BiSon64-ET SUNSENSOR

PRODUCT SPECIFICATION DOCUMENT

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DOCUMENT CHANGE RECORD

Issue	Date	Total pages	Pages affected	Brief description of change
1	28-09-2017	14	All	New document
1a	13-10-2017	14	All	Removed typo's like double Req. numbers to come in line with the verification control document. Added [AD] numbers where needed.
1b	05-10-2018	15	9,11-15	Update: 4 Optical interfaces, 6.1 storage conditions, 6.4 temp cycling, 6.5.3 Random vibrations, 6.5.4 Shock specification, 6.6 Cosmic radiation resistance
2	01-11-2018	15	6 10	Photo of BiSon64-ET proto added Accuracy specifications updated
2a	06-11-2018	14	8	Removed typo
3	03-05-2019	15	11, 14	Update shock specification and thermal cycling
4	28-05-2019	15	9	Update mass to come in line with VCD and ICD
4a	20-06-2019	14	10	Update transition resistance and random vibration time
5	09-12-2019	15	5, 7,9,10, 11,15	Offset paramters added to formula, optical angles referred to ICD, change of remounting accuracy, requirement on resistance of external surfaces deleted, Par 3. More attention to ICD, mechanical interface, accuracies of counterpart added, including ref. to assembly instructions and changed definition of reference points Req 5.3-1 uncalibrated accuracy set to <4° par 5.3 limit on temperature range added, Par 6.4 limit on temperature range for thermal cycling changed, Par 6.5 note added on PIND acceptance testing, Par 6.6 radiation withstanding definition changed

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Abbreviations

AD	Applicable Document
ADC	Analogue to Digital Converter
-B	Baffle
COTS	Commercial Off The Shelf
CTE	Coefficient of Thermal Expansion
EMC	Electro Magnetic Compatibility
-ET	Extended Temperature
FOV	Field of View
ICD	Interface Control Document
LISN	Line Impedance Stabilization Network
LOS	Line Of Sight
MAIT	Manufacturing Assembly Integration and Test
NTC	Negative Temperature Coefficient resistor (thermistor)
PIND	Particle Induced Noise Detection
PSD	Power Spectral Density
RD	Reference Document
Req	Requirement
RMS	Root Mean Square
TBV	To be validated (tests still need to be performed)

Applicable documents

Nr	Document number	Document name	Issue
[AD-1]	110T701	BiSon64-ET interface control drawing	04
[AD-2]	500M085	Precision fastener	01
[AD-3]	500M086	Washer vented	01
[AD-4]	19-LRD-PR-0052	Delivery, Packing, Storage, Handling, and Transportation procedure.	01

Reference documents

Nr	Document number	Document name	Issue

1 Introduction

The BiSon64-ET *sunsensor*, see Figure 1 is a high reliability sunsensor with a nominal field of view of 64 degrees in diagonal which is specifically designed for highly demanding satellite applications.

The ET stands for Extended Temperature and indicates that the sensor is developed to operate over a wide temperature range of up to -120°C…+120°C.

This document shall be read in conjunction with the interface control drawing [AD-1].

Figure 1 BiSon64-ET Sunsensor

2 Solar direction angles

Apart from the quadrant definition as given in [AD-1] it is necessary to define the reference frame of the sun sensor in order to avoid sign errors in the attitude control subsystem. All BiSon64-ET sun sensors use the reference definition given below.

These diagrams provide the definition of the angles α and β to be calculated by means of the formulas given in Equation 1. It can be deducted that a negative α means that the sun is to the top of the sensor and that a negative β means that the sun is to the right of the sensor (both when viewed from the top side).

The illumination given in Figure 2 is for positive α and positive β of the BiSon64-ET sunsensor.

All BiSon64-ET sunsensors use the reference definition given in Equation 1.

