Hz, Vrms=1V (Note 2)	--	--	nF	5	0
6	IR 3	V=25Vdc; t=1min (Note 2)	100	--	MOhm	5	0
7	C4	f= 100Hz, Vrms=0.5V (Note 3)	1.98	2.42	µF	11	0
8	IL	V=16Vdc ±2%; t=5min max (Note 3)	--	1	µA	11	0
9	R	4 wires auto ohm (Note 4)	4.606	4.794	Ohm	6	0

C3 capacitance 100nF at 77 K, no limits are defined for ambient temperature. In the range of 20.28nF at Tamb



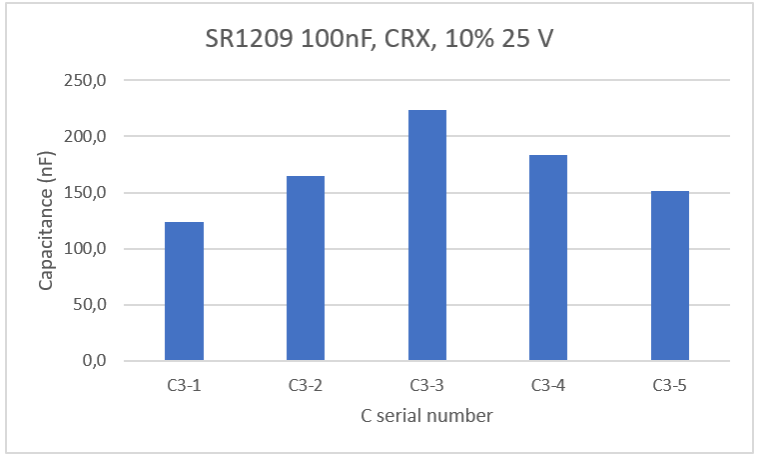
Electrical measurements at 42K findings

- BME 0805 100nF X7R, 10%, 100V drops to a mean of 25% of its nominal value measured at Tamb



S/N	C (nF)
C2-1	28,5
C2-2	23,8
C2-3	23,1
C2-4	23,8
C2-5	24,3
C2-6	30,5
C2-7	25,6
C2-8	19,9
C2-9	19,4
C2-10	20,7

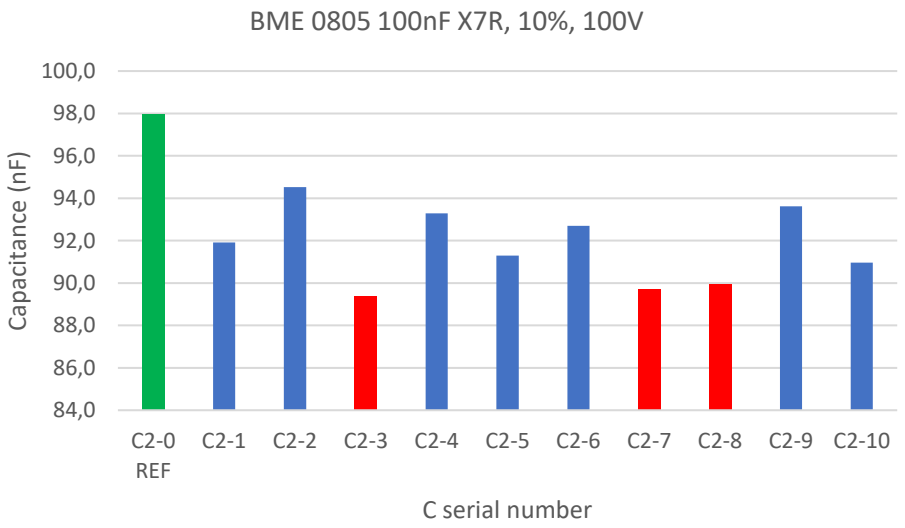
- SR1209 100nF, CRX, 10% 25 V Cryo increased value vs nominal 100nf at 77K



