A Control Scheme of Solar-Power Based PMSM Drive For Compressor Unit

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Abstract- *A design, modeling and control of quasi resonant ZCS (Zero Current Switching) boost converter used in PV (Photovoltaic) power based SPMSM (Surface mounted Permanent Magnet Synchronous Motor) for driving compressor loads of refrigeration plant situated in remote locations. The solar based refrigeration system is an attractive solution as cooling burden matches with the peak incident solar radiation. The field oriented controlled VSI (Voltage Source Inverter) is employed for speed control of SPMSM drive under variation in solar irradiation. The MATLAB/SIMULINK environment is used to model the control of PV power based SPMSM drive. The performance of the developed system is investigated under wide changes in operating conditions. A prototype of 800W PV power based SPMSM drive is developed in laboratory to validate the simulation results.*

Keywords- Permanent Magnet Synchronous Motor(PMSM) DC motor (DC), Silicon Controlled Rectifier(SCR), Alternating Current and Direct Current(AC-DC), Direct Torque Control(DTC),Proportional-Integral(PI), Matrix Laboratory(MATLAB), Alternating current(AC), Insulated Gate Bipolar Transistor(IGBT), Pulse width Modulation (PWM)

I. INTRODUCTION

To adopt renewable energy for their social and economic development, there are sincere efforts around the world. Solar based energy is most attractive and viable option to reduce expense in rural electrification, among the different renewable energy sources [1]. To cater the energy needs such as vehicular, residential consumption, water pumping system, space air craft, heating and cooling etc, the PV (solar photo voltaic) based system has these potential applications[2].For heating and cooling purposes, significant portion of generated energy around the globe are consumed. As the reasonable high time constant of heating and cooling systems, the application of renewable energy sources (solar and wind) to cater such load demands are establishing as a better alternative solution [3]. In power generation and its control these solar-PV systems are highly intermittent, offers extensive challenges for optimum energy extraction. There are several techniques reported in literature for MPPT (Maximum Power Point Tracking) in solar-PV systems integrated have also been reported in [6],[7] complying with power quality standards. In between solar-PV panel and a DC bus of VSI (Voltage Source Inverter), the boost converter based two stage power conversion is the most popular topology used [8]-[10]. Due to increased switching losses at high frequency, the hard switching reduces the conversion efficiency of boost converter. With low switching losses and high efficiency, in high gain boost converter was proposed [11].

To achieve high switching frequency with low switching losses, to improve power density and efficiency, the soft-switching techniques are emerging solutions for converters [12]. To minimize switching losses, voltage current stresses, these techniques employ ZVS (Zero Voltage Switching) or ZCS (Zero-Current Switching) on power semiconductor switches [13]-[18]. Quassi parallel resonant DC link based PWM inverters have been presented in [13] and it was further improved with more flexible PWM (Pulse Width Modulated) capability and easy in control in [14]. A soft switched PWM inverter employing snubber for each switch to achieve ZCS and ZVS operation this reported by H. Zhang et al. [15].

At the cost of additional current and voltage stresses and increased components count, a lossless passive snubber was presented for DC converter [16],[17]. In [18], for better efficiency than a conventional boost converter, a resonant circuit based PV power generation system was proposed. However, with high component counts and provide ZCS and ZVS during turn on and turn off time of switch respectively; most of these circuits are associated. With ZCS and ZVS the quassi - resonant converters are much better option for solar-PV system in view of small change in PV panel operation voltage under change in irradiance. In design of QRC (Quassi Resonant Converter), it facilitates ease.A quassi-resonent soft switching based boost converter receives much attention and potential for AC drive applications due to size, ruggedness, efficiency and maintainability for the stand- alone PV system. In permanent magnet technology with recent advancements, the use of SPMSM is increased for electricity generation and in drives application [19], [20]. The SPMSM is establishing a better that induction motor drives due to high efficiency and high torque density [21].

The DTC (Direct Torque Control) and the FOC (Field Oriented Control) have been investigated mostly for power converters switching to reduce torque pulsation and to minimize harmonics injection in the SPMSM in modern high-performance AC drives [22]-[23].in controlling the flux and motor torque in spite of the change in load torque and machine parameter variation, these control strategies are effective. To accurately track the reference value of torque and speed they force the motor. For industrial AC drives application, the FOC is an established control [24].

The design, modeling, control and implementation of solar PV based QRBC (Quassi Resonant Boost Converter) fed SPMSM drive coupled with compressor unit presents this paper. In [25], the simulation based study of the topology and its control approach, authors have presented. Main contributions of this paper are as follows,

- To minimize switching losses with minimum device count, QRBC with only single switch topology are used.
- To keep balance between power generation and load demand under change in solar irradiance to achieve MPPT operation at most of operating conditions, speed of a SPMSM drive coupled with compressor of refrigeration plant is controlled.
- On field prototype, the proposed control approach is validated.

