BiSon64-ET-B Sunsensor
150T00102

PRODUCT SPECIFICATION

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DOCUMENT CHANGE RECORD

Issue	Date	Total pages	Pages affected	Brief description of change
2	01-03-2022	14	All	New document
2a	11-03-2022	14	12	Table2: level corrected to 10mm peak to peak
2b	02-08-2022	14	11	Split Req 6.1 in Req 6.1-1 storage and Req 6.1-2 Humidity
2c	23-06-23	14	11	Typo in lifetime testing lower temperature corrected from -65°C to -45°C
2d	240304	14	All	New template

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Abbreviations

AD	Applicable Document
-B	Baffle
BOL	Begin of Life
COTS	Commercial Of The Shelf
EMC	Electro Magnetic Compatibility
EOL	End of Life
-ET	Extended Temperature
FOV	Field of View
ICD	Interface Control Document
NTC	Negative Temperature Coefficient resistor (thermistor)
PSD	Power Spectral Density
RD	Reference Document
Req	Requirement

Applicable documents

Nr	Document name	Document number	Issue
[AD-01]	BiSon64-ET-B interface control document	20-LRD-ICD-0002	2
[AD-02]	BiSon64-ET-B interface control drawing	150T701	05
[AD-03]	Precision fastener	500M085	01
[AD-04]	Washer vented	500M086	01
[AD-05]	Bison64 Handling packaging and transportation procedure	24-LRD-PR-0114	1

Reference documents

Nr	Document name	Document number	Issue

1 Introduction

The BiSon64-ET-B Sunsensor, see Figure 1, is a high reliability Sunsensor with a diagonal field of view of >64 degrees, specifically designed for highly demanding satellite applications.
The -B stands for Baffle and indicates that this sensor this straylight is specifically designed for demanding satellite applications with minimised straylight and albedo effects.

This document shall be read in conjunction with the interface control document [AD-01] and the interface control drawing [AD-02].
Specifications will only be achieved when the sensor will be mounted by using the Fastener [AD-03] and washer [AD-04] and assembly on the platform shall be according the procedure as given in paragraph 6.3 of [AD-05].

The base number of the sensor is 150T001 and the last two figures laser engraved on the side of the baffle indicate the revision (in Figure 1 this is 01).

Figure 1 BiSon64-ET-B Sunsensor

2 Solar direction angles

Apart from the quadrant definition as given in [AD-02] 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 by the sun as shown in Figure 2 is for a positive α and positive β of the BiSon64-ET sun sensor.

All BiSon64-ET sun sensors use the reference definition given in Equation 1. This definition is applicable for the non-compensated utilization. In order to achieve higher accuracies the sensor data can be corrected by using standard calibration tables or a simplified compensation formula, see Equation 2.

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

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

Equation 1 BiSon64-ET-B α and β formulas

$$S_{a\_compensated} = S_a - C_a = \frac{Q_1 + Q_4 - Q_2 - Q_3}{Q_1 + Q_2 + Q_3 + Q_4} - C_a = \frac{\tan(\alpha)}{\tan(\alpha_{max})}$$

$$S_{b\_compensated} = S_b - C_b = \frac{Q_1 + Q_2 - Q_3 - Q_4}{Q_1 + Q_2 + Q_3 + Q_4} - C_b = \frac{\tan(\beta)}{\tan(\beta_{max})}$$

Equation 2 α and β formulas with correction in radian

C_a is the offset correction parameter used to compensate zenith offset in the α direction.
C_b is the offset correction parameter used to compensate zenith offset in the β direction.

