

Proba-3 Mission: ISL Architecture and procurement approach for Passives COTS

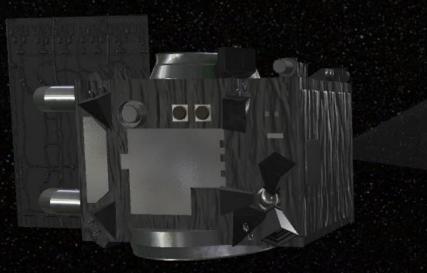
Teodor Bozhanov - Systems Engineer Léo Farhat - EEE Engineer ESA ESTEC 13/10/2022

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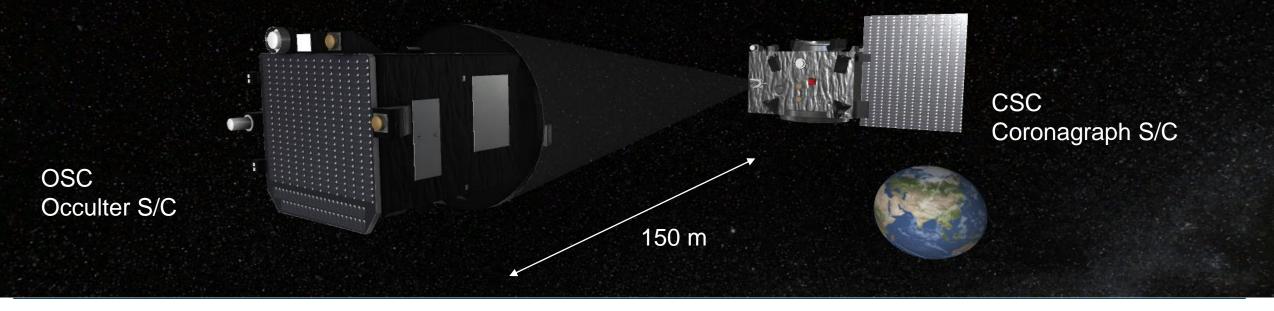


Proba-3 concept

Fly 2 S/C in formation

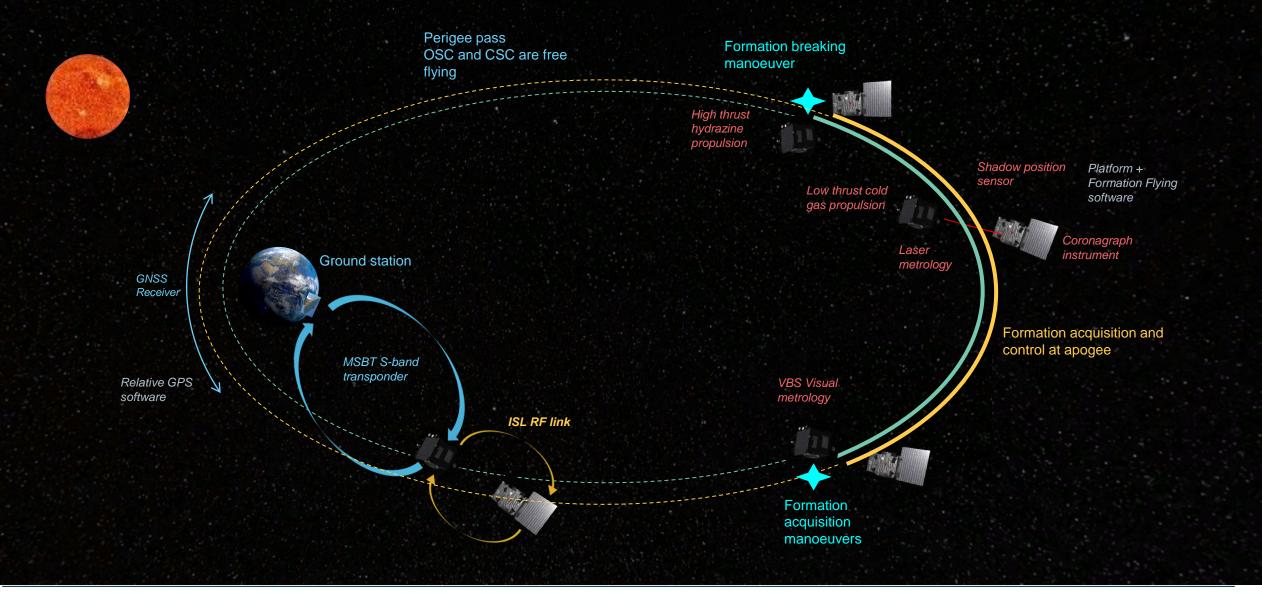
The Coronagraph Spacecraft instrument in the shadow cast by the Occulter spacecraft

