Middle-East Journal of Scientific Research 25 (6): 1298-1302, 2017
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2017.1298.1302

Exploration of Hybrid Switched Reluctance Motor Drives Using H Bridge Converter

S. Sujitha

Department of EEE, New Horizon College of Engineering, Bengaluru, Karnataka, India

Abstract: The presentation of the four phases SRM is researched particularly managed via independent PV kept up module with H Bridge Converters. With a particular ultimate objective to play out the enormous working state of engine, the significant lead of SRM ought to be examined. As a result of rich sun arranged vitality sources the application is shown in quick drives, for example, SRM in this paper. The outcomes also separated and SRM driven by DC source offers overpowering execution in multiplication examination.

Key words: Battery · Charger · H Bridge Converter · PV · SRM

INTRODUCTION

World class however bounteous imperativeness source is required in a solid fragment of associations and expressive arts on requiring snappy control. One clear thing for interminable imperativeness is feasible sun arranged based essentialness sources which related with quick drive as traded reluctance motor drives.

This paper is managed as takes after, the sun filled photovoltaic cells are module as per the sensible structure of the free association with drives and known as light based generator is masterminded in piece 2. In bit 3, for securing criticalness from PV generator, charging advancement is done through batteries and the model can be investigated utilizing truth table. In segment 4, the four stage traded aversion motor which can be driven by utilizing the H Bridge converters is finished. The relationship and results are showed up in bit 5. At long last the conclusion and sensibility of this paper is talked about in zone 6.

Like other electrical machines, SRM is a centrality converter which can secure vitality in the engaging field made by four phase windings and is traded between the electrical and mechanical subsystems. With a particular true objective to drive the motor, H Bridge converter is displayed.

Literature Survey: The H-Bridge converter topology for switched reluctance motor drives that is able to act as an active power factor controller. According to the features of the proposed circuit a conventional PFC stage is unnecessary to comply with the European standards on power quality, thus reducing the cost and the complexity of SR motor drives aimed to equip home appliances, a very cost-sensitive market field. [10].

Proposed energy efficient converter topologies in conventional H Bridge converter is to overcome the limitations of the conventional C Dump converter resulting in improved performance, lower cost and simpler control. [11]

Solar PV Generator: PV modules used in PV system for generating electricity. PV modules are available in range of power ratings that vary from small 2 Wp modules to upto 300Wp modules [5]. But in this experimental analysis based on SRM ratings the power rating of PV modules is designed. Basic rating (ie) P=80 W and OCV = 22 V and SCI = 4.7A is introduced i.e. 36 cells totally 9 x 4 rows.

Parameters of Solar Module: The current voltage relationship of PV module can be given by the following equation:

$$I = I_L - [\, I_0 e^{q(V + I R_s)/nkT} - 1] \quad (1)$$

V_{oc} depends on short circuit current ($I_{sc} = I_L$) and saturation current (I_0).Where I_L is current generated due to light, R_s is series resistance of PV modules, n is ideality factor, I_o is reverse saturation current, T is temperature and k is the Boltzmann constant, q is the charge of the electron [1].

Corresponding Author: Dr. S. Sujitha, Department of EEE, New Horizon College of Engineering, Bengaluru, Karnataka, India.

Short Circuit Current: Short circuit current I_{sc} is the maximum current produced by a solar PV module when its terminals are shorted.

$$I_{sc} = I_L \quad (2)$$

Open Circuit Voltage: Open circuit voltage V_{OC} is the maximum voltage that can be obtained from a solar PV Module when its terminals are left open

$$V_{oc} = kT /q (\ln [(I_L /I_0) +1) \quad (3)$$

Maximum Power: This is defined as the maximum power P_m output of a PV module under standard test condition STC, which corresponds to 1000 W/m^2 and 25°C cell temperature in PV module. Under the STC the power output of PV Module is maximum, therefore it is also referred as peak power or watt (peak) or W_p which is the product of V_m and I_m.

$$P_m=V_m \times I_m \quad (4)$$

Fill Factor: The fill factor is defined as the squareness of the I-V curve and mainly related to the resistive loss in solar module. It can be defined as the ratio of actual maximum power output to the ideal maximum power output. In ideal case, its value can be 100% corresponding to square I-V curve. But it is not feasible to have square I-V. There are always some losses which reduces the value of FF. the best value of FF that can be obtained for a solar module can empirically be written as a function of V_{oc}

$$[V_{oc} – \ln(V_{oc} + 0.72)] / (V_{oc} +1) \quad (5)$$

Based on the above parameters, the solar cell is mathematically modeled using MATLAB/Simulink.

