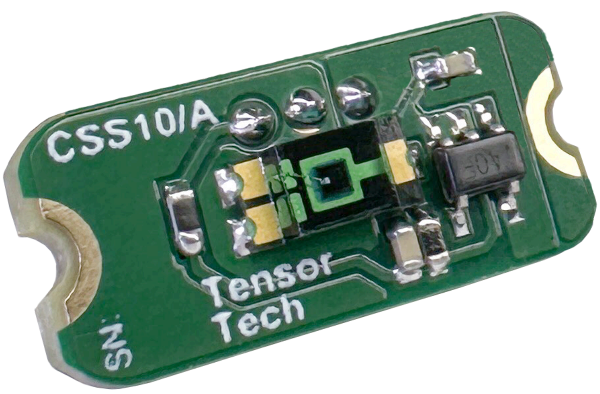
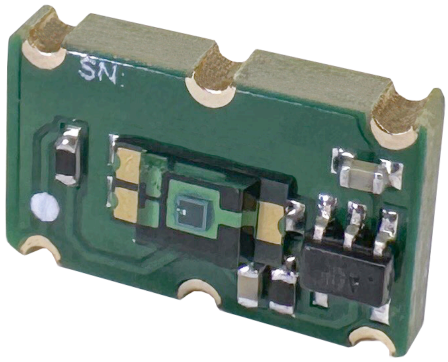
# Datasheet for Coarse Sun Sensor: CSS-10 and CSS-10S




CSS-10




CSS-10S

Release Approval:

| Reviser | Approver |
| --- | --- |
| | |

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# 1. INTRODUCTION

## 1.1 Description

The CSS-10, a coarse sun sensor tailored for spacecraft with minimal[1] pointing demands or those requiring a robust input for sun acquisition algorithms, boasts a simple and durable design. It generates analog signals directly correlated to solar irradiance. The user needs to configure the onboard computer (OBC) or the Attitude Determination and Control System (ADCS) computer's analog-to-digital converter to retrieve data from each CSS-10 sensor. The CSS-10 series offers two versions: **CSS-10** for direct mounting and **CSS-10S** for SMT installation.

Tensor Tech will generate the measurement report utilizing the AM0 solar simulator to authenticate each CSS-10 unit as a reference outcome for the user.

## 1.2 Features

- 1-axis analog coarse sun sensor
- Integrated transimpedance amplifier(TIA) with exceptional offset error
- Field of View: 120° (-60° to +60°)
- Wide operating temperature range: –40 to 100°C
- Output voltage: 0V to 2.4V
- Environmental Test reference NASA GEVS “GSFC-STD-7000B”
- Flight Heritage: since 2022

## 1.3 Block Diagram

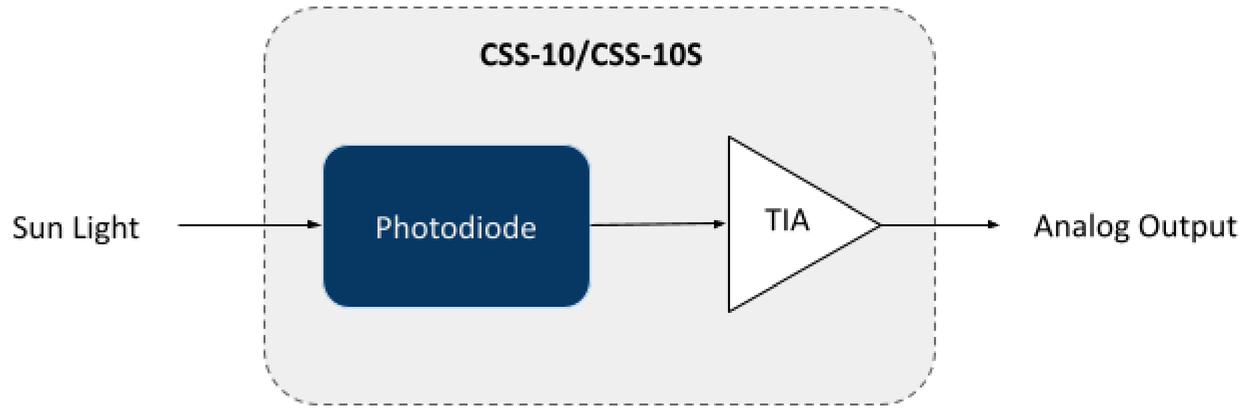


Figure 1-1. CSS-10 Block Diagram

[1] To optimize the sun sensor array's field of view, it is advisable to install multiple CSS-10 sensors on various facets of the satellite.

