STUDENTS' SPACE ASSOCIATION

THE FACULTY OF POWER AND AERONAUTICAL ENGINEERING

WARSAW UNIVERSITY OF TECHNOLOGY

PW-SAT2

INTERFACE CONTROL DOCUMENT

Sun Sensor

November 2016

Issue no. 2 (March 2017)

Changes

Date	Changes	Pages/Section	Responsible
2016-11-30	First issue of the document	-	Grzegorz Ambroszkiewicz
		ch. 3, 4	Michał Gumiela
		-	Dominik Roszkowski
2017-03-23	Updated electrical and software interfaces		Michał Gumiela

Published by

Students' Space Association

Warsaw University of Technology, 2016

Project logo by Krzysztof Karaś

Artist's impressions by Marcin Świetlik

Quote as: PW-Sat2 Team, *Phase C Documentation – Critical Design Review – Sun Sensor Interface Control Document*, Students' Space Association, Warsaw University of Technology, pw-sat.pl 2016

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Abbreviated terms

ADCS	Attitude Determination and Control System
COMM	Communication subsystem
DT	Deployment Team
EM	Engineering Model
EPS	Electrical Power System
ESA	European Space Agency
FM	Flight Model
GS	Ground Station
LEO	Low Earth Orbit
MA	Mission Analysis
MDR	Mission Definition Review
PDR	Preliminary Design Review
SC	Spacecraft
SKA	Studenckie Koło Astronautyczne (Students' Space Association)
SSO	Sun-Synchronous Orbit
SW	Software
TBC	To Be Continued
TBD	To Be Defined
WUT	Warsaw University of Technology

1 INTRODUCTION

1.1 SCOPE

The purpose of this document is to describe interfaces between the Sun Sensor and rest of the PW-Sat2 satellite. Mechanical part is for the whole Sun Sensor Wall with the retroreflector and reference sun sensor (New Space Sun Sensor). The reference sun sensor is a part of the ADCS system, thus the ICD for that device is in the [PW-Sat2-C-01.01-ADCS-ICD] document.

1.2 REFERENCE DOCUMENTS

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1.3 APPLICABLE PROJECT DOCUMENTS

- [PW-Sat2-C-06.00-SunS-CDR] – Sun Sensor overview
- [PW-Sat2-C-10.01-CONF-MICD] – Mechanical ICD of the PW-Sat2

