International Journal of Research in Advanced Engineering and Technology
ISSN: 2455-0876; Impact Factor: RJIF 5.44
www.engineeringresearchjournal.com
Volume 2; Issue 5; September 2016; Page No. 13-16

Design of photovoltaic linear current booster and current multiple circuit for running dc water pump

Tarsin Saragih

Department of Electrical Engineering, Institut Teknologi Medan (ITM), Medan, Indonesia

Abstract
On some solar irradiation, the DC water pump powered by photovoltaic (PV) cannot run because the current and voltage not enough to support the DC water pump for running it. But with this Linear Current Booster (LCB) circuit, current can be increase until the DC water pump start to running normally. This paper presents the circuit design practicality and to create a Linear Current Booster (LCB) that it is powered by photovoltaic module. It also to create the linear current booster, so that produce stable current and be used to operate the DC water pump.

Keywords: Photovoltaic, Linear Current Booster (LCB), DC water pump

1. Introduction
DC load or DC water pump can operate usually depend on stable voltage. The DC water pump needs high starting current. If it connect to photovoltaic directly, the DC water pump cannot operate because current of photovoltaic is not stable. So the DC water pump can operate stable is need Linear Current Booster. Linear Current Booster (LCB) can run DC motors and other DC devices directly from a solar panel where LCB will be boost the current. In the Linear Current Booster (LCB) mode of operation, it is possible to use the circuit to change a low current solar panel input to a higher current output. The Linear Current Booster will gain and stable the current that is resulted by Photovoltaic. Linear Current Booster (LCB) can run DC motors and other DC devices directly from a solar panel without battery.
A Linear Current Booster (LCB) is a special purpose switch mode buck converter that is used in photovoltaic, solar electric, systems to provide a better match between the PV array and a motor load or lower voltage battery. The voltage output of a PV is relatively fixed as the level of sunshine varies. Motors on the other hand are basically constant current devices with the voltage varying with power and speed. The LCB acts as an automatically adjusting DC/DC converter to convert high voltage and low current PV array outputs in low sun conditions to lower voltage and higher current to better operate a DC motor [1].
Linear Current Booster (LCB) is device trades voltage for extra current to start a DC water pump. DC Water pumps take more power to start up than they take to run, and the LCB takes care of this problem. Linear current boosters are also used to increase the run time of DC water pumps and electric DC motors when used in an application that connects to array photovoltaic directly to the load without having a battery in the system. Linear Current Booster can help to reduce the number of panels needed to start and operate DC motors and DC water pump, matches photovoltaic output directly to a motor [2]. In this paper, an LCB and current multiple circuit are designed for running a DC water pump and water capacity of DC water pump is measured.

2. Methodology
A wiring system of DC water pump installation is shown in Fig. 1. The system consist of photovoltaic module, Linear Current Booster (LCB), Current Multiple Circuit and DC water pump. For 12 Volts is use a single panel of photovoltaic (PV) as show in Fig. 1 or wire panels in parallel positive to positive and negative to negative (+ to +, - to -). The proper fuse must be inserted inside the Linear Current Booster (LCB) to protect the pump from overload [3].

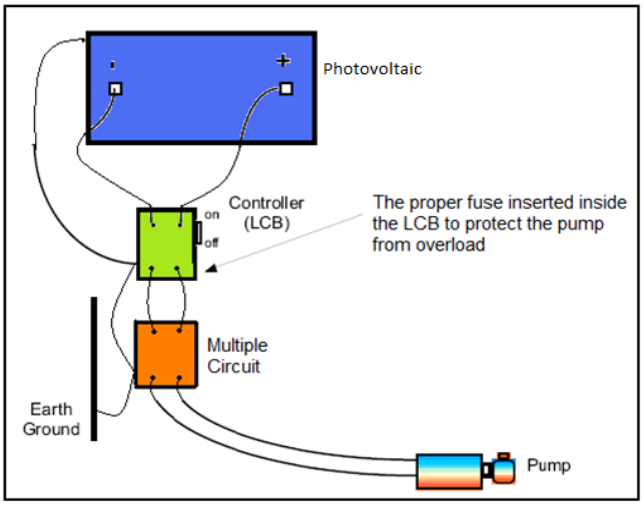

Fig 1: Wiring system of DC water pump installation

2.1 Photovoltaic
Photovoltaic or PV is the field of technology and research related to the application of solar cells for energy by converting solar energy sunlight, including ultra violet radiation directly into electricity as shown in Fig. 2. The advantage of using the photovoltaic is solar power is pollution free during use and facilities can operate with little maintenance or intervention after initial setup. Solar electric generation is economically superior where grid connection or fuel transport is difficult, costly or impossible [4].

