Sentinel-1 SES;
RF Harness Requirements Specification

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Astrium Limited 2007

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1. INTRODUCTION

1.1 Scope

The harness subsystem comprises all cable harness necessary to connect the SAR Electronics Subsystem equipments together. It has to perform its function throughout all mission phases in the presence of all environments encountered.

The document in hand comprises the contractually relevant requirements and constraints for the S-1 SES Harness. This includes:
- The performance, design and interface requirements of subject hardware
- The testing and verification requirements
- The content and delivery dates of deliverable hardware and documentation
- The integration of the hardware

The harness supplier is required to (on a 3-D, 1:1 scale, jig of the SES panel and SES equipments) design and manufacturer the SES harness and its layout on the panel.

This requirements specification contains the key requirements for the RF harness. Where reference to an applicable document is made, those requirements contained within the document are also applicable to the harness supplier (those assigned with #DPH).

1.2 Background

The harness subsystem specified by this document shall operate on the Sentinel-1 spacecraft, which will become part of the Global Monitoring for Environmental Security (GMES) satellite system.

The overall aim of the GMES initiative is to support Europe’s goals regarding sustainable development and global governance by providing timely and quality data, information and knowledge. Access to information has strategic value in the development of Nations and regions and will contribute to Europe’s ability to fulfil its role as a world player.

Specifically, the all-weather imaging capability of the C-Band SAR instrument carried by Sentinel-1 should provide measurement data at high and medium resolutions for land, coastal zones and ice observations in cloudy regions and during night, coupled with radar interferometry capability for detection of small (millimetre or sub-millimetre level) ground movements, with the appropriate frequencies and operating modes required to support the GMES services. This is needed in support of disaster management, urban management and security, humanitarian aid and conflict crisis management, coastal zone pollution monitoring and ice surveillance.
### 2. DOCUMENTS, ACRONYMS AND DEFINITIONS

#### 2.1 Normative Reference Documents

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<td>S1-IF-ASU-PL-0001</td>
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#### 2.2 Informative Reference Documents

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#### 2.3 Applicable Standards

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<td>ECSS-Q-70-08A</td>
<td></td>
<td>Manual soldering of high-reliability electrical connections</td>
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<td>SD14</td>
<td>ECSS-Q-70-26A</td>
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<td>Crimping of high-reliability electrical connections</td>
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</tbody>
</table>
2.4 Acronyms, Definitions and Abbreviations

For Acronyms see the Sentinel-1 acronym list <IRD01>.

2.5 Definitions

2.5.1 Redundancy

Single Redundancy: Single redundancy consists of only A redundancy units, i.e. ICE-A, TGU, Tx MDFE and Rx MDFE.

Full Redundancy: Full redundancy consists of all SES units as required for the flight configuration i.e. ICE-A, ICE-B, TGU, Tx MDFE and Rx MDFE.

2.5.2 Requirements

Requirements within this document are shown in an italic font. Each requirements is preceded by a summary line that contains the following fields, delimited by "/".

Doors Requirement Number> STRUC-xyz. This is a unique number, assigned consecutively

Created From> Shows parent requirement

Verification Method> T = Test, A = Analysis, I = Inspection, R = Review of Design

Information within this document is shown in normal font

Requirement Text - If tables are considered as part of requirement they are referenced clearly in the text and inserted after and separated from the requirement table and are managed as free text attached to the identifier requirement.

Upper Links - The trace to the upper level requirements shall be managed with the following format:

AAA-NNNN where AAA is a label associated to the upper document and NNNN the requirement identifier of this upper level.

Or CREATED key word if the requirement has no link with upper level

All document elements, which are not presented in the format explained above are not requirements and will not be verified or tracked.

For example:-

**STRUC-48/CREATED/A,R**

*The platform mechanical design shall be carried out with the general rules specified in <NRD01>.*
3. SUMMARY DESCRIPTION (FOR INFORMATION ONLY)

3.1 System Context

The harness is an element of the SAR Electronics Subsystem (SES) of the SAR Instrument onboard the Sentinel-1 satellite.

The SES is shown in context in Figure 3-1. The SAR Instrument is split into 2 subsystems, the SES being one of them and the other is the SAR Antenna Subsystem, SAS. As well as interfacing to the SAS, the SES connects directly to equipments on the Platform.

![Figure 3-1: SES in Context](image-url)
The SES consists of the following hardware elements (illustrated in Figure 3-2):
- Integrated Central Electronics (ICE)
- Mission Dependent Frequency Equipment (MDFE)
- Transmit Gain Unit (TGU)
- Harness

**Figure 3-2: SES Architecture**

### 3.2 Summary of Functions

The RF harness subsystem comprises all harness necessary to connect the SAR Electronics Subsystem equipments together.

Each harness includes (where applicable):
- Connectors and connector back-shells
- Contacts
- Cables and wires
- Cable harness shielding
- Cable fixtures
4. FUNCTIONAL AND PERFORMANCE REQUIREMENTS

4.1 General

The Harness required is:
- 1 x BB Harness set 1
- 1 x EM Harness set 2
- 1 x FM Harness

The harness shall comprise (where applicable):
- the connectors and connector back-shells,
- contacts,
- cable and wires,
- cable harness shielding,
- cable harness fixation,
- connector labels,
- accessories, (shrinkable sleeves, splices...)
- bonding straps (if any),
- connector savers,
- dust caps

The Harness shall be compliant with <SD06>.

The Harness shall be designed to cope with the valid electrical design requirements, the mechanical and thermal design requirements, and the environmental and test requirements detailed with this document.

The harness design shall take into account the characteristics of the relevant electrical power and signal sources and loads of all equipment to be interconnected by the harness.
RFHAR-217/CREATE/T
The harness shall be designed to withstand the environments it will encounter during its lifetime without degradation of its performance, and without detrimental influence on the spacecraft or any other unit.

RFHAR-218/CREATE/T
The harness shall guarantee reliable mechanical and electrical interconnection during launch and in-orbit mission under all environmental conditions.

RFHAR-219/CREATE/R
Separation and adequate distribution of power-, signal- and RF- harness between all electrical and electronic SES equipment shall be ensured.
4.2 SES Harness

The harness block diagram can be seen in Figure 4-1.