2 STRUCTURAL INTERFACE

a. Reference hole

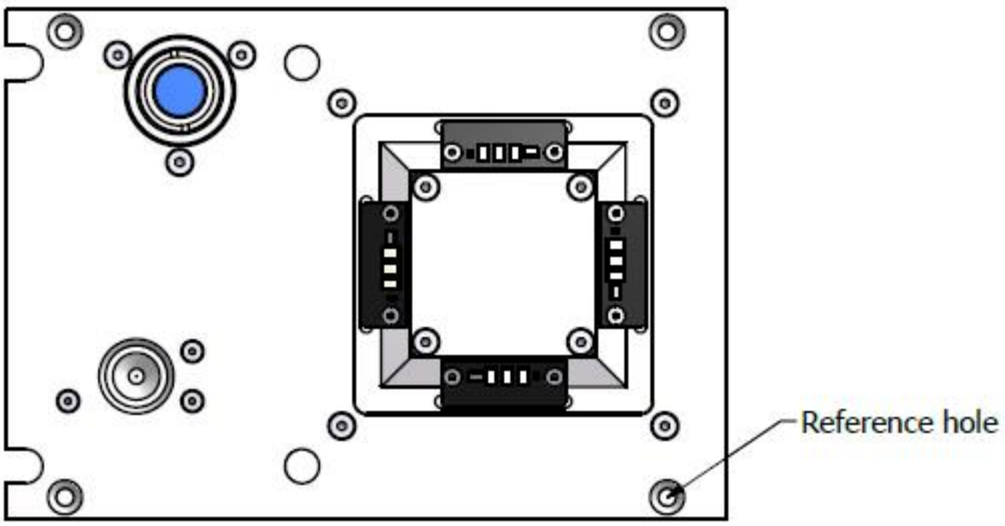

Figure 2-1 Reference point and fixation

b. Envelope dimensions

116x82x14,16 mm

c. Mass

Table 2-1 Sun Sensor mass budget

№	Unit	Material	Mass [g]	Quantity	Total Mass [g]
1	Case	Aluminium 7075	16	1	16
2	Spacer	DELRIN	0,02	4	0,08
3	Case Cover	Aluminium 7075	3,5	1	3,5
4	Wall	Aluminium 7075	16,9	1	16,9
5	Reflector Mount	Aluminium 7075	3,8	1	3,8
6	Reflector Ring	Aluminium 7076	0,5	1	0,5
7	Reflector Mounting Adapter	DELRIN	0,1	1	0,1
8	Reflector Rubber	Vitton (TBD)	0,1	1	0,1
9	Reflector	NBK7+optical coating	0,9	1	0,9
10	Reference Sun Sensor	--	4,4	1	4,4

№	Unit	Material	Mass [g]	Quantity	Total Mass [g]
11	Main Board PCB	FR4+	3,8	1	3,8
12	Sensor PCB	FR4+	0,46	4	1,84
13	ISO 10642 M1,6 x 4	Stainless Steel	0,08	8	0,64
14	ISO 10642 M2 x 8	Stainless Steel	0,2	4	0,8
15	ISO 4035 M2	Stainless Steel	0,09	4	0,36
16	ISO 10642 M1,6 x 6	Stainless Steel	0,11	3	0,33
17	ISO 10642 M2 x 5	Stainless Steel	0,16	7	1,12
	Total				**55,17**

d. Centre of gravity

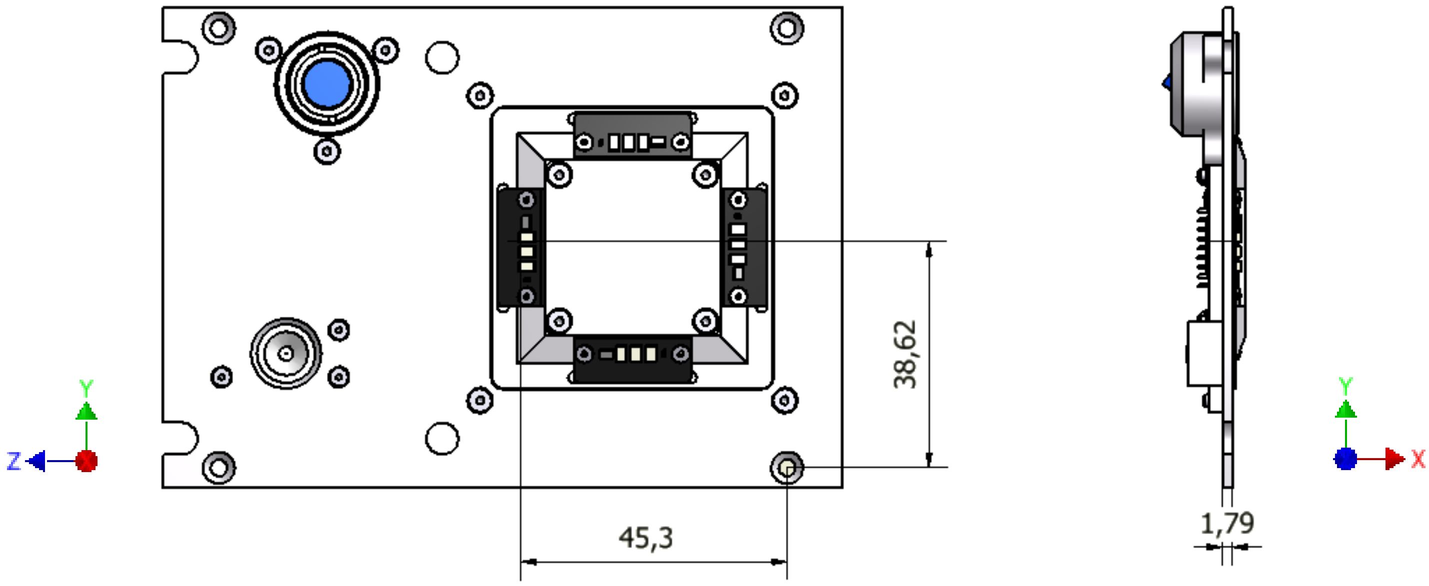

Figure 2-2 Centre of Gravity

Centre of Gravity:

X: -1,79 mm

Y: 38,62 mm

Z: 45,3 mm

In regard to Reference Point

e. Moments of inertia

Ixx = 25,23 kg·mm^2

Iyy = 41,96 kg·mm^2

Izz = 16,82 kg·mm^2

f. Mounting hardware definition

Sun Sensor's Wall is mounted to PW-SAT2 structure by 4 screws ISO 10642 M2,5 x 6.

g. Mounting holes size and location

Sun Sensor has 4x Ø2,9 mounting countersink holes.

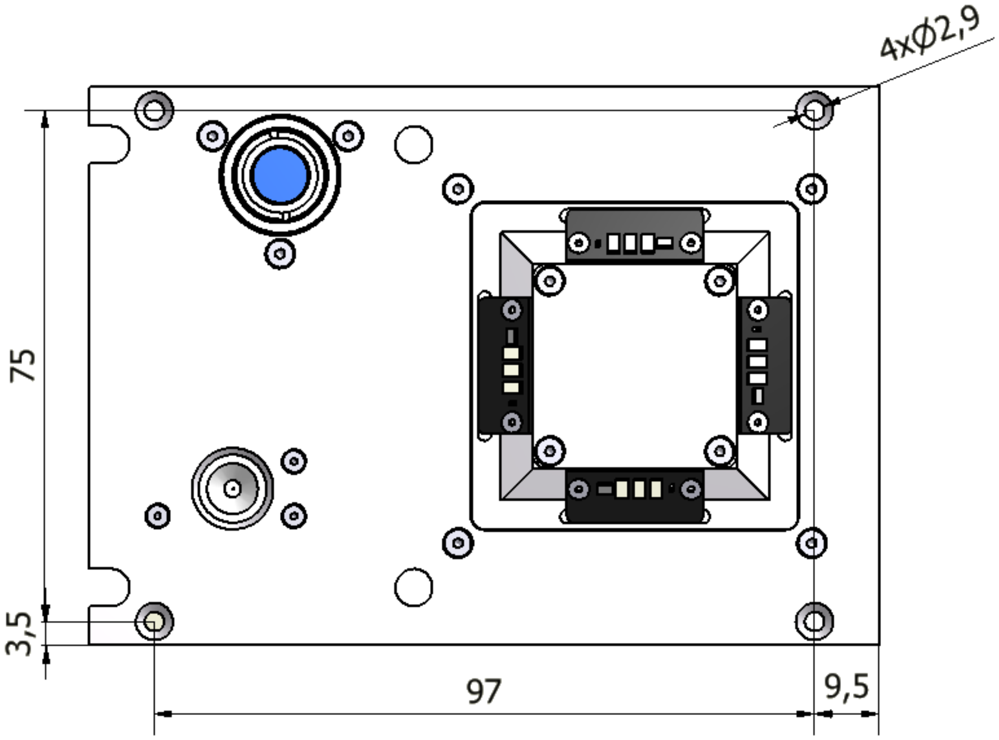

Figure 2-3 Mounting holes location

h. Contact area materials, coatings and finishing

Material: AA7075

Roughness: Ra 3,2

Coatings: All external surfaces anodized

