IMPLEMENTATION OF WIRELESS MONITORING SYSTEM ON THE PERFORMANCE OF 48V DC-DC BOOST CONVERTER IN PHOTOVOLTAIC SOLAR ENERGY

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by

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LIST OF ABBREVIATIONS

AC	Alternating current
ADC	Analogue to digital converter
A/D	Analogue to Digital
ADCON	A/D Control Register
ANSEL	Analogue Select Register
ASIC	Application-Specific Integrated Circuit
ASK	Amplitude Shift Keying
BJT	Bipolar Junction transistor
bps	bit per second
BR	Baud-Rate
BS	Base Station
CCM	Continuous conduction mode
CMOS	Complementary metal oxide semiconductor
CPU	Central Processing Unit
DC	Direct current
DCM	Discontinuous conduction mode
EAS	The rating for avalanche energy
EEPROM	Electrically erasable programmable read only memory
ESR	Equivalent series resistance
GTO	Gate-turn-off thyristor
GHz	Giga Hertz

GUI	Graphical User Interface
IC	Integrated circuit
IGBT	Insulated gate bipolar transistor
IDC	Idiopathic Dilated Cardiomyopathy
IDE	Integrated Development Environment
k	kilo
kΩ	kilo ohm
kB	kilo Byte
kb	kilo bit
kbps	kilo bit per second
kHz	kilohertz
LTC	Linear Technology Center
MCT	MOS-controlled thyristor
MOSFET	Metal oxide silicon field effect transistor
M	meter
mA	milli Ampere
mAh	milli Ampere hour
MCLR	Master Clear
MCU	Microcontroller
MHz	Mega Hertz
mJ	milli Joules
mm	milli meter
ms	milli second

mW	milli Watt
PCB	Printed circuit board
PV	Photovoltaic
PBP	PicBasic Pro
PC	Personal Computer
PIC	Programmable Interface Controller
POR	Power on Reset
PWM	Pulse width modulation
RAM	Random Access Memory
RF	Radio Frequency
ROM	Read-Only Memory
RX	Receiver
SEPIC`	The single-ended primary-inductor converter
VSI	Virtual Socket Interface
ZCS	Zero current switching
ZVT	Zero voltage switching

LIST OF SYMBOLS

C	Capacitor
D	Diode
I_{SW}	MOSFET drain current
I_D	Diode current
I_L	Inductor current
I_{RR}	Diode maximum reverse current
I_{Lmax}	Maximum inductor current
I_{Lmin}	Minimum inductor current
I_{LB}	Average inductor current at boundary condition
I_{outB}	Average output current at boundary condition
I_{in}	Input current
I_{out}	Output current
I_{LBmax}	Maximum average inductor current at boundary condition
$I_{outBmax}$	Maximum average output current at boundary condition
I_{act}	Actual current into PIC12F675
L	Inductor
n	The percentage peak to peak ripple current in inductor
k	Duty cycle
$P_{divider}$	Losses in voltage divider
P_{in}	Input power
P_{out}	Output power

P_O	Rated output power
P_T	Switch power rating
Q_{RR}	Storage charged from forward biased conduction to reverse blocking conduction
R1	Voltage divider resistor 1
R2	Voltage divider resistor 2
$R_{DS(on)}$	Drain to source on-resistance
R	Resistor
$R_{DS(on)}$	Drain to source on-resistance
SW	Electronic switch
t_{on}	Switch on duration
t_{Off}	Switch off duration
T	Switching time period
t_{rr}	Diode reverse recovery time
t_a	Time between zero crossing and the I_{RR}
t_b	Time between the diode I_{RR} and 25% of I_{RR}
V_{in}	DC input voltage
V_{out}	DC output voltage
V_{SW}	MOSFET drain-to-source voltage
V_D	Diode voltage
V_L	Inductor voltage
V_{br}	Diode breakdown voltage
V_{ref}	Reference value in PIC12F675

V_{GS}	Gate-to-source voltage
V_T	Threshold voltage
V_{st}	Sawtooth voltage
$v_{control}$	Control voltage
V_{FB}	Output voltage feedback value
V_{act}	Actual voltage detect by PIC12F675
x	Number of phases
ΔV_{out}	Output voltage ripple
$-\Delta V$	The charger controller detects an inflection point

PELAKSANAAN SISTEM PEMANTAUAN TANPA WAYAR PADA PRESTASI AT-AT PENUKAR DORONGAN 48 V DALAM KUASA SOLAR FOTOVOLTA.