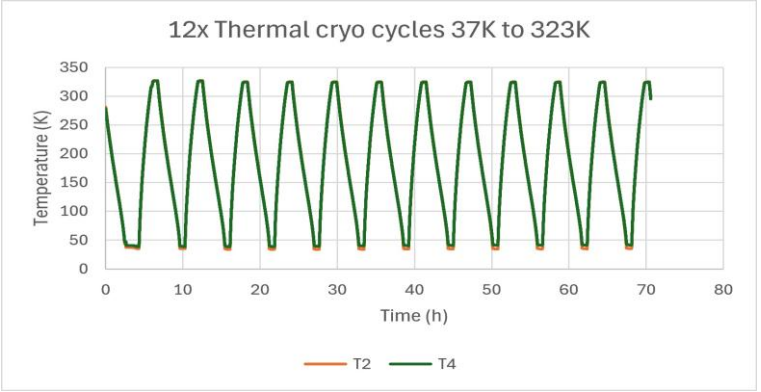
S/N	C (nF)
C3-1	123,3
C3-2	164,9
C3-3	223,4
C3-4	183,1
C3-5	151,5

Resistors and capacitors

Electrical measurements at room temp after Thermal cycles



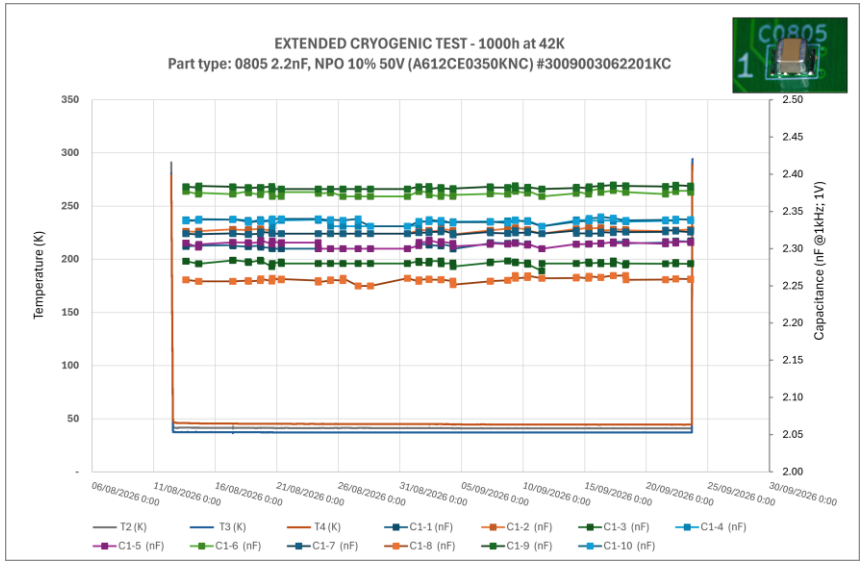
S/N	C2 (nF)
C2-0 REF	98,0
C2-1	91,9
C2-2	94,5
C2-3	89,4
C2-4	93,3
C2-5	91,3
C2-6	92,7
C2-7	89,7
C2-8	89,9
C2-9	93,6
C2-10	91,0