3 ELECTRICAL INTERFACE

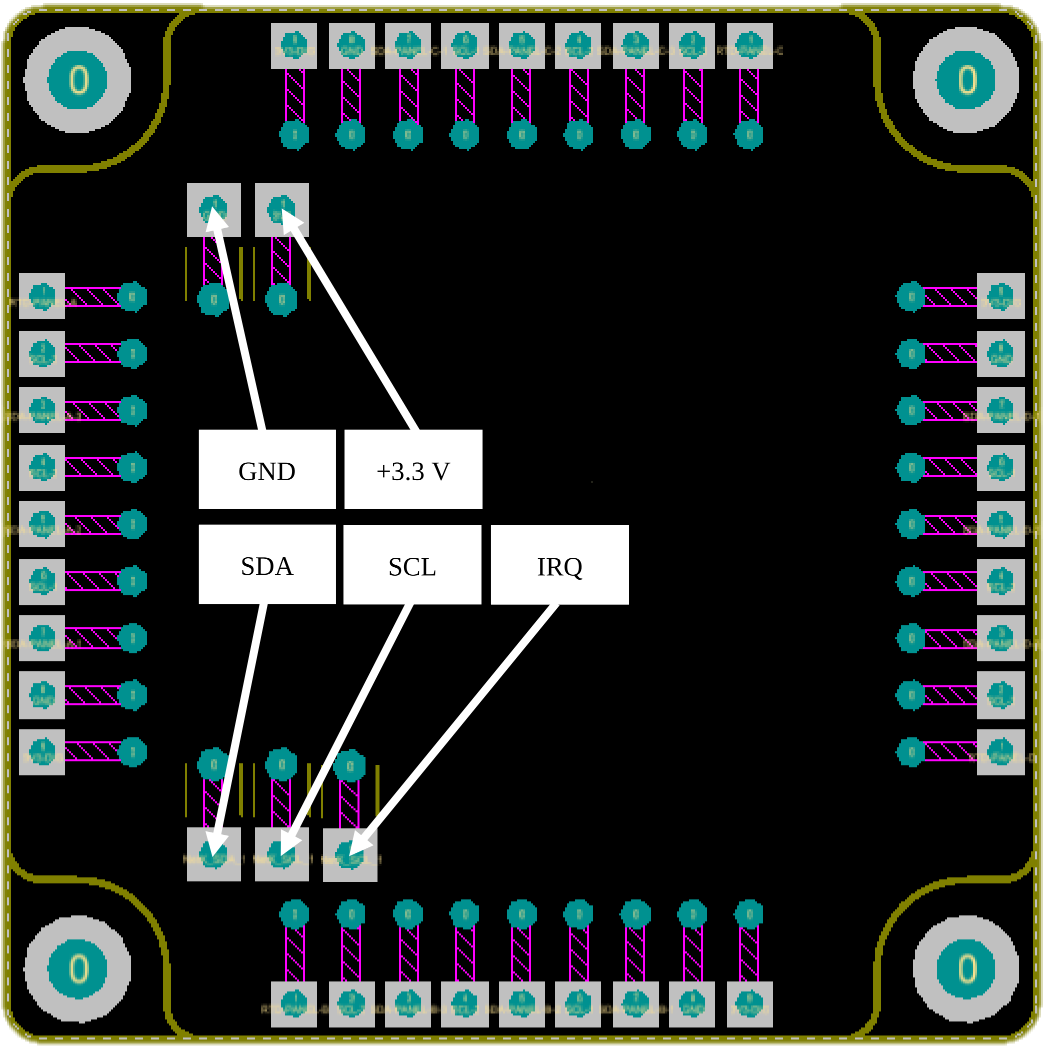

Figure 3-1 Connectors placement (bottom view).

The SunSensor has only five electrical lines: two for power supply (GND, +3.3 V) and three for data exchange via I2C serial bus (SDA, SCL) with interrupt line (IRQ). Instead of pluggable socket, the sensor has soldered AWG28 wires (with stress reliefs – see Figure 3-2). The other side of the wires ends with a proper plug, according to actual needs and specification of PLD board – for details see PLD documentation.