Cα is the offset correction parameter used to compensate Zenith offset in the α direction.
Cβ is the offset correction parameter used to compensate Zenith offset in the β direction.

$$S_a - C\alpha = \frac{Q_1 + Q_4 - Q_2 - Q_3}{Q_1 + Q_2 + Q_3 + Q_4} = \frac{\tan(\alpha)}{\tan(\alpha_{max})}$$

$$S_b - C\beta = \frac{Q_1 + Q_2 - Q_3 - Q_4}{Q_1 + Q_2 + Q_3 + Q_4} = \frac{\tan(\beta)}{\tan(\beta_{max})}$$

Equation 1 BiSon64-ET α and β formulas

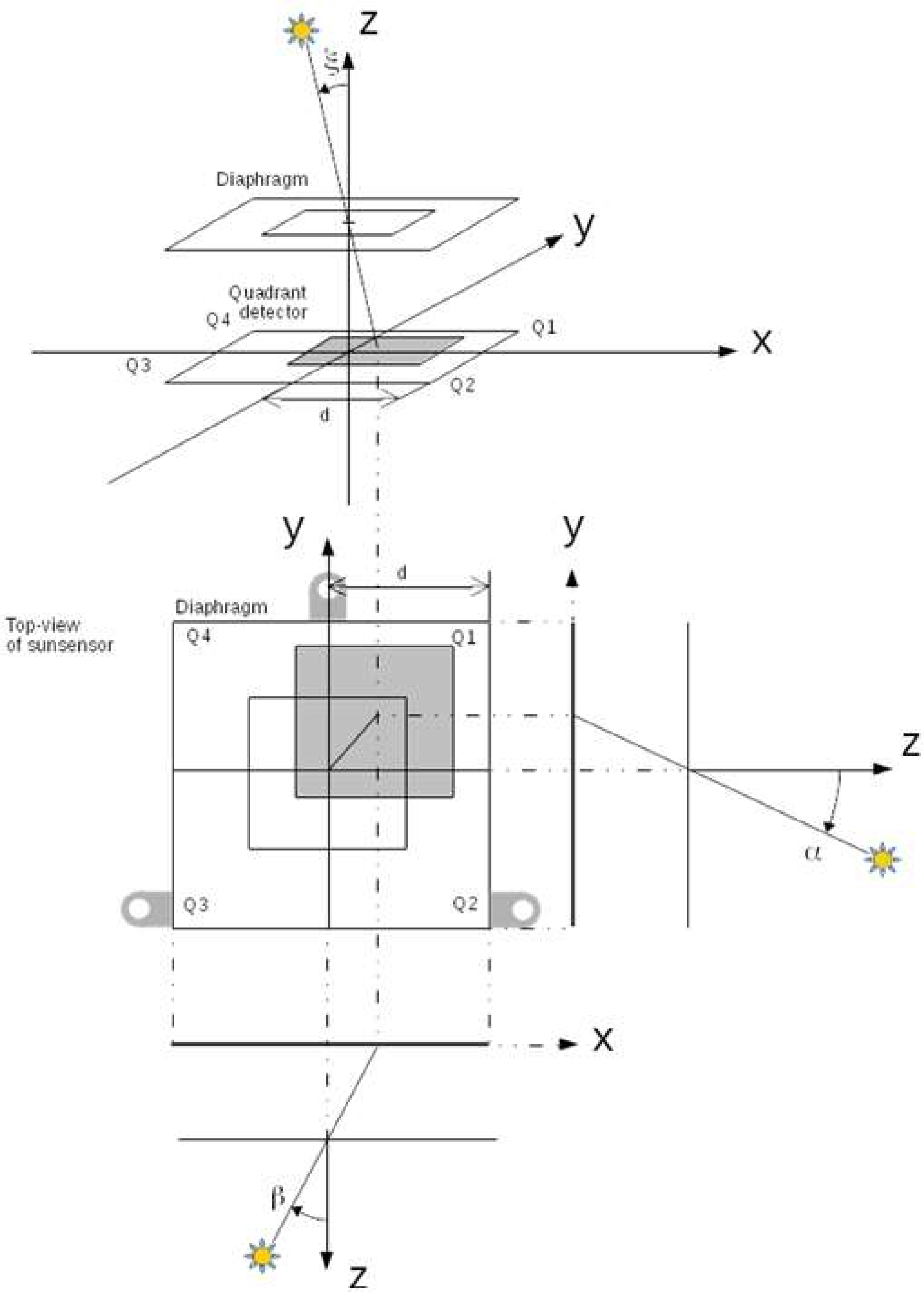

Figure 2 α and β reference frame and angle visualization

3 Mechanical interfaces

The dimensions of the mechanical interfaces are given in [AD-1]. The counterpart on which the Sensor will be mounted shall have at least the same accuracies as the sensor as defined in the ICD drawing. The X axis of the right hand cartesian reference system is defined by the line through the centre of the lower right and lower left mounting points. The Z axis is fixed by means of the plane running through the three mounting feet.

3.1 Repeatability of mounting

Req. 3.1-1 The repeatability of mounting shall be better than 0.06 degrees, when using the prescribed mounting hardware (special fasteners with washers, [AD-2] and [AD-3]). The dimensions and accuracies of the counterpart on which the Sensor will be mounted shall be in line with the sensor specifcations as stated on the ICD [AD-1] and assembly is according to the prescribed procedure as given in paragraph 6.3 of [AD-4].

3.2 Fastening torque

The special fasteners defined in [AD-2] shall be fastened with a torque of 1 Nm ± 10%.

3.3 Mass

Req. 3.3 The mass of the unit is ≤24 grams but more accurately given on page 1 of [AD-1].

3.4 Centre of gravity

The center of gravity is given on page 1 of [AD-1]. But there are no requirements on the CoG.

4 Optical interfaces

The optical interfaces are defined on page 2 of [AD-1] in combination with the reference frame definition as given in par 2.

Req. 4.1 The field of view of the sensor shall be >63° in both diagonals.

The actual angles and associated limits are given on page 2 of the ICD [AD1].