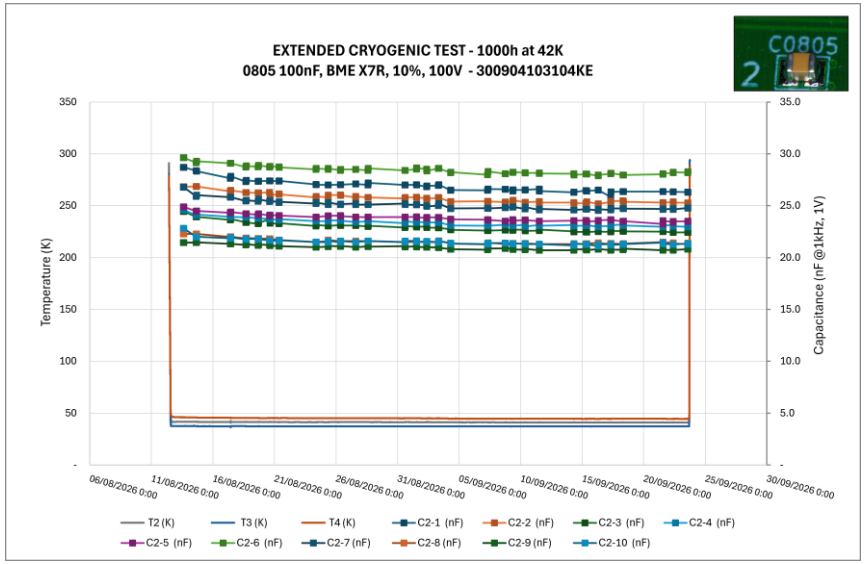


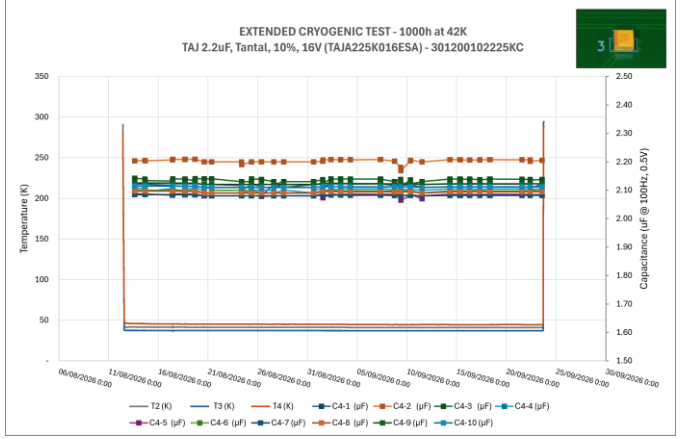
- 3 out of 10 capacitors C2 (BME 0805 100nF X7R, 10%, 100V) show slight decrease in capacitance after 12 cryogenic cycles. No other anomalies were detected.
- C2 (BME 0805 100nF X7R, 10%, 100V) capacitance parameter at room temperature measured after thermal cryo cycles show a drift of more than 3% in 9 of 10 samples in test.
- SR1209 capacitor back to 'nominal' 20nF at room temp
- NO anomalies during visual inspection