II.INTRODUCTION TO PV SYSTEMS

2.1 INTRODUCTION TO PV SYSTEMS

Introduction After we have discussed the fundamental scientific theories required for solar cells in Part II and have taken a look at modern PV technology in Part III, we now will use the gained knowledge to discuss complete PV systems. A PV system contains many different components besides the PV modules. For successfully planning a PV system it is crucial to understand the function of the different components and to know their major specifications. Further, it is important to know the effect on the location of the (expected) performance of a PV system. Types of PV systems PV systems can be very simple, consisting of just a PV module and load, as in the direct powering of a water pump motor, which only needs to operate when the sun shines. However, when for example a whole house should be powered, the system must be operational day and night. It also may have to feed both AC and DC loads, have reserve power and may even include a back-up generator. Depending on the system con Figuration, we can distinguish three main types of PV systems: stand-alone, grid-connected, and hybrid. The basic PV system principles and elements remain the same. Systems are adapted to meet particular requirements by varying the type and quantity of the basic elements. (In Fig. 2.1)

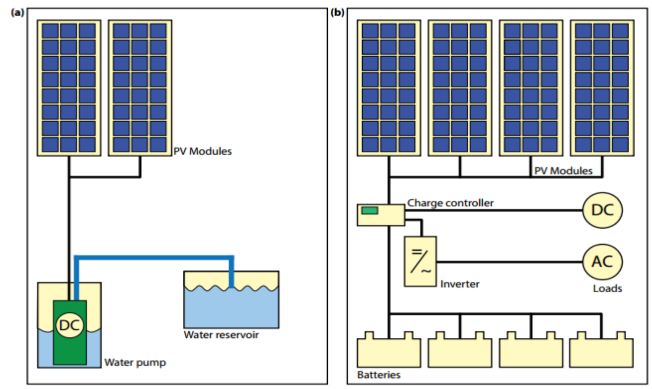


Fig.2.1. : Schematic representation of (a) a simple DC PV system to power a water pump with no energy storage and (b) a complex PV system including batteries, power conditioners,and both DC and AC load

Stand-alone systems Stand-alone systems rely on solar power only. These systems can consist of the PV modules and a load only or they can include batteries for energy storage. When using batteries charge regulators are included, which switch off the PV modules when batteries are fully charged, and may switch off the load to prevent the batteries from being discharged below a certain limit. The batteries must have enough capacity to store the energy produced during the day to be used at night and during periods of poor weather. Fig 2.2 shows schematically examples of stand-alone systems; (a) a simple DC PV system without a battery and (b) a large PV system with both DC and AC loads. Grid-connected systems Grid-connected PV systems have become increasingly popular for building integrated applications. As illustrated, they are connected to the grid via inverters, which convert the DC power into AC electricity. In small systems as they are installed in residential homes, the inverter is connected to the distribution

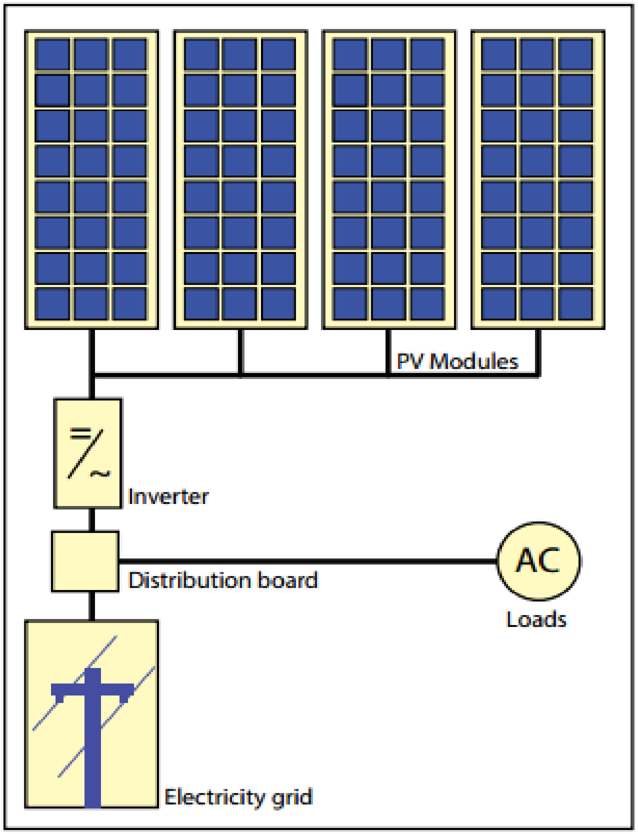


Fig 2.2: Schematic representation of a grid-connected PVsystem.

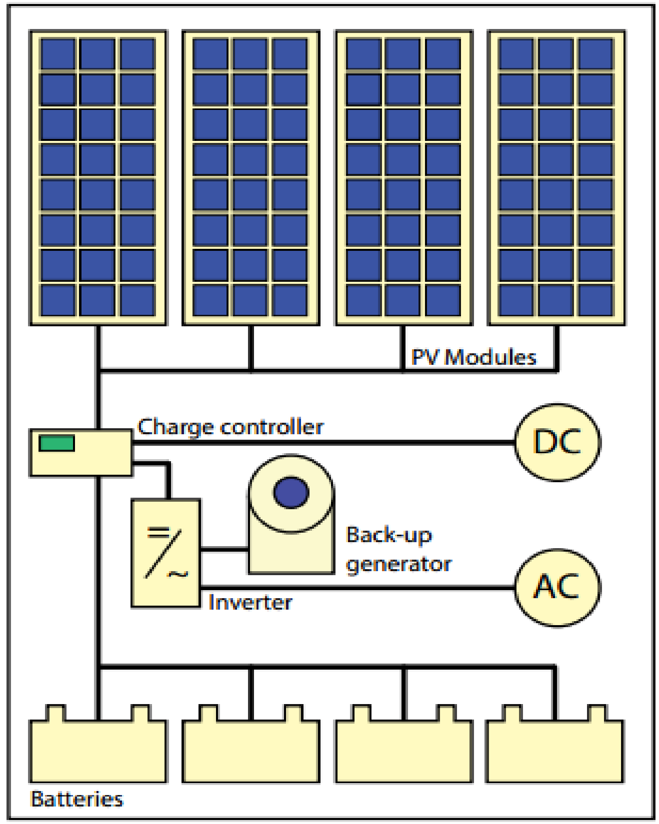


Fig 2.3.: Schematic representation of a hybrid PV system that has a diesel generator as alternative electricity source.

board, from where the PV-generated power is transferred into the electricity grid or to AC appliances in the house. These systems do not require batteries, since they are connected to the grid, which acts as a buffer into that an oversupply of PV electricity is transported while the grid also supplies the house with electricity in times of insufficient PV power generation. Large PV fields act as power stations from that all the generated PV electricity is directly transported to the electricity grid. They can reach peak powers of up to several hundreds of MW p . Fig. 2.3 shows a 25.7 MWp system installed in Germany.

