COMPUTER-AIDED DESIGN SYSTEMS

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COMPUTER-AIDED DESIGN OF MOTOR DRIVER FOR SOLAR POWER PLANT

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Abstract—*The descriptive structure and implementation of motor driver for solar power plant is proposed. Several ways for future optimization reviewed.*

Index Terms—Computer-aided design; solar power plant; solar panels; motor driver.

I. INTRODUCTION

The main problem of each solar panels in context of energy production is efficiency. As we know, there is direct dependency between the angle of incidence of silicon solar panels during the day at sunlight and the density of incident sunlight, those things are very important for actual power of solar panels and their output charging current value. According to those facts solar power plants with fixed position regarding to the sun beams brings less output energy then the same installed silicon solar panels on the power plant with sun tracing mechanism.

With this kind of control mechanism (or rotation mechanism) we can always, during the day, keep our solar platform with silicon panels toward the angle of inclination and directions of sun's beams.

Through the use of this rotation mechanism with solar panels and regulation of the sun's beams angle to those panels during movement of the sun across the sky, it is possible to achieve noticeable increase in the efficiency of solar cells.

This kind of "improvement" of solar power plant in comparison with fixed position plants can be very meaningful at the characteristics of electricity production through the year from 10 % and up to 40 %.

This means that system for rotation purposes must have motor drivers or motor controllers and this part of whole system could be as very effective or ineffective.

II. DESCRIPTIVE MODEL BASED ON SOLAR POWER PLANT WITH MOTOR DRIVER

For the deepest understanding of motor driver purposes and responsibilities we need to start from review a general view of solar power plant (Fig. 1).

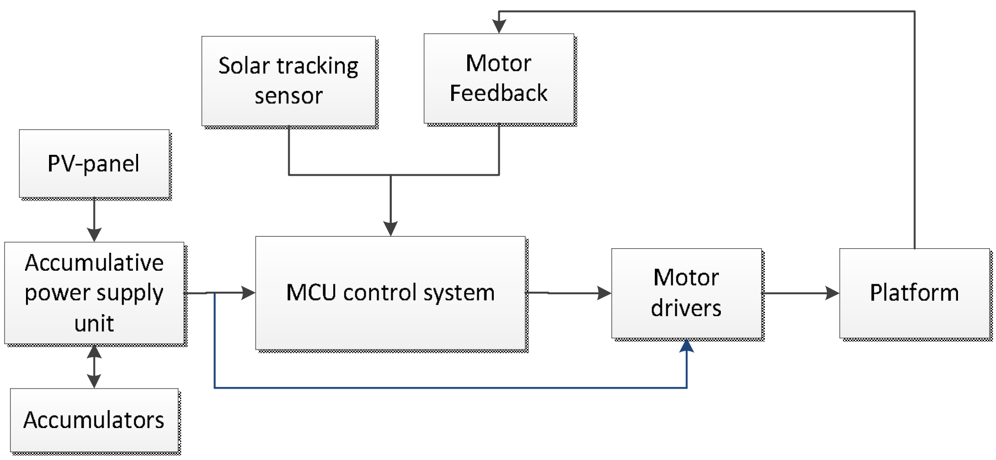

Fig. 1. Structural scheme of solar power plant: PV is photovoltaic panel; MCU is microcontroller unit

Solar power plant consists of such main structural blocks:

– Accumulative power supply;
– microcontroller unit control system;
– motor drivers;
– feedback subsystem.

Each individual structural block can be considered as an independent component of the system in general, which may at any time be replaced by a more perfect or improved, or some blocks could be combined for best performance for specific context.

For future considerations about motor drivers we could illustrate general view of this structural block that represents motor driver with additional subsystems that needed for fully functional control of power plant in general view (Fig. 2).

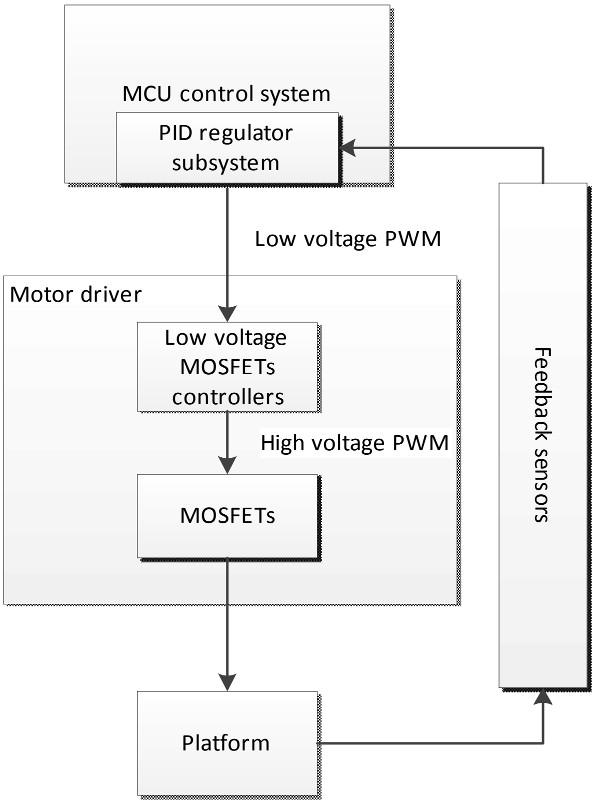

Fig. 2. Structural scheme of motor driver: PID is proportional-integral-derivative controller; PWM is pulse-width modulation

III. Problem statement

To achieve the goal of solar power plant efficiency we could use different techniques.