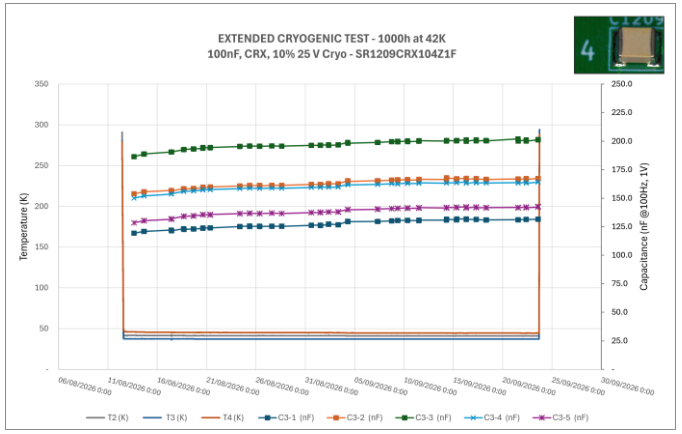
Resistors and capacitors

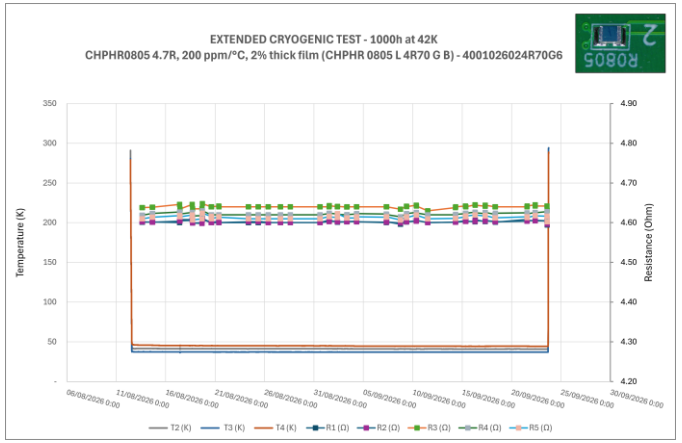
Cryogenic life test 1000h @ 42K











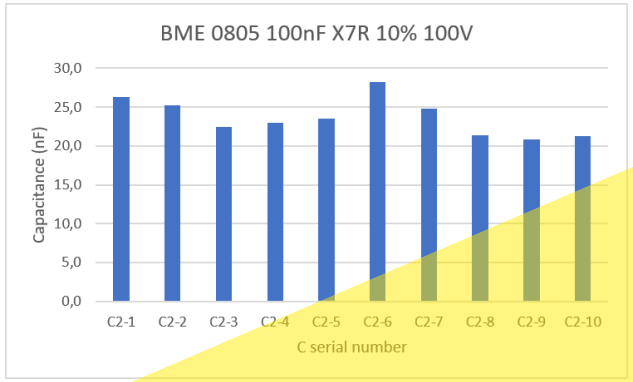
- Capacitance and resistance were measured each working day during at 42K.
- Slight decrease in Capacitance value was observed for all 10 samples of C2 (BME 0805 100nF X7R, 10%, 100V)
- Significant increase in capacitance value for all 5 parts of SR1209 CRX 100nF, CRX, 10% 25V

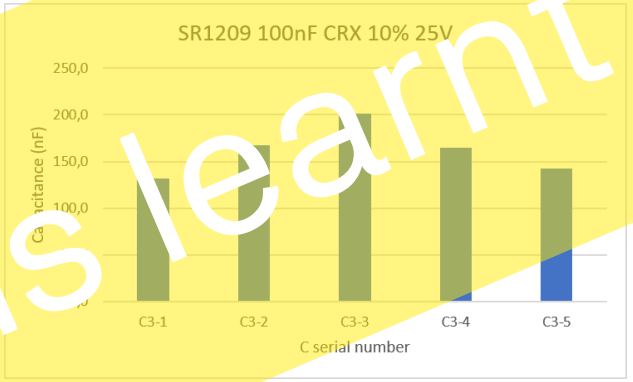
ALTER

Resistors and capacitors

Electrical measurements at 42K after 1000h Cryo life test

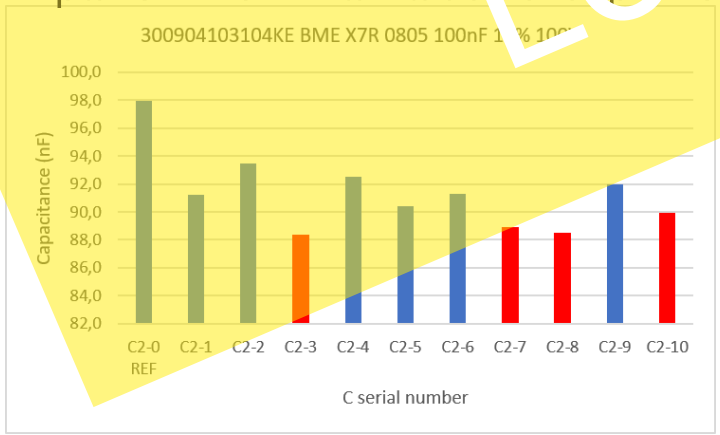
- Similar electrical parameter values to those registered during initial measurements at 42K before Thermal cycles, including BME and SR1209 types

