Dual Axis Sun Tracker with AnalogPAK SLG47004V

Contents

1. References

For related documents and software, please visit:

https://www.renesas.com/eu/en/products/programmable-mixed-signal-asic-ip-products/greenpak-programmable-mixed-signal-products/other-greenpaks/slg47004-greenpak-programmable-mixed-signal-matrix

Download our free GreenPAK Designer software [1] to open the .gp files [2] and view the proposed circuit design. Use the GreenPAK development tools [3] to freeze the design into your own customized IC in a matter of minutes. Find out more in a complete library of application notes [4] featuring design examples as well as explanations of features and blocks within the GreenPAK IC.

[1] GreenPAK Designer Software, Software Download and User Guide
[2] AN-CM-380 Dual Axis Sun Tracker with AnalogPAK.aap, GreenPAK Design File
[3] GreenPAK Development Tools, GreenPAK Development Tools Webpage
[4] GreenPAK Application Notes, GreenPAK Application Notes Webpage
[5] SLG47004V Datasheet
[6] Dual Axis Sun Tracker with AnalogPAK Video

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2. Terms and Definitions

BDC Motor	Brushed Direct Current Motor
I^2C	Inter-integrated circuit (bus)
LED	Light-emitting diode
MF	Multi-Function Macrocell
OpAmp	Operational Amplifier
PCB	Printed circuit board
Vref	Voltage reference

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3. Introduction

Solar trackers are an especially suitable application of AnalogPAK devices, as they can be used in tracking systems in both industrial solar power plants and small home solar charging stations, and have a low price, are available in a small package, and have low energy consumption.

4. Operation of the Dual Axis Sun Tracker

This application note uses two AnalogPAK chips (SLG47004) with identical designs - one for the horizontal axis and one for the vertical axis (Figure 1, Figure 2).

Two SLG47004 ICs detect the maximum light intensity point and rotate two BDC motors in two axes using a linear voltage regulator with electro-mechanical feedback. The circuit design uses operational amplifiers, analog comparators, analog switches, and other basic configurable blocks available in the SLG47004. Both regulation direction and sensitivity tuning of four photoresistor sensors can be regulated using just a switch and button, respectively. Thanks to the sensor sensitivity regulation, the device won't be affected by other light sources such as room lights as long as the light source is not directed toward the sensors assuring that the device doesn`t move. Currently, the energy which is accumulated by the solar panels is not used in this revision of the design, but potentially can be modified to work as a solar cell phone charger as well.