5 Electrical interfaces

The electrical connections are given on page 3 of [AD-1].

The sensor will generate 4 analogue currents.

Req. 5.1 The currents generated shall be 1.45 mA ±20 % at normal incidence and 20°C ± 5°C.
Req. 5.2 The generated currents shall be 1.75 mA ±20 % maximum and 20°C ± 5°C.
Req. 5.3 The currents generated shall be 1.45 mA ±60 % at normal incidence over the full temperature range.
Req. 5.4 The generated currents shall be 1.75 mA ±60 % maximum over the full temperature range.

These values are at 1 AM(0) sun illumination and 0 bias (measured with a transimpedance amplifier) over the full temperature range.

Req. 5.5 The internal thermistor shall have a nominal value of 10kΩ ± 10% @ 25°C.

5.1 Grounding and isolation

Req. 5.1-1 The resistance from the common ground to case shall be 1MΩ<R<10MΩ.
Req. 5.1-2 The capacitance between the sensor and ground shall be < 100pF.

5.2 Deleted

Req. 5.2-1 requirement deleted.

5.3 Specified accuracy

Req. 5.3-1 The specified accuracy of the sensor shall be better than 4 degrees if no calibration table is used. 1)

1) NOTE: For this accuracy to be reached the readout electronics shall have:

- An offset of < 1mV per channel at a full scale of 10V
- 12 bit accuracy
- Inter channel gain equality of better than 0.1%

6 Environmental specifications

6.1 Storage conditions

Req. 6.1 The sensor should be stored in a dust free, dry and temperature controlled environment with a temperature range of 0°C to +30 °C and a relative humidity of 40% to 60% storage lifetime under these conditions is longer than 5 years when kept in the original packaging.

6.2 Operating temperature range

Req. 6.2 The sensor shall perform within non calibrated performance specifications when operated in the range of -120°C to +120 °C.

6.3 Non-operating temperature range

Req. 6.3 The sensor shall withstand a non-operating temperature range of -125°C to +125°C without influencing the non-calibrated performance within operating temperature range.

6.4 Temperature cycling

The sensor shall meet the following temperature cycling requirements.