2.2 PV SYSTEMS MAXIMUM POWER POINT TRACKING

2.2.1 Introduction

The power delivered by a PV system of one or more photovoltaic cells is dependent on the irradiance, temperature, and the current drawn from the cells. Maximum Power Point Tracking (MPPT) is used to obtain the maximum power from these systems. Such applications as putting power on the grid, charging batteries, or powering an electric motor benefit from MPPT. In these applications, the load can demand more power than the PV system can deliver. In this case, a power conversion system is used to maximize the power from the PV system. There are many different approaches to maximizing the power from a PV system, these range from using simple voltage relationships to more complex multiple sample based analysis. Depending on the end application and the dynamics of the irradiance, the power conversion engineer needs to evaluate the various options.

2.2.2 Photovoltaic Operation

Fig 1 shows a simple model of a PV cell. R S is the series resistance associated with connecting to the active portion of a cell or module consisting of a series of equivalent cells. Using Equation 1 and I-V measurements, the value of R S can be calculated. Fig 2.4 shows that R S varies with the reciprocal of irradiance.

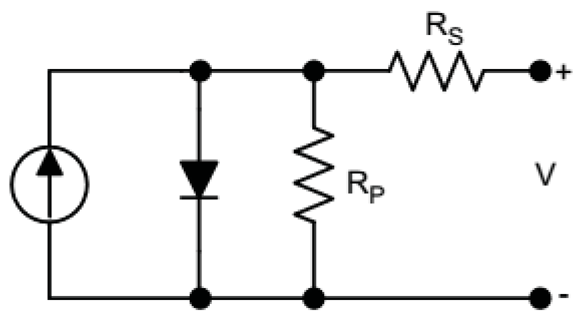


Fig 2.4 . PV cell circuit diagram

Simple PV output current:

$$I = I_{ph} - I_O \times (e^{\frac{q \times (V + I \times R_S)}{n \times k \times T}} - 1) - \frac{V + I \times R_S}{R_P}$$

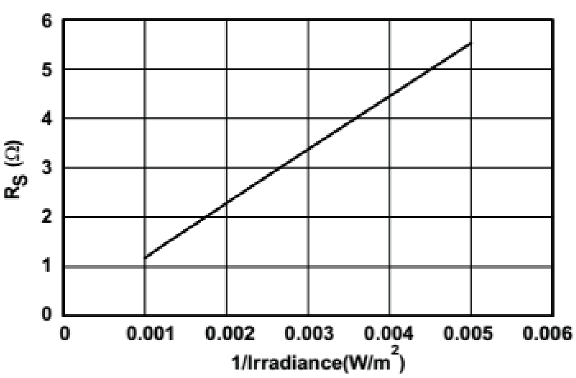


Fig 2.5 . R S vs Reciprocal of Irradiance for Sanyo HIT 215W

R_P is parallel leakage resistance and is typically large, > 100kΩ in most modern PV cells. This component can be neglected in many applications except for low light conditions.

Where:

- I_O = Diode saturation current
- q = Electron charge (1.6x10 -19 C)
- k = Boltzmann constant (1.38x10 -23 J/K)
- n = Ideality factor (from 1 to 2)
- T = Temperature (ºK)

The value is $\frac{q}{n \times k \times T}$ weak function of ln(irradiance). This most likely is a change in the ideality factor as the irradiance changes.

The parameters usually given in PV data sheets are:

- V_{OC} = Open circuit output voltage
- I_{SC} = Short circuit output current
- V_{MP} = Maximum power output voltage
- I_{MP} = Maximum power output current

These values are typically given for 25°C and 1000W/m 2 . Fig2.6 shows a comparison of the I-V and power characteristics at different values of irradiance

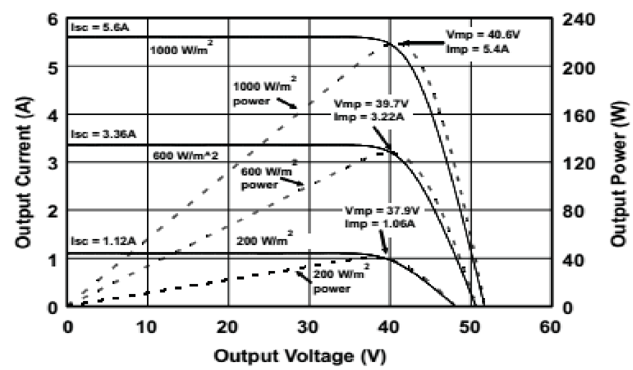


Fig 2.6 Angle of Incidence v_s Relative Output Current

The I_{SC} values are proportional to the irradiance. As well, the I_{MP} changes in proportion to the irradiance as shown in Fig . 2.

Another aspect that sometimes is overlooked is that the output current is also a function of the angle of incidence. Although the total irradiance may be constant, if the angle of incidence is not zero compared to the source, the effective irradiance is reduced which results in a reduction in current as shown in Fig2.6 . This factor may be more evident when a PV system has modules that cannot be uniformly mounted or the system is mobile. In the case where the system is mobile, the angle may be continuously changing and the maximum power point tracking system may require greater tracking speed.