**Figure 4-1: Harness Block Diagram**

4.2.1 BB Harness set 1

RFHAR-226/CREATED/T

*The BB harness set 1 shall be single redundancy and a commercial harness.*

4.2.2 EM Harness set 2

RFHAR-241/CREATED/T

*Em Harness set 2 shall be single redundancy and a commercial harness.*

4.2.3 FM Harness

RFHAR-256/CREATED/T

*FM harness shall be full redundancy and constructed of flight quality parts.*
4.2.4 Harness Lists
RFHAR-260/CREATED/T
Table 4-1 shows the RF harness required for the SES (TBC).

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Redundancy</th>
<th>Connector</th>
<th>Type</th>
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<tbody>
<tr>
<td>ICE-A</td>
<td>A</td>
<td>J21</td>
<td>RF3</td>
</tr>
<tr>
<td>ICE-B</td>
<td>B</td>
<td>J21</td>
<td>RF3</td>
</tr>
<tr>
<td>MDFE</td>
<td>A</td>
<td>J02</td>
<td>RF5</td>
</tr>
<tr>
<td>MDFE</td>
<td>B</td>
<td>J12</td>
<td>RF5</td>
</tr>
<tr>
<td>MDFE</td>
<td>A</td>
<td>J31</td>
<td>RF4</td>
</tr>
<tr>
<td>MDFE</td>
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<td>J32</td>
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</tr>
<tr>
<td>MDFE</td>
<td>A</td>
<td>J21</td>
<td>RF4</td>
</tr>
<tr>
<td>MDFE</td>
<td>B</td>
<td>J22</td>
<td>RF4</td>
</tr>
</tbody>
</table>

Table 4-1: RF Harness

For details on the connector pin-outs refer to the SES ICD – Annex B <NRD01b>. For details on the signals refer to the SES ICD – Annex A <NRD01a>.

Details of the RF harness required for the Sentinel-1 SES can be seen below (TBC).

4.2.4.1

ICE-A: J21

From

ICE-A
SMA
Male

To

MDFE: J03
SMA
Male

4.2.4.2

ICE-B: J21

From

ICE-B
SMA
Male

To

MDFE: J13
SMA
Male

4.2.4.3

MDFE: J02

From

MDFE
SMA
Male

To

TGU: J11
SMA
Male

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### 4.2.4.4

<table>
<thead>
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<td>MDFE: J12 SMA 1 Male</td>
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<tr>
<td></td>
<td>Tx RF B (TGU) SMA 1 Male</td>
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### 4.2.4.5

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<tr>
<td>MDFE: J31 SMA 1 Male</td>
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<tr>
<td></td>
<td>Rx RF V A (ICE) SMA 1 Male</td>
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### 4.2.4.6

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<tr>
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<td>Rx RF V B (ICE) SMA 1 Male</td>
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### 4.2.4.7

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<td>Rx RF H A (ICE) SMA 1 Male</td>
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### 4.2.4.8

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<tr>
<td></td>
<td>Rx RF H B (ICE) SMA 1 Male</td>
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5. DESIGN AND INTERFACE REQUIREMENTS

The SES interfaces and their interface definitions can be seen in the Sentinel-1 SES Interface Control Document <NRD01>, <NRD01a> and <NRD01b>.

The RF interfaces comprise:
- Tx RF interfaces for the transmission of pulses.
- Rx RF interfaces for the reception of the echo signal.

5.1 ELECTRICAL REQUIREMENTS

5.1.1 General

Details of the RF characteristics for each interface can be found in <NRD01a>.

RFHAR-373/CREATE/R
If not stated within this document, the electrical design shall comply with the Electrical design requirements specified in <NRD01c> (those assigned with #DPH).

RFHAR-374/CREATE/T,A,R
The performance requirements shall be met over the full specified range of environmental conditions, over the entire lifetime over the full dynamic range.

RFHAR-377/SE-3812/A
Gain imbalance between H&V receive channels shall not exceed 0.005dB over the bandwidth and dynamic range of each receiver.

RFHAR-378/SE3813/A
The variation in Rx H and V path gain imbalance shall be less than 0.05dB (TBC) over the operating temperature range.

RFHAR-379/SE-3814/A
Difference in phase shift (phase balance) between the H&V receive channels shall not exceed 1.5°, over the bandwidth and dynamic range of each receiver channel.

RFHAR-380/SE-3815/A
The variation in phase balance between H and V shall be less than 1.5° (TBC), over temperature.

RFHAR-381/SE-3749/T
The leakage level from the transmit path at any point into the receive path shall be below -119dBc (TBC).

RFHAR-382/SE-3811/T
The isolation between H&V receive channels shall be greater than or equal to 55 dB.

RFHAR-383/SE-3760/A
The amplitude variation within pulse shall be < 0.03dB (ripple control after removal of linear and quadratic terms).
RFHAR-902/SE-3761/A

Tx variation of amplitude (averaged over every pulse) in any 10min window (5°C temperature change): < 0.05dB

RFHAR-903/SE-7783/A

Tx variation of phase (averaged over every pulse) in any 10min window (5°C temperature change): < 1°

RFHAR-384/SE-3768/A

The total insertion loss of the Tx cables in each path shall not vary by more than 0.025dB over the temperature range given no change in output power setting.

RFHAR-904/SE-3797/A

The mean gain of each of the Rx paths shall not vary by more than ±0.005dB (TBC) over 10 minute operating period (5°C temperature change).

RFHAR-905/SE-7795/A

The mean phase of each of the Rx paths shall not vary by more than 1° (TBC) over 10 minute operating period (5°C temperature change).

RFHAR-906/SE-7801/A

Amplitude ripples in each of the receive paths shall be <0.1 dB peak to peak.

RFHAR-907/SE-7789/A

The gain of each of the receive paths shall not vary by more than 0.1dB over the operating temperature range.

RFHAR-385/CREATED/T

The insertion loss shall be <1dB per metre on all cables

RFHAR-386/SE-3780/T

The return loss on all cable shall be better than 25dB.

5.1.2 Connector Savers

RFHAR-388/CREATED/T

The number of times flight connectors are mated / demated shall not exceed 5 up to unit delivery.

RFHAR-389/S1-EDIS-REQ-000770/T

Connector savers shall be provided for a minimum of 50 mating-de-mating cycles for the connectors.

RFHAR-390/S1-EDIS-REQ-000780/TT

The number of mating/de-mating cycles for all connectors (and connector savers) shall be controlled, recorded and noted down according to the P.A. requirements <NRD05>.

RFHAR-391/S1-EDIS-REQ-000740/I

A hermaphroditic connector saver shall be provided with each connector on the FM harness (for those connectors which mate with the SES equipments).

