Implementation of PV Based Multiplier Boost Converter Fed by PMSM

V. Jayakumar, GN. Sachinamreiss, R. Karthikeyan

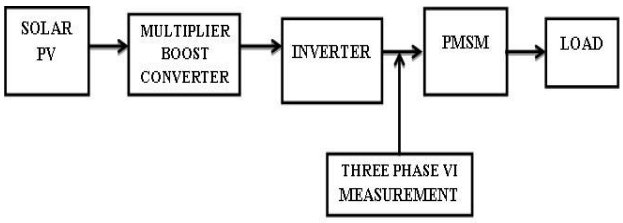
Abstract*: The proposed system is very useful for the agricultural system. The converter topology used here is Multiplier Boost Converter which will enhance better voltage gained from the input source which is solar PV. Now the PV can able to produce 80V which is boosted upto 285V through the converter. The inverter design is quite easy such that it is possible to drive a PMSM motor. The controller is not necessary here as the voltage produced by the DC-DC converter is quite reliable. So this might find application in water pumping and electric vehicles.

***Keywords:* Multiplier boost converter, ripple, PV, PMSM**

I. INTRODUCTION

Solar energy is one of the renewable energy resources which play a crucial role in water pumping applications. Input of the solar panel can be retrieved from sunlight. Solar panel can able to produce the maximum output voltage. Need and requirement can be placid through this converter design [3]. The converter topology used here is multiplier boost converter which converts single input to multiple outputs. In order to drive a permanent magnet synchronous machine it need AC supply. But the converter output is DC supply. For converting DC to AC voltage here inverter is used. While using PMSM it can be able to improve the efficiency of the motor much better over AC induction motor. The energy from the solar PV is not efficient to running a water pumping motor, for utilizing this power, the extracted energy from the PV are to be boosted by using multiplier boost converter. While PMSM motor offers small size and more efficient compare to AC Induction motor [1]. So here PMSM is used for various agricultural applications [2]. Centrifugal water pump is driven by PMSM motor; it receives the tolerable voltage from the inverter that is fed from solar PV through a multiplier boost converter [4].

II. BLOCK DIAGRAM



The block diagram shows complete operation. Multiplier boost gets the supply from solar and dc is converted to ac for fed to PMSM.

III. CONVERTER OPERATION

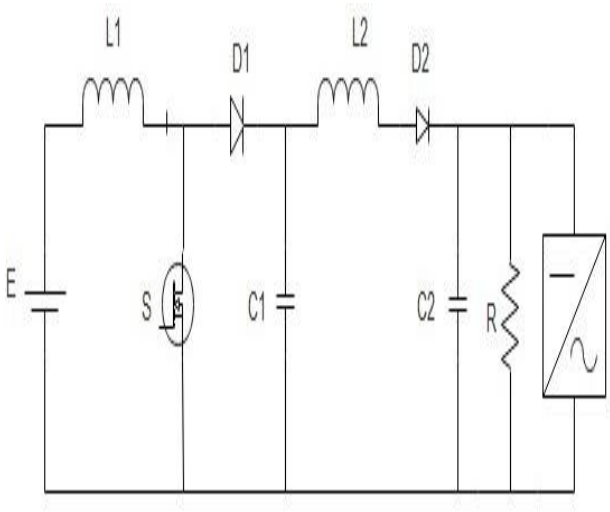


Figure 1.1 Circuit diagram of Multiplier boost converter

The circuit diagram of multiplier boost converter is shown in figure 1.1. The multiplier boost converter can be operated in two modes namely continuous and discontinuous conduction mode [6]. During continuous conduction mode, switch S is in ON condition, diode will be in ON condition. Current passing across the diode then circuit get energized. Finally current passes through the load [5].