Distance: 150 m Occulter \emptyset : 1.4 m Position accuracy need: millimetric



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Operational Orbit Concept



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A Sense of Scale



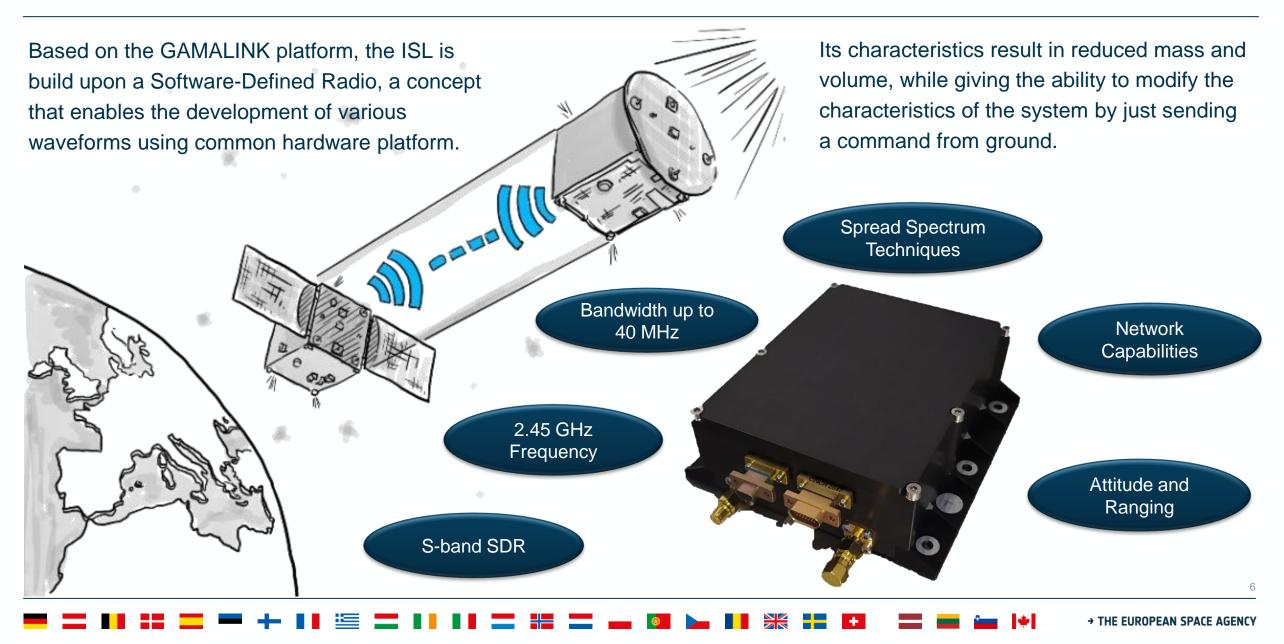
Narrow angle camera

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Wide angle camera

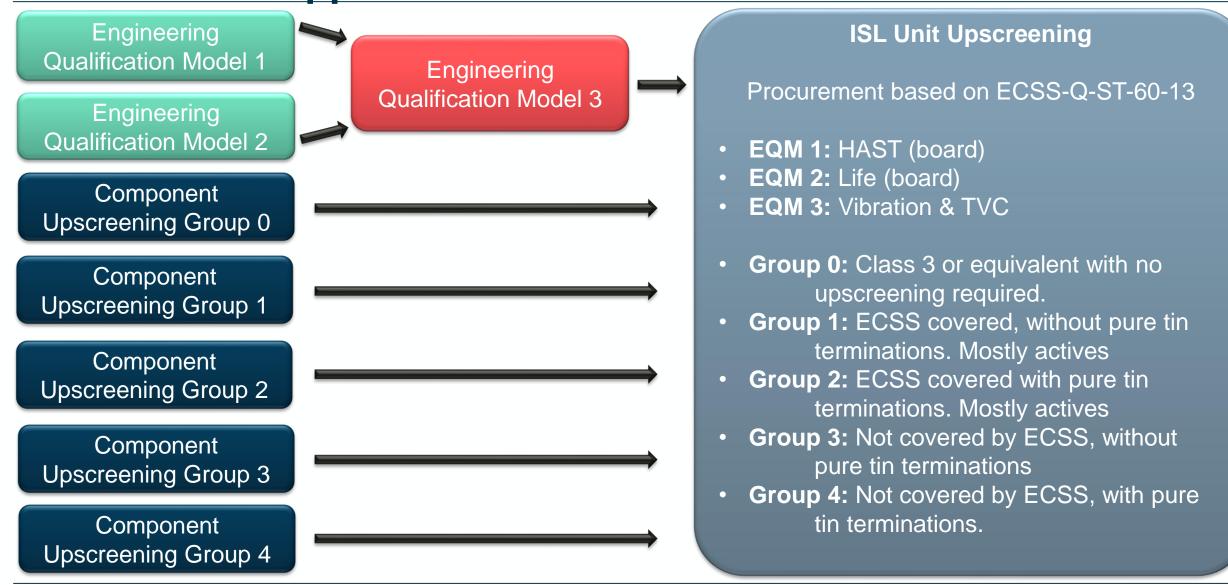
Inter Satellite Link





Upscreening and Qualification Approach





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Component Level

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Component Upscreening Group 0	Type: Capacitors, Inductors, Resistors, Connectors, OCXO, Microcontroller, Buffer, Choke	Tin Whisker Risk: None	No Extra Qualification Testing (except for OCXO)
Component Upscreening Group 1	Type: FPGA, Amplifiers, Switches, Diodes, Microcontrollers	Tin Whisker Risk : None	Testing: Construction Analysis, Radiation
Component Upscreening Group 2	Type: MOSFETS, Modulators, Diodes, Regulators, Overcurrent	Tin Whisker Risk : Yes, Mitigation Implemented	Testing: Construction Analysis, Radiation
Component Upscreening Group 3&4	Type: Commercial Passives and RF Passives	Tin Whisker Risk : Yes for 3 no for 4	Testing: Screening and Qualification

Passive COTS: RF Passive

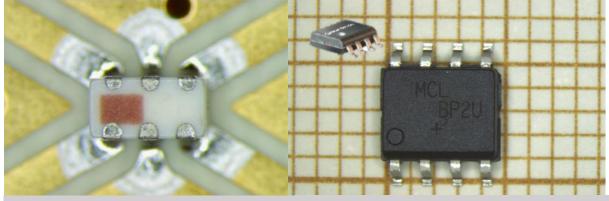
Parts

Part Type: Description:

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Manufacturer: Pure Tin: DCW-22-332+ Directional Coupler, 22 dB Coupling 1.2-3.3 GHz