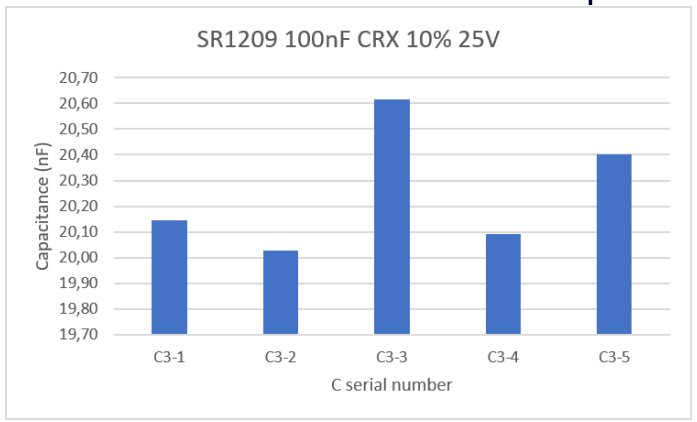




Electrical measurements at room temp

- All parts in nomimal values except 4 of BME types and known SR1209 value at room temp





Lessons learnt

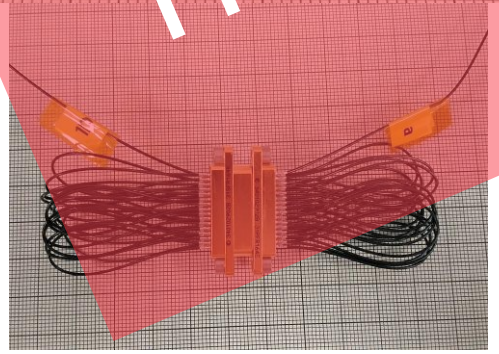
Micro-D, Sub-D and splice

Characteristics	Part type/Description	Component Number	Mnfr	Number of samples	Thermal cycles	Extended Criogenic test
Sub-D & Micro-D Splice	MDM Solder Bucket 31S Space Splice HD Sub-D 26-pin Male and Female	- ESCC 340102902B31SFR164E + 340102902B31PFR164E - ESCC 340109701B - ESCC 340100202BDAMA26PNMB + 340100202BDAMA26SNMB	C&K	2 sets 2 sets 2 sets	29K-323K	500h-->1000h@29K

INITIAL PICTURES:

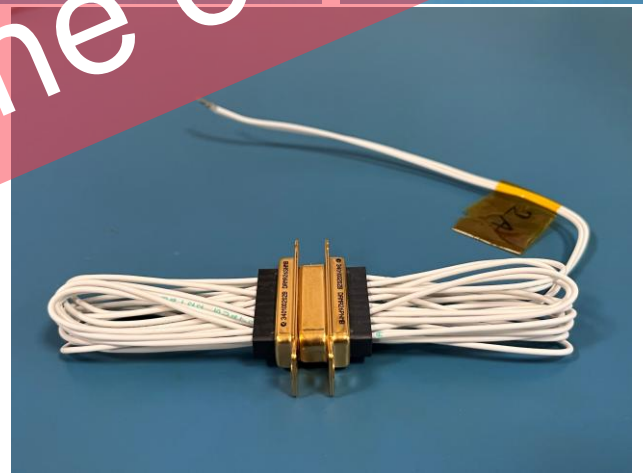
Micro-D 31 P-S solder bucket



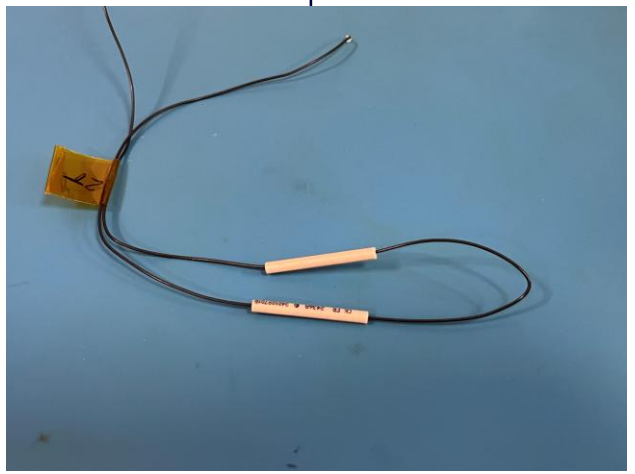


High density Sub-D 26P-S





Splice



Thanks to C&K for providing some of the parts!