Designing of Solar Module: Standard Single Solar Cell Rating available in market based on short circuit current and open circuit voltage is given in table 1.

Table 1: Solar Cell Rating

Cell Rating	
Im	= 3 A
Vm	= 0.5 V
Pm	= 2.5 W

The Solar PV modules are arranged in series and parallel combination to drive the SRM. In this study 36 single solar cells are arranged in series pattern to attain open circuit voltage of 18 V single solar module and corresponding short circuit current of 5 A. The 14 such modules are arranged in series and parallel to obtain OCV of 252 V.

Battery and Charger: The battery is used when non shine hour or night time operation of the load is required. Batteries in PV System contribute the recurring cost as the life of the batteries is significantly shorter than the life of the PV cell [3]. Overcharging and over-discharging reduces the life of the battery and increasing the operative cost of PV system. Therefore, together with batteries, a proper control circuit is required which is known as charge controller [1].

The battery is utilized when non sparkle hour or evening time operation of the heap is required. Batteries in PV System contribute the repeating taken a toll as the life of the batteries is altogether shorter than the life of the PV cell [3]. Overcharging and over-discharging decreases the life of the battery and expanding the agent cost of PV framework. In this way, together with batteries, a legitimate control circuit is required which is known as charge controller [1].

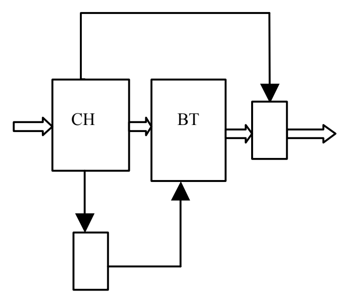


Fig. 1: Block diagram of Charger- battery

Converter and SRM: The 8/6 SRM with H Bridge Converter is regulated to PV system using MATLAB /Simulink library components in this proposed research is shown in fig.2.

The H-bridge arrangement is generally used to reverse the polarity of the motor, but can also be used to 'brake' the motor, where the motor comes to a sudden stop, as the motor's terminals are shorted, or to let the motor 'free run' to a stop, as the motor is effectively disconnected from the circuit. There are several possible configurations to energize a switched reluctance machine and these different energizing structures distinguish themselves by their number of semiconductors and passive components. They also depend on the number of phases and the way of which the stator coils are connected. Each phase has two IGBTS and two diodes. The number of semiconductors is the same that for an inverter of a Synchronous machine. However, the structure is completely different. One can also notice that it is not possible to short-circuit the source because the resistance of the coils limits the current.

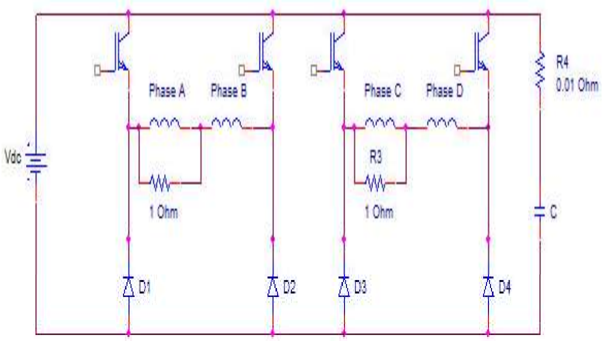


Fig. 2: Circuit of four-phase H Bridge Converter

This enables the diode D1 to be forward biased and the current path is closed through Cd which increases the voltage across it. This has the effect of reducing the A-phase current and, when the current falls below the reference by Äi (i.e., current window), T1 is turned on to maintain the current close to its reference. When current has to be turned off completely in phase A, T1 is turned off and partially stored magnetic energy in phase A is transferred to energy dump capacitor, Cd. The remaining magnetic energy in the machine phase has been converted to mechanical energy. [12]

This converter has the advantage of minimum switches allowing independent phase current control. The main disadvantage of this circuit is that the current commutation is limited by the difference between voltage across C, Voltage across each phase Vdc and the dc link voltage. Speedy commutation of currents requires larger Vo, which results in increasing the voltage rating of the power devices. Further, the energy circulating between C and the dc link results in additional losses in the machine, Z_{13}, Lr and Dr, thereby decreasing the efficiency of the motor drive.