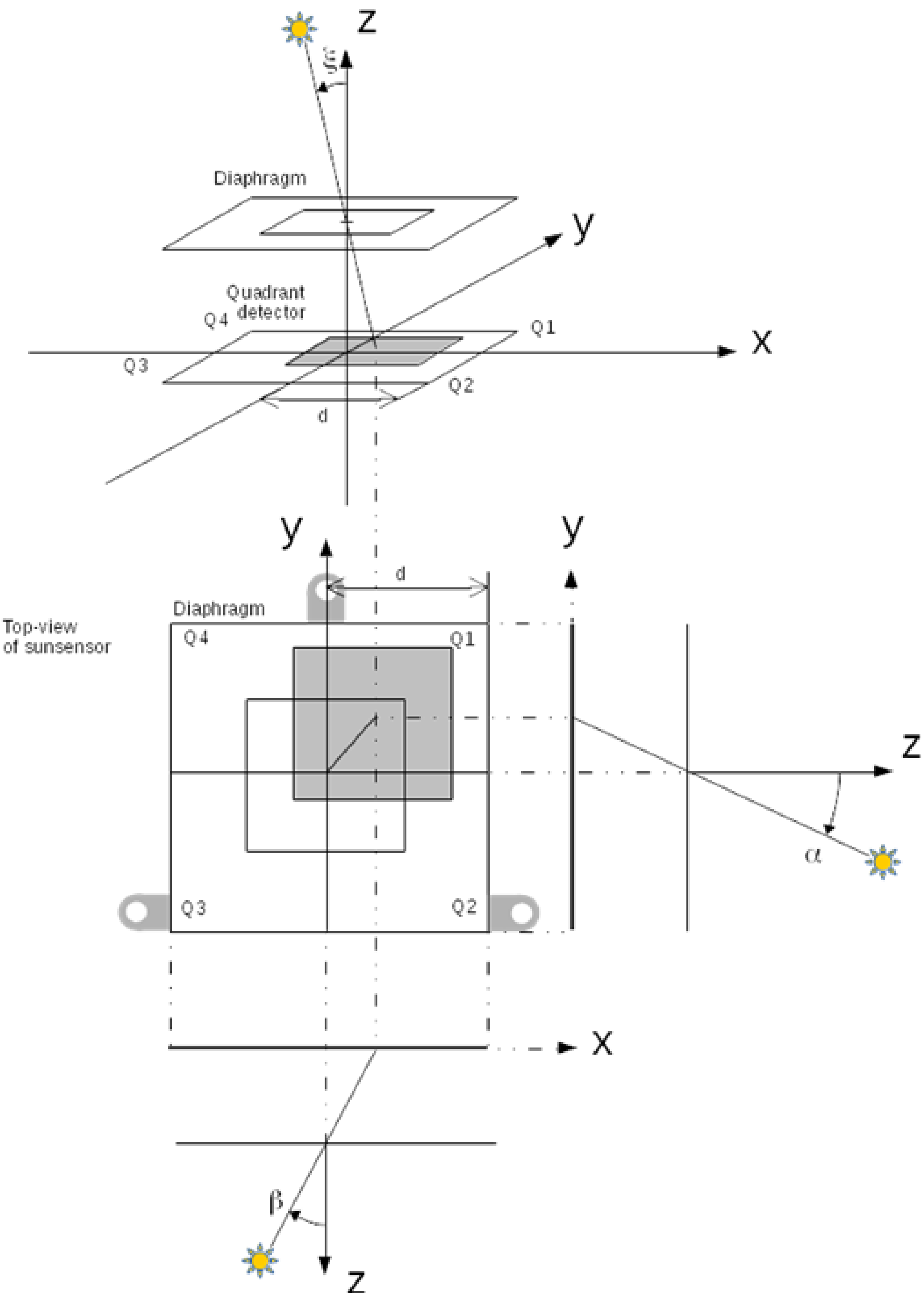

Figure 2 α and β reference frame and angle visualization

3 Mechanical interfaces

The dimensions of the mechanical interfaces are given in interface control drawing [AD-02]. The counterpart on which the Sensor will be mounted shall have at least the same accuracies as the sensor as defined in the IC-Drawing.
The X-axis of the right hand Cartesian reference system is defined by the line through the center 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 The repeatability of mounting will be better than 0.06 degrees when using the prescribed mounting hardware (special fasteners with washers, [AD-03] and [AD-04]). This repeatability is part of the accuracies as mentioned in paragraph 5.2.
For this value to be met, the dimensions and accuracies of the counterpart on which the sensor will be mounted shall be within the sensor specifcations as stated on sheet 1 of [AD-02] and assembly shall be according to the procedure as given in paragraph 6.3 of [AD-05].

3.2 Fastening torque

The special fasteners defined in [AD-03] shall be fastened with a torque of 1 Nm ± 10%.

3.3 Mass

Req. 3.3 The mass of the unit is ≤33 grams and more accurately given on sheet 1 of [AD-02].

3.4 Centre of gravity

The center of gravity is given on sheet 1 of [AD-02] (for information only).

4 Optical interfaces

The optical interfaces are defined on sheet 2 of [AD-02] in combination with the reference frame definition as given in par 2.

Req. 4 The nominal field of view of the sensor will be >64° in both diagonals.

The actual angles and associated limits are given on sheet 2 of [AD-02].

5 Electrical interfaces

The electrical connections are given on sheet 3 of [AD-02].

The sensor will generate 4 analogue currents.