Fig 2: Photovoltaic (PV) module

2.2 Linear Current Booster (LCB)

The purpose of a Linear Current Booster is to take a variable input voltage and produce a steady output voltage. The common regulator type is linear mode. Linear regulators are simple, but waste a lot of power in the process of regulating the voltage. Linear regulators can be thought of as self-adjusting series resistors. Linear Current Booster (LCB) such as this one are much more efficient. The LCB is convert DC input voltages to pulses of low voltage DC. The DC pulses are used to charge a storage capacitor to the desired output voltage. The voltage is regulated by varying the width of the DC pulse.

The Linear Current Booster (LCB) circuit is suitable for a variety of uses. If have a solar powered 12 Volt lead-acid battery power source, the circuit can be used to efficiently power lower voltage devices. It can be used to provide power to devices that normally use a set of small batteries for power. Common voltages such as 1.5V, 3V, 4.5V, 6V, 7.5V, 9V, 12V and until 19V can be produced by this circuit. The Linear Current Booster (LCB) circuit model was created by using Pspice software as shown in Fig. 3. Photograph of top view of the Linear Current Booster circuit prototype is shown in Fig. 4.

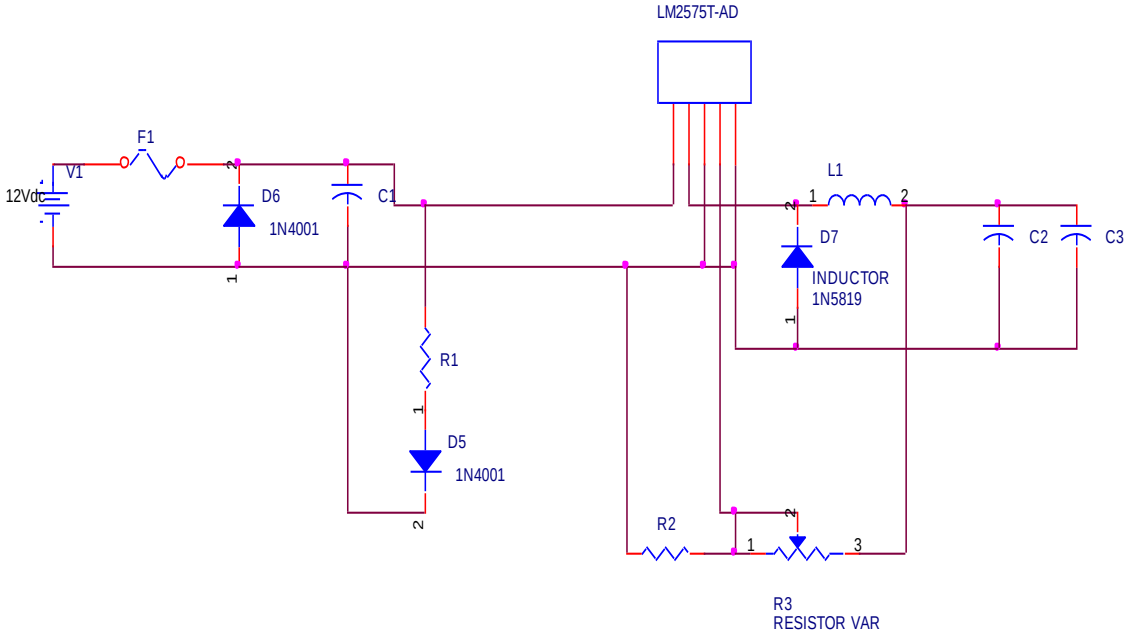

Fig 3: Linear Current Booster schematic diagram

Fig 4: Photograph of top view of the Linear Current Booster circuit prototype

2.3 Current Multiple Circuit

The current multiple circuit schematic diagram and its photograph of top view are shown in Fig. 5 and Fig. 6, respectively. The resistors R1 to R6 are included for stability and prevent current swamping as the manufacturing tolerances of DC current gain will be different for each transistor. As the circuit is designed to handle loads of up to 30 A, then six TIP2955 are wired in parallel to meet this demand. The dissipation in each power transistor is one sixth of the total load, but adequate heat sinking is still required. Maximum load current will generate maximum dissipation, so a very large heat sink is required. In considering a heat sink, it may be a good idea to look for either a fan or water cooled heat sink. In the event that the power transistors should fail, then the regulator would have to supply full load current and would fail with catastrophic results. A 1 A fuse in the regulators output prevents a safeguard.