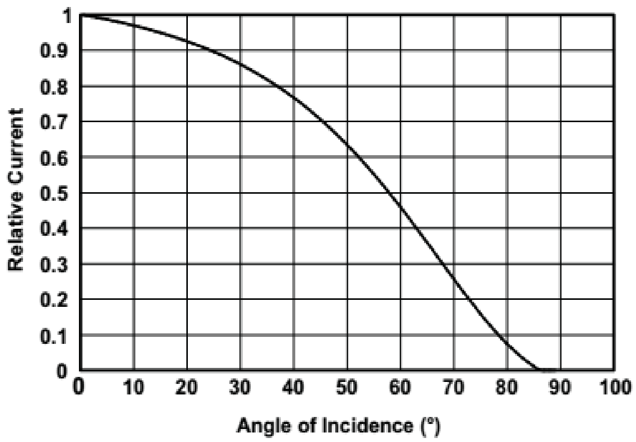


Fig 2.7 Angle of Incidence v_s Relative Output Current

2.2.3 MPPT Methods

One of the more complete analyses of MPPT methods is given in Reference 1. This paper compares 7 different methods along derivatives of two of the methods. These methods include:

1. Constant Voltage
2. Open Circuit Voltage
3. Short Circuit Current
4. Perturb and Observe
5. Incremental Conductance
6. Temperature
7.Temperature Parametric MPPT methods 1 through 5 are covered in this document.

2.2.4 Constant Voltage

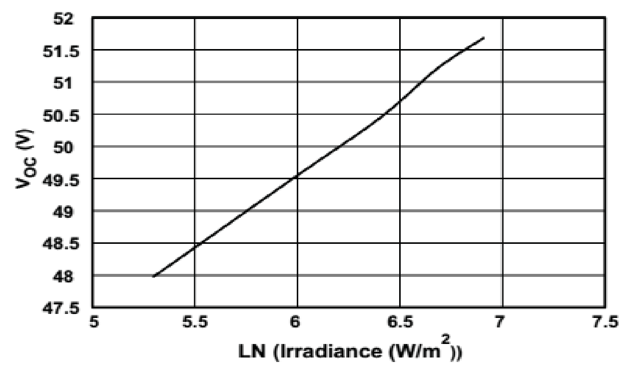
The constant voltage method is the simplest method. This method simply uses single voltage to represent the V MP . In some cases this value is programmed by an external resistor connected to a current source pin of the control IC. In this case, this resistor can be part of a network that includes a NTC thermistor so the value can be temperature compensated. Reference 1 gives this method an overall rating of about 80%. This means that for the various different irradiance variations, the method will collect about 80% of the available maximum power. The actual performance will be determined by the average level of irradiance. In the cases of low levels of irradiance the results can be better.

2.2.5 Open Circuit Voltage

An improvement on this method uses V OC to calculate V MP. Once the system obtains the V OC value, V MP is calculated by Equation 3:

$$V_{MP} = k \times V_{OC} \tag{3}$$

The k value is typically between 0.70 to 0.80. It is necessary to update V OC occasionally to compensate for any temperature change. Fig show that V OC also changes with ln(irradiance).



Sampling the V_{OC} value can also help correct for temperature changes and to some degree changes in irradiance. Monitoring the input current can indicate when the V_{OC} should be re-measured. The k value is a function of the logarithmic function of the irradiance, increasing in value as the irradiance increases. An improvement to the V_{OC} method is to also take this into account. Fig 2.8 gives an example of how input current can also be used to adjust the k value for indoor lighting PV systems. As the V_{MP} value is adjusted, I_{PV} becomes closer to the I_{MP} .

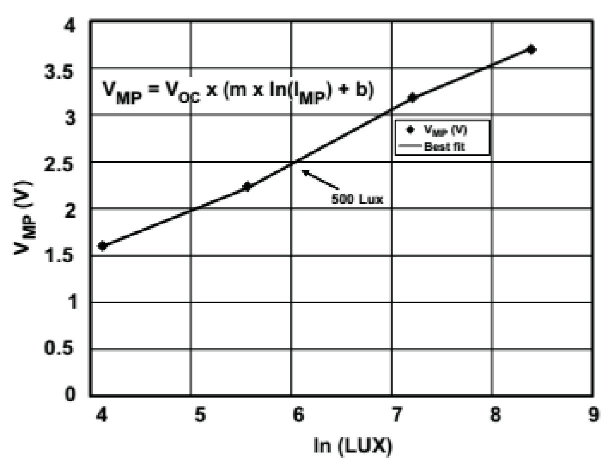


Fig 2.8 V_{MP} vs Illumination (Lux) for Low Irradiance

2.2.6 Short Circuit Current

The short circuit current method uses a value of I SC to estimate I MP .

This method uses a short load pulse to generate a short circuit condition. During the short circuit pulse, the input voltage will go to zero, so the power conversion circuit must be powered from some other source. One advantage of this system is the tolerance for input capacitance compared to the V OC method. The k values are typically close to 0.9 to 0.98.

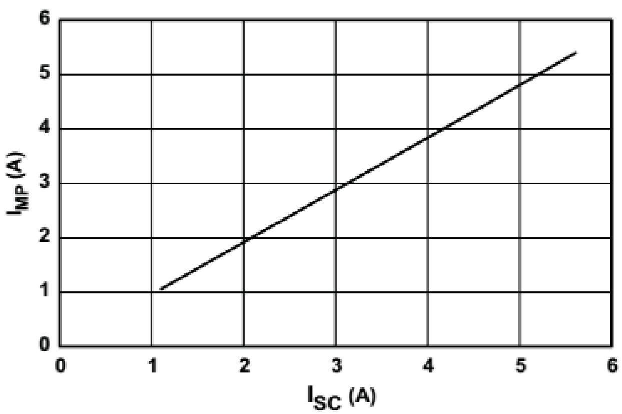


Fig. 2.9: I MP vs I SC From 200 to 1000 W/m 2 for Sanyo HIT 215W

As can be seen from Fig 2.9, the estimate of I MP is quite good with a R 2 value of 0.99999.

