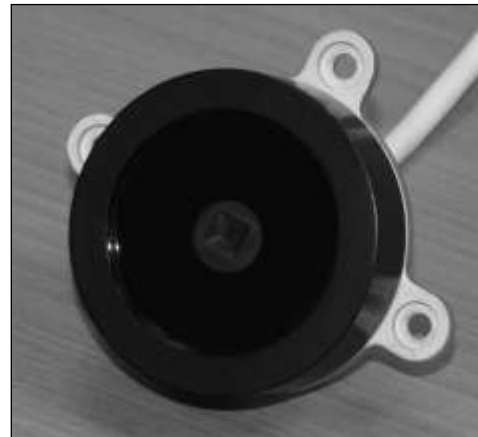


Solar MEMS Technologies S.L.

Sun Sensor ISS-AX
Analog sensor

Technical Specifications



Features

- Two orthogonal axes sun sensor*
- Wide or narrow field of view*
- High accuracy*
- 4 analog outputs*
- Low power consumption*
- Wide operating voltage range: 5÷12 V*
- Industrial temperature range: - 40° to 85°*
- Reduced size*
- Low weight*
- IP65 protection*
- Reverse polarity protection*

Applications

- Sun tracking/pointing systems*
- Solar Trackers*
- Heliostats*
- Photovoltaic*
- CSP, CPV and HCPV*
- Stirling*

ISS-AX sun sensor measures the incident angle of a sun ray in both orthogonal axes. The high sensitivity reached is based on the geometrical dimensions of the design.

Its characteristics make it a suitable tool for high accurate sun-tracking and positioning systems, with low power consumption and high reliability.

ISS-AX sun sensor has been designed with a unique and novel own technology based on MEMS fabrication processes to achieve high integrated sensing structures at low cost.

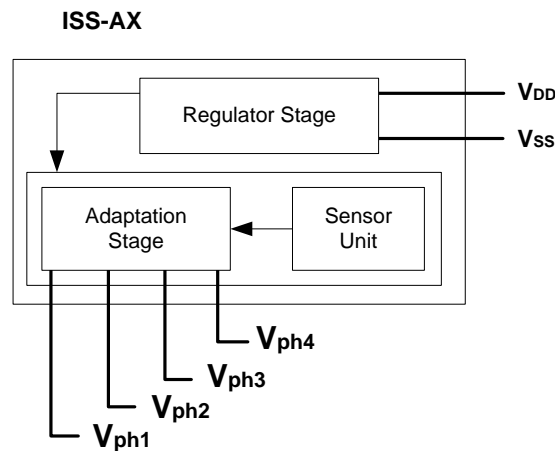


Fig 1. Block Diagram

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Responsibility exemption:

Solar MEMS has checked the concordance of this document with the described software and hardware. However, as it is impossible to exclude deviations, Solar MEMS is not liable for full concordance. Solar MEMS reviews this document periodically. If necessary, possible corrections will be included in the next version.

Solar MEMS is not liable for the correct operation of the system if the user does not follow the instructions of this document or use replacement parts that are not covered by this guarantee.

1. General Specifications

Parameter	ISS-A60	ISS-A25	ISS-A15	ISS-A5	Unit	Comments
Sensor type	2 axes	2 axes	2 axes	2 axes	-	Orthogonal
Field of view (FOV)	120	50	30	10	°	Aperture of the cone of view
Accuracy (*)	< 10	< 10	< 10	< 10	%	3σ
Precision (*)	< 0,06	< 0,04	< 0,02	< 0.01	°	Sensitivity
Average consumption	9	9	9	9	mA	
Dimensions						
Diameter	80	80	80	80	mm	
Height	27	27	27	27	mm	
Weight	100	100	100	100	g	
Level of protection	IP65	IP65	IP65	IP65		CEI 60529 Standard
Expected life time of 10 years + Pressure test at 0,05 mbar and 25°C						

(*) Accuracy test in Laboratory: cable of 2 meters, collimated light source, radiation of 900 W/m², CAD resolution of 10 bits, and filter stage with sampling frequency of 50 Hz and bandwidth of 0,4 Hz.

Table 1. General Specifications

Different models of the ISS-AX are offered, differing in the field of view (FOV) of the sensor. The accuracy of the sensor is inversely proportional to the field of view. All these models have been tested on solar trackers with Solar MEMS Helios Controller.

