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AxoMach & SpaceFibre
ESCC qualification

AxoMach and SpaceFibre Qualification Test Plan (according to HDR harnesses ESCC specification no.3409)

Axo.com BEH department

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AUTHOR's SUMMARY
This document describes the Qualification Test Plan to perform for AxoMach and SpaceFibre harnesses qualification according to the new set of ESCC specification for HDR cable assemblies no.3409.

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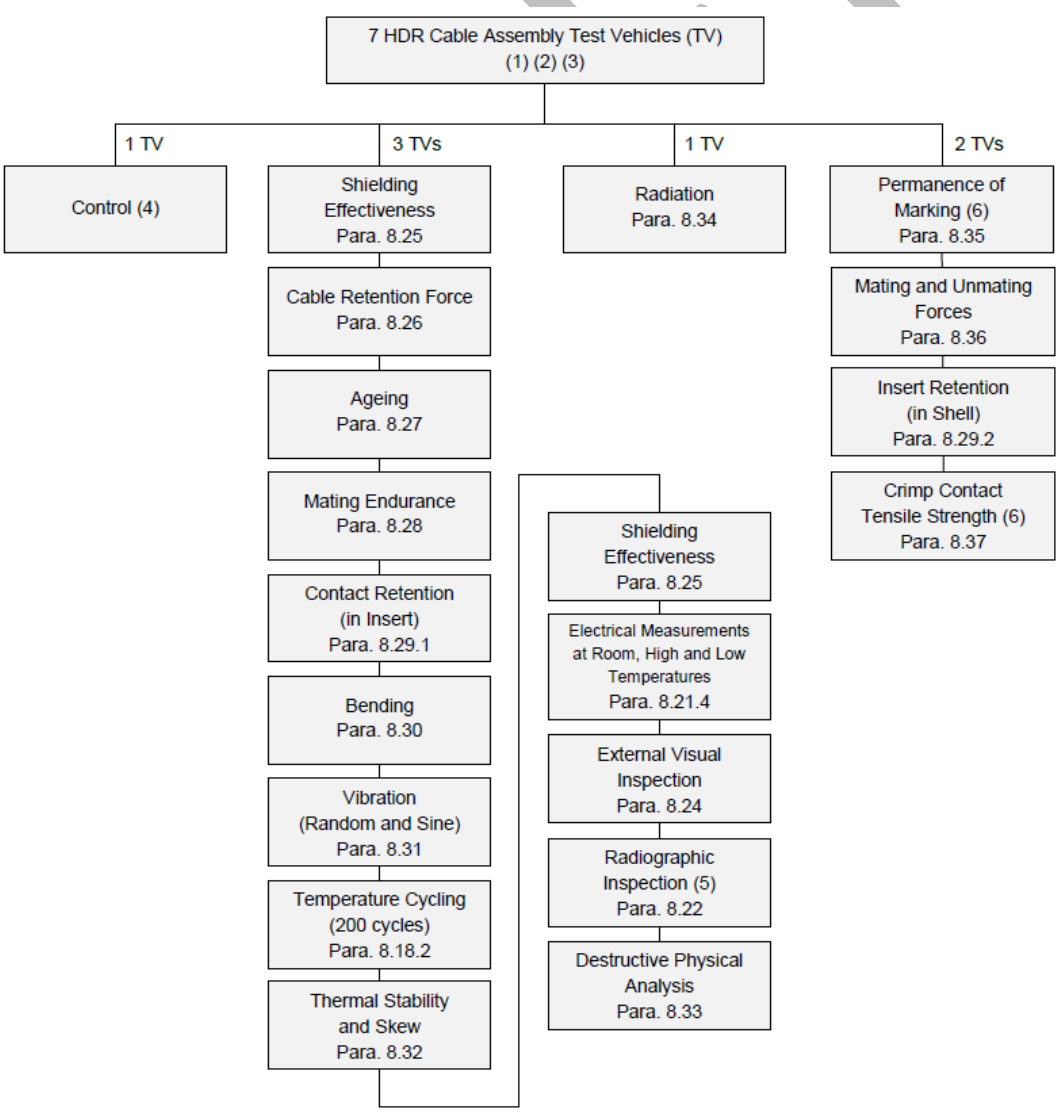
1 SCOPE

1.1 QUALIFICATION PHILOSOPHY

The qualification philosophy of High Data Rate cable assemblies is to qualify a complete High Data Rate solution from the equipment to the other, that is to say to qualify both the cable assembly and the two opposite equipment connectors.

High Data Rate cable assemblies (based on type AxoMach) are specified according to Generic Specification no. 3409 and Detail Specification no. 3409/001. High Data Rate equipment connectors (based on type AxoMach) are specified according to Generic Specification no. 3401 and Detail Specification no. 3401/089. To be consistent with the qualification philosophy, the test requirements applicable to Qualification Testing of equipment connectors were replaced by Qualification Testing in accordance with ESCC no. 3409 qualification requirements.

The qualification is based on the ESCC Generic Specification no. 3409 for High Data Rate Cable Assemblies, following chart F4A (refer to ESCC no. 3409 page 45 for notes) shown below. From the left to the right, test sequences are referenced as Group I, Group II, Group III and Group IV.



Based on the qualification philosophy and on the test sequences required by ESCC no. 3409, the test vehicles were designed to be representative of the use.

- Group I and Group II test sequences are applicable to the complete harness solution (cable assembly + two equipment connectors).
- Group III test sequence is applicable to the harness only, as in situ the PCB connectors are protected from the radiative exposure.
- Group IV test sequence is more focused on the interface and is applicable on the interface between a PCB connector and cable mount connector.

1.2 SCOPE

This document describes the Qualification Test Plan to perform in order to qualify AxoMach and AxoMach SpaceFibre high data rate harnesses and equipment connectors. The proposed test sequence is based on ESCC Generic specification no. 3409, and occasionally ESCC Generic specification no. 3401 as requested by the ESCC no. 3409.

2 APPLICABLE DOCUMENTS & ABBREVIATIONS

2.1 STANDARD DOCUMENTS

ESA Standard	Description
ECSS-Q-ST-70-08C	Manual soldering of high-reliability electrical connections
ECSS-Q-ST-70-26C	Crimping of high-reliability electrical connections
ESCC Generic Specification No. 3401	Connector, electrical, non-filtered circular and rectangular ESA/SCC generic specification N° 3401
ESCC Detail Specification No. 3401/089	Connectors, electrical, rectangular, microminiature, High Data Rate (Female coaxial contacts). Based on types AxoMach and SpaceFibre No. 3401/089
ESCC Detail Specification No. 3401/090	Connector savers and accessories, electrical, rectangular, microminiature, High Data Rate. Based on types AxoMach
ESCC Generic Specification No. 3409	High data rate cable assemblies ESCC generic specification N° 3409
ESCC Detail Specification No. 3409/001	High Data Rate cable assembly with microminiature, rectangular, coaxial connectors. Based on types AxoMach and SpaceFibre N° 3409/001
ESCC Basic Specification No. 2263408	Evaluation test programme for radio frequency, high data rate and high voltage cable assemblies

2.2 CUSTOMER APPLICABLE DOCUMENTS

Reference	Title	Issue
None		

2.3 AXON' APPLICABLE DOCUMENTS

Reference	Title	Issue
P567525	Axon' SMA connector	A^
P545457	AxoMach HDR inline male connector, 1 way	E^
P545460	AxoMach HDR inline male connector, 2 ways	E^
P545463	AxoMach HDR inline male connector, 4 ways	E^
P566418	AxoMach HDR inline panel mount female connector, 4 ways	B^
P555778	AxoMach SpaceFibre inline male connector	C^
P570719	AxoMach SpaceFibre inline panel mount female connector	A^
P545459	AxoMach HDR parallel gap female connector, 1 way	D^
P545462	AxoMach HDR parallel gap female connector, 2 ways	D^
P545465	AxoMach HDR parallel gap female connector, 4 ways	D^
P555780	AxoMach SpaceFibre HDR parallel gap female connector	C^
P552560	AxoMach SpaceFibre HDR QFX female connector	B^
P545801	AxoMach HDR QFX female connector, 2 ways	E^
P549310	AxoMach Saver, 4 way	C^
P566472	AxoMach Blanking Plate, 2 ways	B^
P571080	AxoMach SpaceFibre Saver	A^
P568742	AxoMach ESCC 3409 QTP - Test Vehicle no.1	A^
P568743	AxoMach ESCC 3409 QTP - Test Vehicle no.2	A^
P568744	AxoMach ESCC 3409 QTP - Test Vehicle no.3	A^
P568745	AxoMach ESCC 3409 QTP - Test Vehicle no.4	A^
P568746	AxoMach ESCC 3409 QTP - Test Vehicle no.5	A^
P568747	AxoMach ESCC 3409 QTP - Test Vehicle no.6	A^
P568748	AxoMach ESCC 3409 QTP - Test Vehicle no.7	A^

P568749	AxoMach ESCC 3409 QTP - Test Vehicle no.8	A^
P571583	AxoMach ESCC 3409 QTP - Harness TV1-1	A^
P571584	AxoMach ESCC 3409 QTP - Harness TV1-2	A^
P571585	AxoMach ESCC 3409 QTP - Harness TV2-1	A^
P571586	AxoMach ESCC 3409 QTP - Harness TV2-2	A^
P571587	AxoMach ESCC 3409 QTP - Pigtail 1 way for TV5	A^
P571588	AxoMach ESCC 3409 QTP - Pigtail 2 way for TV6	A^
P571589	AxoMach ESCC 3409 QTP - Pigtail 4 way for TV7	A^
P571590	AxoMach ESCC 3409 QTP - Pigtail SpaceFibre for TV8	A^
P840563	Cable S25SP	C^
P540264	Cable Coax QFX86 SPCW / SPC ESA	C^

2.4 DEFINITION OF TERMS AND ABBREVIATIONS

The terms and definitions of the ESCC generic specifications no. 3409 and no. 3401 and detail specifications no. 3409/001 and no. 3401/089 are applicable for this document.

The following abbreviations are used for this document:

HDR	High data rate
CA	Cable Assembly
NA	Not applicable
PCB	Printed Circuit Board
QTR	Qualification Test Report
QTP	Qualification Test Plan
TV	Test vehicle
Jumper/Extender harness	Harness with 1 plug and 1 plug or receptacle connector of the same number of ways
QFX	Quasiflex® (Hand-formable semi rigid substitute)
//gap	Parallel gap = Panel Mount Receptacle with Pin PCB Terminations

3 QUALIFICATION SAMPLES

3.1 SAMPLE DEFINITION RATIONALE

The purpose of this Qualification Test Plan is to validate the technologies (e.g. matching between wires and contacts, crimping, soldering, withstanding of the potting materials etc) and also the components used for HDR harnesses and equipment connectors manufacturing, regarding the requirements of the HDR cable assemblies ESCC specification no. 3409 and the requirements of the associated ESCC Detail Specifications.