Req.	Conditions	Temperature range	Number of cycles
6.4-1	Burn in 2)	-55°C….+125°C	10 (on each sensor)
6.4-2	Full range high rate thermal cycle in vacuum	-125°C….+125°C	100
6.4-3	Thermal shock cycling according to MIL-STD-883 Method 1010B	-55°C….+125 °C	800

Table 1 Thermal cycling specification

2) NOTE: As part of the acceptance test procedure a 10 cycle burn in test is performed according to MIL-STD-883 Method 1010 B before final electrical measurements and visual inspection.

6.5 Vibration specifications

Vibration specifications of the sensor are given below. It should be noted that these are already verified qualification levels. Any safety margins required for the mission shall therefore be subtracted from the given level to see if the sensors meet mission requirements. The sine and random qualifications have been performed using the in [AD-2] and [AD-3] defined hardware and torqued to the level specified in chapter 3.2.

6.5.1 Eigenfrequency

Req. 6.5.1 The first eigenfrequency shall be > 200Hz.

6.5.2 Sine vibration

Req. 6.5.2 The sensor shall be able to function properly after being subjected to vibration test levels specified in Table 2 in all three axes.

Sine vibrations	
Frequency (Hz)	Level
5..44.6	20mm peak to peak 10mm zero to peak
44.6..100	40g
1 octave/minute 1 sweep up/1 sweep down	

Table 2 Sine vibrations

6.5.3 Random vibrations

Req. 6.5.3 The sensor shall be able to function within specifications after being subjected to vibration test levels specified in Table 3 in all three axes.

Random vibrations		
Frequency / Hz	dB	g^2/Hz
20...80	13dB/oct	0.1
80...400	0dB/oct	2
400...2000	-9dB/oct	0.25
RMS level 41.4 g		
Duration 150 seconds		

Table 3 Random vibrations

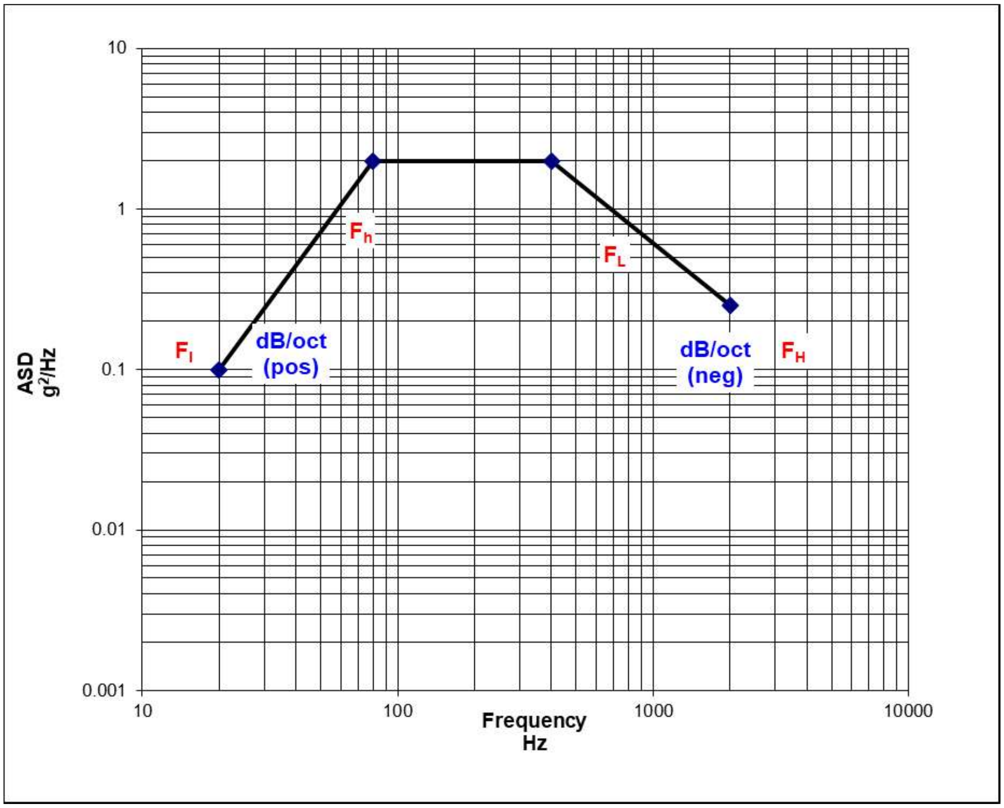

Figure 3 Random vibration profile

6.5.4 Shock specification

Req. 6.5.4 The sensor shall be able to function within specifications after being subject to vibration test levels specified in Table 4 in all three axes.