The energy recovery circuit is activated only when T1, T2, T3, or T4 switches are conducting to avoid freewheeling of the phase currents. The control pulses to Z_{13}, end with the turn-off of the phase switches. The control pulse is generated based on the reference and actual value of E with a window of hysteresis to minimize the switching of Z_{13}. This circuit has gained in popularity since its introduction in the early stages of SRM drive research and development; therefore, an analysis of this circuit is presented here. Analysis in the following sections considers computation of switching losses of the power devices, maximum voltage and current ratings of the power devices for an SRM drive of known power rating; ratings of the energy recovery capacitor, Cd, inductor Lr and its duty cycle; and the efficiency of the overall circuit. [11].

The advantages of H Bridge converter are summarized as follows

- Requirement of minimum number of switches.
- Independent phase current control is possible in H Bridge converter.

The disadvantages of H Bridge converter are summarized as follows

- Current commutation is limited by the difference between the voltage across C and the link.
- H Bridge converter is not suitable for high speeds.
- Efficiency of the H Bridge converter is lower.
- H Bridge converter is unable to provide zero voltage.

The application of the C-Dump converter is in the low speed applications.

Simulation Results: There are several possible configurations to energize a switched reluctance machine and these different energizing structures distinguish themselves by their number of semiconductors and passive components. They also depend on the number of phases and the way of which the stator coils are connected. Each phase has two IGBTS and two diodes. The number of semiconductors is the same that for an inverter of a Synchronous machine. However, the structure is completely different. One can also notice that it is not possible to short-circuit the source because the resistance of the coils limits the current.

Table 2: Specifications for H Bridge Converter

Switches and Components	Symbol	H Bridge Converter
IGBT	R	1.00E-03
	Vf	1
	Rs	200
	Cs	1.00E-07
Diode	R	1
	Vf	0.8
	Rs	1000
	Cs	Inf
Passive Components	Lr	-
	Cd	-
	Rd	0.1
	C	1.00E-06
	R*2	1