2. Electrical characteristics

Symbol	Parameter	Min	Typical	Max	Unit
VDD	Supply voltage	5	5	12	V
IDD	Feed current	-	9	-	mA
Vph	Photodiode voltages (analog outputs)	0	-	4,5	V
Recommended					
VDD	Supply voltage	5	-	12	V
Vr	Supply voltage ripple	0	-	100	mVpp
TOP	Operating temperature	-40	-	85	°C
Absolute maximum					
VDD	Supply voltage	0	-	16	V
TOP	Operating temperature	-40	-	85	°C

Table 2. Electrical characteristics

Reverse polarity protection.

3. Sun Sensor ISS-AX

ISS-AX sensor measures the incidence angles of a solar radiation respect to its perpendicular. This information is provided through 4 analog outputs.

3.1. Description

ISS-AX measures the incidence angle of a sun ray in both axes, based on a quadrant photodetector device. The sunlight is guided to the detector through a window above the sensor. Dependent of the angle of incidence, the sunlight induces photocurrents in the four quadrants of the detector.

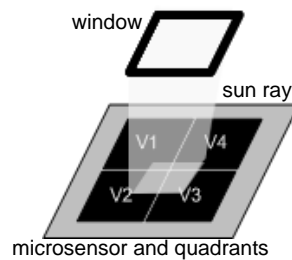


Fig 2. Microsensor of ISS-AX

3.2. Reference Axes

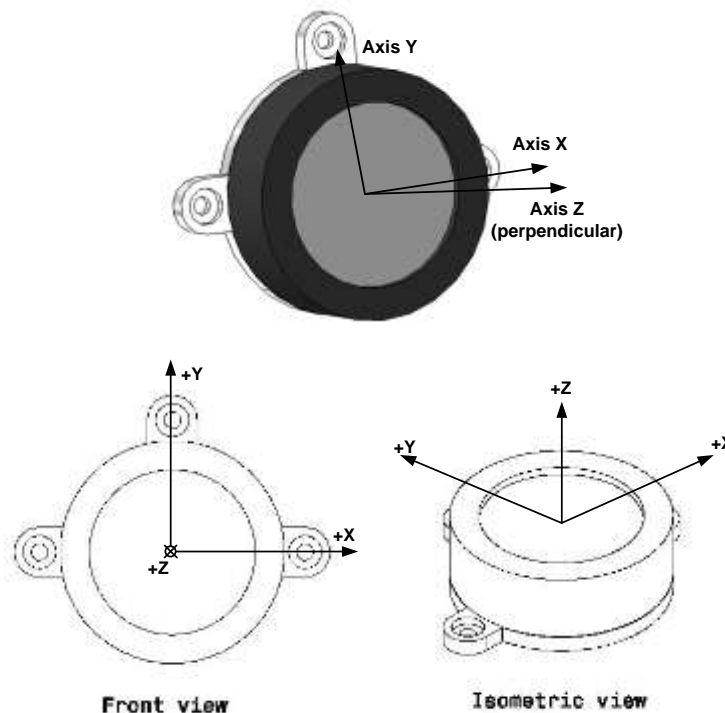


Fig 3. ISS-AX reference system

Z axis is perpendicular to the sensor base plane.

3.3. Measurements

The *Angle X* and *Angle Y* specify the angular position of the incident sun ray inside the field of view of the ISS-AX sensor.