2.3 PULSE WIDTH MODULATION

Pulse width modulation (PWM) is a modulation technique that generates variable-width pulses to represent the amplitude of an analog input signal. The output switching transistor is on more of the time for a high-amplitude signal and off more of the time for a low-amplitude signal. The digital nature (fully on or off) of the PWM circuit is less costly to fabricate than an analog circuit that does not drift over time.

PWM is widely used in ROV applications to control the speed of a DC motor and/or the brightness of a lightbulb. For example, if the line were closed for 1 μs, opened for 1 μs, and continuously repeated, the target would receive an average of 50% of the voltage and run at half speed or the bulb at half brightness. If the line were closed for 1 μs and open for 3 μs, the target would receive an average of 25%.25% Duty Cycle 50% Duty Cycle 75% Duty CycleThere are other methods by which analog signals are modulated for motor control, but OCROV and MSROV systems predominate with the PWM mode due to cost and simplicity of design.

A Pulse Width Modulation (PWM) Signal is a method for generating an analog signal using a digital source. A PWM signal consists of two main components that define its behavior: a duty cycle and a frequency. The duty cycle describes the amount of time the signal is in a high (on) state as a percentage of the total time of it takes to complete one cycle. The frequency determines how fast the PWM completes a cycle (i.e. 1000 Hz would be 1000 cycles per second), and therefore how fast it switches between high and low states. By cycling a digital signal off and on at a fast enough rate, and with a certain duty cycle, the output will appear to behave like a constant voltage analog signal when providing power to devices.

Example: To create a 3V signal given a digital source that can be either high (on) at 5V, or low (off) at 0V, you can use PWM with a duty cycle of 60% which outputs 5V 60% of the time. If the digital signal is cycled fast enough, then the voltage seen at the output appears to be the average voltage. If the digital low is 0V (which is usually the case) then the average voltage can be calculated by taking the digital high voltage multiplied by the duty cycle, or 5V x 0.6 = 3V. Selecting a duty cycle of 80% would yield 4V, 20% would yield 1V, and so on.

PWM signals are used for a wide variety of control applications. Their main use is for controlling DC motors but it can also be used to control valves, pumps, hydraulics, and other mechanical parts. The frequency that the PWM signal needs to be set at will be dependent on the application and the response time of the system that is being powered. Below are a few applications and some typical minimum PWM frequencies required:

- Heating elements or systems with slow response times: 10-100 Hz or higher
- DC electric motors: 5-10 kHz or higher
- Power supplies or audio amplifiers: 20-200 kHz or higher

Note: Certain systems may need faster frequencies than what is listed here depending on the type of response desired.
Below are some graphs demonstrating PWM signals with different duty cycles:

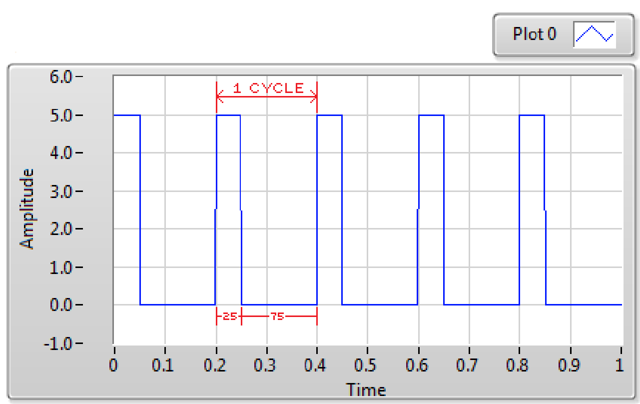


Fig 2.10: 25% Duty Cycle

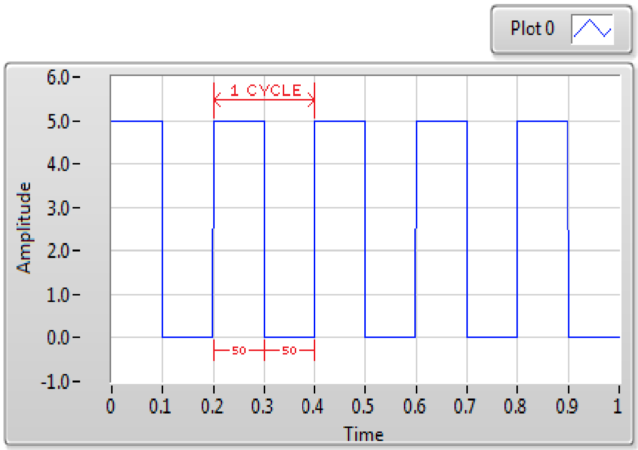


Fig 2.11: 50% Duty Cycle

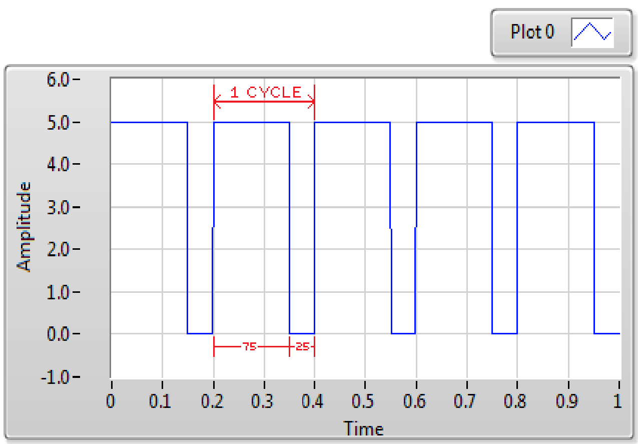


Fig . 2.12: 75% Duty Cycle

For AC–DC and DC–AC converters, the reference signal typically contains at least one sinusoidal component at the fundamental frequency of the AC input or output of the converter. For poly-phase (e.g. three-phase) converters, each phase will have a separate reference and their sinusoidal components are shifted from each other by the same phase angle that separates the input or output phase voltages. Often, the PWM references also contain harmonics of the fundamental component. This is the case, for example, in three-phase converters where triple harmonics can be purposely injected into the PWM references to increase the utilisation of the DC voltage, that is, to maximise the AC voltages that can be produced from a given DC voltage source before the modulator saturates . For the reasons stated above as well as for the purpose of developing general PWM models, the reference signal, r(t), is this chapter is assumed to consist of a DC and a single-frequency sinusoidal component in general:

$$r(t) = R0 + R1\cos(2\pi f1t + \theta 1) \qquad (2.6)$$

This will be used in the spectral analysis of different PWM methods in the next two sections. Each of the amplitudes R0 and R1 can be set to zero depending on the specific applications under study. Additional harmonics can also be included in Mathematical analysis will be presented for different PWM processes in the following sections to develop a more in-depth understanding of their characteristics and to provide models that can be used for different design purposes. Introduces double Fourier series as a general method to characterise constantfrequency PWM processes. Spectral characteristics of different PWM methods are also compared using the double Fourier series models.

Smallsignal modelling of both constant-frequency and variable-frequency pulse-width modulator for dynamic modelling and control design of DC–DC converters. The section also studies the effects of interleaved PWM of multiple converter modules and uses the analytical spectral models to characterise the ripple cancellation effectsunder different interleaving strategies. In fig. 2.10, 2.11, 2.12discusses peak current control, a control method widely used in DC–DC converters where the inductor current is used in place of the carrier signal for PWM control.

III.WORKING PRINCIPLE

3.1 SYSTEM TOPOLOGY AND WORKING PRINCIPLE

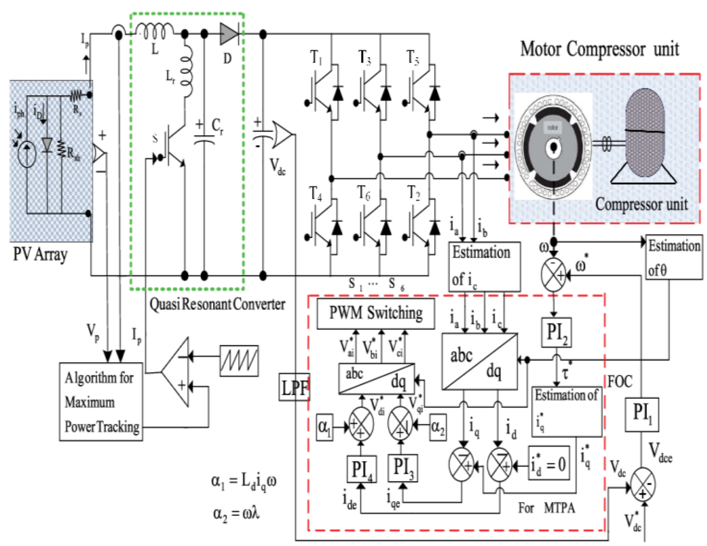


Fig. 3.1 System configuration of Solar-PV power based SPMSM drive for refrigeration plants

The proposed system configuration of a solar PV fed SPMSM drive for refrigerationplant is shown in Fig.3.1 The system is comprised with various segments. There is a PV array,a three phase VSI, an intermediate QRBC (Quasi Resonant Boost Converter), 8 pole SPMSM (Surface mounted Permanent magnet synchronous Motor) coupled with a vapor compressor unit for a refrigeration system. The PV array is made using a solar cell unit. The series and parallel configuration of solar cell assemble a larger unit called photo voltaic panel or array. Because oflow energy conversion efficiency of solar PV, it is beneficial to use a highly efficient power conversion system to utilize the PV generated power at its maximum.In the proposed system, PV array is connected to the QRBC to increase the output voltage level and reduce the switching losses. The boost converter is always operated in continuous conduction mode to reduce the stress on the passive components and semiconductor devices. Further, the intermediate converter feeds power to the VSI, supplying the SPMSM coupled with a compressor unit. The MTPA based field oriented control is used for the VSI to obtain fast-dynamic response of the SPMSM under change in solar irradiations. The DC bus voltage Vdc is kept constant using power balance concept on speed control of the PMSM. The working principle of proposed system is based on extraction of maximum power from solar-PV system. The SPMSM speed is a function of power available at DC bus of VSI and it is controlled in such a manner that balances between input and output power must remain constant.

3.2. MODELLING AND DESIGN PROCEDURE

The proposed system is designed for the 800 W peak power capacity SPMSM drive available in the laboratory. The design and mathematical equations used for the modeling are as follows.

3.2.1. DESIGN OF PHOTO VOLTAIC PANEL

In the proposed system, 900 W PV panel is used to supply SPMSM drive. The PV panel consists of a solar module. Each solar module consists of a series connected 72 solar cells. In standard operating conditions (1000 W/m2; 25°C), the solar cell has an open circuit voltage of0.5- 0.6V. By taking in consideration 0.6V, the PV module has an open circuit voltage of 45.42V. The operating voltage of a module is around 75%- 80% of its open circuit voltage [4]. A PV module Eco-300, with peak power of 300 W at standard condition is used in this implementation. In view of this for required capacity 3 PV modules are connected in series.