3.2 SAMPLE DEFINITION

As samples are EEE parts, their part number and designation fully define them. The following table gives the family, the Axon' part number and a brief description of the components and their compatible cable used to manufacture HDR harnesses.

Item type	Axon' Part Number	Sample description	ESCC designation (or connector code)	Compatible cable and part number
SMA connectors	P567525	Axon' SMA connector	Con. Code 17	Ax2.4S : P840563
Inline connectors	P545457	AxoMach HDR inline male connector, 1 way	Con. Code 01	Ax2.4S : P840563
	P545460	AxoMach HDR inline male connector, 2 ways	Con. Code 02	
	P545463	AxoMach HDR inline male connector, 4 ways	Con. Code 03	
	P566418	AxoMach HDR inline panel mount female connector, 4 ways	Con. Code 09	
	P555778	AxoMach SpaceFibre inline male connector	Con. Code 10	
	P570719	AxoMach SpaceFibre inline panel mount female connector	Con. Code 18*	
PCB connectors	P545459	AxoMach HDR parallel gap female connector, 1 way	340108901B	None
	P545462	AxoMach HDR parallel gap female connector, 2 ways	340108902B	
	P545465	AxoMach HDR parallel gap female connector, 4 ways	340108903B	
	P555780	AxoMach SpaceFibre HDR parallel gap female connector	340108904B	
	P552560	AxoMach SpaceFibre HDR QFX female connector	340108908B	QFX086S : P540264
	P545801	AxoMach HDR QFX female connector, 2 ways	340108906B	
Accessories	P549310	AxoMach Saver, 4 way	340109003B	N.A.
	P566472	AxoMach Blanking Plate, 2 ways	340109005B	
	P571080	AxoMach SpaceFibre Saver	340109007B*	

Table 1: Components designation

* These connectors are not yet listed in the ESCC Detail Specifications.

3.3 TEST ACCESSORIES & SAMPLES INTERCONNECTION

Samples were designed by pair in order to avoid the use of test accessories, especially to conduct electrical measurements:

- Pigtail connectors will be directly connected onto test means
- PCB connectors will be soldered onto interface test boards able to be connected onto electrical measurement devices

For the specific case of shielding effectiveness measurement, test jigs and samples interconnection are detailed in paragraph 4.4.4.

4 QUALIFICATION TEST PLAN

4.1 TEST PROGRAM RATIONALE

The purpose of this test plan is to ensure that the qualification test sequence performed on AxoMach and SpaceFibre harnesses and PCB connectors will be in compliance with the requirements of ESCC Generic Specification No. 3409, chart F4A.

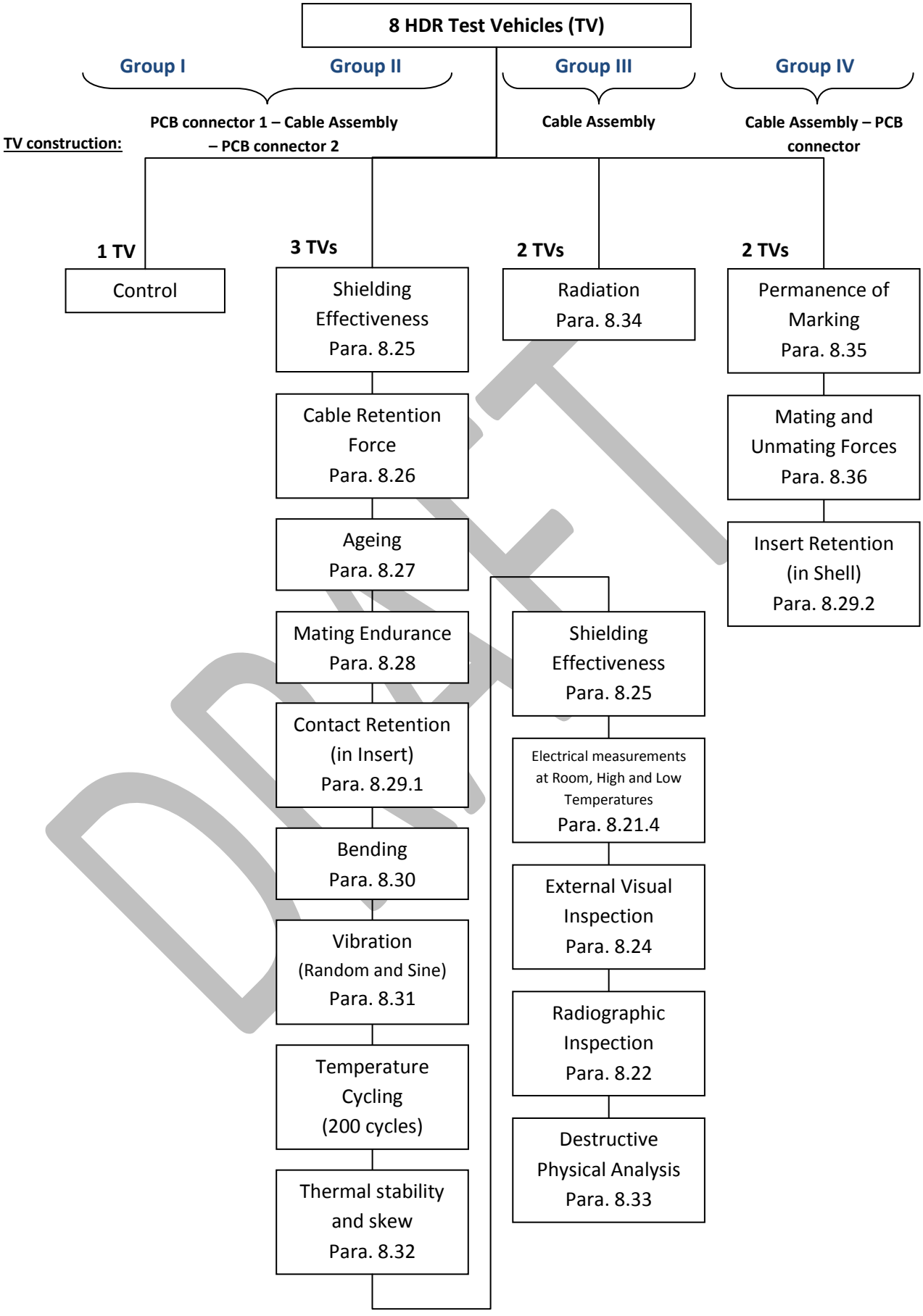
4.2 TEST SEQUENCE

The diagram below gives the test sequence that will be followed up to qualify AxoMach and SpaceFibre harnesses and PCB connectors. This test sequence is compliant with ESCC Generic Specification No. 3409, chart F4A.

Some adjustments are noticeable:

- Chart F4A / Crimp contact tensile strength: this test is done during the manufacturing process and is not part of this qualification test sequence (refer to ESCC No. 3409/001, Appendix A, Agreed Deviations for Axon Cable)
- Chart F4A / Group III: radiation tests will be performed on 2 TVs (instead of 1)

Referenced paragraphs are related to ESCC No. 3409.

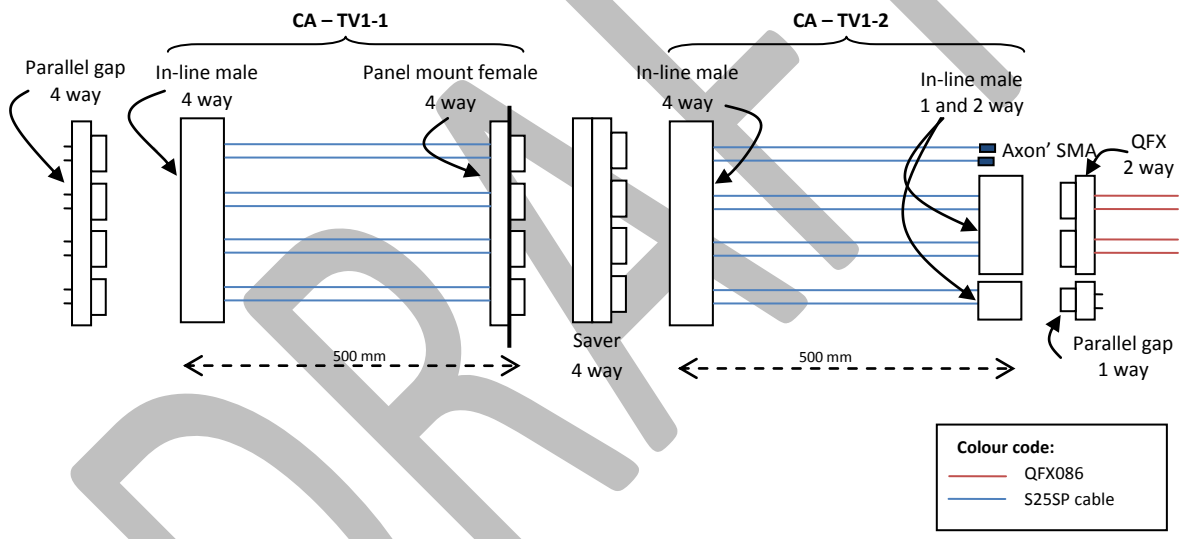


4.3 DEFINITION OF TEST VEHICLES

4.3.1 TEST VEHICLE NO. 1 (AXOMACH)

Designation	TV No. 1
Construction	PCB connector 1 – Cable Assembly – PCB connector 2
Associated Test Sequence	Group I (control sample) and Group II

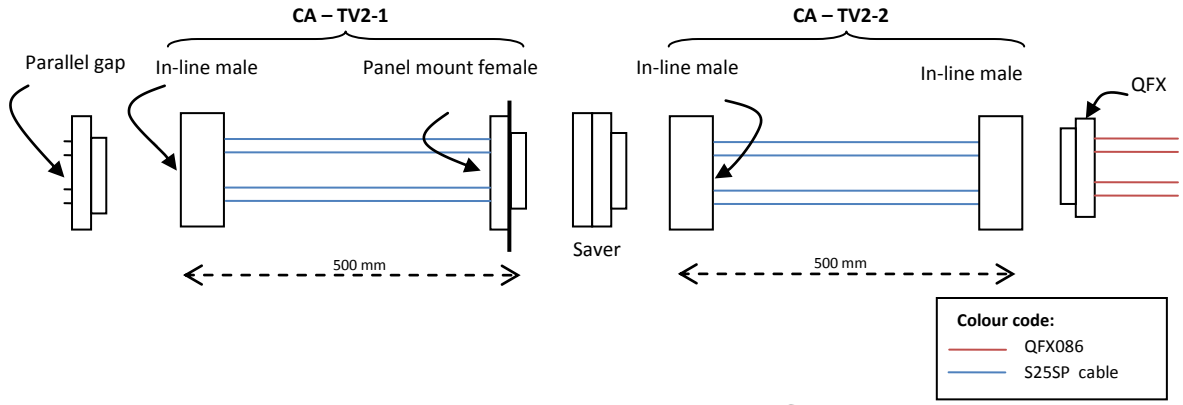
Test vehicle no. 1 is composed of AxoMach PCB connectors (parallel gap and QFX types) and two cable assemblies. The first cable assembly (ref. as TV1-1) is composed of one in-line male connector (4 way) to one in-line panel mount female connector (4 way). The second cable assembly (ref. as TV1-2) is composed of one in-line male connector to two SMA connectors and two in-line male connectors (2 way and 1 way). Depending on the test performed, an AxoMach 4 way saver can be inserted between the two cable assemblies. For all tests except shielding effectiveness test, the AxoMach PCB connectors are soldered on PCB (PCB is built with matched impedance lines terminated to SMA PCB connectors).