First of all, first part of the problems is main control system design, which must fulfill criteria of minimizing the error angle between the sun and the normal angle of platform.

Second step expects that control system works in efficient way and motor driver consists following criterias:

– performance;
– energy consumption efficiency;
– accuracy;
– speed.

Performance and energy consumption efficiency could be acquired through modern microelectronics base and good design of printed circuit board (PCB) schematic and parts that perfectly fit to specific motor. Accuracy and speed could be made through using calibrated and optimal PID regulators that programmed at MCU's control system.

IV. Design of motor driver

To ensure control of motor drivers those drivers implement classical *H*-bridge circuit (Fig. 3) for each physical driver, with two semi-bridge controllers.

This kind of control schematic will give a robust control for motor driver.

Semi-bridge controllers are used in pairs with MOSFETs to provide must efficient way to control them. Each controller provide ability to manipulate left or right part of *H*-bridge (S1+S2 or S3+S4) separately by low-level logical signals from microcontroller unit.

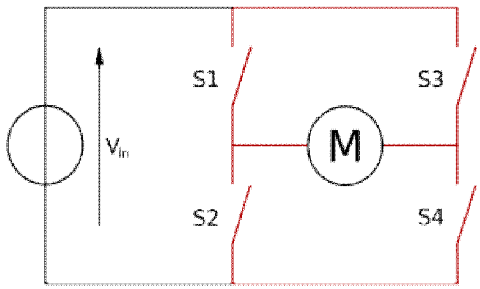

Fig. 3. General schematic of *H*-bridge

In general main logic of *H*-bridge could be described when the switches S1 and S4 (according to figure) are closed (and S2 and S3 are open) a positive voltage will be applied across the motor. By opening S1 and S4 switches and closing S2 and S3 switches, this voltage is reversed, allowing reverse operation of the motor.

When all main aspects of design are done, we can use many useful CAD/CAM instruments to create and prepare schematics, gerbers for production. For example, at the Fig. 4 we use tracing utility that provide by MentorGraphics Expedition Flow, which we used for develop motor control driver. This system provides all instruments for full production flow that starting from schematics of PCB and ends with technical documentation and helper files for manufacturing.

V. Possible improvements

As main improvement at future we can propose to embed additional microcontroller into motor driver PCB and provide it with PID regulator and software that could calibrate it on the fly. Reduce control options of main MCU by moving motor feedback logic to embedded microcontroller at motor driver, that will needed for PID.

These actions will create new high-level controllable motor driver, which has inside perfectly encapsulated control logic. It will give much easier to implement positioning algorithms, because it could be controlled in “go right by 5 degrees” manner.

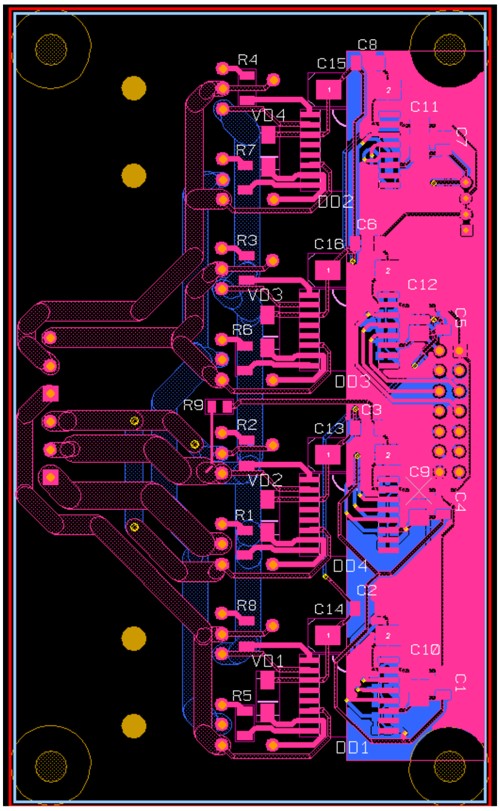

Fig. 4. Motor driver PCB created at MentorGraphics

VI. Conclusions

Developed type of motor control driver satisfies not only task for sun tracking solar power plant, but could be used at much wider context, such as robotics, avionics etc.

This driver gives ability to build at result robust control system for solar power plant that could be used efficiently by different criteria such as energy consumption, that is very critical for this development, and with sufficiently controlled speed and accuracy at output.

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В. М. Синєглазов, Д. П. Карабецький. Системи автоматизованого проектування сонячної електростанції

Запропоновано описову модель сонячної енергетичної установки. Визначено прямі втрати потужності в залежності від кута неузгодженості. Розроблено алгоритм керування сонячної електростанції.

Ключові слова: система автоматизованого проектування; сонячна електростанція; сонячні батареї; алгоритм стеження за сонцем.

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В. М. Синеглазов, Д. П. Карабецкий. Системы автоматизированного проектирования солнечной электростанции

Предложена описательная модель солнечной энергетической установки. Определены прямые потери мощности в зависимости от угла рассогласования. Разработан алгоритм управления солнечной электростанции.
Ключевые слова: система автоматизированного проектирования; солнечная электростанция; солнечные батареи; алгоритм слежения за солнцем.

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Направление научной деятельности: аэронавигация, управления воздушным движением, идентификация сложных систем, ветроэнергетические установки.
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