BP2U+ Power Divider/Combiner, 2 Way-0°, 2.1-2.5 GHz MINI-CIRCUITS No



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Directional Coupler Power Divider/Combiner

ESCC 3502 Test Flow	Method and Conditions	Screening an Qualification tests are based on			
Screening		ESCC3502 Generic Specification for SAW RF filters,			
Temperature Cycling	MIL-STD-883, M 1010 Test cond: B (25 cycles)	in SMT.			
Parameter Drift Values (Initial)	As specified in the Detail Specification				
Power Burn-In / Baking ¹	MIL-STD-883, Test Method 1015 / 1033. maximum operating temperature/ 240h	Several non-applicable tests were removed, e.g			
Parameter Drift Values (Final)	As specified in the Detail Specification	High Temperature Bake, PIND and Seal tests which are only applicable to hermetic or cavity packages			
High and Low Temperatures Electrical Measurements	As specified in the Detail Specification				
Room Temperature Electrical Measurements	As specified in the Detail Specification				
Qualification					
Temperature Cycling (6 pieces)	MIL-STD-883, M 1010 Test cond: B (100 cycles)	Temperature Cycling and Life test were only perfomed as qualification tests to simplify the test			
Lifetest (5 pieces)	MIL-STD-202 Method 108 1000h	flow.			
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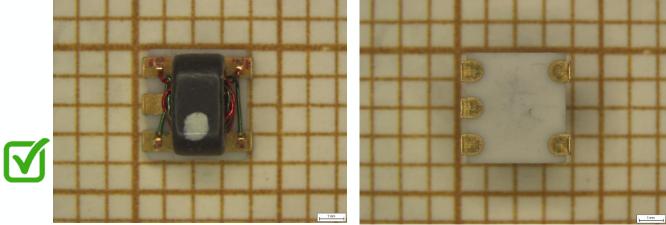
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Passive COTS: Transformer