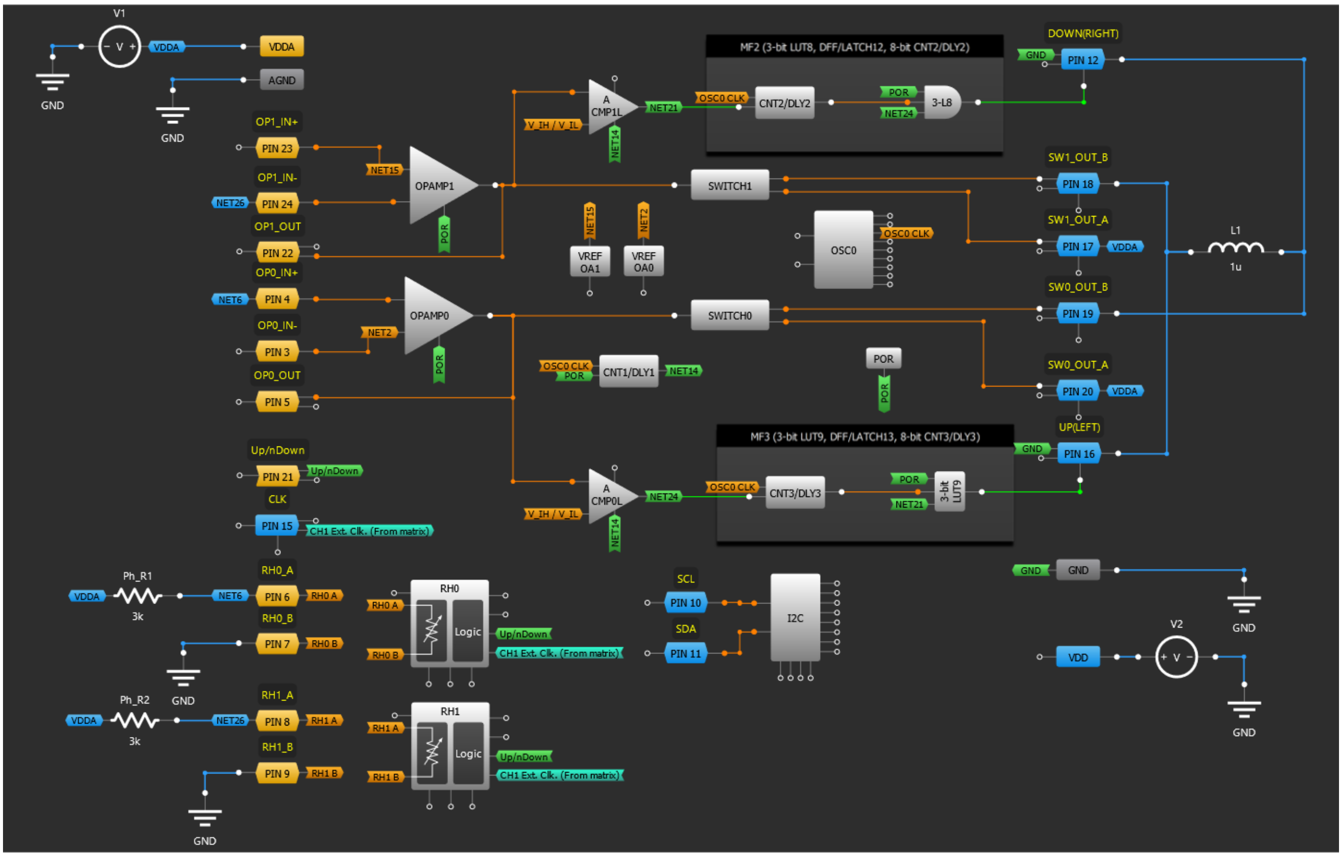

Figure 1. Single Axis Design Block Diagram

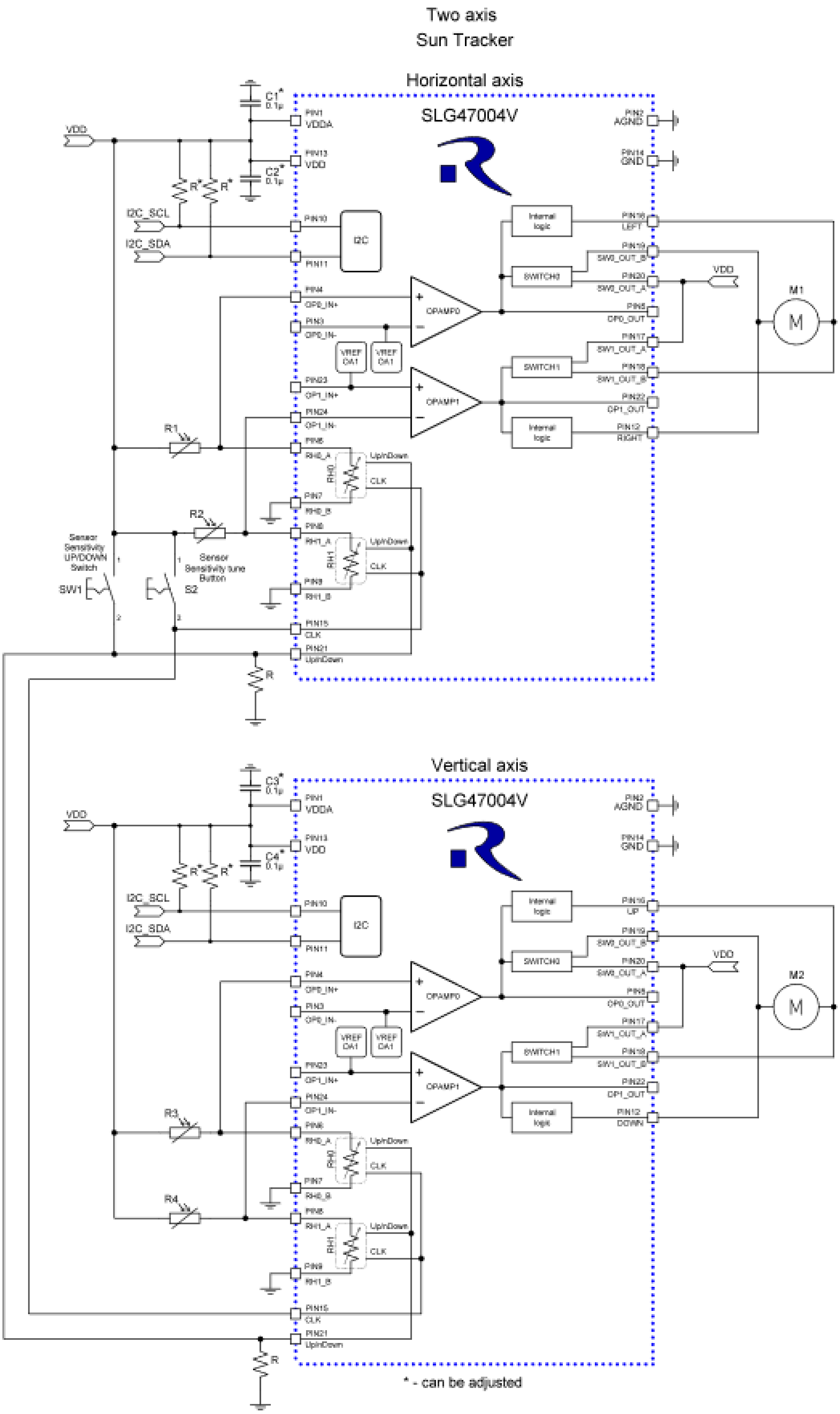

Figure 2. Dual Axis Sun Tracker Application Circuit

To rotate the model of the sun tracker in the up/down and right/left directions, BDC motors (B10-27-B-04) with a reduction gear are used as drives, which are directly controlled by internal analog switches SWITCH0 and SWITCH1.

Two resistive dividers with a photoresistor (PGM5506) on the high-side of the divider, and an internal rheostat on the low-side of the divider are used as a light detector on each axis. The use of internal rheostats allows for the adjustment of the sensitivity of the light detector by changing their resistances using switch SW1 and button S2 (Figure 2).

To determine the rotational direction of the tracker on the light detector, an X-shaped mask is used. When the light source is moved, the mask shades the photoresistors from the side, opposite to the direction of movement of the light source (Figure 5 - Figure 9).

A full bridge (SWITCH0 - PIN12 and SWITCH1 - PIN16) is used to drive the BDC motors on each axis of rotation. The voltage on which is set in linear mode is determined by two voltage regulators (OpAmp0 and OpAmp1 with VREF OA0 and VREF OA1) with electromechanical feedback made on resistive dividers R3 and R4.

- R3 (photoresistor): RH0 (internal rheostat) for OpAmp0
- R4 (photoresistor): RH1 (internal rheostat) for OpAmp1.

Analog comparators ACMP0 and ACMP1, with multifunctional macrocells MF2 and MF3 (which function to act as protection from dead time to prevent shoot-through of the full bridge), are used to determine the direction of rotation of the BDC motor (the direction of opening of the full bridge).

5. Development of a Test Sample of the Sun Tracker

A test sample was developed, manufactured, and tested to verify the the practical application of the design.

The PCB was designed as a double-sided 60 mm diameter circular shape (Figure 3, Figure 4, and Figure 5).

The Top side of the board consists of two AnalogPAK SLG47004V devices and a 4-pin connector for power supply (VDD, GND) and transmission of I²C commands (SCL, SDA, for the device testing and commissioning). The rest of the elements, except for the power connector, are also placed on the Top side.