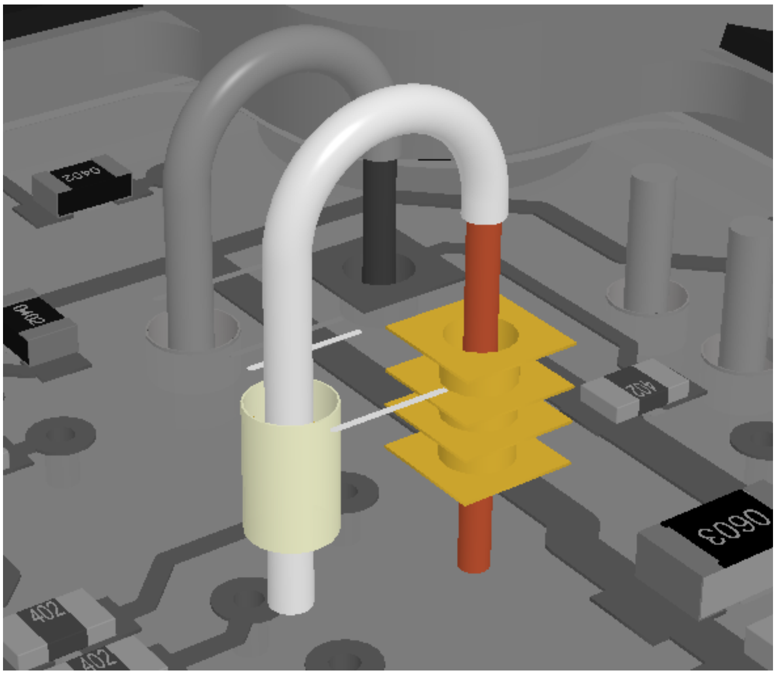

Figure 3-2 Soldered wire with a stress relief.

Table 2 The SunSensor pinout

Pin	Name	Type	Voltage level	Description
1	GND	Power	0 – 3.3 V	Ground of main power supply
2	+3.3 V	Power	0 – 3.3 V	Power supply voltage
3	SDA	Signal	0 – 3.3 V	I^2C interface, SDA line
4	SCL	Signal	0 – 3.3 V	I^2C interface, SCL line
5	IRQ	Signal	0 – 3.3 V	Data ready interrupt signal

4 COMMUNICATION INTERFACES

To communicate with OBC, the SunSensor uses I^{2}C communication interface in slave mode.

4.1 I^{2}C ELECTRICAL CHARACTERISTICS

Apart from protective series resistances on SDA and SCL lines, the SunSensor does not have I^{2}C bus repeater or separator, thus protective circuitry has to be added on external board.

Table 4-1 I^{2}C electrical characteristics

Parameter	Value
I^{2}C node	slave
I^{2}C pull-up resistors (SCL and SDA)	none
I^{2}C logic level	3.3 V
I^{2}C series resistance (SCL and SDA)	100 Ω
I^{2}C repeater	none

4.2 COMMUNICATION PROTOCOL

Communication protocol with the SunSensor is based on a command - register approach. First byte of each transaction is always opcode. The opcode's most significant bit determine whether it is a command ('1') or data request ('0'). Moreover commands might be followed by parameters bytes.

Single command is responsible for measurement trigger with particular parameters (see Table 4-2). There are several registers (see Table 4-3), that are accessible by the I2C master device in read mode.

4.2.1 COMMANDS

Table 4-2 Command list of the SunS

Command	Opcode	Parameter	Parameter
Trigger measurement with parameters	0x80	Gain 0 - 3	ITIME 0 - 255

Maximum time of command execution is dependent on ITIME value and vary from 100 ms up to 1 s.

4.2.2 DATA REQUEST

It does not matter which address of the register will be requested by a opcode – the SunSensor always sends data starting at 0x00 'Status register'.