RFHAR-894/CREATED/I
The FM harness shall be delivered with connector savers connected.
Connector savers shall not be removed from the equipment, except as required for special test and rework until equipment is integrated onto the flight panel.

RFHAR-393/CREATED/T
The use of connector savers for ground testing shall not alter the performance.

RFHAR-893/CREATED/I
Connector Savers shall be coloured red (for ease of identification).

5.1.3 EMC Requirements

RFHAR-395/CREATED/R
If not stated within this document the harness shall be compliant to the requirements stated in the EMC requirements specification <NRD02> (those assigned with #DPH).

RFHAR-396/S1-EMCS-REQ-000430/T
Cables falling into different EMC classifications shall be segregated in cabling and connectors to the maximum extent possible to minimize interference coupling.

RFHAR-397/S1-EMCS-REQ-000420/T
Cable bundles of the different EMC classes shall be separated by the use of overall shields or metallic barriers between adjacent bundles.

The cable harness is subdivided into the EMC classifications shown in Table 5-1:

<table>
<thead>
<tr>
<th>Class:</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>Power</td>
</tr>
<tr>
<td>Class 2</td>
<td>Digital Signals,</td>
</tr>
<tr>
<td>Class 3</td>
<td>Analogue and low level signals</td>
</tr>
<tr>
<td>Class 4</td>
<td>Ordinance PYRO signal</td>
</tr>
<tr>
<td>Class 5</td>
<td>RF Signals</td>
</tr>
<tr>
<td>Class 6</td>
<td>SDI, DDI signals</td>
</tr>
</tbody>
</table>

Table 5-1: EMC Classification

RFHAR-400/CREATED/R,I
Where wires of different types have to cross each other, the angle of crossing must be 90° ± 20°. Harness layouts shall be designed to minimise the need for such crossings.

5.1.3.1 Bonding and Grounding

Bonding is the method by which adjacent conductive elements are electrically connected in order to minimise any potential differences and thus flow of electrical currents.

RFHAR-403/S1-EMCS-REQ-000500/R
The connector shell shall be electrically conductive and shall be bonded to the overall harness shield and to the connector case.

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RFHAR-404/S1-EMCS-REQ-000310/T
The connector backshell shall exhibit a DC resistance of 7.5mΩ (via connector receptacle) to equipment case or secondary structure (bracket) when connected.

RFHAR-405/CREATED/R
The structure termination of shields shall be made via the connector housing.

RFHAR-409/S1-EMCS-REQ-000020
To prevent corrosion, bonding of dissimilar materials should be avoided in accordance to the P.A requirements for subcontractors <NRD05>.

5.1.3.2 Shielding
RFHAR-895/S1-EDIS-REQ-000430/R,I
To control EMI fields, shielding shall be provided using the following provisions where applicable:
- Braided metallic sheaths
- Metallic tape (aluminium foils)
- Electrodog
- Metallic mesh
- Conductive enclosure structural compartments
- Conduits
- Partitions

RFHAR-414/S1-EMCS-REQ-000500/T
This shield, together with the shielded connector backshells, shall form an uninterrupted complete shield from one equipment connector to another.

5.1.4 Coaxial Cable
RFHAR-417/CREATED/T
The coaxial cable used within Sentinel-1 shall meet or exceed the following electrical parameters:
- Impedance: 50Ω
- Power Handling: Capable of carrying 2.0 watts (TBC)
- Insulation Breakdown: Insulation resistance between inner and outer conductor shall not be less than 5000MΩ, using a test voltage of 500V DC.
- Dielectric: No corona, multipaction or other break-down shall occur in the dielectric when tested at 100V rms, 60Hz.
- RF high Potential withstanding voltage: Minimum of 200V peak (TBC)
- Contact Resistance: Centre: maximum of 30mΩ
- Outer: maximum of 30mΩ
- Time Delays: Maximum of 4ns/m (TBC)
- Capacitance: Maximum of 88pF/m (TBC)
- Electrical Breakdown: The cable shall not suffer from corona, multipaction or any other type of electrical breakdown within the pressure range 94.65889kPa – 107.99112kPa (710-810 Torr) and below 13.33224mPa (10-5 Torr) (TBC)
5.2 MECHANICAL REQUIREMENTS

5.2.1 General Requirements

RFHAR-430/SE-4080/R
If not stated within this document, the harness shall be compliant to the applicable requirements stated in <NRD04> (those assigned with #DPH).

RFHAR-431/CREATED/R
ECSS-E-30 shall be applicable (<SD07>, <SD08>, <SD10> and <SD11>).

RFHAR-432/CREATED/R
All drawings, specifications and engineering data shall only use the International System of Units (SI units), with the exception of gravity, and the language shall be English.

RFHAR-433/CREATED/R
The following shall be taken into account:

- Fabrication and assembly loads
- Handling and transportation loads
- Test loads (including thermal stresses)
- Launch loads (vibration (including shock), thermal and depressurisation)
- Operational loads (including thermal, attitude and orbit control induced loads)
- Structural dimensioning of the units shall consider critical combination of simultaneously acting loads (e.g. mechanical and thermal)

RFHAR-440/CREATED.R
The harness design shall ensure an easy access to the connectors for mating, dismounting and test adapter interconnection.

RFHAR-441/S1-EDIS-REQ-000640/R
The following standards (TBC) shall be applied for manufacturing and assembly of the RF harness:

Soldering: ECSS-Q-70-08<SD13>

RFHAR-443/CREATED/R
Insulation stripping shall be performed according to ECSS-Q-70-26A <SD14>.

Thermal methods shall be preferred.

5.2.1.1 RF-harness Manufacturing and installation

RFHAR-445/CREATED/R
A 3D, 1:1 scale, SES mock-up shall be used for design and routing studies, definition of fixation points and manufacturing of the harness.

RFHAR-446/CREATED/T
The mock-up shall comprise all units, boxes, stay-out areas, interface connector brackets and stand-offs in scale 1:1 with representative outer envelopes and correct connector interfaces.
RFHAR-447/CREATED/I
The harness supplier shall provide for each harness configuration model sets of section templates, where the location of all harness fixations like tie-bases, P-clamps, saddle-clamps, and stand-offs are shown, and where the contours of these items are cut out.

Note: The template shall be used for satellite –harness fixation hardware attachment by structure subsystem in advance to the cable harness integration on satellite level. The foils shall be delivered.

RFHAR-449/CREATED/T
The cut out (stated above) shall be 2 mm bigger at all sides than the real hardware.