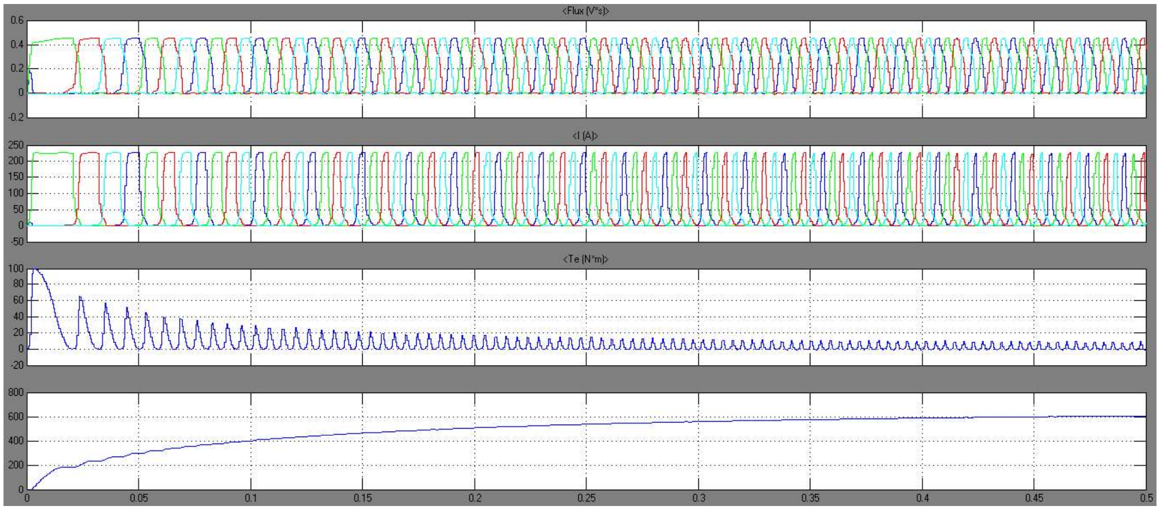


Fig. 4: Simulation Results for SRM driven by DC link Voltage of 240 V

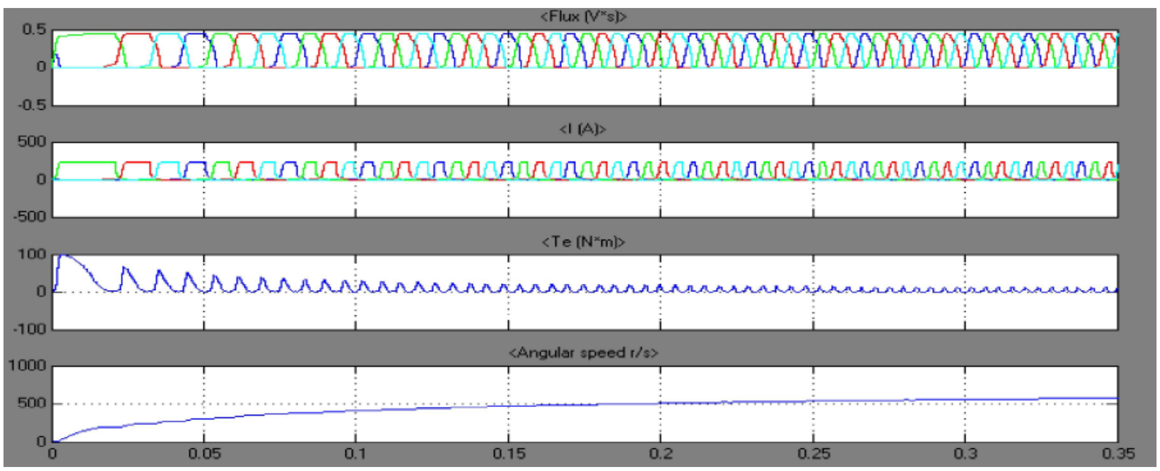
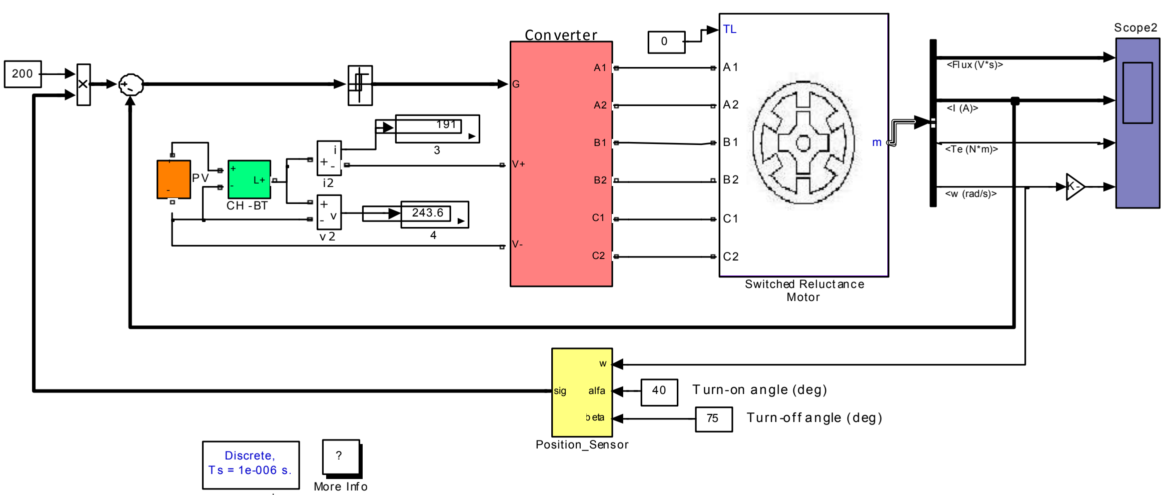


Fig. 5: Simulation Results for SRM driven by Regulated PV System



The Table 5.14 for the corresponding simulation results for H Bridge converter indicates that the motor attains a speed of 590 radians per second at the simulation time of 0.35 seconds, corresponding torque, speed and phase current are also discussed.