4.3.2 TEST VEHICLE NO. 2 (SPACEFIBRE)

Designation	TV No. 2
Construction	PCB connector 1 – Cable Assembly – PCB connector 2
Associated Test Sequence	Group I (control sample) and Group II

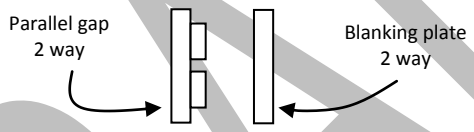
Test vehicle no. 2 is composed of SpaceFibre PCB connectors (parallel gap and QFX types) and two cable assemblies. The first cable assembly (ref. as TV2-1) is composed of one in-line male connector to one in-line panel mount female connector. The second cable assembly (ref. as TV2-2) is a jumper with in-line male connectors. Depending on the test performed, a SpaceFibre saver can be inserted between the two cable assemblies. For all tests except shielding effectiveness test, the SpaceFibre PCB connectors are soldered on PCB.



4.3.3 TEST VEHICLE NO. 3 (AXOMACH BLANKING PLATE)

Designation	TV No. 3
Construction	PCB connector – Blanking plate
Associated Test Sequence	Group II

A test vehicle composed of a parallel gap connector and a plug (2 way) is used to quality plugs in mechanical and thermal environments.



4.3.4 TEST VEHICLE NO. 4

Designation	TV No. 4
Construction	Cable assembly
Associated Test Sequence	Group III

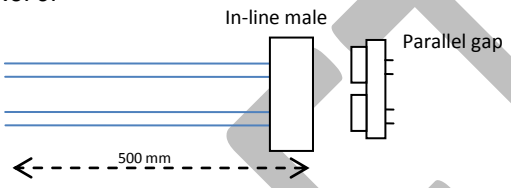
Test vehicle No. 4 is a pair of harnesses with SMA connectors.

4.3.5 TEST VEHICLES NO. 5, 6, 7 (AXOMACH) AND 8 (SPACEFIBRE)

Designation	TV No. 5 (AxoMach 1 way) TV No. 6 (AxoMach 2 way) TV No. 7 (AxoMach 4 way) TV No.8 (SpaceFibre)
Construction	Cable assembly (pigtail) – PCB connector
Associated Test Sequence	Group IV

To test the interface between cable mount connector and PCB connectors (Group IV test sequence), test vehicles composed of a pigtail with an in-line male connector connected to a parallel gap connector are used (all versions are tested: AxoMach 1, 2 and 4 way and SpaceFibre).

Example of TV No. 6:



4.3.6 SAVERS

For qualification purposes, savers are occasionally used on TV no. 1 (AxoMach saver 4 way) and 2 (SpaceFibre saver). For Group I, electrical measurements are performed on TV no. 1 and 2 with and without saver.

The use of saver during the test plan is detailed in the paragraph 4.5.

4.3.7 NUMBER OF TVS

The table below summarizes the number of test vehicles necessary for the completion of the qualification test sequence:

TV N°	Axon Part Number (Top level)	Group I	Group II	Group III	Group IV	Total
1	P568742A	1	3	0	0	4
2	P568743A	1	3	0	0	4
3	P568744A	0	3	0	0	3
4	TBD	0	0	24 (TBC)	0	24 (TBC)
5	P568746A	0	0	0	2	2
6	P568747A	0	0	0	2	2
7	P568748A	0	0	0	2	2
8	P568749A	0	0	0	2	2
					Total	**21**

Table 2: Number of test vehicles

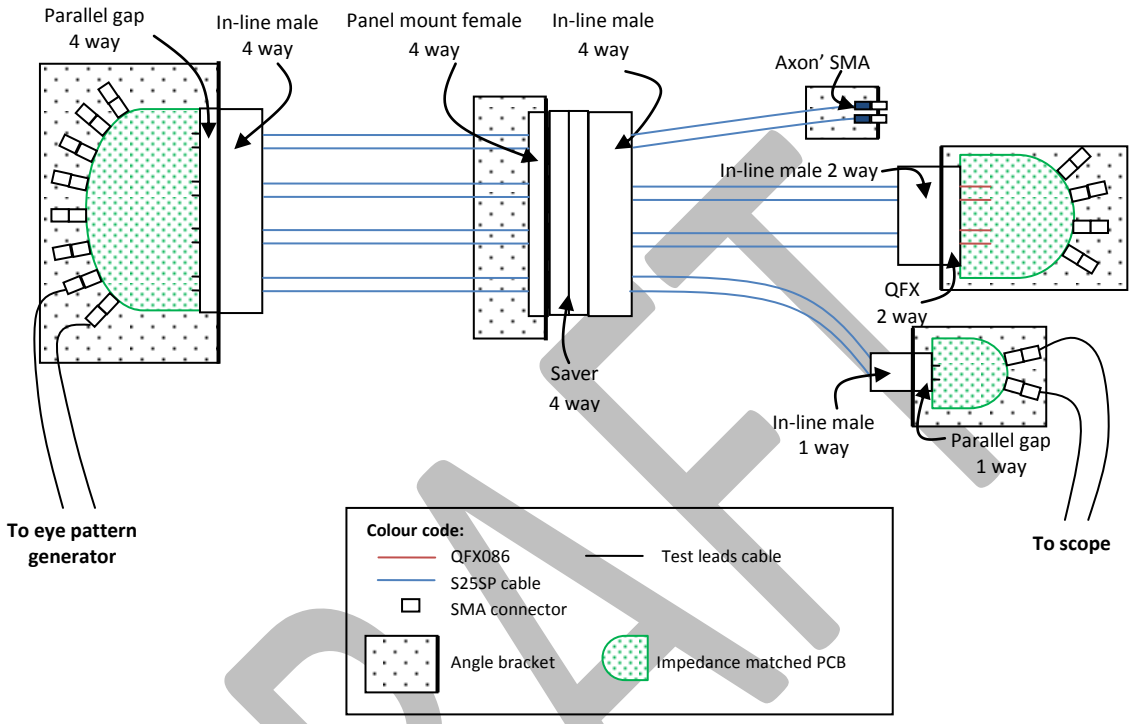
4.4 TEST JIGS AND CONFIGURATION

Precautions shall be taken while handling PCB test jigs during measurements.

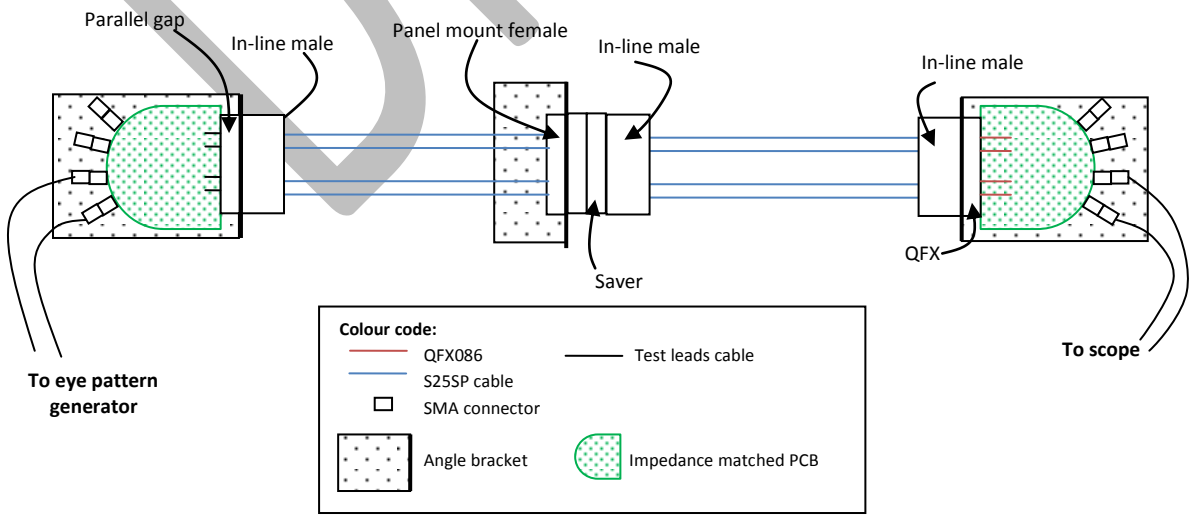
4.4.1 CONFIGURATION FOR ELECTRICAL MEASUREMENT

All lines are tested one after the other.

Configuration for TV no. 1 (AxoMach)



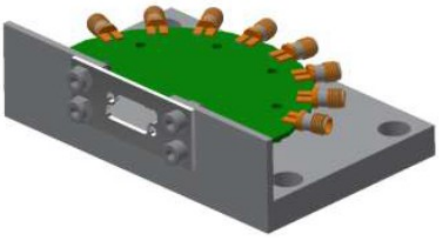
Configuration for TV no. 2 (SpaceFibre)



4.4.2 CONFIGURATION FOR VIBRATION TEST

Vibration tests are performed on test vehicles No. 1, 2 and 3.