ALTER

Micro-D, Sub-D and splice

SETUP:

- Not complex but laborious setup
- Use of qualified assembly house for the solder bucket micro-Ds
- For the electrical measurements at ambient and cryogenic temperatures, connectors mated and prepared with cables so as to have all the pins connected in one daisy chain.
- Daisy chain resistance measured with precision ohmmeter using Helium Cryostat electrical feed-through and a 4 wires connection.
- A mechanical assembly formed by a copper L shape piece will be prepared to have the connectors mounted in a panel.
- Kapton used for Splice connection to copper plate



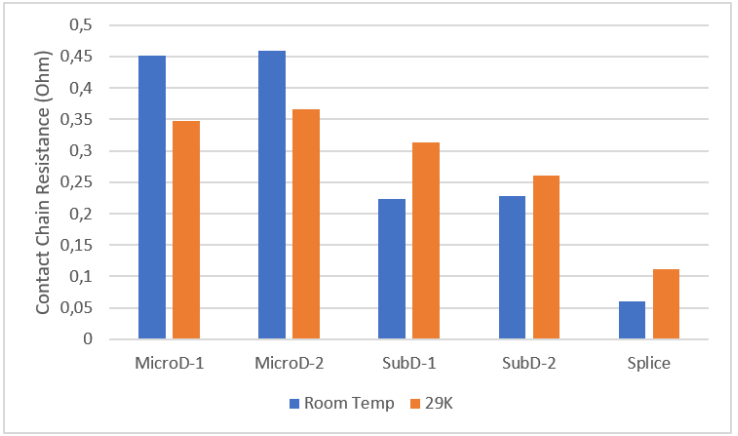
Resistors and capacitors

Electrical parameters at room temp and functional characterization at 29K

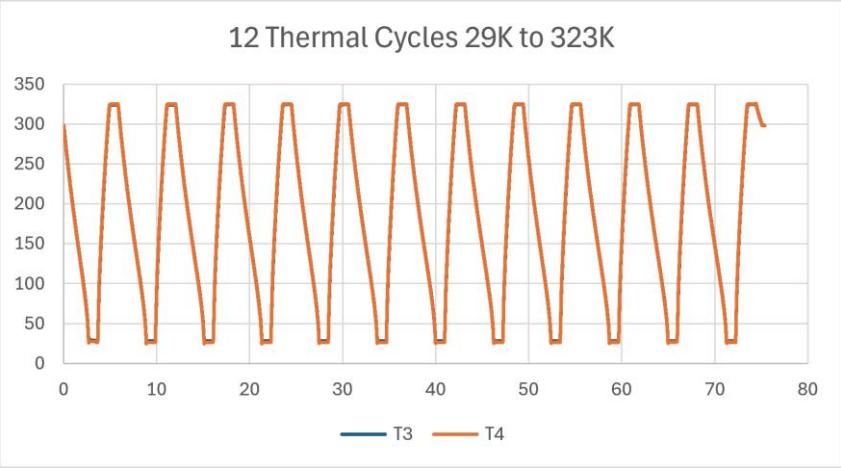
- All connectors according to specifications

N.º	SYMBOL	DESCRIPTION	CONDITION (T_{AMB}=+22 ±3 ºC)	LIMITS (Notes 1 and 2)			UNIT
				MIN.	TYP.	MAX.	
1	R	Contact Chain Resistance	4 wires; I=20 mA	--	--	-	Ohm
2	Ri	Insulation Resistance - Contact Chain to chassis	100 VDC; 60 seconds	1000	--	--	MOhm

Notes:
1. Daisy chain resistance is expected to be in range of ohms. No values or limits are specified. Initial measures will be kept as reference for subsequent measures.
2. Insultation resistance between contact chain and chassis.