RFHAR-450/CREATED/T
The template shall be 0.3mm thick, handy and sectioned with reference marks for proper fitting in the structure.

5.2.1.2 Interface & Configuration Control Drawings / Documents
RFHAR-452/CREATED/R
The interface and configuration control drawings / documents to be delivered by the harness supplier shall include as a minimum the following information:

- Cable harness routing,
- Cable harness fixation elements,
- Reference coordinate system,
- Connector type, identification, location and clearances,
- Mounting hardware (as delivered) including allowed torque,
- Position and orientation of identification label including connectors fixation points for bonding straps.
- Material lists, as designed and as-built
- ADP and documents listed in the SOW

RFHAR-462/CREATED/R
The following configuration control information shall be incorporated on all interface and configuration drawings / documents:

- Designation of item,
- Product identifier number on each cable harness,
- Drawing number of the supplier,
- Issue / revision number,
- Date of issue / revision,
- Approval of the supplier,
- Approval of the prime.
5.2.2 Connectors

RFHAR-472/CREATED/R
For the harness the following connector types shall be used:
- Non-magnetic coaxial connectors of the SMA ESA SCC types (preferred series 3402-001 and 3402-002) (TBC) for RF cables.

RFHAR-474/CREATED/R,I
The connectors on Sentinel-1 coaxial cables shall be straight (SO1) or elbow (SO2) SMA connectors, meeting the requirements of MIL-C-39012 (TBC).

RFHAR-475/S1-EDIS-REQ-000500/R,I
RF coaxial connectors shall be male on the harness.

RFHAR-476/CREATED/R
All harness connectors shall be non-magnetic.

RFHAR-477/CREATED/R,I
The FM connector shell finish shall be gold-plated.

RFHAR-478/CREATED/R
All harness connections shall be designed to withstand all the manipulations required after manufacture; i.e. those caused by harness installation, plus the fitting and removal of test cables and test equipment.

RFHAR-480/CREATED/T
All harness connectors shall fit with its counterpart at the equipment.

5.2.2.1 Mechanical Arrangement

RFHAR-482/S1-EDIS-REQ-000510/T
Male and female connectors shall be mechanically locked together

RFHAR-483/CREATED/T
The housing of harness connectors shall be mechanically and electrically connected to the unit connector housing (by screwing etc.).

5.2.2.2 Attachment Requirements

RFHAR-485/CREATED/R
All connector fixation nuts shall be secured by approved adhesive.

RFHAR-486/CREATED/I,R
Surface scratching split- or star-washers shall not be used for locking.
5.2.3 Fixations and Protection

RFHAR-488/CREATED/I
All parts shall be free of burrs, sharp edges and other imperfections that might affect assembly, or lead to malfunction, or cause injury to personnel.

RFHAR-489/CREATED/I
The harness wiring shall provide a suitable fixation provision at least every 20cm (TBC), depending on the diameter of the harness bundle.

RFHAR-490/CREATED/T
The harness wiring shall have relieved wire / cable loops to the fixation points and the connector.

5.2.4 Harness Wiring

RFHAR-492/S1-EDIS-REQ-000350/R
Silverplated wires shall be used.

5.2.4.1 Routing

The maximum RF harness length (per cable) is envisaged to be <1.5m.

RFHAR-495/CREATED/R
The layout and the routing of the harness shall be realized in accordance with <SD06>, taking into account the layout of the flight panel to which the SES is to be attached.

RFHAR-496/S1-EMCS-REQ-000450/R
The harness shall be routed as close as possible to the equipment or instrument structures.

RFHAR-497/CREATED/T
The maximum height of the harness with respect to the panel shall be minimised and shall be ≤ 35mm (TBC).

RFHAR-498/CREATED/R
For the connection to unit connectors, which are high above the mounting plane, a 90° bundle support (90° back shells or similar) shall be considered.

RFHAR-499/CREATED/R
When designing the routing of the harness, connector savers shall not be included (as these are not part of the flight harness).

RFHAR-500/CREATED/R
Individual harness route lengths shall be minimised consistent with the other routing requirements of this section.

RFHAR-501/CREATED/T
The harness routing shall not prevent the installation and removal of the SES equipments.
Harness bundles of different EMC classifications shall be separated. The minimum cable bundle separation distances are shown in Table 5-2.

<table>
<thead>
<tr>
<th>EMC Class</th>
<th>Parallel EMC Class</th>
<th>Separation distance D (mm) per parallel run L (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L &lt; 40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>70</td>
</tr>
<tr>
<td>1</td>
<td>6</td>
<td>70</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>70</td>
</tr>
</tbody>
</table>

Table 5-2: Minimum Cable Bundle Separation Distances

5.2.4.2 Stay-Out Areas

Mechanical stay out areas required by the SES flight panel shall be respected by harness engineering.

5.2.4.3 Wire and Cable Tying

Cables and wires shall be clamped or tied without deformation and stress.

The tying method shall utilise spot ties, which shall be realised by at least two complete turns of lacing cord around all conductors to be bundled.

If no overall shield is foreseen, the lacing cord shall be secured with a non-slip knot to prevent movement of the tie during handling of the unit cable harness assembly and shall be secured by adequate bonding material.

The spacing between the spot ties shall not exceed 60mm, with respect to the overall shielding wrapping.
5.2.4.4 Bending Radii

For coaxial cabling the bend radius limitations as specified by the manufacturer shall strictly be applied.

5.2.4.5 Designation of Wires and Cables

All cable harness suppliers shall use the same wire and cable acronyms according to Table 5-3.

<table>
<thead>
<tr>
<th>Code</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>COAX</td>
<td>Coaxial cable</td>
</tr>
<tr>
<td>SL</td>
<td>Single line</td>
</tr>
<tr>
<td>TP</td>
<td>Twisted Pair</td>
</tr>
<tr>
<td>T3C</td>
<td>Twisted 3 cores</td>
</tr>
<tr>
<td>T4C</td>
<td>Twisted 4 cores</td>
</tr>
<tr>
<td>TCX</td>
<td>Twinax cable</td>
</tr>
<tr>
<td>SSL</td>
<td>Single shielded line</td>
</tr>
<tr>
<td>TSP</td>
<td>Twisted shielded pair</td>
</tr>
<tr>
<td>TDSP</td>
<td>Twisted double shielded Pair</td>
</tr>
<tr>
<td>TS3C</td>
<td>Twisted shielded 3 cores</td>
</tr>
<tr>
<td>TS4C</td>
<td>Twisted shielded 4 cores</td>
</tr>
<tr>
<td>MIL</td>
<td>Twisted Shielded Pair for MIL-STD-1553B Bus</td>
</tr>
</tbody>
</table>

Table 5-3: Designation of Wires and Cables

5.2.4.6 Cable Sizing (Wire Gauge)

The diameter of all coaxial cables shall be 0.19" nominal (TBC).
5.2.5 Structure Requirements

5.2.5.1 Mass

RFHAR-520/CREATED/T

The harness mass, in flight configuration, shall be ≤ 1.5kg including design margin as shown in Table 5-4.