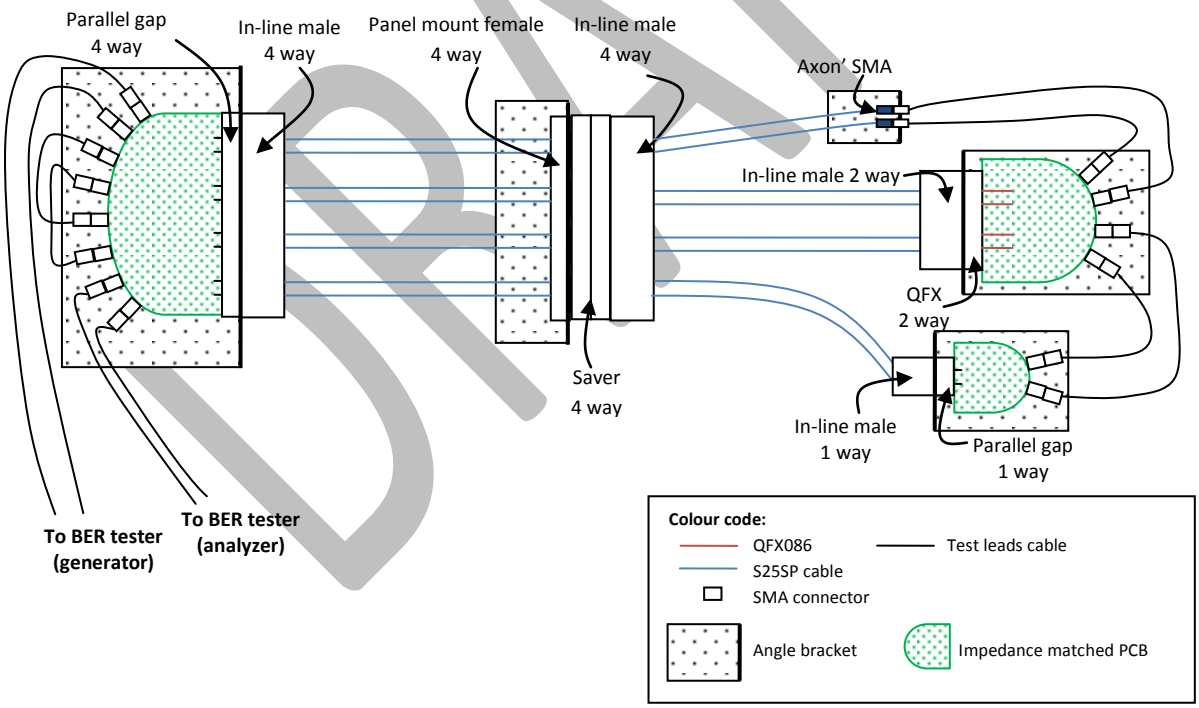
For test vehicles no. 1 and 2, the equipment connectors are connected to impedance matched PCB. Impedance matched PCB are ended with SMA connectors. The assembly (equipment connectors and impedance matched PCB) is fixed on a support (aluminum angle bracket). For TV no. 1 the SMA connectors are mated to opposite SMA connectors, fixed on an angle bracket.



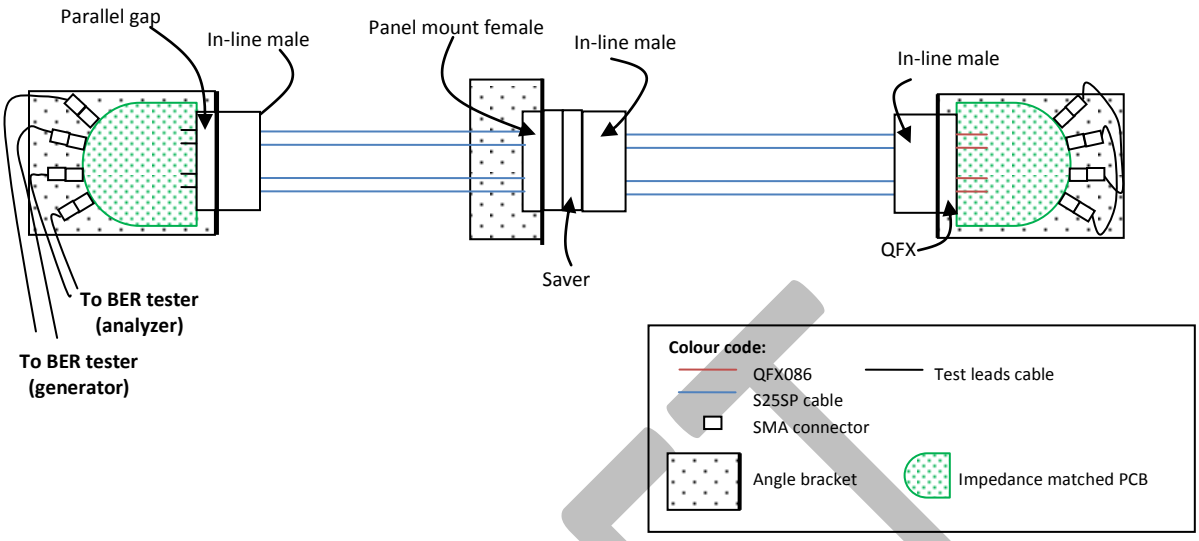
For TV no. 3 (parallel gap connector mated with blanking plate), the 3 samples are tested during the same vibration run. The 3 samples are fixed on the same angle bracket, positioned on the vibration plate during a vibration run of a TV no.1 sample.

The same aluminum vibration plate is used for all the test vehicles.

Configuration for TV no. 1 (AxoMach)



Configuration for TV no. 2 (SpaceFibre)



Below is shown the 3D model for the positioning of test vehicles no. 1 and 3 on the vibration plate.

Test jig with coaxial cable and SMA connectors are used during vibration tests: 6 SMA-SMA extensions and 4 extensions towards measuring tools.

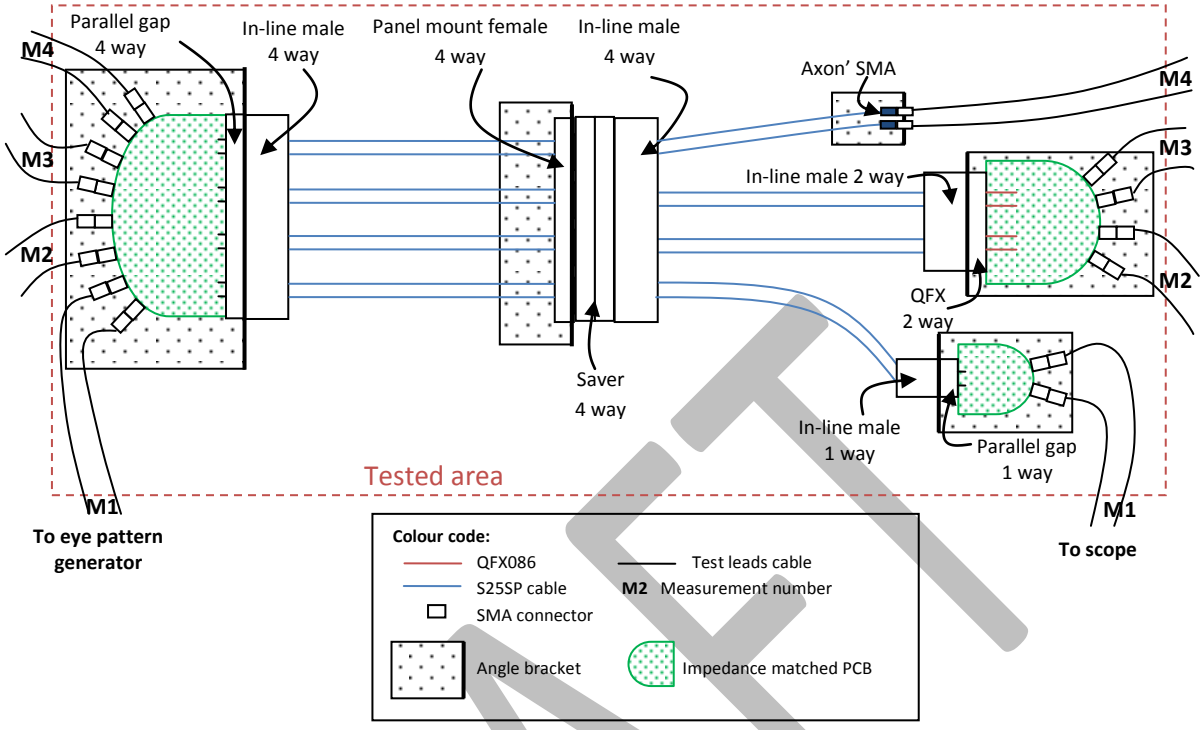
Test leads number	Cable	Length (m)	Connector	Quantity
TJ1 to TJ4	TBD	Long	TBD	4
TJ5 to TJ6	TBD	short	TBD	2
TJ7 to TJ8	TBD	Long	To measurement tool	4

4.4.3 CONFIGURATION FOR THERMAL TEST

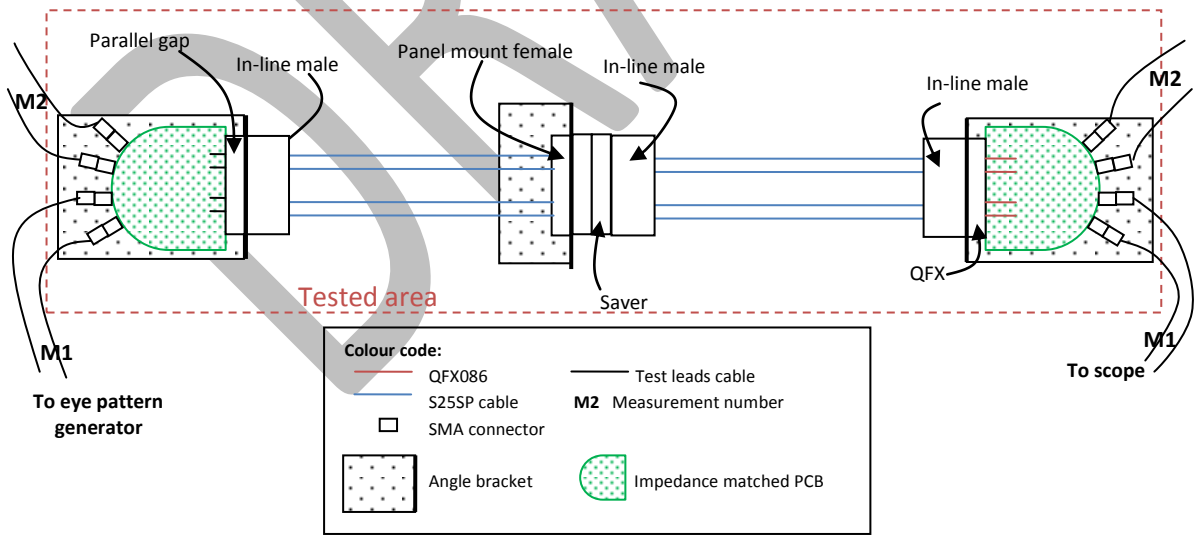
Thermal tests are performed on test vehicles No. 1, 2 and 3.