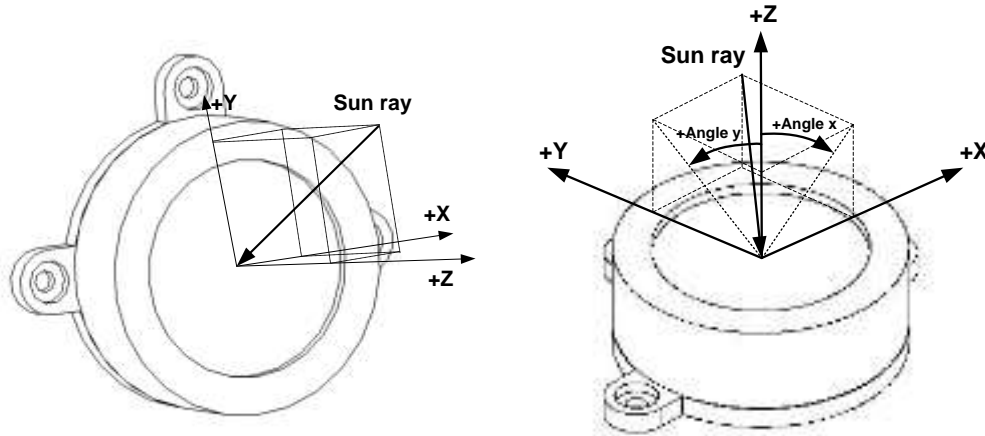


Fig 4. References for measured angles

Angle X and *Angle Y* of the incident ray can be obtained with a simple **set of equations** involving the four photodiode voltages generated by the sensor (V_{PH1} , V_{PH2} , V_{PH3} , and V_{PH4}):

$$X_1 = V_{PH3} + V_{PH4}$$

$$Y_1 = V_{PH1} + V_{PH4}$$

$$X_2 = V_{PH1} + V_{PH2}$$

$$Y_2 = V_{PH2} + V_{PH3}$$

$$F_X = \frac{X_2 - X_1}{X_2 + X_1}$$

$$F_Y = \frac{Y_2 - Y_1}{Y_2 + Y_1}$$

$$\text{Angle } X = \text{arctg}(C \cdot F_X)$$

$$\text{Angle } Y = \text{arctg}(C \cdot F_Y)$$

Type	Value
ISS-A60	1,889
ISS-A25	0,477
ISS-A15	0,273
ISS-A5	0,125

Table 3. Values of the parameter C according to the type of sensor ISS-AX (Geometric Correction)

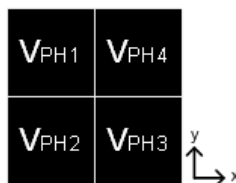


Fig 5. References for the photodiodes

The accuracy of the sensor increases when receiving a radiation perpendicular to the sensor, close to zero degrees in X and Y. This is an outstanding feature that makes it suitable for tracking applications. The **accuracy** can be **increased** in more than one order of magnitude by compensating the offset error after the installation of the sensor by means of **Calibration or Alignment**.

The use of a **filtering stage is recommended** (for example: 50 Hz sampling frequency and 0,4 Hz bandwidth).

4. Calibration or Alignment

Calibration process increases the accuracy of the ISS-AX sun sensor. The zero degrees position is the pair of angles X/Y that it is measured on the installation according to, for example, the maximum power generated of a CPV panel.

Example of calibration process: Solar Tracker:

1. Install the Sun Sensor ISS-AX on the tracker.
The sensor must be installed according to the solar panels, in the same plane, as well as possible. This will improve the use of the sun sensor field of view.
2. Control the solar tracking to get the maximum power generated.
Get the Angle X and Angle Y of the sun sensor ISS-AX. This pair will be your zero degrees position for the maximum power generation.
3. Control the solar tracker in closed-loop using your new zero degrees position of the ISS-AX sun sensor as reference: rectify the angles measured by the sensor according to this zero degrees position.

5. Recommendations

Depending on the application of the Sun Sensor ISS-AX, we recommend the use of the following models:

- Solar Tracker with Photovoltaic:
The accuracy requirements are not demanding, so it's recommended to **use the ISS-A60 model, to get a wide field of view.**
- Solar Tracker with CPV or similar:
The accuracy requirements are very demanding, so it's recommended to **use the ISS-A5 model, to get high accuracy and narrow field of view**, because a wide field of view increases the effects of the **environmental conditions** on the accuracy of the sun sensor: clouds effect and seeing of the ground.
- Other applications:
It depends on the demanding of the field of view and the accuracy.

6. Electrical interface

Colour	Terminal	Type	Comments
Red	VDD	Power	Power Supply
Blue	VSS	Power	Ground
Yellow	Vph1	Analog output	Photodiode 1: upper-left
Green	Vph2	Analog output	Photodiode 2: lower-left
Brown	Vph3	Analog output	Photodiode 3: lower-right
White	Vph4	Analog output	Photodiode 4: upper-right
Grey	Rtn	Analog reference	Signal return
Pink	-	-	Not connected
Shield	-	-	Connect to the blue wire

Table 4. Electrical interface

The housing of the sun sensor ISS-AX is isolated electrically.