3.2.2. DESIGN OF QRBC

The design of a resonant converter is based on the reference DC bus voltage and open circuit voltage of the PV array. The design of a resonant inductor (Lr) depends on characteristics impedance (Zo) and resonant frequency (fo). It is given as .

$$L_r = Z_o / 2\pi f_o$$

where$Zo$and $fo$are the characteristics impedance and resonant frequency respectively. The value of $Zo$is found as,

$$Z_o = \frac{V_{dc}^2 / P_o}{Q}$$

Where Po is output power, $Vdc$is DC bus voltage and Q is normalized load. The Q is obtained using control characteristics curve between voltage gain and fnConsider Q value 6 in this study. Resonant frequency is given as,

$$f_o = f_s / f_{ns}$$

where$fs$is switching frequency considered 15 kHz and $fns$is normalized frequency considered0.58 in this study. The Lr is obtained as 135.45 μH and it is considered 150 μH in this implementation. The design of a resonant capacitor depends on characteristics impedance $ZO$and resonant frequency$fo$and given as

$$C_r = \frac{1}{Z_O 2\pi f_o}$$

It is found as 328.4 nF. The capacitor is selected 330 nF in this implementation.To limit the input current ripple and output voltage, value of filter inductor L and capacitor C are given as

$$\mathrm{C} = \frac{D}{f_s R_o \Delta V_{dc}/v_{dc}}$$

where D is duty cycle, $fs$is switching frequency, $Ro$is load resistance and Δ $Vdc/vdc$is ripple in output DC voltage considered 0.1 % in this case, C is obtained as 385.18μf and it is considered500μf in this implementation.

The filter inductor is found using the critical inductor value is as,

$$L = \frac{R_0(1-D^2)D}{2f_s}$$

The minimum inductor value is found as 0.1μH. However, in this implementation it is considered as 10 mH. The IGBTs (Insulated Gate Bipolar Transistors) for QRBC is designed based on the maximum voltage across the switch and maximum current flowing during on time. Maximum current through **the switch is given as**

$$i_s = I_p + V_{dc}/Z_o$$

where Ip is average PV current, Vdc is DC link voltage of the VSI. Ip is considered 8 A, Vdc is 300V and Zo is obtained as 18.75Ω. The peak current through the switch is obtained as 24A.

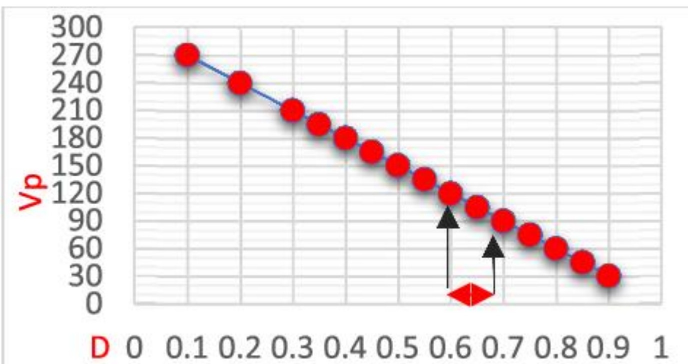


Fig. 3.2 PV voltage v/s duty cycle (D) with constant DC link voltage

3.3 CONTROL ALGORITHM

Fig. 3.3 presents the comprehensive control approach used in this implementation. The control scheme is presented in two sections, i.e. control of PV fed ZCS quasi resonant converter to operate at PV panel at MPP and control of VSI using field oriented control with MTPA for good transient response under change in reference SPMSM speed due to change in solar irradiation. Basic equations used in proposed control approach are as follows.