All the lines are tested one after the other, so 4 measurements are performed on TV no.1 and 2 measurements are performed on TV no. 2. 16 test leads towards measuring tools are used during thermal tests. See the picture below which illustrates the configuration during thermal test.

Configuration for TV no. 1 (AxoMach)



Configuration for TV no. 2 (SpaceFibre)



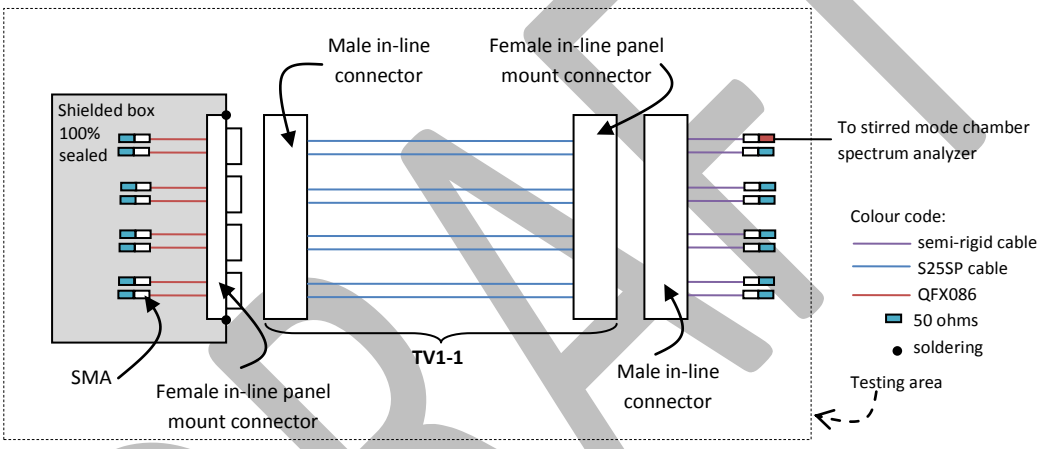
Test jig number	Cable	Length (m)	Connector	Quantity
TJ9 to TJ25	TBD	Long	To measurement tool	16

4.4.4 CONFIGURATION FOR SHIELDING EFFECTIVENESS TEST

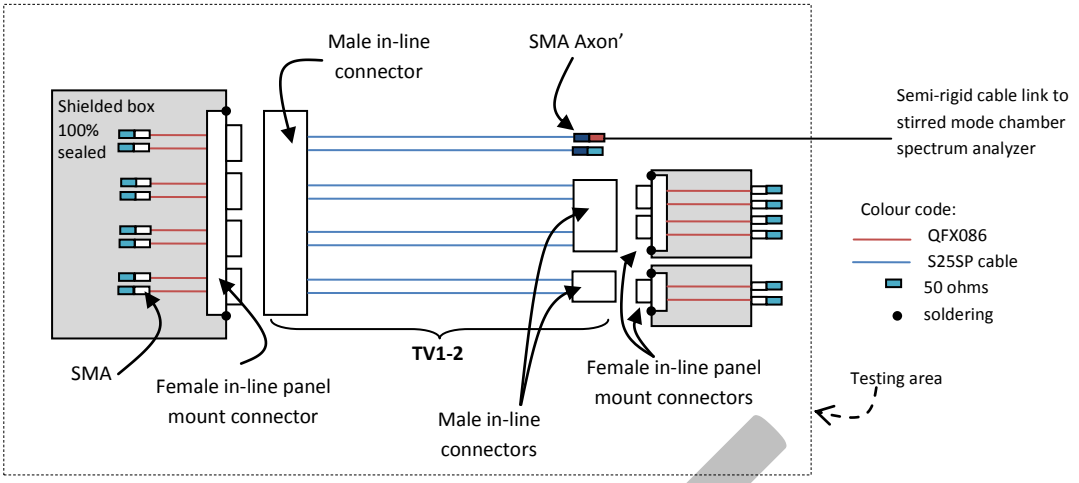
Configuration for TV no. 1 (AxoMach)

The shielding effectiveness test is performed on the two separated cable assemblies TV1-1 and TV1-2 (refer to §4.3.1).

- For CA TV1-1, the male in-line connector is mated to a female in-line panel mount connector soldered on a shielded box (100% shielded). Inside the shielded box, all SMA are connected to 50 ohms loads. On the other side of the CA TV1-1, the female in-line panel mount connector is mated to a special test jig composed of a male in-line connector with SMA connectors. Semi-rigid cables are used on this test jig to prevent CEM leakage. At the end of this test jig, one line is connected to the stirred mode chamber spectrum analyzer, whereas all the other lines are connected to 50 ohms loads. The connection to the analyzer is successively moved on each line, so as to perform a total of 8 measurements (1 measurement per line).

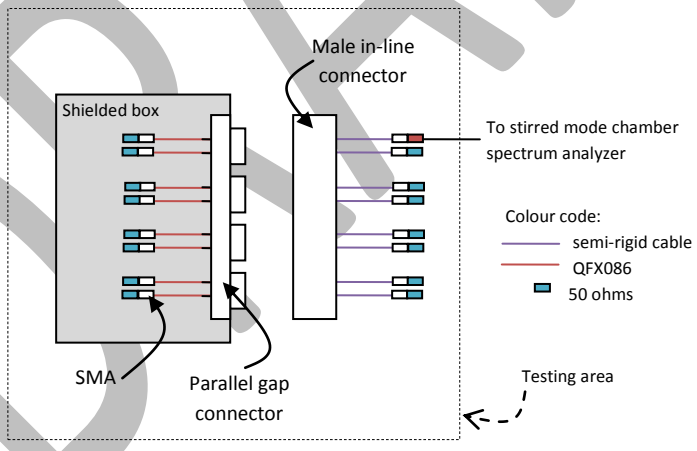


- For CA TV1-2, all male in-line connectors are mated to female in-line panel mount connectors soldered on a shielded box (100% shielded). For the 4 way shielded box, all lines are terminated with SMA connected to 50 ohms loads inside the box. For the 2 way and 1 way shielded box, all lines are terminated with SMA outside the box. The connection to the analyzer is successively moved on each line, so as to perform a total of 8 measurements (2 measurements for the 2 SMA lines, 4 measurements for the lines connected to the male in-line 2 way, 2 measurements for the lines connected to the male in-line 1 way).



The shielding effectiveness test is not applicable to the QFX connector.

The shielding effectiveness test is performed on the parallel gap connector separately from the cables assemblies' tests. It is only performed on the 4 way connector which is the worst case between 4 way, 2 way and 1 way parallel connectors. The parallel gap connector is fixed on a shielded box (no soldering, to characterize the performance of the seal). The pin terminations are soldered to QFX cable, ended with SMA connectors connected to 50 ohms loads. Outside the shielded box, the parallel gap connector is mated to the special test jig as described for TV1-1. A total of 8 measurements is performed (1 measurement per line).

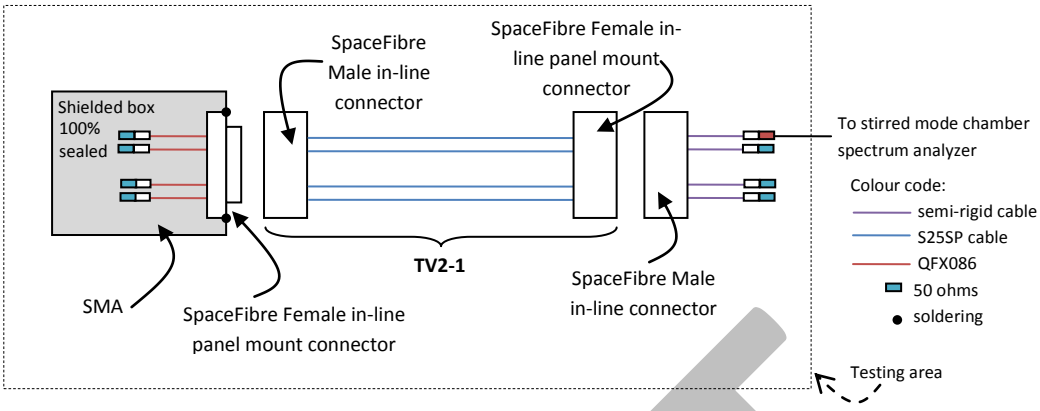


Configuration for TV no. 2 (SpaceFibre)

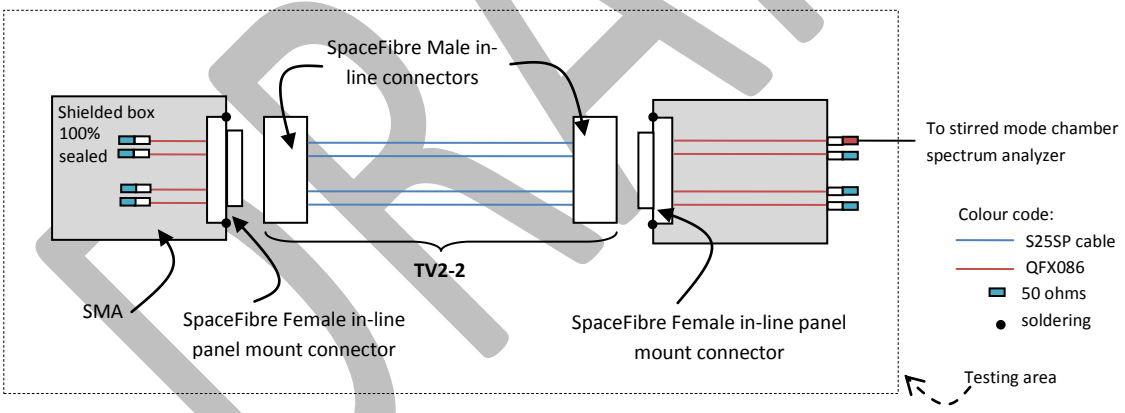
The shielding effectiveness test is performed on the two separated cable assemblies TV2-1 and TV2-2 (refer to §4.3.2).