This is to be verified by a mass measurement on the fully assembled cable harness, with tolerances stated in Section 7.3.

RFHAR-522/CREATED/T

The harness fixtures and fittings, for flight configuration, shall be ≤ 0.35Kg including design margin as shown in Table 5-4 (this value includes fixtures and fittings for both cable- and RF- harness).

5.2.5.1.1 Mass Margin Philosophy

To assess the relative degree of confidence, the Satellite equipment has been divided in five categories of design maturity and, for each of these, a percentage uncertainty has been associated depending on its category of design maturity.

The five categories considered are:

- Maturity Level A: applied where the mass is just estimated (Proposal Phases).
- Maturity Level B: applied when a preliminary mass computation based on equipment layout exists (Preliminary Design Review)
- Maturity Level C: applied when an EM detailed mass computation based on finalised design exists (Baseline Design Review stage, when applicable to the design development of the equipment).
- Maturity Level D: applied when the mass computation is based on final engineering drawings by means of PFM detailed mass breakdown or on the data of SM or EM models (Critical Design Review).
- Maturity Level E: applied when the mass is based on hardware measurement.

The allocated percentage margins of uncertainty (at instrument or equipment level) for each category as a function of their design maturity and particular topology are given in Table 5-4.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PROP.</th>
<th>PDR</th>
<th>BDR</th>
<th>CDR</th>
<th>MEAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structures, reflectors, balancing mass, misc.</td>
<td>15</td>
<td>10</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Mechanisms, Pyres</td>
<td>15</td>
<td>10</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>THC (harness, misc.)</td>
<td>15</td>
<td>10</td>
<td>7</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Elect. Boxes</td>
<td>15</td>
<td>10</td>
<td>7</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Batteries</td>
<td>15</td>
<td>10</td>
<td>5</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Harness (DC, RF, WG)</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 5-4: Mass Margin
5.2.5.2.1 Centre of Gravity and Moments of Inertia
RFHAR-540/S1-MDIS-REQ-400650/T,A,R

The harness moment of inertia and centre of gravity shall be calculated.

5.2.5.2 Strength and Stiffness
RFHAR-546/S1-MDIS-REQ-300010/R,A

The harness shall be designed to withstand the mechanical (test) loads (sine and random vibration and shock) as required for the Sentinel-1 SES, as defined in <NRD04>. 
5.2.5.3 Interface Control Drawings

5.2.5.3.1 Flight Panel

The dimensions and layout of the flight panel can be seen in Figure 5-1.

![Figure 5-1: Flight Panel Interface Control Drawing](image-url)
The flight panel layout can be seen in Figure 5-2.

The flight panel layout is TBC (the below drawing is representative, however it will be updated with the full interface control drawing of the flight panel layout when available).

Figure 5-2: SES Flight Layout
5.2.5.3.2 ICE

The ICE Interface Control Drawing (ICD) can be seen in Figure 5-3.

The ICE ICD is TBC (the below drawing is representative, however it will be updated with the full interface control drawing of the ICE when available).

Figure 5-3: ICE ICD
5.2.5.3.3 MDFE

The Mission Dependant Filter Equipment is composed of two separate MDFEs with distinct transmit (Tx) and receive (Rx) functions, each containing two filters:

- Tx MDFE
- Rx MDFE

5.2.5.3.3.1 Tx MDFE

The Tx MDFE ICD can be seen in Figure 5-4.

The Tx MDFE ICD is TBC (the below drawing is representative, however it will be updated with the full interface control drawing of the Tx MDFE when available).

Figure 5-4: Tx MDFE ICD
5.2.5.3.3.2 Rx MDFE

The Rx MDFE ICD can be seen in Figure 5-5.

The Rx MDFE ICD is TBC (the below drawing is representative, however it will be updated with the full interface control drawing of the Rx MDFE when available).

Figure 5-5: Rx MDFE ICD
5.2.5.3.4 TGU

The TGU ICD can be seen in Figure 5-6.

The TGU ICD is TBC (the below drawing is representative, however it will be updated with the full interface control drawing of the TGU when available).

Figure 5-6: TGU ICD
5.3 THERMAL REQUIREMENTS

RFHAR-572/CREATED/R
   <SD07> shall be applicable.

RFHAR-573/SE-4089/R
   If not stated within this document, the applicable thermal requirements of <NRD04> shall be met (those assigned with #DPH).

5.3.1 Thermal Design Requirements

RFHAR-575/CREATED/R
   The harness shall be designed to withstand the thermal environments it will encounter during its lifetime without degradation of its performance, and without detrimental influence on the spacecraft or any other unit.

The SES temperature limits are shown in Table 5-5.

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>Minimum °C</th>
<th>Maximum °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating</td>
<td>-15</td>
<td>+55</td>
</tr>
<tr>
<td>Acceptance</td>
<td>-20</td>
<td>+60</td>
</tr>
<tr>
<td>Qualification</td>
<td>-25</td>
<td>+66</td>
</tr>
<tr>
<td>Start-up</td>
<td>-25</td>
<td></td>
</tr>
<tr>
<td>Non-operating</td>
<td>-40</td>
<td>+75</td>
</tr>
</tbody>
</table>

Table 5-5: SES Temperature Range

RFHAR-578/CREATED/R,A
   The harness shall be configured to ensure that it is not put under excess strain as a result of thermal expansion and contraction.

RFHAR-579/S1-EDIS-REQ-000640/R,A
   The contact or insert temperature shall not exceed the limits specified in the applicable connector specifications.
5.4 GENERAL REQUIREMENTS

5.4.1 Parts, Materials and Processes

RFHAR-582/CREATED/R
<SD11> shall be applicable.

RFHAR-583/CREATED/R
Parts, stress and derating shall be carried out in accordance with requirement stated in <NRD05>.