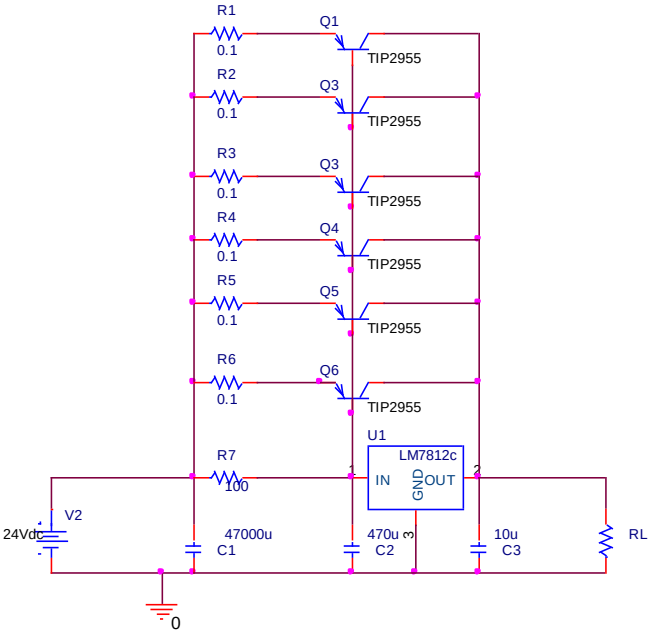

Fig 5: Current Multiple schematic diagram

Fig 6: Photograph of top view of the current multiple circuit prototype

2.4 Placing Linear Current Booster and Current Multiple Components

After already completed designed Printed Circuit Board (PCB) layout and Patterning Printed Circuit Board, and then placing a Linear Current Booster (LCB) and Multiple Circuit components on PCB. Before placing the components on the PCB must ensure that the components right located and on the right foot component is installed. When placing components has been done on the PCB, then solder each leg component. In Fig.4 and Fig.6 are examples of components that have been completed soldering and installed on PCB. In Fig. 7is photograph of top view of the Linear Current Booster (LCB) and Multiple Circuit prototype which is it already complete with casing.

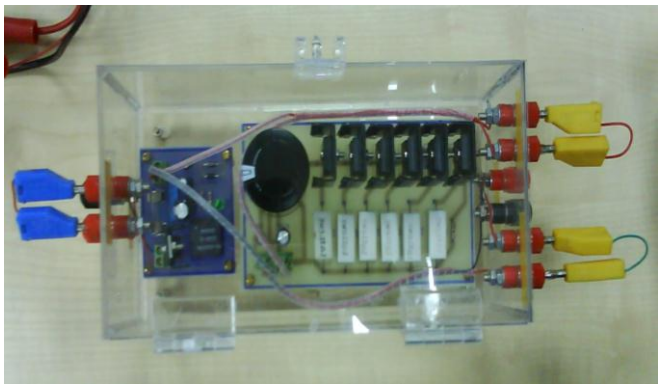

Fig 7: Photograph of current multiple circuit and Linear Current Booster (LCB) prototype in casing

3. Results & Discussion

The Linear Current Booster (LCB) will gain and stable the current that is resulted by photovoltaic (PV). It also can be able to stable the voltage. The DC water pump can operate usually depend on stable voltage and DC water pump needs high starting current. If it connected to photovoltaic directly, the DC water pump cannot operate, because current of photovoltaic is not stable. So the DC water pump can operate stable is need Linear Current Booster (LCB) but this LCB will only pass 1 Amp or less. Fig. 8 and Fig. 9 show the operation and experiment of DC water pump running with LCB and current multiple circuit that is powered by photovoltaic module. The LCB will be stable the current and voltage else the current multiple circuit will boost the current until the DC water pump can run. From this experiment of the DC water pump running with LCB and Multiple Circuit to show that the result of PV current, DC load current and water capacity in Table 1.