- For CA TV2-1, the SpaceFibre male in-line connector is mated to a SpaceFibre female in-line panel mount connector soldered on a shielded box (100% shielded). Inside the shielded box, all SMA are connected to 50 ohms loads. On the other side of the CA TV2-1, the SpaceFibre female in-line panel mount connector is mated to a special test jig composed of a SpaceFibre male in-line connector and SMA connectors (same construction as described for TV no. 1).

The connection to the stirred mode chamber spectrum analyzer is successively moved on each line, so as to perform a total of 4 measurements (1 measurement per line).

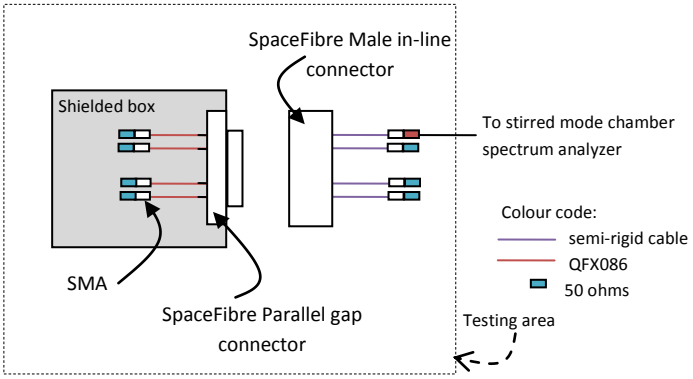


- For CA TV2-2, the two SpaceFibre male in-line connectors are mated to two SpaceFibre female in-line panel mount connectors soldered on a shielded box (100% shielded). On one side, the SMA connectors are connected to 50 ohms loads inside the shilded box. On the other side, the SMA connectors are outside the box; one line is connected to the analyzer whereas the other lines are connected to 50 ohms loads. The connection to the stirred mode chamber spectrum analyzer is successively moved on each line, so as to perform a total of 4 measurements.



The shielding effectiveness test is not applicable to the SpaceFibre QFX connector.

The shielding effectiveness test is performed on the SpaceFibre parallel gap connector separately from the cables assemblies' tests. The parallel gap connector is fixed on a shielded box (no brazing). The pin terminations are soldered to QFX cable, ended with SMA connectors connected to 50 ohms loads. Outside the shielded box, the parallel gap connector is mated to the special test jig as described for TV2-1. A total of 4 measurements is performed (1 measurement per line).



With this configuration for EMC tests, all harnesses' configurations are tested.

CA Type	Tested TV	Harness configuration
AxoMach CA	TV1-1	In-line male connector – in-line female connector
	TV1-2	In-line male connector – SMA connectors
		Jumper in-line male connectors
SpaceFibre CA	TV2-1	In-line male connector – in-line female connector
	TV2-2	Jumper in-line male connectors

4.4.5 CONFIGURATION FOR RADIATION TEST

For initial and final electrical measurements, test vehicles will be directly connected to measuring tools. No specific test leads are required.

4.5 APPLICABILITY MATRIX FOR GROUP II (TV NO. 1, 2 AND 3)

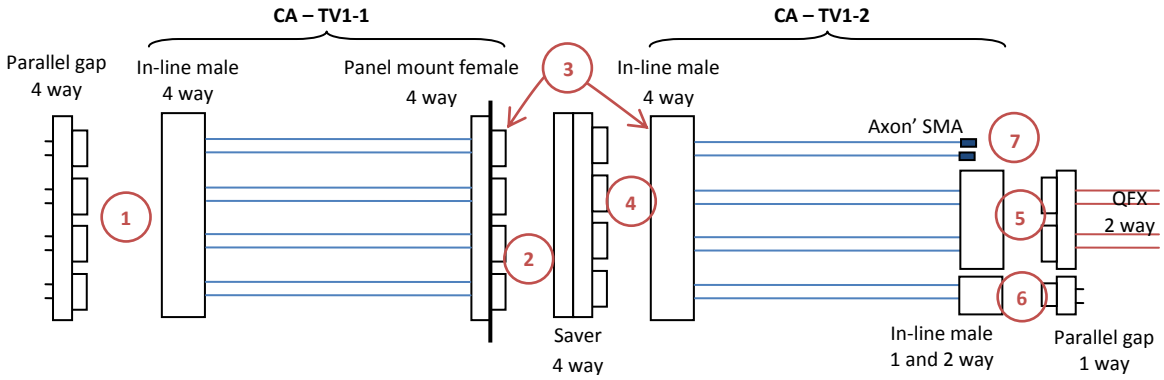
The matrix below detailed applicability and test vehicle configurations (during test and for initial and final measurements or inspections) for each test of Group II. This concerns TV no. 1, 2 and 3.

This matrix shall be read in conjunction with the test plan for group II detailed in paragraph 4.6.3.

4.5.1 TEST VEHICLE NO. 1 (AXOMACH)

TV no. 1 is composed of:

- 2 subharnesses : TV1-1 and TV1-2
- 7 mating interfaces numbered on the diagram below (note: interface no. 7 is the interface between the Axon' SMA connector and an opposite SMA connector).



Group II Test Plan	Configuration during test	Specific Initial / Final measurements or inspections
Shielding effectiveness	See conf. §4.4.4	
Cable retention force	Test performed separately on TV1-1 and TV1-2. **TV1-1**: Fixed side: Panel mount 4 way; Axial force applied on: In-line 4 way **TV1-2**: Fixed side: In-line 4 way; Axial force applied on: SMA / In-line 2 way / In-line 1 way	▪ Interface dimension check on each subharnesses' connectors ▪ Electrical measurements are performed on the complete TV1 with and without saver
Ageing	The complete TV1 is placed in the oven (including the PCB on which the PCB connectors are soldered). The saver is added on 1 of the 3 TV1 samples.	▪ The mating and unmating forces are measured for each interface.
Mating endurance	Test performed on each interface.	▪ The mating and unmating forces are measured for each interface. ▪ Electrical measurements are performed on the complete TV1, on each line, with and without saver.
Contact retention (in insert)	Test performed on female connectors only (parallel gap, QFX, in-line panel mount, SMA, saver female side).	

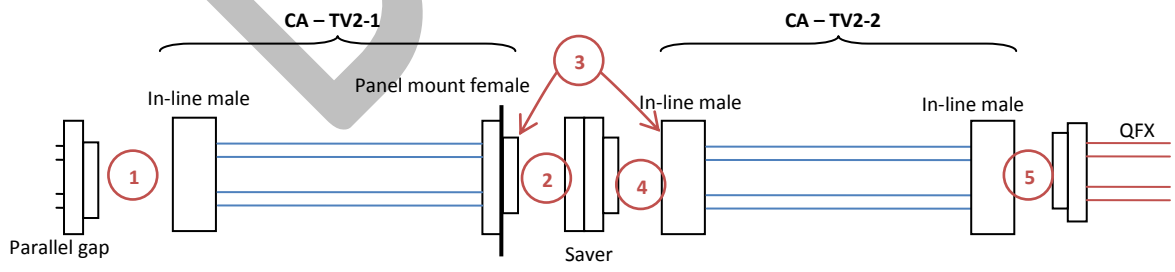
Bending	Test performed separately on TV1-1 and TV1-2.	▪ Electrical measurements are performed on the complete TV1. ▪ Shielding effectiveness test is performed on the 2 subharnesses (see conf. §4.4.4)
Vibration	See conf. §4.4.2. The saver is added on 1 of the 3 TV1 samples.	
Temperature cycling	The complete TV1 is placed in the oven (including the PCB on which the PCB connectors are soldered).	-
Thermal stability and skew	See conf. §4.4.3. The electrical measurements are performed on each line.	
Shielding effectiveness	See conf. §4.4.4	
Electrical measurements Ambient/Low/High	See conf. §4.4.3. The electrical measurements are performed on each line.	
External visual inspection	On the complete TV1	
Radiographic inspection	Inspection of mated interfaces 1, 3, 5, 6 and 7.	
DPA	TBD	

Table 3: Group II configuration and test applicable to TV no.1

4.5.2 TEST VEHICLE NO. 2 (SPACEFIBRE)

TV no. 2 is composed of:

- 2 subharnesses : TV2-1 and TV2-2
- 5 mating interfaces numbered on the diagram below.



<table>
<tr><th>Group II Test Plan</th><th>Configuration during test</th><th>Specific Initial / Final measurements or inspections</th></tr>
<tr><td>Shielding effectiveness</td><td colspan="2">See conf. §4.4.4</td></tr>
<tr><td>Cable retention force</td><td>Test performed separately on TV1-1 and TV1-2.
<table><tr><th></th><th>Fixed side</th><th>Axial force applied on</th></tr><tr><td>TV2-1</td><td>Panel mount</td><td>In-line</td></tr><tr><td>TV2-2</td><td>In-line 1</td><td>In-line 2</td></tr></table></td><td>▪ Interface dimension check on each subharnesses' connectors
▪ Electrical measurements are performed on the complete TV2 with and without saver</td></tr>
<tr><td>Ageing</td><td>The complete TV2 is placed in the oven (including the PCB on which the PCB connectors are soldered).
The saver is added on 1 of the 3 TV2 samples.</td><td>▪ The mating and unmating forces are measured for each interface.</td></tr>
<tr><td>Mating endurance</td><td>Test performed on each interface.</td><td>▪ The mating and unmating forces are measured for each interface.
▪ Electrical measurements are performed on the complete TV2, on each line, with and without saver.</td></tr>
<tr><td>Contact retention (in insert)</td><td colspan="2">Test performed on female connectors only (parallel gap, QFX, in-line panel mount, saver female side).</td></tr>
<tr><td>Bending</td><td>Test performed separately on TV2-1 and TV2-2.</td><td>▪ Electrical measurements are performed on the complete TV2.
▪ Shielding effectiveness test is performed on the 2 subharnesses (see conf. §4.4.4)</td></tr>
<tr><td>Vibration</td><td colspan="2">See conf. §4.4.2.
The saver is added on 1 of the 3 TV2 samples.</td></tr>
</table>

Temperature cycling	The complete TV2 is placed in the oven (including the PCB on which the PCB connectors are soldered).	-
Thermal stability and skew	See conf. §4.4.3. The electrical measurements are performed on each line.	
Shielding effectiveness	See conf. §4.4.4	
Electrical measurements Ambient/Low/High	See conf. §4.4.3. The electrical measurements are performed on each line.	
External visual inspection	On the complete TV2	
Radiographic inspection	Inspection of mated interfaces 1, 3 and 5.	
DPA	TBD	