Table 4-3 Register map of the SunS

Address	Name	Description	Data type	Type	Physical interpretation
0x00	Status	bit 0: error state bit 1: new data bit 2-3: last reset source	bit field 8 bit	R	-
0x01	Who AM I	Fixed id value (TBD)	uint8_t	R	-
0x02	Azimuth angle		int16_t	R	milidegrees
0x04	Elevation angle		int16_t	R	milidegrees
0x06	Temperature A		int16_t	R	milidegrees Celsius
0x08	Temperature B		int16_t	R	milidegrees Celsius
0x0A	Temperature C		int16_t	R	milidegrees Celsius
0x0C	Temperature D		int16_t	R	milidegrees Celsius
0x0E	Temperature structure		int16_t	R	milidegrees Celsius
0x10	Gain	Gain of ALS sensors	uint8_t	R	raw
0x11	ITIME	Integration time of ALS sensors	uint8_t	R	raw
0x12	ALS 1A VL RAW		uint16_t	R	raw
0x14	ALS 1B VL RAW		uint16_t	R	raw
0X16	ALS 1C VL RAW		uint16_t	R	raw
0x18	ALS 1D VL RAW		uint16_t	R	raw

Address	Name	Description	Data type	Type	Physical interpretation
0x1A	ALS 2A VL RAW		uint16_t	R	raw
0x1C	ALS 2B VL RAW		uint16_t	R	raw
0x1E	ALS 2C VL RAW		uint16_t	R	raw
0x20	ALS 2D VL RAW		uint16_t	R	raw
0x22	ALS 3A VL RAW		uint16_t	R	raw
0x24	ALS 3B VL RAW		uint16_t	R	raw
0x26	ALS 3C VL RAW		uint16_t	R	raw
0x28	ALS 3D VL RAW		uint16_t	R	raw
0x2A	ALS 1A IR RAW		uint16_t	R	raw
0x2C	ALS 1B IR RAW		uint16_t	R	raw
0x2E	ALS 1C IR RAW		uint16_t	R	raw
0x30	ALS 1D IR RAW		uint16_t	R	raw
0x32	ALS 2A IR RAW		uint16_t	R	raw
0x34	ALS 2B IR RAW		uint16_t	R	raw
0x36	ALS 2C IR RAW		uint16_t	R	raw
0x38	ALS 2D IR RAW		uint16_t	R	raw
0x3A	ALS 3A IR RAW		uint16_t	R	raw
0x3C	ALS 3B IR RAW		uint16_t	R	raw
0x3E	ALS 3C IR RAW		uint16_t	R	raw
0x40	ALS 3D IR RAW		uint16_t	R	raw
0x42	Temperature A		uint16_t	R	raw
0x44	Temperature B		uint16_t	R	raw
0x46	Temperature C		uint16_t	R	raw
0x48	Temperature D		uint16_t	R	raw
0x4A	Temperature structure		uint16_t	R	raw
0x4C	ALS Status		uint16_t	R	-

Address	Name	Description	Data type	Type	Physical interpretation
0x4D	ALS 1A ID		uint8_t	R	-
0x4E	ALS 1B ID		uint8_t	R	-
0x4F	ALS 1C ID		uint8_t	R	-
0x50	ALS 1D ID		uint8_t	R	-
0x51	ALS 2A ID		uint8_t	R	-
0x52	ALS 2B ID		uint8_t	R	-
0x53	ALS 2C ID		uint8_t	R	-
0x54	ALS 2D ID		uint8_t	R	-
0x55	ALS 3A ID		uint8_t	R	-
0x56	ALS 3B ID		uint8_t	R	-
0x57	ALS 3C ID		uint8_t	R	-
0x58	ALS 3D ID		uint8_t	R	-

The SunSensor 7-bit I^2C slave address is TBD and might be easily changed according to the needs.

4.3 Communication via I^2C - Measurement procedure

Normally, the sensor is in an idle mode. Once a proper command (opcode) with arguments is written to the SunS, the sensor takes one measurement and saves data into its registers. During this process the data are not valid and shouldn’t be read. Completion of this operation is notified by the IRQ signal. Then the values in the data registers are ready to be read and the sensor goes in an idle mode. Data can be requested by the ‘data request’ opcode. The ‘new data’ flag bit in Status register is kept set till the first data read.