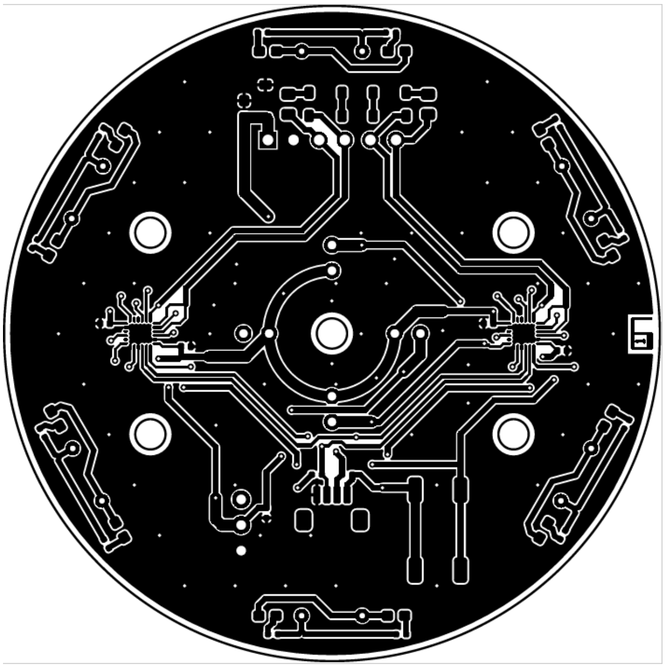

Figure 3.Top Side of PCB

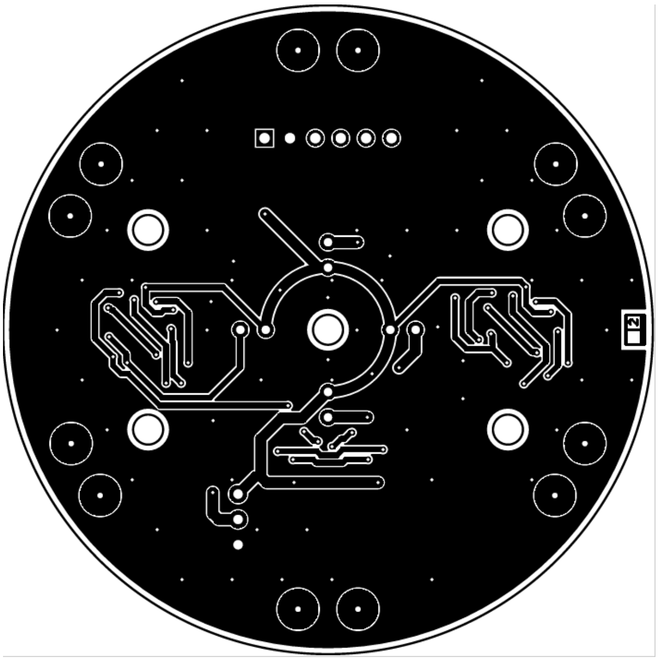

Figure 4. Bottom Side of PCB

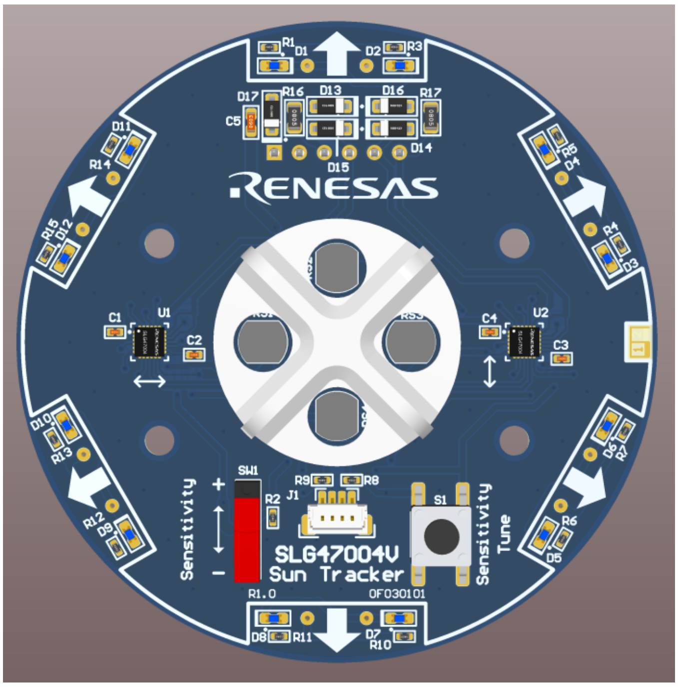

Figure 5. View of Top Side of PCB During Modelling

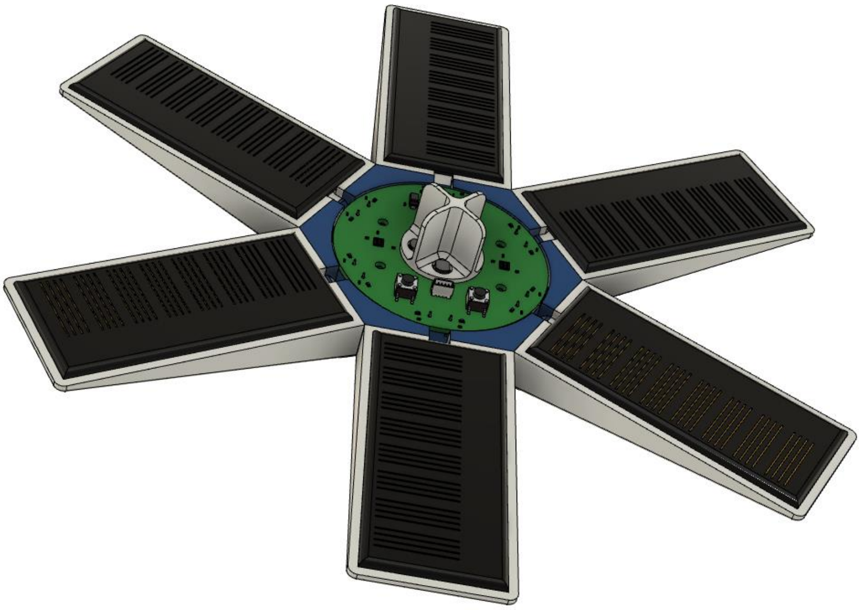

Figure 6. View of Front Side of the Sun Tracker During Modelling

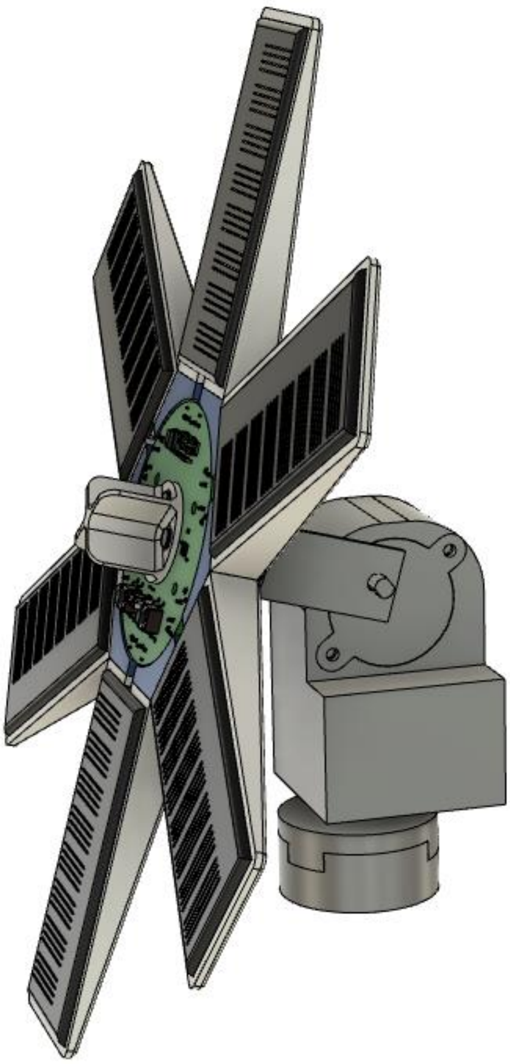

Figure 7. Side view of the Sun Tracker During Modelling

Figure 8. Front View of the Finished Model of the Sun Tracker

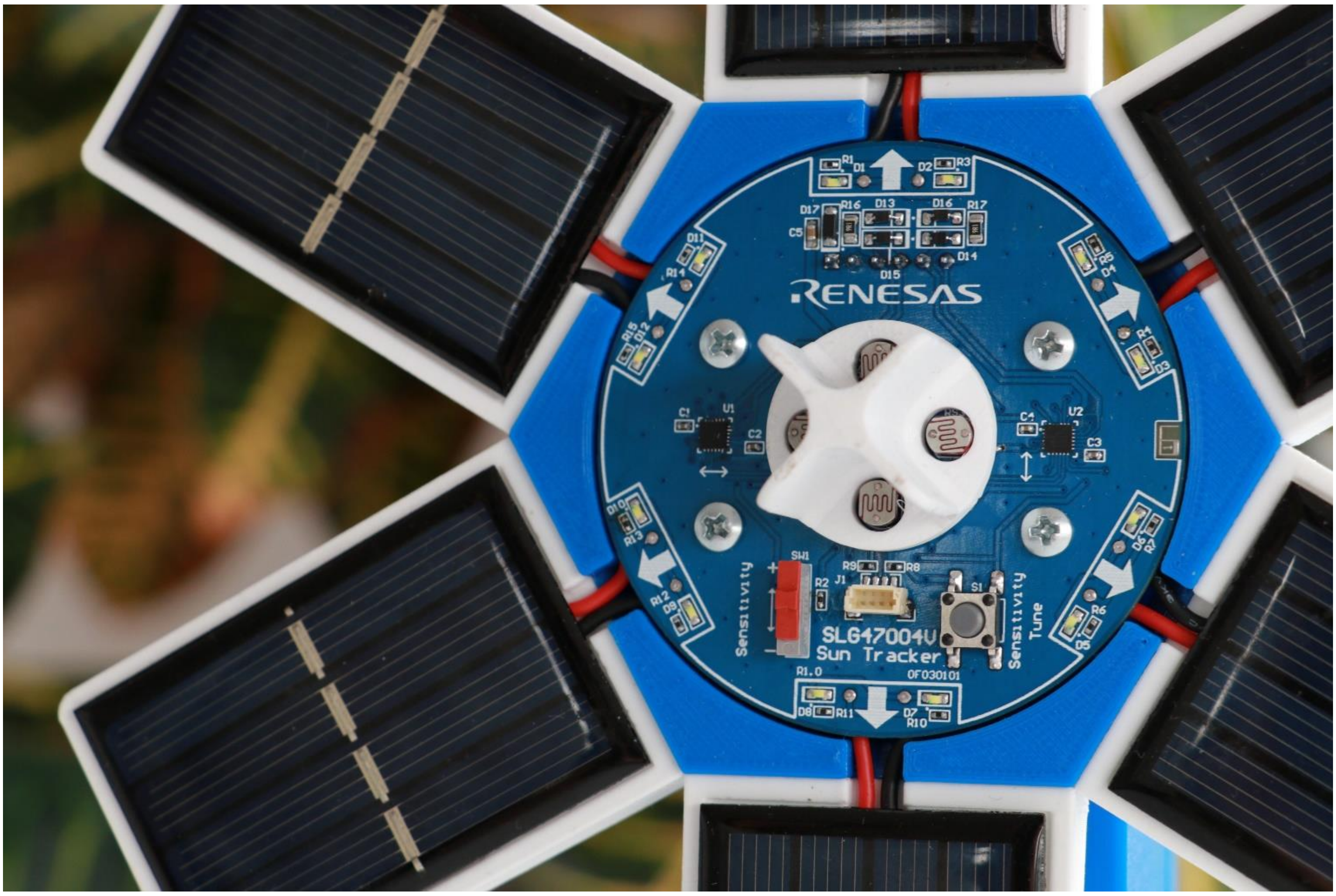

Figure 9. Zoomed-in Front View of the Finished Model of the Sun Tracker

The **Dual Axis Sun Tracker** model is made in the form of a flower with petals made of solar cells on an aluminum tripod, the head of which rotates to follow the sun or other light source (Figure 6, Figure 7, Figure 8, and Figure 9).

The operation of the **Dual Axis Sun Tracker** can be viewed in the accompanying video "Dual axis Sun Tracker with AnalogPAK".

6. Conclusion

In this Application Note, the feasibility of using AnalogPAK as the main or auxiliary control element in both domestic and industrial tracking systems is considered and tested on a test model.

The proposed **Dual Axis Sun Tracker** design can be successfully used as a demoboard to demonstrate the capabilities and functionality of AnalogPAK from Renesas.

After some refinement, the **Dual Axis Sun Tracker** can be used as a portable solar charger for pocket power banks, smartphones, and other small gadgets.

In addition, the **Dual Axis Sun Tracker** can be adapted for use in the solar tracking systems of industrial solar power plants.

7. Revision History

Revision	Date	Description
1.00	August 29, 2024	Initial release.

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