The voltage equation in continuous conduction mode is,

$$L_{DC}\frac{dI_{dc}}{dt} = E_i \quad \text{..... (1)}$$

$$L_{DC}\frac{dI_{dc}}{dt} = E_i - E_o \quad \text{.....(2)}$$

From the above equation we can derive,

$$\triangle I_{dc1} = \frac{E_i}{L_{dc}}\triangle t_{on} = \frac{E_i TD}{L_{dc}} \quad \text{.....(3)}$$

$$\triangle I_{dc2} = \frac{E_i - E_o}{L_{dc}}\triangle t_{off} = \frac{(E_i - E_o)T}{L_{dc}}(1-D) \quad \text{.....(4)}$$

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where D – duty ratio, $D = \frac{t_{on}}{t_{on} + t_{off}}$ ..... (5)

When the circuit is at ideal state, we can obtain

$$\frac{E_o}{E_i} = \frac{1}{1-D} \quad \text{.....(6)}$$

The input and output power of the multiplier boost converter are equal,

$$E_i I_{dc} = E_o I_o \quad \text{.....(7)}$$

By substituting above equation, then

$$\frac{I_o}{I_{in}} = 1 - D \quad \text{.....(8)}$$

When circuit is at practical state,

$$\triangle I_{dc} = \triangle I_{dc1} + \triangle I_{dc2}$$

$$\triangle I_{dc} = \frac{T}{L_{dc}}\left[E_i - E_o(1-D)\right] \quad \text{.....(9)}$$

During discontinuous conduction mode, switch S is in OFF condition, diode will be in OFF condition. No current passing across the diode, then circuit get de-energized. Similarly, the same operation is repeated for coupled multiplier boost converter [7]. Finally the voltage level is boosted

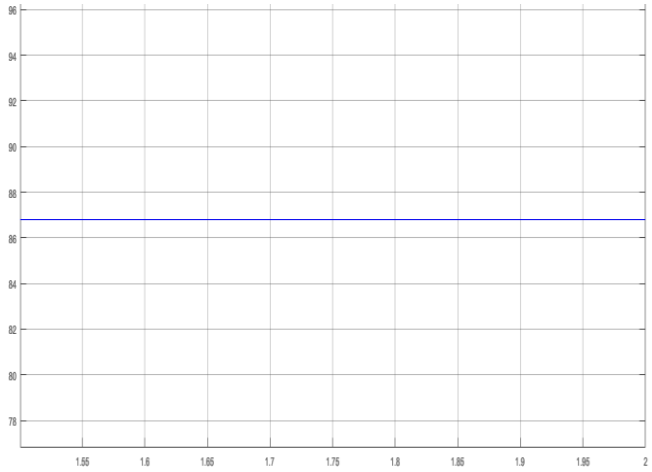

Fig 1.2: Waveform of solar panel output voltage

The above figure 1.2 represents the output voltage of solar panel which produces 86 V

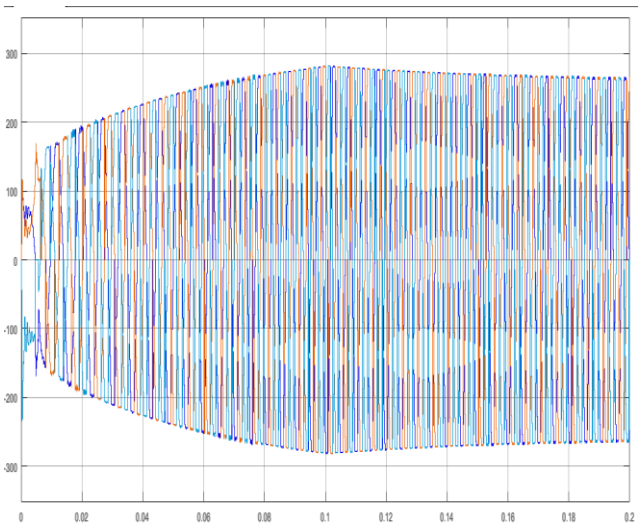

Fig 1.3:Waveform of motor voltage

The above figure 1.3 represents the voltage of the motor which is measured at 290 V