Req. 5-1 The generated currents will be -2.00 mA ±10% at normal incidence and 20°C
Req. 5-2 The generated currents will be -2.80 mA ±10% maximum at 20°C
Req. 5-3 The temperature coefficient of the current generated will be between 0 and +0.1 %/°C

NOTE: These values are at 1 AM(0) sun illumination and 0 bias (measured with a transimpedance amplifier) over the full temperature range and without albedo signal.
In orbit measurements have shown that the collected albedo signal can be significant and might lead to saturation in the acquisition chain if not accounted for. Albedo signals however are non deterministic and both altitude and local node time dependent. As as result, they cannot be unambiguously specified. Based on currently available on-orbit data a full scale range including a margin of 25% is expected to cover all orbits above 600km, and all inclinations. It should however be noted that all specifications presume the signal is albedo free.

Req. 5-4 The internal thermistor will 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 will be 1MΩ<R<10MΩ.
Req. 5.1-2 The capacitance between the sensor and ground will be < 100pF.
Req. 5.1-3 The resistance from sapphire window to housing will be <1MΩ
Req. 5.1-4 The resistance from baffle to housing shall be <1MΩ

5.2 Specified accuracy

Req. 5.2-1 The specified accuracy for the sensors is better than 3.5 degrees if no calibration table is used.

Req. 5.2-2 The specified accuracy for the sensors is better than 2 degree if a sensor specific offset and gain correction is implemented.

Req. 5.2-3 The specified accuracy for the sensors is better than 0.5 degree 3σ if calibration tables are used.

6 Environmental specifications

6.1 Storage conditions

Req. 6.1-1 The sensor shall 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 0% to 40%. Storage lifetime under these conditions is longer than 5 years when kept in the original packaging.

Req. 6.1-2 The sensors will perform within specifications after a Humidity qualification test according ECSS-E-ST-10-03C requirement 5.5.1.2 Humidity test

6.2 Operating temperature range

Req. 6.2 The sensors will perform within specifications when operated in the range of -55°C to +85°C.

6.3 Non-operating temperature range

Req. 6.3 The sensors will survive a non-operating temperature range of -65°C to +105°C.

6.4 Temperature cycling

The sensor 0meet the following temperature cycling requirements during qualification as given in Table 1. This has been demonstrated by no shift in performance >0.1° over the field of view if a membrane is mounted and a die shear strength of > 2.5kgf (after test on the photodiode)

Req.	Conditions	Temperature range	Number of cycles
6.4-1	Full range high rate thermal cycles	-65°C….+105°C	10
6.4-2	Thermal cycling	-45°C..+105°C	2000

Table 1 Thermal cycling specification for qualification

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-03] and [AD-04] defined hardware and torqued to the level specified in chapter 3.2.

6.5.1 Eigenfrequency

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

6.5.2 Sine vibration

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

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

Table 2 Sine vibrations (qualification)

6.5.3 Random vibration qualification

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

Random vibrations						
Frequency (Hz)	**ASD (G^2/Hz)**	**dB**	**OCT**	**dB/OCT**	**Area**	**Grms**
20.00	0.0810	*	*	*	*	*
100.00	2.0000	13.93	2.32	6.00	66.30	8.14
175.00	2.0000	0.00	0.81	0.00	216.30	14.71
500.00	1.5000	-1.25	1.51	-0.82	767.28	27.70
2000.00	0.0376	-16.01	2.00	-8.00	1174.02	34.26
Total RMS level: 34.26g						
Duration: 180 seconds						

Table 3 Random vibrations (qualification)