5.4.1.1 Cables

RFHAR-585/CREATED/R
Coaxial, tri-axial and symmetric cables shall be ESA SCC types (preferred series 3902-002) (TBC), or procured per MIL-C-17.

RFHAR-586/CREATED/R
Coaxial, tri-axial and symmetric cables shall be procured as Microwave/RF Assemblies (assembled with connectors), and shall completely be tested and qualified by the manufacturer.

5.4.1.2 Material Selection

RFHAR-588/CREATED/R
Materials used for the harness shall be compliant to the P.A requirement <NRD05>.

RFHAR-589/CREATED/R
Early notification of new or unproven materials shall be provided together with proposed testing and analysis for approval by the project specific product assurance.

RFHAR-590/CREATED/I
Materials lists to be delivered by the contractor shall include at least the following information:
- Applicable drawing ID / usage
- Type of material
- Identification of life limited items
- Identification of flight heritage or reference to standard parts list
- Main dimension

RFHAR-596/CREATED/R
Life limited materials shall be avoided wherever possible. If limited life items are intended to be applied in flight hardware, they shall be identified in the material list (including maintenance / replacement requirements) and indicated to the customer when the decision is made to use the materials.

RFHAR-597/CREATED/R
No lubricants shall be used without prior written agreement of the customer.
5.4.1.3 Degradable Materials

Degradable materials shall be avoided.

Where used the following requirement applies:

The extreme values which could occur during the lifetime shall be used in the design.

5.4.1.4 Magnetism

Non-magnetic materials shall be used.

No permanent magnets are allowed.

5.4.1.5 Dielectric

In the following list are indicated the dielectric materials that should be minimised in order to reduce the occurring of an ESD event:

- Standard Teflon
- Uncoated Kapton (thickness > 50µm)
- Epoxy glass
- Silica cloth

5.4.2 Lifetime

The harness shall be designed for an in-orbit design lifetime of 7.25 years following a maximum on-ground storage of 10 years.

In determining the lifetime of the harness, worst case parameters shall be used.

5.4.3 Reliability

5.4.3.1 Reliability

The harness reliability shall be 0.99778.
5.4.3.2 Availability

RFHAR-619/SE-4747/R,A

The cable harness shall be designed to provide an in-orbit availability of 100% over the lifetime.

Availability is defined as the capability to provide scanning data as a percentage of the total lifetime.

5.4.3.3 Maintainability Requirements

Deleted.

5.4.4 Design Safety

RFHAR-624/CREATED/R

For components requiring specific treatment during on-ground handling and transportation the harness supplier shall make corresponding manuals available.

RFHAR-625/CREATED/R

Safety hazards shall be identified (wherever necessary) in all relevant test and integration procedures referring to the project specific safety assurance procedures.

The safety assurance procedures shall also include preventive measures to control and eliminate these hazards.

5.4.5 Identification and Marking

RFHAR-628/S1-EDIS-REQ-000550/I

Every harness connector shall have an identification label. The label ID shall be:

K / ZZ / YY

Where:

K = equipment identification code in accordance with the Integrated P.A Plan
ZZ = progressive number of like equipments
YY = receptacle equipment connector number (according to the equipment ICD)

RFHAR-634/CREATED/I

The identification shall be legible with unaided eye from 0.5m distance.

RFHAR-635/S1-EDIS-REQ-000370/I

Each harness shall be identified at both ends with sufficient information for assembly, test and fault location.

RFHAR-636/1-EDIS-REQ-000520/I

The location and content of connector identification labels shall be included in the ICD of the relevant unit.
A bag containing cable harness components shall carry the following information:
- Project Name
- Unit/Component Name
- PT Item Code
- Part Number
- Serial Number

Any piece of hardware used only during ground operations, shall be clearly identified as non-flight item (red coloured and a red flag carrying the notation “NOT FOR FLIGHT” attached to them). Such items shall be clearly identified on the relevant Interface Control Drawing.

This requirement only applies to flight harness.

5.4.6 Accessibility / Maintainability

The design of the harness shall provide sufficient accessibility to enable the mounting and removal of the harness with standard tools.

The harness design shall ensure an easy access to all connectors for failure free mating/de-mating.

No field maintenance, servicing or adjustment shall be required within the specified in-orbit lifetime.

5.4.7 Transportation, Handling and Storage

5.4.7.1 Transport

The harness shall be transported using a container specifically designed to protect the flight hardware during ground or air transportation.

The harness containers, covers (for exposed connectors) and packaging shall be environmentally controlled/monitored (vibration, shock, temperature, pressure, humidity, electrical static discharge and contamination) and instrumented to ensure that the environments encountered during shipping and storage do not exceed expected flight (acceptance) levels.

The storage container shall be designed to protect the unit without causing deterioration for the specified storage period.
5.4.7.2 Equipment Packing

RFHAR-654/CREATED/I

Blanking caps shall be fitted to any ports. Blanking caps shall be labelled and instructions included in the Handling and Transportation Procedures, to ‘Remove before Flight or Test’ as applicable.

RFHAR-655/CREATED/T

All units shall be packaged to ensure that it is sealed in a dry inert atmosphere using non-contaminating materials.

RFHAR-656/CREATED/R

The pre-cleaned harness shall first be placed in a bag and sealed within.

RFHAR-657/CREATED/R,I

The protected unit shall be placed in a second bag with dehydrating agent and a label stating “OPEN IN A CONTAMINATION CONTROLLED ENVIRONMENT”.

RFHAR-658/CREATED/R

The second bag shall be sealed.

RFHAR-659/CREATED/R

The sealing of both bags shall be performed in cleanroom conditions.

5.4.7.3 Container Identification

RFHAR-661/CREATED/I

Each container shall be labelled, tagged or marked to show at least the following:

- Name of Manufacturer
- Project Name
- Unit Name / Model
- Part Number
- Serial Number
- Date of Manufacturer
- Astrium Purchase Order Number
- Contact Number (where applicable)
- Quantity and weight (kg)

RFHAR-671/CREATED/I

In addition to the above, the container shall also be labelled with:

- The statement “ONLY TO BE OPENED IN CLEANROOM CONDITIONS”
- Any recommendations necessary for the protection of the unit
5.4.7.4 Handling
RFHAR-675/CREATED/R

*All cable harness parts and materials shall be touched only with clean gloves.*

5.4.8 CAD Requirements
CHAR-779/S1-CAD-REQ-000060/I

*The exchange format for CAD models shall be compatible with Catia V5.*
6. ENVIRONMENTAL REQUIREMENTS

The harness must be able to operate within the Environmental conditions/requirements stated within this section without degradation.