Table 4: Group II configuration and test applicable to TV no.2

4.5.3 TEST VEHICLE NO. 3 (BLANKING PLATE)

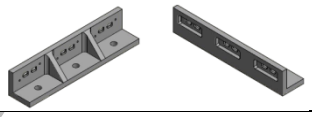
Group II Test Plan	Configuration during test	Specific Initial / Final measurements or inspections
Shielding effectiveness	NA	
Cable retention force	NA	
Ageing	-	▪ Electrical measurements: NA ▪ Mating and unmating forces: NA
Mating endurance	NA	
Contact retention (in insert)	NA	
Bending	NA	
Vibration	The 3 samples are tested on the same support during the same vibration run. 	▪ Mated shell conductivity measurement before and after test ▪ Visual inspection after test
Temperature cycling	NA	
Thermal stability and skew	NA	
Shielding effectiveness	NA	
Electrical measurements Ambient/Low/High	NA	
External visual inspection	NA (already performed after vibration)	
Radiographic inspection	NA	
DPA	TBD	

Table 5: Group II configuration and test applicable to TV no.3

4.6 TEST PLAN

All the tests to be performed are detailed below with the applicable test procedure. Criteria, details and / or comments were added when necessary. For electrical tests (wiring and HDR control), procedure, test conditions and criteria are detailed in the following table:

4.6.1 ROOM TEMPERATURE ELECTRICAL MEASUREMENTS

Characteristics		ESCC no.3409	Test method and conditions	Symbol	Limits (ESCC no.3409/001)		Units	Notes
					Min	Max		
Wiring	Dielectric Withstanding Voltage / Voltage proof leakage current	§8.21.1.1 MIL-STD-202, Test Method 301	▪ Relative humidity ≤50% ▪ Test voltage of 600Vrms applied for 1minute ▪ No evidence of flashover or breakdown	I_{VPL}	-	2	mA	
	Insulation resistance	§8.21.1.2 MIL-STD-202, Test Method 302	▪ Test voltage of 500Vdc ▪ Points of measurement between the connector centre contact(s) and the body of the TV ▪ Measurement shall be read after 1 minute of voltage application	R_I	5	-	GΩ	
	Conductor resistance	§8.21.1.3	▪ 4 wires method ▪ On the cable assembly pin to pin, and shell to shell for the outer shield ▪ At room temperature I_{test} = 1A	R_C	-	110	mΩ/m	
	Shield resistance			R_S	-	45 per cable	mΩ/m	HDR 1 way assembly: 22.5 mΩ/m HDR 2 way assembly: 11.3 mΩ/m HDR 4 way assembly: 5.6 mΩ/m
	Mated shell conductivity	§8.21.1.4	▪ Test current of 1±0.1A (DC or AC rms) at a maximum voltage of 1.5V (DC or AC rms)	R_M	-	5	mΩ	

HDR control	Uniformity of characteristic impedance	§8.21.1.5	▪ Pulse rise time ≤ 50ps	Z_C	90	110	Ω	
	Intra-pair Skew	§8.21.1.6	▪ PRBS-7 pattern with 1 V_{pp} differential amplitude	SK_1	-	20	ps	For cable assembly that either has one HDR connector and two or more SMA connectors, has all SMA connectors or is a pigtail: $SK_1 \leq 10ps$
	Inter-pair Skew			SK_2	-	20	ps	For cable assembly that either has one HDR connector and two or more SMA connectors, has all SMA connectors or is a pigtail: $SK_2 \leq 10ps$
	Mask test	§8.21.1.7		MT	See Eye-Pattern requirement of ECSS-E-ST-50-11			Only applicable on SpaceFibre cable assembly
	Jitter pp		▪ PRBS-7 pattern with 1 V_{pp} differential amplitude	Jpp	-	20	ps	
	Jitter rms			Jrms	-	5	ps	
	Near-end Crosstalk	§8.21.1.8		N_{ext}	- -	-45 -35	dB dB	f≤10GHz f≤5GHz
	Far-end Crosstalk			F_{ext}	- -	-45 -35	dB dB	f≤10GHz f≤5GHz
	Insertion loss	§8.21.1.9	▪ Frequency (F) up to 10 GHz	IL_{CA}	Formula to apply: $IL_{assembly}$ (dB) = $IL_{ca} * L + IL_{co}$ IL_{ca} : insertion loss of the cable (in dB/m) L : length of the cable assembly (m) IL_{co} : insertion loss		dB	For cable Ax2.4S: $IL_{ca} = 0.63\sqrt{F} + 0.017F$ For connectors: ▪ AxoMach : $IL_{co} = 0.2F$ ▪ SMA connectors : $IL_{co} = 0.03\sqrt{F}$

					of the connector (dB)		

Table 6: Procedure & criteria for room temperature electrical measurements

4.6.2 TEST PLAN - GROUP I

GROUP I					
Test no.	Test designation	Test procedure ESCC no.3409 section	Detailed procedure and test conditions	Initial/Final measurement and criteria	Comments
G1-1	Control	§8.21.2	Refer to Table 6		

Table 7: Test plan for Group I

4.6.3 TEST PLAN – GROUP II

GROUP II					
Test no.	Test designation	Test procedure ESCC no.3409 section	Detailed procedure and test conditions	Initial/Final measurement and criteria	Comments
G2-1	Shielding effectiveness (SE)	§8.25 IEC Publication no. 61726	Max. frequency range of the reverberant chamber not less than 10GHz 100 measurements points/decade	SE ≤ -60dB	SE (dB) = (Pi/Pt) (dB) – Xc (dB), where Pi and Pt are respectively the incident power from the generator and the transmitted power to the TV, Xc is the cage loss.
G2-2	Cable retention force	§8.26	Sample preparation: ▪ Samples are held vertically and fixed such that the forces and torques to be applied will not cause it to move ▪ Their cables are kept as unbent and untwisted as possible	Initial: ▪ **Interface dimension check** (ESCC no. 20500). Criteria: refer to ESCC 3409/001, §1.6.2 Final:	

<table>
<tr>
<td></td>
<td></td>
<td></td>
<td>Procedure:
▪ The connector at one end of the tested sample is held while an axial force is applied to the connector at the other end along the cable axis
▪ The force is gradually increased up to the cable retention force : 25N
▪ The cable retention force is applied for 2 minutes</td>
<td>▪ Visual examination (ESCC no. 20500).
Criteria: no evidence of damage or loosening of parts
▪ Interface dimension check (ESCC no. 20500).
Criteria: refer to ESCC 3409/001, §1.6.2
▪ Wiring : refer to Table 6</td>
<td></td>
</tr>
<tr>
<td>G2-3</td>
<td>Ageing</td>
<td>§8.27
MIL-STD-202, Test method 108 (non-operating)</td>
<td>@ +125°C for 240h</td>
<td>Final:

At ambient temperature and after a minimum recovery period of 2 hours

▪ Visual examination (ESCC no. 20500).
Criteria: no evidence of damage or loosening of parts
▪ Wiring : refer to Table 6
▪ Mating & unmating forces (ESCC 3409, §8.19.2)

<table><tr><th>Shell size</th><th>Mating force (N) max</th><th>Unmating force (N) max - min</th></tr><tr><td>1 way</td><td>5.6</td><td>5.6-0.4</td></tr><tr><td>2 ways</td><td>11.2</td><td>11.2-0.8</td></tr><tr><td>4 ways</td><td>22.4</td><td>22.4-1.6</td></tr></table>
▪ HDR control: refer to Table 6</td>
<td></td>
</tr>
<tr>
<td>G2-4</td>
<td>Mating endurance</td>
<td>§8.28</td>
<td>▪ Procedure: ESCC Generic No.3401, Para 9.18
▪ 500 cycles (1 cycle is defined as one</td>
<td>Final:
▪ Visual examination (ESCC no. 20500).</td>
<td></td>
</tr>
</table>

<table>
<tr>
<td></td>
<td></td>
<td></td>
<td>mating and one unmating)
▪ Mating/unmating speed: 5 mm / second maximum
▪ Cycling rate: ≤ 8 cycles / minute maximum</td>
<td>Criteria: no evidence of damage or loosening of parts

After a recovery period of 2 hours minimum

▪ Mating & unmating forces (ESCC 3409, §8.19.2)
<table><tr><th>Shell size</th><th>Mating force (N) max</th><th>Unmating force (N) max - min</th></tr><tr><td>1 way</td><td>5.6</td><td>5.6-0.4</td></tr><tr><td>2 ways</td><td>11.2</td><td>11.2-0.8</td></tr><tr><td>4 ways</td><td>22.4</td><td>22.4-1.6</td></tr></table>▪ Wiring : refer to Table 6
▪ HDR control: refer to Table 6</td>
<td></td>
</tr>
<tr>
<td>G2-5</td>
<td>Contact retention (in Insert)</td>
<td>§8.29.1

ESCC no. 3401, §9.17</td>
<td><u>Sample preparation</u>
▪ Connector rear accessories, if applicable, are removed.

<u>Procedure</u>
▪ The force shall be applied to the engagement end of the contact either directly or by using an appropriate adaptor at a rate not exceeding 5N per second until 14.8N is reached
▪ The force shall be maintained for a minimum period of 5 seconds</td>
<td><u>After the force has been removed:</u>
The axial displacement of the contact shall be measured and not exceed 0.3mm.</td>
<td>For female connectors only</td>
</tr>
<tr>
<td>G2-6</td>
<td>Bending</td>
<td>§8.30</td>
<td>▪ The centre section of the cable of the TV shall be wrapped entirely around a mandrel having a diameter equal to the</td>
<td><u>Final:</u>
▪ Visual examination (ESCC no. 20500). Criteria: no cracks, flaws or other</td>
<td></td>
</tr>
</table>

<table>
<tr>
<td></td>
<td></td>
<td></td>
<td>minimum bending radius. First wrap shall be against the natural flow of the cable. Then second wrap shall be done according to the natural flow. Then wrapping shall be done alternatively to a total of 2 times in each direction.
▪ Minimum bending radius: 25 mm</td>
<td>damage in the cable jacket material
▪ Wiring : refer to Table 6
▪ HDR control (<u>except</u> crosstalk): refer to Table 6
▪ Shielding effectiveness : refer to G2-1</td>
<td></td>
</tr>
<tr>
<td>G2-7</td>
<td>Vibration (Random and Sine)</td>
<td>§8.31

<u>RANDOM</u>
MIL-STD-202, Test Method 214

<u>SINE</u>
MIL-STD-202, Test Method 204</td>
<td>Each complete TV including both connector sets shall be mounted on the vibration generator either directly or by means of a fixture. The outer connector of each connector set shall be mounted rigidly on the vibration generator or fixture, as applicable.