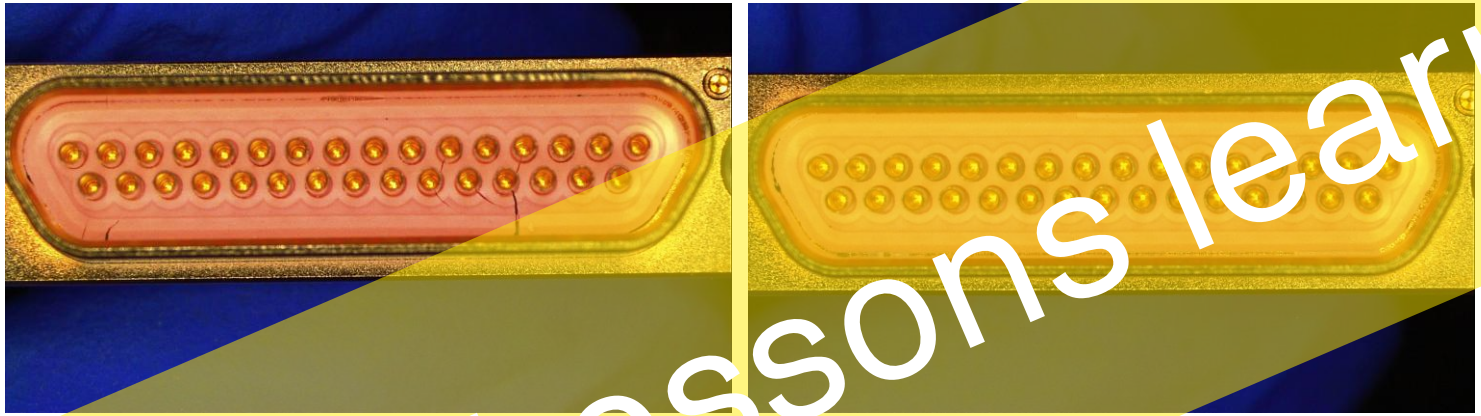
Thermal cycles



Resistors and capacitors

After thermal cycles

- Sub-Ds and splice passed visual inspection and electrical masurements at room temp
- Both **Micro-D socket** connectors showed cracks on the pink interfacial (Fluorosilicone elastomer) seal but passed electrical



Lessons learnt

- NRB decision: Continue with Cryogenic life test and extend this from 500h to 1000h. It is noted the isolation at contact level is 'assured' by the pin connectors thanks to LCP insulator.
- Cryogenic Life test ended last Friday without anomalies from the continuous monitoring of contact resistance.
- Next last step: Final Final visual inspection



SUMMARY & CONCLUSIONS

Summary

Important lessons learnt for passive components at Cryogenic temperatures for a wide range of components massively used in space mission