RFHAR-677/CREATED/R

*If not stated within this document, the harness shall be compliant to the Environmental requirements in *<NRD04>* (those assigned with #DPH).*

RFHAR-678/CREATED/R

*<SD04>* shall be applicable.

RFHAR-679/CREATED/R,A

*The harness shall be designed to withstand the environments it will encounter during its lifetime without degradation of its performance.*

6.1 Atmospheric Conditions

RFHAR-681/S1-ERTS-REQ-300450/R

*The transportation environment shall be as shown in Table 6-1.*

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>MEASURED VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Temperature</td>
<td>From 0°C to 35°C</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>From 20% to 60%</td>
</tr>
<tr>
<td>Pressure</td>
<td>From 700hPa to 1060hPa</td>
</tr>
<tr>
<td>Rate of Pressure Change</td>
<td>143Pa/sec</td>
</tr>
<tr>
<td>Number of cycles of pressure change</td>
<td>less than 12 for aircraft transportation</td>
</tr>
</tbody>
</table>

*Table 6-1: Transportation Environment*

RFHAR-683/S1-ERTS-REQ-300460/R,I

*The Assembly, Integration and Test shall be carried out in controlled area only. The cleanroom environment shall be as seen in Table 6-2.*

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>MEASURED VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>22°C ± 3°C (except for launch base activities)</td>
</tr>
<tr>
<td>Humidity</td>
<td>55% ± 5% RH</td>
</tr>
<tr>
<td>Pressure</td>
<td>From 970hPa to 1060hPa</td>
</tr>
<tr>
<td>Cleanliness</td>
<td>Class 100,000 or better</td>
</tr>
</tbody>
</table>

*Table 6-2: Cleanroom Environment*

RFHAR-685/S1-ERTS-REQ-300470/R

*The storage environment must meet the following climatic conditions as shown in Table 6-3.*

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>MEASURED VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>22°C ± 3°C</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>From 40% to 60%</td>
</tr>
<tr>
<td>Cleanliness</td>
<td>Class 100,000</td>
</tr>
</tbody>
</table>

*Table 6-3: Storage parameters*
All equipments shall be designed to operate within an environment of free space vacuum of $1.3332237 \times 10^{-8}$ Pa ($1 \times 10^{-10}$ Torr).

RFHAR-898/S1-ERTS-REQ-400050/R
All environmental tests, except for thermal cycling test and thermal vacuum/vacuum cycling test, shall be conducted at standard ambient conditions as shown in Table 6-4.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>MEASURED VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>$22^\circ C \pm 3^\circ C$</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>$55% \pm 5%$</td>
</tr>
<tr>
<td>Ambient pressure</td>
<td>800 to 1050 hPa</td>
</tr>
</tbody>
</table>

Table 6-4: Ambient Conditions

6.1.1 Cleanliness
RFHAR-688/CREATED/R
<SD12> shall be applicable.

6.2 Mechanical Environment

6.2.1 Ground Operations Loads
RFHAR-691/CREATED/R
The harness shall be compliant to the applicable requirements stated in the mechanical environment section of <NRD04> (those assigned with #DPH).

6.2.2 Launch and Transfer Orbit Phase
RFHAR-693/CREATED/R
The harness shall be compliant to the applicable requirements stated in the mechanical environment section of <NRD04> (those assigned with #DPH).

6.2.3 Operational Orbit Phase
RFHAR-695/CREATED/T
The harness shall be compliant to the applicable requirements stated in the mechanical environment section of <NRD04> (those assigned with #DPH).

6.3 Thermal Environment
RFHAR-697/CREATED/R,A
The harness shall meet the requirements defined in the Thermal Environment section of <NRD04> (assigned with #DPH) except for the equipment qualification and acceptance temperature limits that are superseded by those in this document.
6.4 Radiation Environment

6.4.1 Total Dose
RFHAR-700/S1-RAD-REQ-000030/R,A
The harness shall withstand a radiation total dose of 115krads (TBC) without any degradation of
operation/performance.

See the Radiation Environment requirements in <NRD04> for more information/definitions associated with
this requirement.

CHAR-897/CREATED/R,A
The harness shall be compliant to the applicable requirements stated in the radiation environment
section of <NRD04> (those assigned with #DPH).

6.5 EMC Environment

6.5.1 EMC Performance Requirements
RFHAR-704/CREATED/R,A
The harness shall meet the applicable EMC performance requirements stated within <NRD02> (those
assigned with #DPH).

6.5.2 Radiated Emissions (E field)
RFHAR-706/ S1-EMCS-REQ-00840/R,A
The harness supplier shall advise the customer whether the design requirements stated within this
document will enable the harness to help the system to meet the Radiated Emissions, Electric Field
requirement of <NRD02>.

If not, the harness supplier shall help identify further design requirements to enable the Radiated
Emissions, Electric Field requirement to be met.

6.5.3 Radiated Emissions (H field)
RFHAR-708/ S1-EMCS-REQ-00850/R,A
The harness supplier shall advise the customer whether the design requirements stated within this
document will enable the harness to help the system to meet the Radiated Emissions, Magnetic Field
requirement of <NRD02>.

If not, the harness supplier shall help identify further design requirements to enable the Radiated
Emissions, MagneticField requirement to be met.

6.5.4 Radiated Susceptibility (E field)
RFHAR-710/ S1-EMCS-REQ-00860/R,A
The harness shall comply with the Radiated Susceptibility, Electric Field requirements of <NRD02>.

6.5.5 Radiated Susceptibility (H field)
RFHAR-712/ S1-EMCS-REQ-00870/R,A
The harness shall comply with the Radiated Susceptibility, Magnetic Field requirements of <NRD02>. 
6.6 Contamination Environment

6.6.1 On-ground Phase
RFHAR-717/CREATED/R
If not stated within this document, the Harness is required to meet the on-ground phase environment stated in <NRD04> (assigned with #DPH).

6.6.2 In-Orbit Phase
RFHAR-719/CREATED/R
If not stated within this document, the Harness is required to meet the in-orbit phase environment stated in <NRD04> (assigned with #DPH).
7. VERIFICATION REQUIREMENTS

A brief summary defining the scope of each Verification Method is provided below:

- Test
  This method encompasses functional performance tests, environmental tests, measurements etc. to be performed following agreed and approved test procedures. Operational and/or environmental conditions shall be simulated to the extent possible. In general the method by test is preferred, unless one of the other methods can be established at acceptable level of confidence while being cost and schedule effective.