Table 3: Performance analysis for H Bridge Converter

Voltage (V)	Flux (wb)	Current (mA)	Toque (Nm)	Angular Speed (rad/sec)	Speed (RPM)
242	0.755	2390	65	590	2368

Verification: To verify the results for stand alone regulated PV associated SRM drive obtained using simulation is done by comparing results with SRM driven by available DC Source. Comparing these two results using fig. 4 and 5 the standalone SRM is most economical. Also torque maintains constant which regulates the speed. Hence this type may be used for high speed applications where the abundance of solar source practically.

To confirm the outcomes for standalone controlled PV related SRM drive acquired using MATLAB Simulation is finished by contrasting outcomes and SRM driven by accessible DC Source. Looking at these two outcomes using fig. 4 and 5 the independent SRM is generally sparing. Additionally torque keeps up steady which controls the speed. Consequently this sort might be utilized for rapid applications where the wealth of sun oriented source for all intents and purposes

CONCLUSIONS

In this paper, a brief analysis of Regulated PV fed SRM drive using H Bridge converter configuration is made. The comparison is based on the performance of 8/6 pole SRM with a DC link voltage of 240 V. It is found that the energy stored in dump resistor is proportional to the torque production and increase in performance of the motor[7] and [8]. The Photo voltaic module connected to 4 phase SRM is regulated by RRC through battery and Charge contollers and position sensors. The usefulness of the model has been established by applying it to various conditions and applications.

APPENDIX

SRM Specifications:

4 Phase, 8/6 pole, 240 V

Stator Resistance R_s = 0.05 ohm

Moment of Inertia J = 0.05 kg-m^2

PV Cell:

14 PV modules are arranged in series and parallel combinations to get 242 V.

REFERENCES

1. Sujitha, S. and C. Venkatesh, 2014. Analysis of Regulated PV Switched Reluctance Motor Drives Using Repression Resistor Converter, International Journal of Engineering and Technology, ISSN: 0975-4024, 06(03): 1309-1313.
2. Sujitha, S. and Dr. C. Venkatesh, 2012. Design and Analysis of Standalone Solar Assisted Switched Reluctance Motor Drives. In: International Journal of Soft Computing and Engineering, 2012
3. Tsai HL. Insolation-oriented model of photovoltaic module using MATLAB/Simulink. Solar Energy 2010; 84: 1318-26.
4. Tsai, H.L., C.S. Tu and Y.J. Su, 2008. Development of generalized photovoltaic model using MATLAB/ Simulink. In: Proceedings of the world congress on engineering and computer science, 2008, San Francisco, USA; pp: 1-6.
5. Chin, C.S., A. Babu and W. McBride, 2011. Design, modeling and testing of a standalone single axis active solar tracker using MATLAB/Simulink. In: Renewable Energy, 36: 3075-90.
6. Solanki, C.S., 2011. Solar Photovoltaics: Fundamentals, Technologies and Applications. New Delhi, PHI learning Pvt. Ltd.,
7. Ji Keyan, Zhang Zhuo, 2011. Study on direct torque control system of Switched Reluctance motor, In: ICCSE 2011; 0904-08.
8. Zhang, Z. and N.C. Cheung, 2011. Analysis and design of cost effective converter for SRM drives using Component sharing. In: 4th International conference on power electronics system and Applications; pp: 099-104.
9. Mehrdad Ehsani, Ramani, James. H. Galloway. Dual Decay Converter for SRM Drives in Low voltage Applications. In: IEEE Transaction on Power Electronics, April 1993. pp: 224-230.
10. Consoli, A., A. Testa, N. Aiello, F. Gennaro and M. LoPresti, 2001. Unipolar converter for switched reluctance motordrives with power factor Improvement', Sixteenth annual IEEE applied power electronics conference and exposition, 2: 1103-1108.
11. Mir, S., I. Husain and M.E. Elbuluk, 1997. Energy-Efficient C-Dump converter for switched reluctance motors, IEEE Transactions on Power Electronics, 12: 912-921.
12. Hava, A., J. Wacknov and T.A. Lipo, 1993. New ZCS resonant power converter topologies for variable reluctance machine drives'. in the proceedings of IEEE power electronics specialist conference, pp: 432-439.