The cable of each test vehicle shall be secured to the vibration-plate using 2.5±0.5mm wide cable-ties looped through aluminium tie-down posts starting 200 (+25 -0)mm from the reference place or centreline of the mated connector sets and every 200mm minimum thereafter. Appropriate protective padding shall be placed between the cable jacket and tie down plates to prevent damage to the cable.

<u>RANDOM</u>

▪ Random Vibration Test Curve:
<table>
<tr><th colspan="2">Envelope: Grms = 38.5</th></tr>
<tr><td>20 to 60 Hz</td><td>+6dB/Octave</td></tr>
<tr><td>60 to 400 Hz</td><td>2g²/Hz</td></tr>
<tr><td>400 to 800 Hz</td><td>-6dB/Octave</td></tr>
<tr><td>800 to 1000 Hz</td><td>0.5g²/Hz</td></tr>
</table>
</td>
<td><u>Final:</u>
▪ Visual examination (ESCC no. 20500). Criteria: no evidence of damage or loosening of parts
▪ Wiring: refer to Table 6</td>
<td></td>
</tr>
</table>

			<table><tr><td>1000 to 2000 Hz</td><td>-6dB/Octave</td></tr></table> ▪ Duration: 180s in each of the 3 mutually perpendicular axes ▪ Electrical continuity shall be monitored continuously during the test. No discontinuities > 1µs are allowed. **SINE** ▪ Sweep frequency: 5-100-5 Hz, with a slope rate of 2 Octaves/min max. ▪ Total number of cycles: 9 (3 times in each of the 3 mutually perpendicular axes) ▪ Vibration amplitude: ▪ 5Hz to 26Hz: 11mm (peak) ▪ 26Hz to 100Hz: 30g		
G2-8	Temperature cycling (200 cycles)	§8.18.2	▪ 200 cycles with 15 minutes minimum at each extreme storage temperature : -55°C, +125°C ▪ Temperature transfer slope ≤ 10°C/minute	Final: At ambient temperature and after a minimum recovery period of 2 hours ▪ **Visual examination** (ESCC no. 20500). Criteria: no evidence of damage or loosening of parts ▪ **Wiring:** refer to Table 6 ▪ **HDR control**: refer to Table 6	
G2-9	Thermal stability and skew	§8.32	▪ Temperature steps: -55°C, -5°C, 0°C, +5°C, +10°C, +15°C, +20°C, +25°C, +125°C ▪ Temperature transfer slope ≤ 10°C/minute ▪ Operating data rate: 10Gb/s	During testing: ▪ **Intra-pair skew and inter-pair skew**: 125% of the limits specified in Table 6	

			▪ Data points: skew shall be measured after 15 minutes stabilization at each temperature step		
G2-10	Shielding effectiveness	§8.25 IEC Publication no. 61726	Max. frequency range of the reverberant chamber not less than 10GHz 100 measurements points/decade	SE ≤ -60dB	SE (dB) = (Pi/Pt) (dB) – Xc (dB), where Pi and Pt are respectively the incident power from the generator and the transmitted power to the TV, Xc is the cage loss.
G2-11	Electrical measurement at room, high and low temperature	§8.21.4	@ Tamb = 22±3°C	▪ **Dielectric withstanding voltage / Voltage proof leakage current:** refer to Table 6 ▪ **Mask test:** refer to Table 6 ▪ **Jitter pp and rms:** refer to Table 6 ▪ **Insertion Loss:** refer to Table 6	
			@ T = +125°C (+0 -5°C)	▪ **Dielectric withstanding voltage / Voltage proof leakage current:** refer to Table 6 ▪ **Mask test:** refer to Table 6 ▪ **Jitter pp and rms:** 133% of the limit specified in Table 6 ▪ **Insertion Loss:** the limit shall be calculated using the formula: IL(at T) = 1.2 x IL(at 22°C) x (1+(T-22)x0.002)	
			@ T = -55°C (+5-0°C)	▪ **Dielectric withstanding voltage / Voltage proof leakage current:** refer to Table 6 ▪ **Mask test:** refer to Table 6 ▪ **Jitter pp and rms:** refer to Table 6 ▪ **Insertion Loss:** the limit shall be calculated using the formula:	

				IL(at T) = 1.2 x IL(at 22°C) x (1+(T-22)x0.002)	
G2-12	External visual inspection	§8.24 ESCC no. 20500	With magnification power x10	No evidence of damage or loosening of parts	
G2-13	Radiographic inspection	§8.22 ESCC no. 20900		Refer to §8.22 of ESCC no.3409	
G2-14	Destructive physical analysis	§8.33 ESCC no. 21001	On both the connectors and the cable of the assembly		

Table 8: Test plan for Group II

4.6.4 TEST PLAN – GROUP III

GROUP III					
Test no.	Test designation	Test procedure ESCC no.3409 section	Detailed procedure and test conditions	Initial/Final measurement and criteria	Comments
G3-1	Radiation	§8.34	▪ Mounting: ▪ Test set-up atmosphere shall exclude oxygen (i.e. tested under continuous Nitrogen flow or in vacuum) ▪ Test set-up shall be implemented so that the test vehicle temperature during testing is limited to ≤+40°C ▪ Ambient test temperature during irradiation T_{amb} = +20 ±10°C ▪ Radiation source: electron or gamma ▪ Radiation dosage: 30 MRad ▪ Frequency domain: up to 10GHz ▪ Dose rate: ≤ 45MRAD/hour	Initial and Final: ▪ **Visual examination** (ESCC no. 20500). Criteria: no evidence of damage or loosening of parts ▪ **Wiring:** refer to Table 6 ▪ Voltage proof leakage current ▪ Insulation resistance ▪ **HDR control**: refer to Table 6 ▪ Uniformity of characteristic impedance ▪ Insertion loss ▪ Skew ▪ Jitter	

Table 9: Test plan for Group III

4.6.5 TEST PLAN – GROUP IV

<table>
<tr><th colspan="6">GROUP IV</th></tr>
<tr><th>Test no.</th><th>Test designation</th><th>Test procedure
ESCC no.3409 section</th><th>Detailed procedure and test conditions</th><th>Initial/Final measurement and criteria</th><th>Comments</th></tr>
<tr><td>G4-1</td><td>Permanence of marking</td><td>§8.35

ESCC No. 24800</td><td></td><td>▪ Markings shall remain legible
▪ No discoloration, damage deterioration of the material or finishes</td><td></td></tr>
<tr><td>G4-2</td><td>Mating and unmating forces</td><td>§8.36</td><td><u>Sample preparation</u>
▪ Attachment systems are removed

<u>Procedure</u>
▪ Samples under test are mated and unmated 4 times with force applied gradually and distributed equally about the connector.
▪ Mating and unmating forces are measured on the first and the last cycles.</td><td><table><tr><th>Shell size</th><th>Mating force (N) max</th><th>Unmating force (N) max - min</th></tr><tr><td>1 way</td><td>5.6</td><td>5.6-0.4</td></tr><tr><td>2 ways</td><td>11.2</td><td>11.2-0.8</td></tr><tr><td>4 ways</td><td>22.4</td><td>22.4-1.6</td></tr></table></td><td>Both connectors in each HDR cable assembly are tested. In the event of any failure, a 100% test shall be performed.</td></tr>
</table>

G4-3	Insert retention	§8.29.2 ESCC no. 3401, §9.23	<u>Sample preparation</u> ▪ Connector rear accessories, if applicable, are removed. ▪ The portion of the load-applying device that touches the surface of the insert may be shaped to clear the contacts if installed, and any raised areas on the inserts (bosses, barriers or identifiers). <u>Procedure</u> ▪ Inserts are submitted to axial loads in directions tending to push them out of the shell. Half of the devices shall be subjected to load applied from the front and half to load applied from the rear. ▪ The load is applied and increased gradually at an approximate rate of 0.7kg/cm² per second, until the maximum load (**4N**) is reached. ▪ The maximum load is maintained for 5 seconds	The connector inserts shall not be dislodged from their normal position within their shells.	Not applicable on SMA connectors. Insert with or without contacts are tested.

Table 10: Test plan for Group IV

5 TEST LOCATION AND EQUIPMENT

When Axon' has the facilities available to carry out the tests specified in the QTP, these will be performed in Axon' premises. In all other cases, the tests will be carried out by specialized and independent laboratories. The following table summarizes the test location as a function of the equipments available in Axon' premises at the time of writing.

Test	Testing site
Visual examination Conductor and shield resistance Measurement of insulation resistance Voltage proof test Mated shell conductivity Measurement of characteristic impedance Skew Eye pattern and jitter Insertion loss EMC High temperature measurement Ageing Temperature cycling Endurance Insert retention Mating & unmating forces Cable retention force Bending Radiographic inspection Permanence of marking	AXON'
Vibration Radiation	Depending on subcontractors contracts

The testing equipment list will be specified in the QTR.

Appendices

Appendix 1 - OVERVIEW – CROSS TABLE TEST PLAN

		Aspect & dimensions			Electrical testing										Mechanical testing	
ESCC no. 3409 section		Visual examination	Dimension check	Radiographic inspection	Voltage proof leakage current	Insulation resistance	Conductor & shield resistance	Mated shell conductivity	Uniformity of Zc	Skew	Mask test & jitter	Crosstalk	Insertion loss	Shielding effectiveness	Mating & unmating forces
§8.21.2	G1-1 Control				x	x	x	x	x	x	x	x	x		
§8.25	G2-1 Shielding effectiveness													x	
§8.26	G2-2 Cable retention force	x	x		x	x	x	x							
§8.27	G2-3 Ageing	x			x	x	x	x	x	x	x	x	x		x
§8.28	G2-4 Mating endurance	x			x	x	x	x	x	x	x	x	x		x
§8.29.1	G2-5 Contact retention	x	x												
§8.30	G2-5 Bending	x			x	x	x	x	x	x	x		x	x	
§8.31	G2-6 Vibration	x			x	x	x	x							
§8.18.2	G2-7 Temperature cycling (200 cycles)	x			x	x	x	x	x	x	x	x	x		
§8.32	G2-8 Thermal stability and skew									x					
§8.25	G2-9 Shielding effectiveness													x	
§8.21.4	G2-10 Electrical meas. At room, high and low temp.				x	x	x			x	x		x		
§8.24	G2-11 External Visual Inspection	x													
§8.22	G-12 Radiographic inspection			x											
§8.38	G2-13 Destructive physical analysis														
§8.34	G3-1 Radiation	x			x	x			x				x		
§8.35	G4-1 Permanence of marking	x													
§8.36	G4-2 Mating and unmating forces														x
§8.29.2	G4-3 Insert retention	x													