- Analysis
  This method evaluates available engineering data, or uses mathematical and/or simulation tools to verify the respective requirements.

- Review of Design
  This verification method shall be used when approved design reports, technical descriptions, engineering drawings unambiguously show that the requirement is met.

- Inspection
  Verification by inspection is done when testing is insufficient or inappropriate. This method of verification is for those requirements that are normally performed by some form of visual inspection. This would include workmanship, labelling, envelope requirements etc.

RFHAR-730/SE-4680/R
The Harness AIV/AIT programme shall ensure that the design and performance requirements, defined in this document are verified by the method defined herein, and are met before launch.

RFHAR-731/SE-4682/R
A verification plan, and/or a verification control document (VCD) for the Harness shall specify the method, means and techniques to which the requirements specified herein will be verified. The document shall be in accordance with the ECSS standard(s) <SD01>, <SD02> & <SD03>.

RFHAR-732/SE-4683/R
The Verification Plan shall record in matrix form compliance with the design and performance requirements as defined in the SoW and lower tier documents.

RFHAR-7353/SE-4684/R
In the verification plan the method of verification shall be identified as well as the level of integration when verification is performed.

RFHAR-735/SE-4686/R
The Verification Plan shall provide for:

- Design qualification, i.e. demonstration that the design of the Harness, of its GSE and other items specified as part of the programme comply with adequate margin with the requirements,

- Acceptance of products generated in the programme, by demonstrating that hardware and software are free from workmanship errors and material faults, that they conform with the design baseline, and that they perform and function as required in the specified flight environment,

- Delivery of correct documentation.
Acceptance of the cable harness shall be based upon:
- Availability of deliverable documents / EIDP,
- Availability of deliverable H/W,
- Successfully performed cable harness level tests,
- No major open work resulting from NCR’s.

The harness is only accepted by the customer when stated so in writing to the subcontractor.

Repeatability and reproducibility of tests shall be maintained throughout the AIT programme.

Following testing the harness shall be inspected to confirm no physical damage.

7.1 Verification Approach

The basic verification concepts and definitions on which the harness verification approach is to be based shall be as described in Section 4 of <SD02>.

The verification objectives shall be as stated in Section 4.1 of <SD02>.

The verification process logic shall be as stated in Section 4.2 of <SD02>.

The verification methods shall be as stated in Section 4.3 of <SD02>.

The verification levels shall be as stated in Section 4.4 of <SD02>.

The verification stages shall be as stated in Section 4.5 of <SD02>.
7.2 Analyses

The requirements to perform functional analysis and the information outputs of that analysis shall be compliant to that in <SD05>.

RFHAR-760/CREATED/R

Methods of verification by analysis will be supported by an analysis report covering each respective parameter.

7.3 Test Tolerances

RFHAR-762/S1-ERTS-REQ-400010/T

The following maximum allowable test tolerances shall apply to unit and module level tests, shown in Table 7-1. These tolerances apply only to test conditions, and do not include instrument accuracies.

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass</td>
<td>± 2 x 10^{-3} Kg or ± 0.1% (whichever is greater)</td>
</tr>
<tr>
<td>Centre of gravity (CoG):</td>
<td>Within a 1mm radius sphere</td>
</tr>
<tr>
<td>Moment of inertia (MoI)</td>
<td>± 3%</td>
</tr>
</tbody>
</table>

Table 7-1: Test Tolerances

RFHAR-900/S1-ERTS-REQ-400020/R

The accuracy of instruments used to control or monitor the test parameters shall be verified periodically by calibration procedures and shall be compatible with the test objectives.

RFHAR-901/S1-ERTS-REQ-400030/T,R

The accuracy of the instruments shall be at least one order of magnitude better than the tolerance of the variable to be measured, as specified in Table 7-1.
7.4 Equipment Level Tests
RFHAR-765/CREATED/R
The harness tests shall be compliant to <NRD04>.

RFHAR-766/CREATED/R
The harness functional/performance test plan/procedures shall be written by the subcontractor and be approved by the customer in advance and shall cover as minimum:

- All tests steps to verify the function and performance requirements of this document (and those referenced to in applicable documents)
- Reference to the requirement to be verified
- Description of test set-up
- Configuration of HW and SW under test
- Measurement accuracy (voltage, current, temperature etc…)
- Calibration dates of support equipment

RFHAR-773/CREATED/R
The harness test plan shall be in accordance with ECSS Standard <SD03>.

RFHAR-774/CREATED/T
The following tests shall be performed for the harness (as a minimum):

- Mass determination
- Continuity test (of signals and grounding)
- Resistance test
- Isolation test
- Contact Retention test
- Shield Bonding test

7.4.1 Functional and Performance Tests
RFHAR-782/CREATED/R
The objective of test item functional performance tests is to verify the performance of the item/unit during the test program.
7.4.2 Mechanical Environment Tests

7.4.2.1 Pressure and Venting

RFHAR-793/CREATED/T
A transition from ambient pressure to vacuum shall not influence the specified performance (including no impact on mechanical integrity).

RFHAR-794/S1-MDIS-REQ-302630/R,A
The harness shall have suitable venting provisions, that is 2mm$^2$ venting hole area per litre volume. Outgassing vents shall be <5mm diameter.
For EMC reasons, there shall be no other opening than necessary for connectors and venting holes.

7.4.3 Space Conditioning

RFHAR-822/CREATED/T
Space conditioning shall be performed whenever design choices for a unit of an assembly induce behaviour differences between in flight environment and on-ground environment.

The contractor shall propose the corresponding test program, submitted to customer approval. For example, but without limitation to, materials moisture release, outgassing & strain releases shall be conducted whenever necessary.

7.4.4 Physical Measurements

RFHAR-824/CREATED/R
The harness mass, dimensions and layout shall be measured against the requirements stated in the Interface Control Drawing.
8. PRODUCT ASSURANCE REQUIREMENTS

RFHAR-826/CREATED/R

Product Assurance requirements applicable to the harness shall be met as defined in the PA Requirements for Contractors <NRD05> and in the ESA P.A. Requirements <IRD02>.
## DOCUMENT CHANGE RECORD

Record of change from Issue 1 to Issue 2.

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<td>Figure 5-4</td>
<td>Figure split to include migration to two MDFEs (Figure 5-4 and Figure 5-5)</td>
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Configuration Management
Library