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Part Type: Description:

Manufacturer: Pure Tin: TC1-1-13MG2+ RF Transformer, up to 3GHz MINI-CIRCUITS No



ESCC 3201 Test Flow	Method and Conditions	Screening an Qualification tests are based on			
Screening					
Thermal Shock	MIL-STD-202, M 107 Test cond: A-1 (25 cycles)	ESCC3201 Genric Specification for inductors and transformers.			
Room Temperature Electrical Measurements	As specified in the Detail Specification				
Burn-In	MIL-STD-202, Method 108 125°C / 168h	Temperature Cycling and Life test were only			
High and Low Temperature Electrical Measurements	As specified in the Detail Specification	perfomed as qualification tests to simplify the t			
Room Temperature Electrical Measurements	As specified in the Detail Specification	-flow.			
External Visual	ESCC Basic Specification No. 20500				
Qualification		Remaining tests (e.g. Mechanical) are covered by			
Thermal Shock (10 pieces)	MIL-STD-202, M 107 Test cond: A-3 (100 cycles)	Assembly Verifcation and/or QMs boards.			
Lifetest (15 pieces)	MIL-STD-202 Method 108 1000h				

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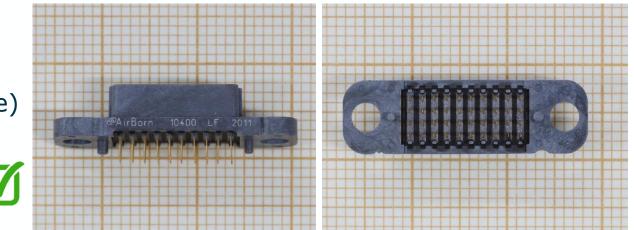
Passive COTS: Board to Board Connectors

Part Type:

Description:

Manufacturer: Pure Tin: VSF-04-10-50-02-G VSM-04-10-200-50-02 Board to Board Vertical Connectors (Male+ Female) AIRBORN No

Screening				
Visual		Perform workmanship inspection per Table 4A.		
Mechanical		Dimensions per detail specifications		
Insulation Resistance (Room Temperature)		MIL-STD-1344, Method 3003, mated and may be board mounted. Apply pin to pin and pin to hardware of plug. Measurement shall not be less than 5000 MΩ.		
Low Signal Level Contact Resistance		MIL-STD-1344, Method 3002 and Note 6. Resistance values shall comply with Note 6. Environmental conditioning is not required.		
Qualification				
Temperature Cycling (2 pieces)	MIL-STD-1344, Method 1003, Test Cond A (5 cycles).			
Resistance to Solder Heat and Solderability	PC Type Contacts - MIL-STD-202, Method 210, Test Cond C			
Low Signal Level Contact Resistance	MIL-STD-1344, Method 3002. Measured contact resistances shall be per MIL-DTL-55302, Table III, or as specified.			
Mating and Unmating Force	MIL-DTL-55302 para 4.5.4. Precondition with 3 mating cycles.			
Contact Retention (Push Test) (Crimp Remove Contacts Only)	MIL-STD-1344, Method 2007. Test 7 contacts min in each connector sample.			