Pyro shock	
Frequency	Level
Hz	g
100	40
1000	2100
10000	10000
3 shocks in any direction	

Table 4 Pyro shock specifications

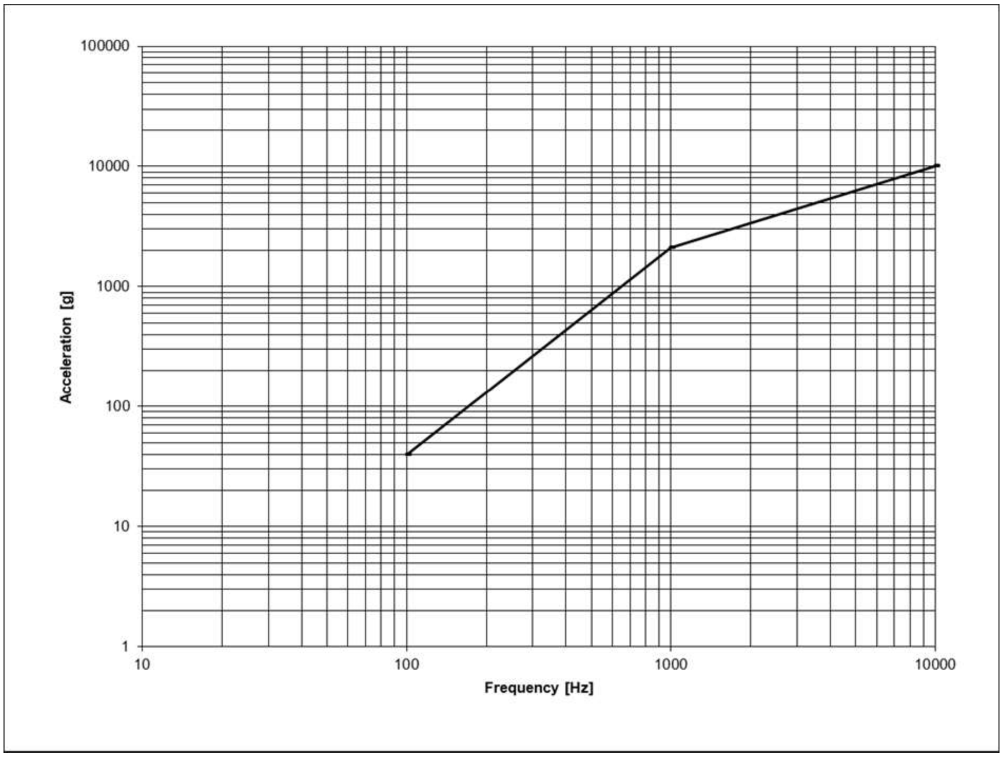

Figure 4 Pyro shock spectrum specified

6.5.5 PIND testing

Req. 6.5.5 The sensors shall be able to function within specification after being subject to a PIND test [3)] (Particle Induced Noise Detection) according to MIL-STD-883 Method 2020 A.

3) NOTE: This test is performed on every sensors as part of the factory acceptance testing.

6.6 Cosmic radiation resistance

Req. 6.6 The sensors shall be able to function 20 years in orbit after using electric orbit raising during one year to reach the orbit without additional radiation shielding [4)].

4) NOTE: The bare diodes have been tested up to 1016 1MeV electrons which is equivalent to:

- 240 Mrad total ionizing dose
- $314 \cdot 10^9$ MeV cm^2/g total non-ionizing dose (displacement damage)

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