ABSTRAK

Tenaga solar adalah sumber tenaga yang murah, bersih dan sedia ada. Salah satu aplikasi yang paling penting bagi sistem pengawal caj solar adalah digunakan sebagai penyimpanan cas bateri untuk mengawal selia bateri 'State –of – Charge' dan mencegah bateri daripada keadaan bahaya. AT- AT penukar dorongan adalah salah satu komponen utama yang berfungsi dan dipercayai dalam sistem pengawal caj solar yang digunakan untuk meningkatkan voltan rendah dari panel solar kepada voltan yang lebih tinggi. Cadangan AT – AT penukar dorongan yang digunakan dalam kajian ini adalah papan litar demostrasi DC1286 A-B AT –AT penukar dorongan yang direka khas dari Linear Technology Corporation yang mana rekaannya direka untuk aplikasi voltan dan arus yang tinggi dan boleh mengeluarkan voltan dan arus keluaran 48 V, 3 A. Prosedur yang digunakan untuk memantau atau menilai bekalan kuasa panel fotovolta dan sistem AT-AT penukar dorongan dengan menggunakan pemantauan masa sebenar bekalan kuasa panel fotovolta dan AT- AT peningkat dorongan, sistem ini dapat menilai prestasi sistem solar. Sistem pemantauan akan mengumpul voltan dan arus masukan bekalan fotovolta dan voltan keluaran dan arus keluaran AT – AT penukar dorongan dan memaparkan data diantaramuka pemantauan (GUI) yang telah direka bentuk untuk analisa pada masa hadapan. Eksperimen telah dijalankan dengan AT – AT penukar dorongan beroperasi dalam mod pengaliran berterusan (CCM) dengan voltan keluaran 48 V, 144 W kuasa keluaran dan 200 kHz menukar setiap kekerapan. Keputusan eksperimen menunjukkan bahawa AT –AT penukar dorongan yang dicadangkan itu mampu

menghasilkan voltan keluaran 48 V daripada AT –AT penukar dorongan yang berterusan dengan voltan masukan yang pelbagai daripada bekalan kuasa panel fotovolta 8 V hingga 36 V di mana bebannya adalah 16 **Ω**. Akhir sekali, analisa bagi sistem voltan keluaran fotovolta (PV) telah siap untuk menyasarkan reka bentuk pada masa hadapan dengan voltan keluaran 48 V pengawal caj solar.

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ABSTRACT

Solar energy is cheap, clean and readily available resource. One of the most important solar charge controller’s applications in solar power system is used as battery storage to regulate battery state-of –charge and help prevent batteries from hazardous conditions and protects battery from being overcharged by-photovoltaic array. A DC-DC boost converter, one of functional and reliable major components in solar charge controller system was used to boost the low voltage from solar panel to a higher voltage. The proposed boost converter was used in this research is DC1286A-B demonstration circuit board from Linear Technology Corporation was designed for high application, providing output voltage 48 V and output current was at 3 A. The procedures used to monitor or evaluate photovoltaic power supply and boost converter system with using the real time monitoring of photovoltaic power supply and boost converter system, the expert system can evaluate the performance of the solar system. The monitoring system will collect voltage and current of input photovoltaic power supply and output DC- DC boost converter and display the data to the designed monitoring interface (GUI) for future analyzed. Experimental work was carried out with the DC-DC boost converter operating in continuous conduction mode (CCM) with 48 V output voltage, 144 W output power and 200 kHz switching frequency. The experimental results showed that the proposed designed was able to produce a constant 48 V output boost converter with range input from photovoltaic 8 V to 36 V at 16 Ω load conditions. Lastly, the final analysis of the output PV system was completed to target the future design of 48 V output of solar charge controller.

CHAPTER ONE

INTRODUCTION

1.1 Background of Study

Moving into the modern world, the call for the use of portable and environmentally friendly appliances is growing. One of this is the use of solar energy system as renewable energy source. This energy source has significantly contributed to sustainable energy supply. Solar energy or sunlight is not only considered to be the original source of almost all energy on earth but also the most significant source of renewable energy (Tan Yu and Isa, 2009). In generating solar energy, solar power system basically needs four distinct components, namely the solar panel, power converter, controller and battery storage. Solar panel or photovoltaic (PV) systems generate electricity from solar radiation(Halder, 2011). Photovoltaic (PV) which has many benefits especially to the environment, economy and society is used to convert sunlight (photon) directly into electricity. A charge controller has been regarded as one of the important devices in stand-alone photovoltaic systems to prevent the battery from damage due to overcharging and over-discharging, reverse current flow at night and to protect the life of the batteries in a PV system(Saini et al., 2013).

To use solar energy as power supply, the controller should be able to keep the battery charged and deliver constant power to the load. To design the charge controller, engineer must be knowledgeable about other required components. The life time of battery can deteriorate without the use of charge controller. Another important component of the photovoltaic power supply system is the DC- DC converter. A power electronic component that is used in a solar charge controller to get highest efficiency, availability and reliability of charging process (Halder, 2011). Many renewable power sources such as photovoltaic power system have relatively low-voltage output. This output voltage of PV panels is highly dependent on solar irradiance and ambient temperature. Hence, DC loads should not be directly connected to the output of PV panels.

The model used in this research consists of DC-DC boost converter placed between solar PV panel and the loads. The DC-DC boost converter fixes the output voltage of the PV system. The boost converter circuit is used to increase voltage that is generated by PV panel, to meet voltage level of the load (Husna et al., 2012). The proposed dc-dc boost converter featuring in this research is constant frequency current mode boost controller and constant frequency operation results in small and efficient circuit. This converter also provides high output voltage accuracy over wide load range.

1.2 Problem Statement

There are many source of energy that can be used to charge the battery such as electricity directly provided by Tenaga Nasional Berhad (TNB), alternative energy from wind turbine, solar energy, rainfall turbine, thermoelectric generator and many more. Since solar energy is well known for being clean and environmentally friendly, it is selected for this research. The major part of the solar power system is the charge controller. The concept of solar charge controller becomes globally accepted as a practical and feasible for solar power system. If the PV panel is placed under sunlight, tremendous amount of electricity can be extracted depending on the size of the solar panel and the efficiency of solar charger itself. However, PV panel produces DC voltage, but the voltage is unregulated and changes depend on solar irradiation