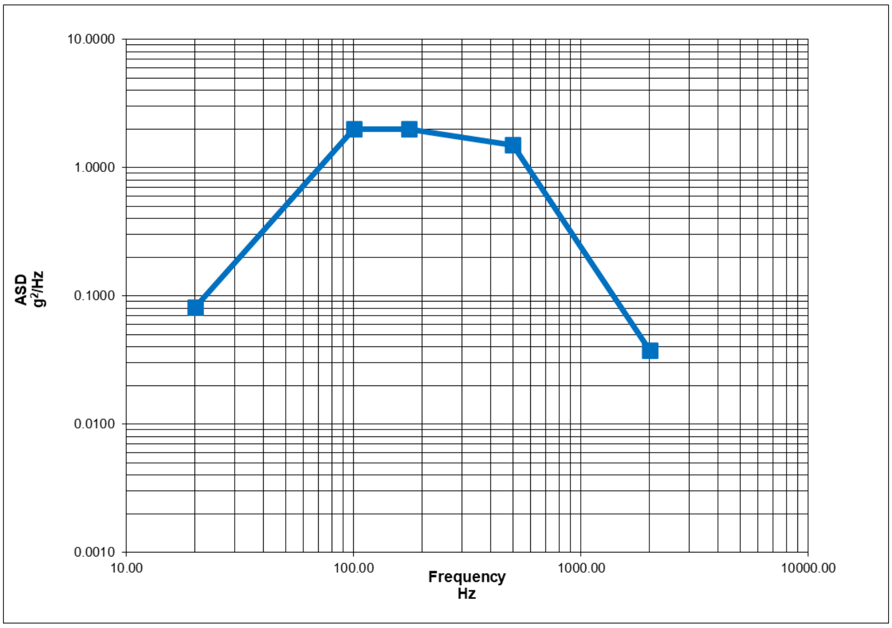

Figure 3 Random vibration profile (qualification)

6.5.4 Shock specification

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

Pyro shock	
Frequency Hz	**Level g**
100	40
1000	2100
2000	3000
10000	3000
3 shocks in any direction	

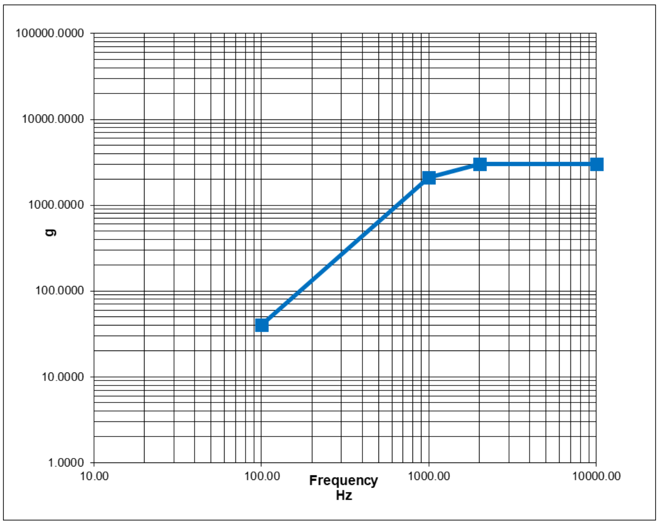

Figure 4 Pyro shock specification and profile (qualification)

6.6 Cosmic radiation resistance

Req. 6.6 Bare diodes will sustain 8E14 1MeV electron testing without failure at a fluence of 1E11 electrons per second. After 100 hours annealing at +100°C, the dark current will be less than 5µA measured at 5Vdc reverse bias.

6.7 Standard acceptance testing activities

6.7.1 Acceptance Vibration testing

Req. 6.7.1 The sensors will be exposed to random vibration in the Z-axis only with levels as specified in Figure 5 as part of the acceptance test sequence, unless a deviation is specifically agreed.

Frequency (Hz)	ASD G²/Hz
20	0.0405
100	1
175	1
500	0.75
2000	0.0188
Total RMS level: 24.23 g	
Duration 60 sec	

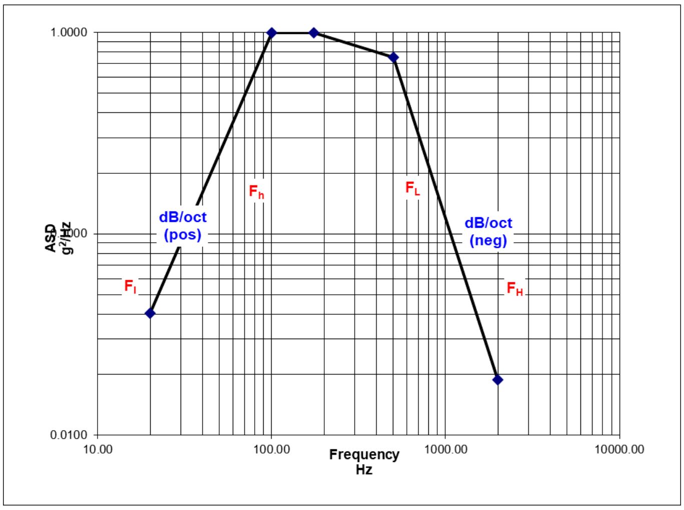

Figure 5 Random vibration specification and profile (acceptance)

6.7.2 Standard acceptance thermal cycling

Req. 6.7.2 The sensors will be exposed to 10 thermal vacuum cycles between -40°C and +80°C as part of the acceptance test sequence, unless a deviation is specifically agreed.

6.7.3 Acceptance calibration

Req. 6.7.3 The sensors will be calibrated after the Acceptance Test, unless a deviation is specifically agreed.

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