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FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING

FINAL YEAR PROJECT REPORT

TITLE: MPPT SOLAR CHARGE CONTROLLER WITH AUTOMATIC DC LOAD MANAGEMENT FOR STANDALONE SOLAR SYSTEMS.

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A final year project report submitted to the Department of Electrical Engineering in Partial Fulfillment of the Requirements for the Award of a Bachelor's Degree in Electrical Engineering of Busitema University.

JUNE 2024

DECLARATION

I hereby declare that this project report is my original work except where explicit citation has been made and has never been published and/or submitted for any other degree award to any other university or institution of higher learning for any academic award.

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APPROVAL

This is to certify that this project report has been compiled by NGOBI JOHNSON Registration Number **BU/UP/2020/1232** under the supervision and guidance of the University supervisors. It is now ready for submission to the Department of Electrical Engineering.

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LIST OF ACRONYMS

IncCond: Incremental Conductance

LCD: Liquid Crystal Display.

MPPT: maximum power point tracking

P&O: perturb and observe

SCC: Solar charge controller

SDM: single diode model

EAGLE: Easily Applicable Graphical Layout Editor

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ABSTRACT

This paper describes the design and prototype of a solar charge controller with two key features: Maximum Power Point Tracking (MPPT) and automatic DC load management. The MPPT system continuously tracks the solar panel's peak power output using a DC-DC buck converter and an Arduino Nano microcontroller. The automatic DC load management selectively switches on and off different loads based on the voltage of a 12V, 7Ah battery. The Arduino Nano implements the MPPT algorithm using the Perturb and Observe method. To verify the system's effectiveness, we performed simulations in a Proteus environment and built a hardware prototype. The system incorporates several protective measures to safeguard against various issues: reverse polarity, under/over battery charge/discharge, short circuits, and open circuits. These protections are achieved using 10A fuses, IRFZ44N MOSFETs, and P6KE36CA diodes placed at both the input and output of the system. The final design can handle a maximum current of 10A at 12V voltage.

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CHAPTER ONE

1.1 BACKGROUND

The energy demand of the country increases with respect to growth and development. Along with this energy generation should be eco-friendly and from renewable energy sources. Solar energy plays an important role as a primary source of energy, especially for rural areas. The worldwide rising level of pollution has formed a threatening situation due to our enormous reliance on traditional energy sources. The expanding demand for electricity cannot be fulfilled by conventional energy sources, so it's time to use renewable energy sources for the generation of electrical energy. Also burning fossil fuels leads to atmospheric damage like unexpected climate changes, global warming, etc. There is a growing need for renewable energy sources such as solar, hydro, tidal, geothermal, wind, etc. in the current situation. Solar energy is one of the good alternatives to fossil fuel energy[1].

Among the different renewable energy resources solar energy is in the lead. This is due to the wide range of the energy supply from solar energy from a few watts to several megawatts. Solar energy is plentiful; it has the greatest availability compared to other energy sources. The amount of energy supplied to the earth in one day by the sun is sufficient to power the total energy needs of the earth for one year[2].

There are two types of solar energy utilization technologies, namely thermal solar energy and photovoltaic solar energy. Photovoltaic solar energy technology is a technology of utilizing solar energy by converting that energy into an electric current by using a semiconductor device called a solar cell[3]. Photovoltaic electricity generation offers the benefits of clean, non-polluting energy generation, production of energy close to the consumer, very little or no maintenance requirement, and of having a very long lifetime[4][2] .

Despite the need and rapid expansion of solar energy uses, the non-linearity characteristics of the solar cells pose a major challenge to harness maximum power from the solar cell. In particular, the current-voltage (I-V) and power-voltage (P-V) characteristic curves of the solar photovoltaic (PV) system exhibit a non-linear property that highly depends on solar irradiance, temperature, and electrical characteristics of the connected load. Thus, the current and voltage vary the maximum output power of the PV system depending on the prevalent variation in solar irradiation and temperature. This non-linear nature of the PV panel lowers the energy

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