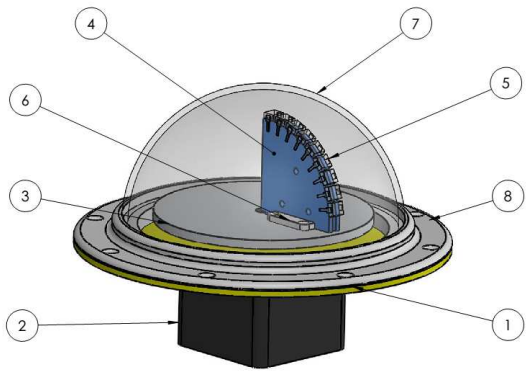
5th European Symposium on Super Capacitors & Hybrid Solutions
April 23-25, 2015

OPTIMAL POSITION SENSOR FOR ORIENTATION OF PHOTOVOLTAIC PLANTS

R. K. Popov*, S. Lishev*, A.Georgiev**
*Dept. of Optoelectronic and Laser Technique, Technical University of Sofia, Branch Plovdiv, 4000 Plovdiv, Bulgaria,
** Dept. of Mechanics, Technical University of Sofia, Branch Plovdiv, 4000 Plovdiv, Bulgaria

Abstract

The produced volume of an electrical energy in non-concentrated, photovoltaic plants may significantly increase if the panel orientation is changing, to follow the optimal position. There are a number of methods and sensors, used to find the PV panel optimal orientation, which depend not only on sun position, but on sky (sun) insulation factors, too. In some cases the diffuse component of the solar radiation produces much more electricity, then direct one. In this article sensor for direct, real time measurement of an optimal PV plant orientation position is proposed. The principal of operation is based on full sky scanning procedure that allows finding in real time an optimal inclination and azimuth angles. It uses a rotating sensor array scanning the sky, which has 9 silicon PV sensors (Fig. 8), mounted at different tilt angles (10, 20, 30, 40, 50, 60, 70, 80 and 90 degrees) from the horizon. The PCB assembly is fixed on the top of the rotating disk 3 by the PCB support 6. Stepper motor 2 is rotating the disk and the sensor array. The inside area is covered by the quartz glass cover in case to protect sensors by the environment conditions. The optimal position angles (elevation and azimuth) are determined by the comparison of the signal levels, detected from the sensor array in a whole turn data frame. This process is controlled by PIC24FJ128GA010 microcontroller using Microchip's Explorer 16 development board. It has various interfaces, including digital I/O, serial UART module, ADC inputs and USB device module. RAM memory is 8K bytes and is sufficient for storing input values from readings. PV sensor array is connected to 9 channel transimpedance amplifier for amplification and signal level matching and then to analog-to-digital module of the microcontroller. The ADC module is high-speed, pipelined 12-bit A/D converter. The microcontroller unit performs measurement and control algorithm and allows calculated data through RS485 interface connection. At every step MCU reads PV sensors array signals and finds the maximum value. At the end of the rotation the algorithm finds the maximum value of all and interpolates with its near sensor value to find the exact optimal angle of elevation. The azimuth resolution is set to 0,9 degree and match to a half step size of the stepper motor.



ITEM No.	DESCRIPTION	QTY.
1	Stepper Motor Base	1
2	Stepper Motor	1
3	Rotating Disk	1
4	Printed Circuit Board	2
5	Silicon PV Sensor	9
6	PCB Support	1
7	Quartz Glass Cover	1
8	Plastic Ring	1

Figure 8. The mechanical part of the optimal PV plant orientation sensor

REFERENCES (SELECTION)

[1] Ritchie, E., Argeseanu, A., Leban, K. Robust Solar Position Sensor for Tracking Systems. Proc. of the 9th WSEAS Int. Conf. on POWER SYSTEMS, ISSN: 1790-5117, ISBN: 978-960-474-112-0, 49-54.

[2] Roth, P., Georgiev, A., Boudinov, H. Design and construction of a system for sun-tracking. Renewable Energy. 29 (3), 393-402 (2004).

[3] Roth, P., Georgiev, A., Boudinov, H. Cheap two-axis sun-following device. Energy Conversion and Management. 46 (7-8), 1179-1192 (2005).

[4] J.C. Sáenz-Díez Muro1, E. Jiménez Macías1, J.M. Blanco Barrero1, J. Blanco Fernández. Optimal orientation procedure of photovoltaic solar systems through the use of a multicellular photovoltaic sensor. Proc. of the Int. Conf. on Renewable Energies and Power Quality (ICREPQ'12), Santiago de Compostela (Spain), 28th to 30th March (2012).