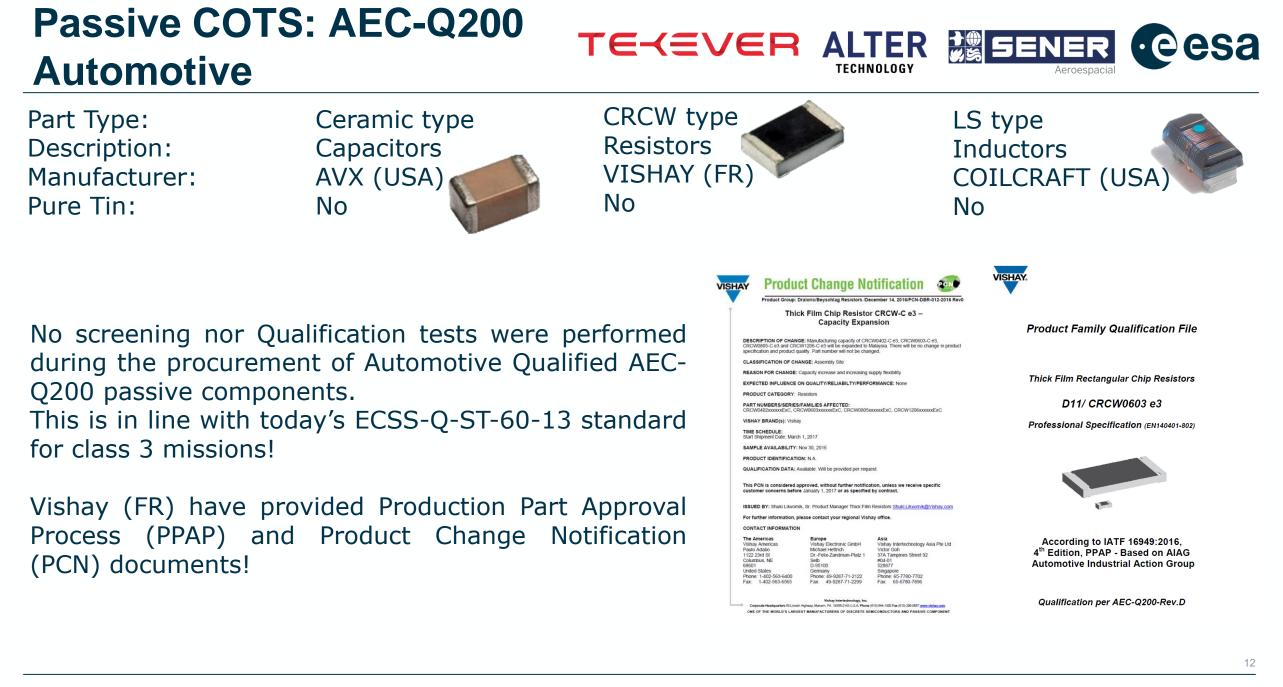


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Screening an Qualification tests are based on NASA EEE-INST-002 (Level 2 Commercial) for PCB Connectors (based on MIL-DTL-55302).

Temperature Cycling, amting forces and contact retention were only perfomed as qualification tests to simplify the test flow. Remaining tests (e.g. Mechanical) are covered by Assembly Verifcation and/or QMs boards.



Passive COTS: AEC-Q200 Automotive with Pure Tin



BNX Serie EMI Suppression filter MURATA (JP) Pure Tin

BLM Serie Ferrite Bead MURATA (JP) Pure Tin

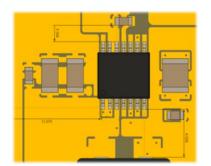
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NFM Serie Ceramic Capacitor MURATA (JP) Pure Tin



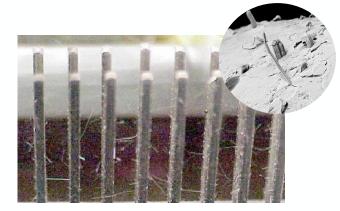
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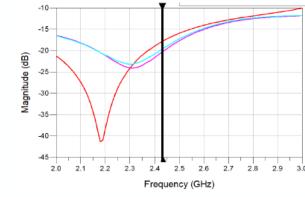




A Tin Whiskers Mitigation plan has been provided in order to have a complete analysis on this issue and define a way forward:

- Physical barriers and distance between components (as per EIA-STD-0005-2)
- Use of conformal coating
- Impact study of the coating on the RF performances





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COTS Passive Components TETER ALTER

Commercial Passive components procured according to ESCC/NASA standards (with reduced testing)

- ESCC 3502: BAW Filter, Coupler and Splitter / Combiner
- ESCC 3201: Transformers (Power and RF)
- NASA EEE-INST-002: PCB Board-to-Board Connectors

AEC-Q Automotive Qualified Passive components procured without screening or qualification (Class 3): Capacitors, Resistors, Inductors, Bandpass Filters, EMI Filters and Ferrite beads