# 2. SPECIFICATIONS

| Parameter | Description | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| FOV | Field of View | - | 120 | - | ° |
| Accuracy | Incident light angle measurement error[2] | - | 5 | - | |
| Voltage | 3.3V Bus, Operating | 3.1 | 3.3 | 3.5 | V |
| | 3.3V Bus, Absolute Maximum | -0.4 | - | 6 | |
| Temperature | Operating | -40 | - | 100 | °C |
| | Absolute | -40 | - | 100 | |
| Radiation Hardness | | 10 | - | - | krad(Si) |
| Output Voltage | AM0 Solar Simulator irradiates on $\theta = 0°$ | - | 2.2 | - | V |
| Output Voltage Offset Error @100°C | | - | 0.1 | - | mV |
| Output Voltage Gain Error @100℃[3] | | - | 2 | - | % |
| Output Voltage Temperature Coefficient[4] $\alpha$ | | | +4.31 | | ΔmV/Δ℃ |

## 2.1 CSS-10

| Parameter | Description | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Mass | Total Mass | - | 0.5 | - | gram |
| Length | Dimensions | - | 13 | - | mm |
| Width | | - | 6 | - | mm |
| Height | | - | 7.05 | - | mm |

[2] Additional details are available in the CSS calibration table.
[3] With temperature coefficient compensation.
[4] For achieving the best calibration results, please refer to the calibration table for each CSS-10 and perform temperature compensation accordingly.

## 2.2 CSS-10S

| Parameter | Description | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Mass | Total Mass | - | 0.4 | - | gram |
| Length | Dimensions | - | 10 | - | mm |
| Width | | - | 6 | - | mm |
| Height | | - | 2.85 | - | mm |