7. Mechanical data

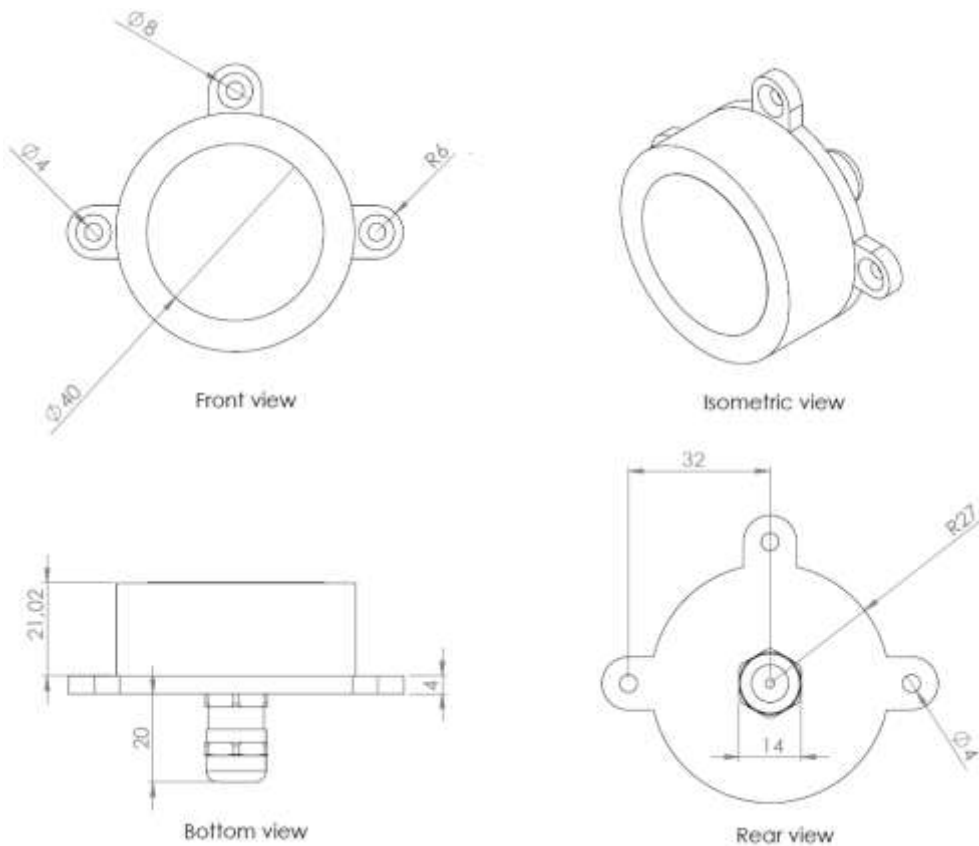


Fig 6. ISS-AX dimensions

The box of the ISS-AX sensor is composed of a top and bottom housing, both made of Aluminum 6082: it has good corrosion resistance. The top housing has a protective coating of anodizing and it is black lacquered, and the bottom housing has a protective coating of matt anodizing.

8. Warranty

Solar MEMS Technologies S.L. warrants the ISS-AX sun sensor to the original consumer purchaser any product that is determined to be defective for the following terms will be repaired, or replaced.

The warranty is one year from date of purchase.

The product in question must be sent to Solar MEMS Technologies S.L. (address is shown below) within the warranty period and the original consumer purchaser must comply with the following conditions, to be eligible for repair or replacement under this warranty:

- The product must not have been modified or altered in any way by an unauthorized source.
- The product must have been installed in accordance with the installation instructions and the technical specifications.

This limited warranty does not cover:

- Damage due to improper installation;
- Accidental or intentional damages;
- Misuse, abuse, corrosion, or neglect;
- Product impaired by severe conditions, such as excessive wind, ice, storms, lightning strikes or other natural occurrences;
- Damage due to improper packaging on return shipment.

Any and all labor charges for troubleshooting, removal or replacement of the product are not covered by this warranty and will not be honored by Solar MEMS Technologies S.L.

Return shipping to Solar MEMS Technologies S.L. must be pre-paid by the original consumer purchaser. Solar MEMS Technologies S.L. will pay the normal return shipping charges to original consumer purchaser within the European Union countries only.

Address of Solar MEMS Technologies S.L.

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Solar MEMS has a system of quality and environment according to the ISO 9001 and ISO 14001 standards, provided by the certification company Applus CTC.