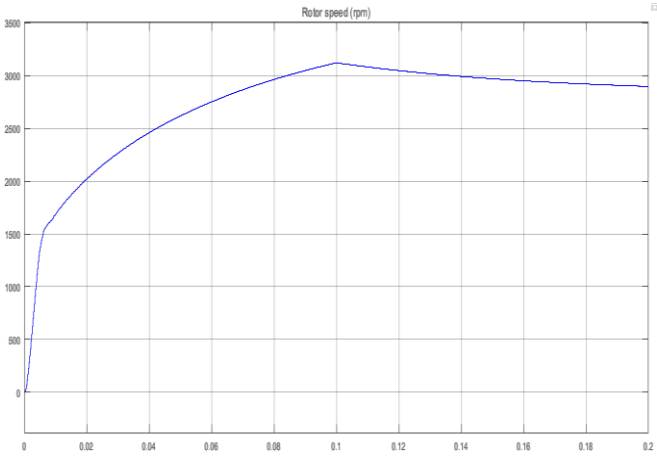

Fig 1.4:Waveform of rotor speed

The above figure 1.4 represents the speed of the rotor which is measured at 3000 RPM

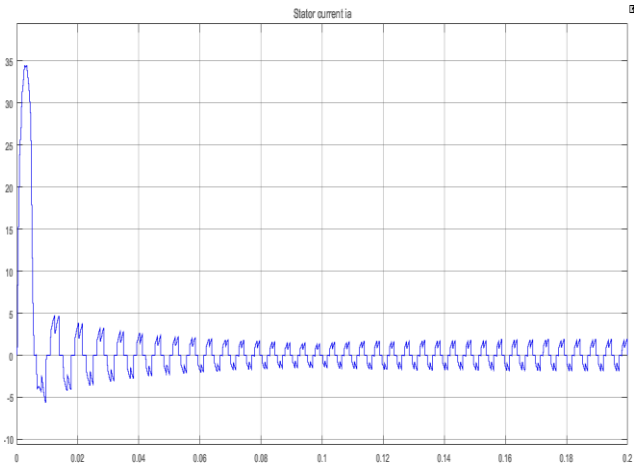

Fig 1.5:Waveform of the stator current

The above figure 1.5 represents the current of the stator which is measured at 34 A

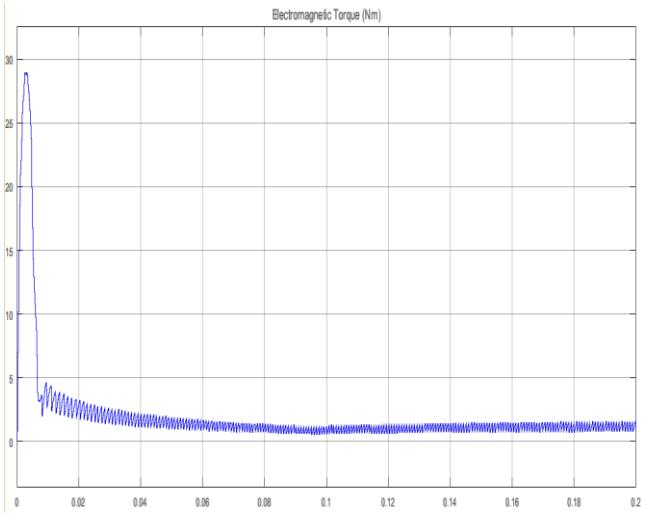

Fig 1.6: Waveform of electromagnetic torque

The above figure 1.6 represents the motor torque which is measured at 30 N-M

IV. SPECIFICATION

S.NO	COMPONENTS		RATING
01	Solar PV	Output voltage	80V
02	Converter	Inductance	20e-6 H
		Capacitance	50e-6 F
		Resistance	250 ohm
		Output voltage	285 V
03	Permanent magnet synchronous machine	Input voltage	285 V
		Rotor speed	3000 RPM
		Torque	30 N-m
		Stator current	34

V. CONCLUSION

The design and analysis of this converter plays a vital role in agricultural field, water pumping. The settling time to reach the speed of the motor is about 0.2s.Centrifugal water pumping is driven by PMSM motor. The proposed multiplier boost converter is designed for solar applications. For high power applications, solar PV is utilized will enhance the efficiency and reliability. By using this converter will reduce the switching losses. The simulation results are verified by MATLAB software

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