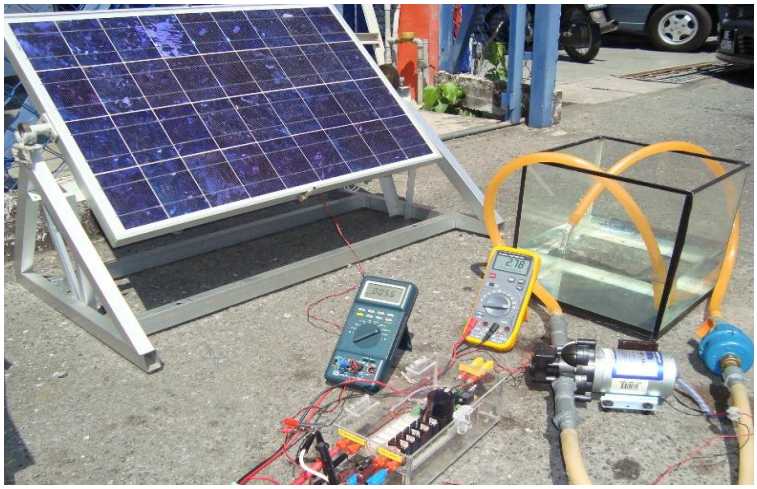

Fig 8: Experiment of DC water pump running with LCB and current multiple circuit

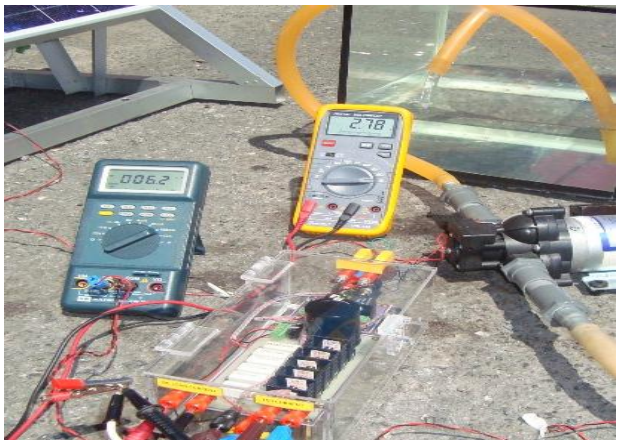

Fig 9: Measurement of PV current and load current prototype by multi meter

Table 1 shows the result of DC water pump running with Linear Current Booster (LCB) and Multiple Circuit. Where the photovoltaic (PV) and DC load current will be increase when the temperature and solar radiation increase. From this result can be compared the Photovoltaic (PV) and DC load current where the current value of the DC load more stable than PV current because the load current through in LCB circuit. The DC load current also higher than PV current such as in Fig. 9. It is because the Linear Current Booster (LCB) and current multiple circuit were boost the current until the DC water pump running. This system can deliver more output DC load currents and will produce higher current with combination Linear Current Booster (LCB) and current multiple circuit. From this data result, described that with have the LCB and circuit multiple circuit will allow DC water pump to start earlier and run even on cloudy days.

Table 1: Result of DC Water Pump running with LCB and current multiple circuit

HOUR	SOLAR RADIATION W/m²	TEMPERATURE °C	PV CURRENT (mA)	LOAD CURRENT (A)	WATER CAPACITY (m^3)	WATER PUMP
8.30 am	194.1	35.8	3.4	1.9	1160	RUNNING
9.00 am	251.4	36.9	3.9	1.97	1175	RUNNING
9.30 am	310.2	40.3	4.0	2.66	1190	RUNNING
10.00 am	486.0	44.0	4.7	2.77	1205	RUNNING
10.30 am	580.2	42.0	4.9	2.75	1121	RUNNING
11.00 am	666.9	46.6	5.01	2.71	1237	RUNNING
11.30 am	723.6	50.8	6.1	2.75	1252	RUNNING
12.00pm	876.8	52.7	5.3	2.76	1267	RUNNING
12.30pm	939.0	49.4	5.1	2.74	1282	RUNNING
1.00 pm	921.1	48.2	4.7	2.72	1297	RUNNING
1.30 pm	950.8	46.8	4.8	2.72	1311	RUNNING
2.00 pm	986.0	49.7	5.1	2.76	1311	RUNNING
2.30 pm	994.9	49.9	6.2	2.78	1311	RUNNING

4. Conclusion

From the test result, the performance of this project such is wanted, when the DC water pump running with Linear Current Booster (LCB) and current multiple circuit powered by photovoltaic, then DC water pump can operate. The objective these project to run DC Water Pump and get water capacity of water. Based on the result, result of DC water pump running with LCB and Multiple Circuit, this circuit have a good performance where the Linear Current Booster (LCB) will stable the current and voltage and Multiple Circuit was boost the current until the water pump running.

5. References

1. Larry Elliott. Linear Current Boosters, 1997. http://www.ibiblio.org/london/alternativeenergy/homepowermagazine/archives/6/06pg12.txt, 2009.
2. Adolf Goetzberger, Volker U Hoffmann. *Photovoltaic solar energy generation*, Germany, 2005.
3. Dankoff Solar Product. Booster Pump, 2003. http://www.conergy.us/PortalData/3/Resources/products/solar_pumps/pdf/slowpump_booster_instructs.pdf, 2009.
4. Roger A Messenger, Jerry Ventre. *Photovoltaic systems engineering*, New York, 2004.