Characteristics	Part type/Description	Component Number	Manufacturer	Number of samples	Thermal cycles	Extended Criogenic test	RESULTS
Microswitch	T6932 Microswitch	ESCC 370100302B	Petercem	3pcs	37K-323K	15000 cycles	OK
Wires & Cables	- Junction cable x thermistors - Assembly of four ESCC 3901.019 silver plated copper, Variant 26 (P35862A), 1 Kapton KPT616 07/16 and 1 Kapton KPT01901/04 - CEH 2807 INOX wire, CELLOFLON (expanded PTFE), and polymide, AWG28 - Fluoropolymer Insulated, Low Frequency, 600V, -200 to + 200 degC, Based on Type CSWL variant 01	- ESCC 390101850 - P559699=P584717A+kapton noir - P541327A - ESCC 3901020401B	Axon	2 x 1m 1 x 2m 2 x 1m 3 x 1m	37K-323K	500h@37K	OK
Heater	Heaters 30x20 mm, single layer, PSA, with cable 390101922 (26AWG) 1EFIST949001	ESCC 400900210R5789	Zoppas Industries (RICA)	3pcs	29K-323K	500h@29K	- One Heater (SN3) detached from copper substrate. - Cracks and slight/total detachment on the peripheral sides of the insulation material
Nano D85	Nano-D 85 Titane FLEX Nano-D 85 FLEX Nano-D 85 CFEE	- NM-225-085-225-JC00-D55 + NK-2G5-085-135-TH00-D56 - NK-2G2-085-135-JC00-E1Q + NK-2F2-085-435-TH00-E1Q	Airborn	2sets 2sets	29K-323K	500h@29K	OK
PHR2010 resistor PT1000 platinum sensor	PHR 2010 7K98 0,1% 500mW 25ppm/ºC Chip QP1K0.232.2L73.B.0300	ESCC 4001023047981B2 ESCC 400601508040300	Vishay Sfernice IST	5pcs 5pcs	29K-323K	500h@29K	After Life test, during visual inspection and after cleaning with IPA, lack of adhesion on the parts using Stycast mounting
Resistors and Capacitors	0805 2.2nF, NPO 10% 50V (A612) 0805 100nF, BME X7R, 10%, 100V TAJ 2.2uF, Tantal, 10%, 16V 100nF, CRX, 10% 25 V Cryo CHPHR0805 4.7R, 200 ppm/°C, 2%	ESCC 3009003062201KC ESCC 300904103104KE 301200102225KC SR1209CRX104Z1F ESCC 4001026024R70G6	AVX AVX AVX Presidio Vishay Sfernice	10pcs 10pcs 10pcs 5pcs 5pcs	37K-323K	1000h@42K	OK Lessons learnt but NO CRACKS!
Sub-D & Micro-D Splice	MDM Solder Bucket 31S Space Splice HD Sub-D 26-pin Male and Female	- ESCC 340102902B31SFR164E + 340102902B31PFR164E - ESCC 340109701B - ESCC 340100202BDAMA26PNMB + 340100202BDAMA26SNMB	C&K	2 sets 2 sets 2 sets	29K-323K	500h-- >1000h@29K	Micro-D socket connectors showed cracks on the pink interfacial seal but passed electrical even after 1000h cryo life test

Conclussions

Qualification Results for Cryogenic Temperature Testing of EEE Components in the ESA ARIEL Science Mission

- Results for passive and active components are key elements for ARIEL mission
- Do not underestimate the effects of cryogenic testing in passive (nor active) devices
- Discussion to set the representative conditions for testing.
- Planning, planning, planning.....
- User representative materials and processes. Wisdom people will say “Fly as you test, test as you fly”.
  Right Lionel Bonora?
- If not your field of expertise, ask for support to experts in extreme temperature testing



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Manuel SÁNCHEZ RUIZ
EEE Parts Engineer and Product Assurance
Parts Engineering Department
ALTER TECHNOLOGY TÜV NORD S.A.U.
manuel.sanchez@altertechnology.com

Ph: +34 664 703 203 - mobile
Web: www.altertechnology.com
Address: C/ Tomás A. Edison 4
41092 Sevilla – SPAIN

Manuel MORALES DOMINGUEZ
EEE Parts Engineer and Product Assurance
Parts Engineering Department
ALTER TECHNOLOGY TÜV NORD S.A.U.
manuel.morales@altertechnology.com

Ph: +34 673 509 405 - mobile
Web: www.altertechnology.com
Address: C/ Tomás A. Edison 4
41092 Sevilla – SPAIN

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