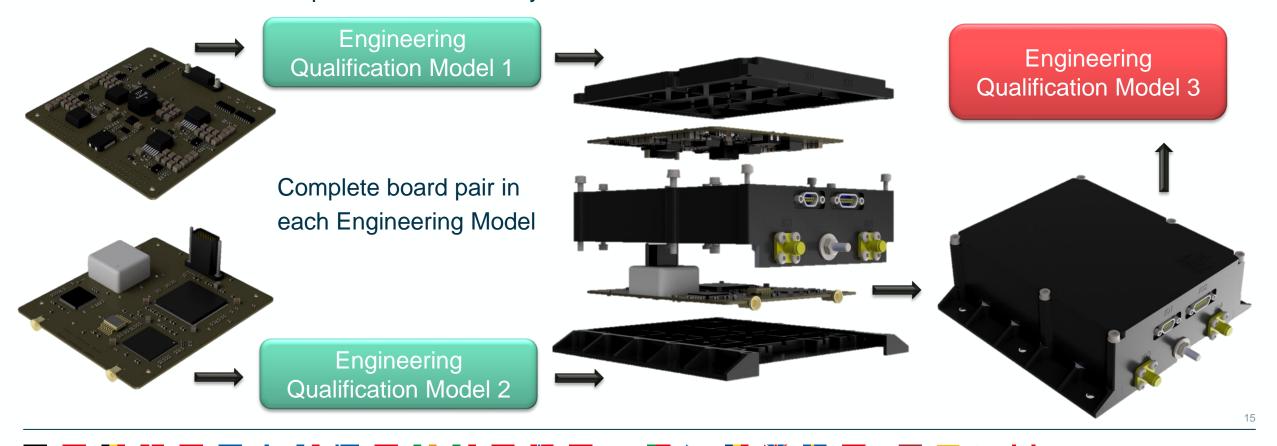
A Tin whisker mitigation plan was performed consisting mainly of conformal coating and impact study at unit level.

Component Description	Part Reference	Pure Tin (Y/N)	Automotive Grade (AEC-Q200)	Upscreening scope baseline
Bandpass Filter	885062-A	Ν	Y	None
Splitter/Combiner	BP2U+	N	-	RF Passives ESCC 3502
Transformer	TC1-1-13MG2+	Ν	-	Transformers ESCC 3201
EMI Filter	BNX026H01	N	Y	None
Transformer	750313443	N	-	Transformers ESCC 3201
EMI Filter	NFM21HC105R1C3	Y	Y	None
Ferrite Bead	BLM18KG221BH1D	Y	Y	None
Directional Coupler	DCW-22-332+	Y	-	RF Passives ESCC 3502
IPSU-Data Link Connector (IPSU)	VSF-04-10-50-02-G	N	-	Connectors EEE-INST-002
IPSU-Data Link Connector (DL)	VSM-04-10-200-50- 02	N	-	Connectors EEE-INST-002

Board Level

An approach employed by Proba-V was adapted for the ISL, where two upscreening (engineering) models were developed for board level testing, one used for HAST and one for Life tests.

A third board was developed to test the unit in the representative vibration, thermal and electrical environment. All of the tests were completed in their entirety and were successful.



Outcomes and lessons learned



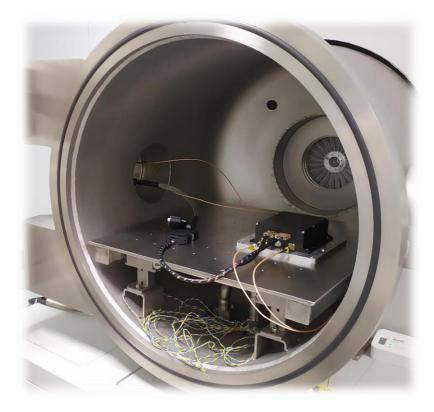
- The selection of the commercial parts was done according to existing reliability data.
- ECSS-Q-ST-60-13 at the time of ISL procurement did not include a procurement approach for passives.
- No screening was performed for AEC-Q automotive qualified passives, in line with the current requirements of ECSS-Q-ST-60-13.
- Screening and qualification tests and conditions were adjusted and tailored to the mission requirements.
- Several tests were not conducted at component level, since they were covered at board level. Throughout the screening and qualification no issues were observed in any of the Commercial passive components.
- In contrast, for some active parts, additional mitigation actions needed to be taken.

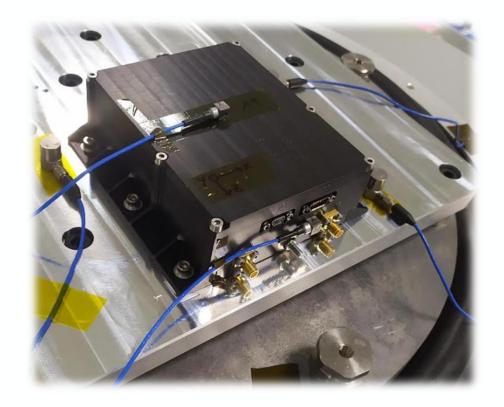
ISL Current Status

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• Currently the ISL is in its final stages of acceptance testing, ready for Spacecraft integration

Thank You for Your Time !





Any Questions?