## 2.3 Typical Directivity

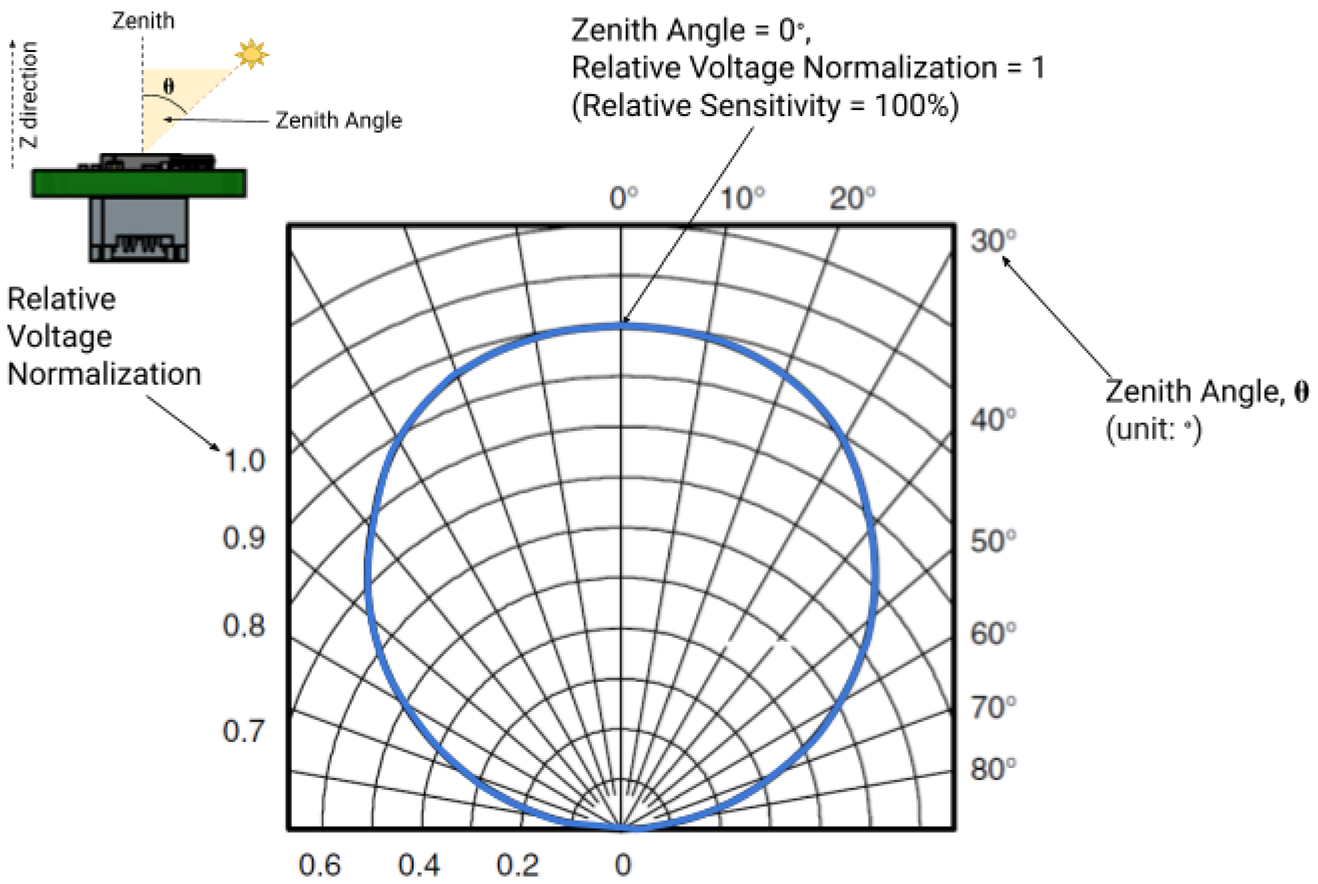


Figure 2-1. Typical Relative Sensitivity

# 3. APPLICATION NOTE

## 3.1 Lookup Table for Angle Determination

Figure 3-1 introduces an example graph depicting Vout vs. Zenith Angle in the measurement report generated by Tensor Tech. The AM0 solar simulator is employed to authenticate each CSS-10 unit, establishing it as a reference outcome for the user.

| Zenith Angle (unit: °) | Vout @60℃ (unit: V) |
|---|---|
| 0 | 2.0737 |
| 5 | 2.0658 |
| 10 | 2.0442 |
| 15 | 2.0102 |
| 20 | 1.9592 |
| 25 | 1.891 |
| 30 | 1.8058 |
| 35 | 1.6987 |
| 40 | 1.5854 |
| 45 | 1.4701 |
| 50 | 1.3486 |
| 55 | 1.2313 |
| 60 | 1.0999 |

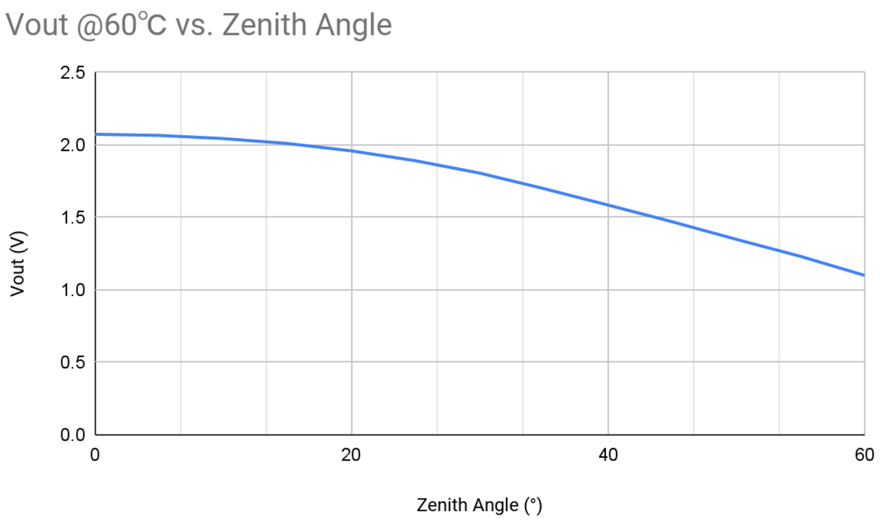


Figure 3-1. Example of Vout @60℃ vs. Zenith Angle

The horizontal axis in Fig 3-1 corresponds to the zenith angle, representing the angle between the actual sun (i.e., the direction of the light source illuminating the photodiode) and the zenith. Here, the zenith serves as a reference point along the CSS-10's Z-axis.

The vertical axis in Fig 3-1 corresponds to Vout, which represents the directly measured voltage from the output pin.

## 3.2 Temperature Compensation

The PIN photodiode utilized in the CSS-10 demonstrates high linearity with respect to temperature and output voltage. This characteristic enables the user to enhance accuracy by compensating for the output voltage prior to referencing the lookup table.
After obtaining the measured values for $V_{out}$ and $T$, the user can utilize Eq. 3-1 to determine the temp-compensated output voltage, $V_{out\text{-}comp.}$. This calculation involves known parameters $\alpha$ and $T_0$.

$$V_{out\text{-}comp.} = V_{out} - \alpha\,(T - T_o) \qquad \textit{Equation 3-1}$$

$V_{out\text{-}comp.}$ : temperature compensated output voltage (unit: V)

$V_{out}$ : measured output voltage (unit: V)

$\alpha$ : output voltage temperature coefficient (refer to the specification table in Ch. 2)

$T$ : measured temperature (unit: °C)

$T_0$ : designated temperature[5] (unit: °C)

The resulting value of $V_{out\text{-}comp.}$ shall be closely aligned with the corresponding value of $V_{out}$ @ designated temperature $T_0$ (ex. $V_{out}$ @60°C) in the lookup table of the reference report provided by Tensor Tech.

# REVISION HISTORY

| Date | Editor | Version | Contents |
|---|---|---|---|
| 2024.02.06 | S. Lee, Z. Liu,<br>C. Hu, A. Wang,<br>A. Chen, A. Huang | 1.0.0 | Initial release |

[5] The designated temperature will be addressed in the reference report of CSS-10 provided by Tensor Tech.