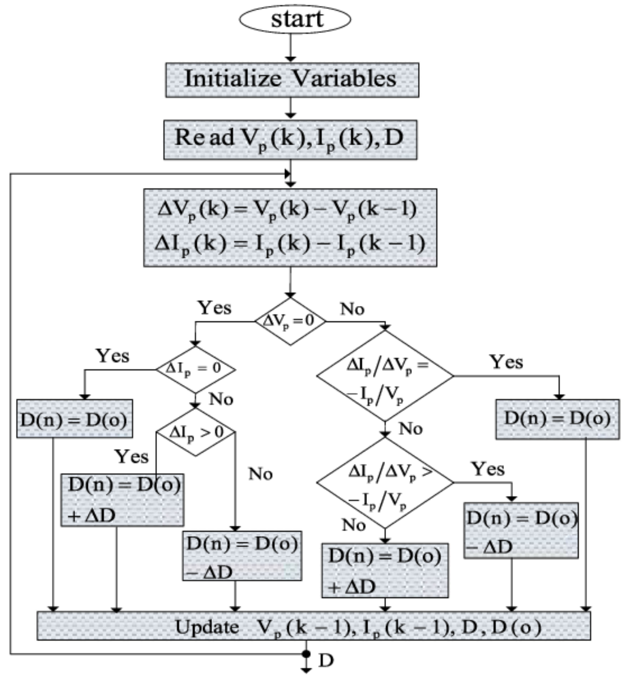


Fig. 3.3 control algorithm

IV. IMPLEMENTATION OF METHODOLOGY BY USING SIMULATION

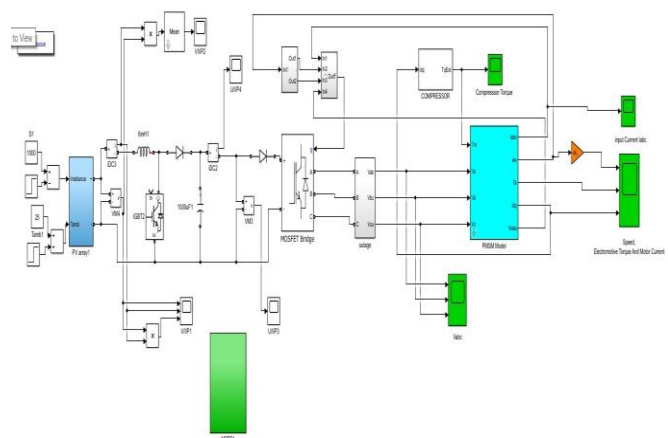


Fig. 4.1 simulation model for Solar Power Based Pmsm Drive Employed Refrigeration Plants

In Fig. 4.1 Shows PV refrigerator compressor systems area unit is receiving a lot of attention in recent years. Additionally, PV pumps have major developments within the field of electric cell material and technology. They're wide utilized in domestic and ethereal mammal provides and small-scale irrigation systems [2,3].For such PV systems, most electric receptacle trailing management is most popular for economical operation. All has conferred a MPPT system for PV system by utilizing steady state power reconciliation condition at DC link. It's any improved by Mikihiko for sensorless application. The PV system has found several potential applications like residential, vehicular, house air craft and refrigerator compressor system. PV -refrigerator compressors very competitive compared to ancient energy technologies and best suited to remote website applications that have tiny to moderate power needs. Most of the prevailing electrical phenomenon irrigation systems provide a mechanical output power from zero.85 kW up to a pair of.2 kW. The potency of Induction motors area unit less compared to static magnet motors, whereas DC machines aren't appropriate for submersible installations [12].the duty cycle of boost convertor.

4.2 SIMULATION RESULTS AND DISCUSSION

WITH COMPRESSOR

PWM inverter is used for the conversion of DC to AC. Comparing these two graph three phase voltage and current width (voltage value) of the inverter using PIC is higher than the SMC.

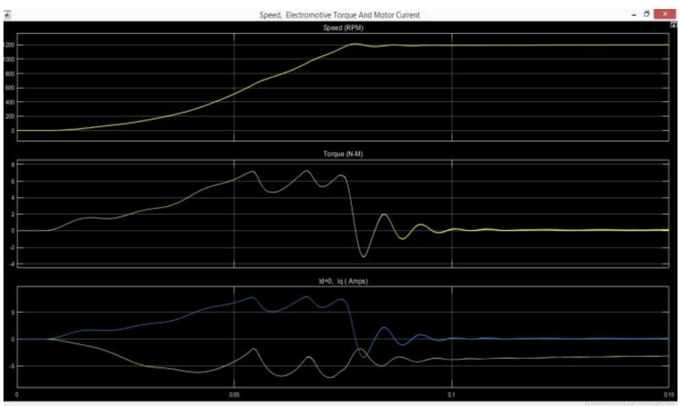


Fig.4.2 The output of the speed and Stator current

In Fig. 4.2 Shows A PV system has been sculptured for the PMSM drive is employed in white goods mechanical device system. PV white goods mechanical device systems are straightforward, reliable, conserve energy and want less maintenance. It has been incontestable that projected system offer satisfactory management on motor speed for white goods mechanical device and simulated results were shown. They will feed power to the grid.

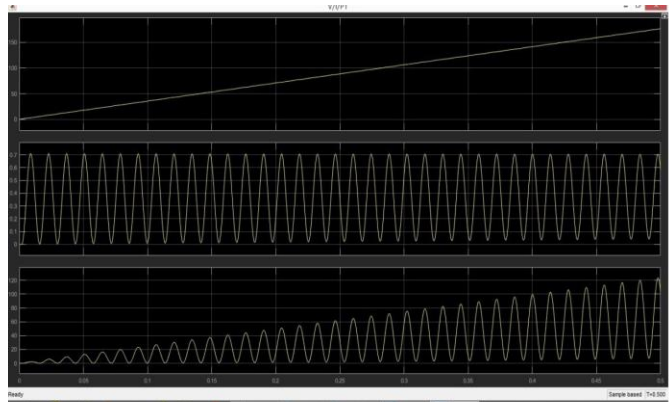


Fig .4.3 The output of the DC BUS voltage

In Fig. 4.3 Shows The PV system is employed to transfer the facility to the grid, once motor is off. The controller should act to keep up the DC bus voltage constant as attainable and improve the steadiness of the entire system. Grid-connected electrical phenomenon power systems that have a capability over one kilowatts will meet the standards.

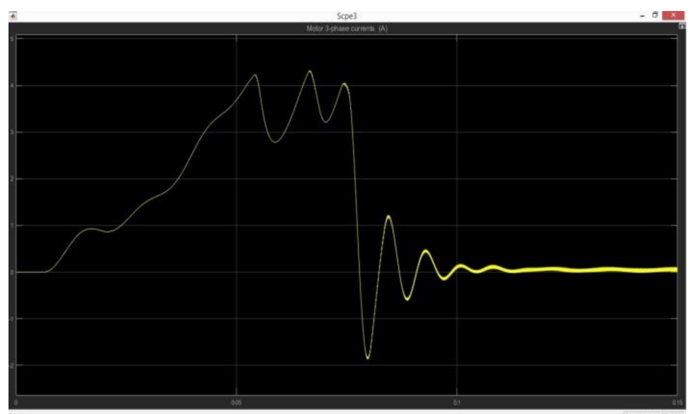


Fig.4.4 The output of Compressor Torque

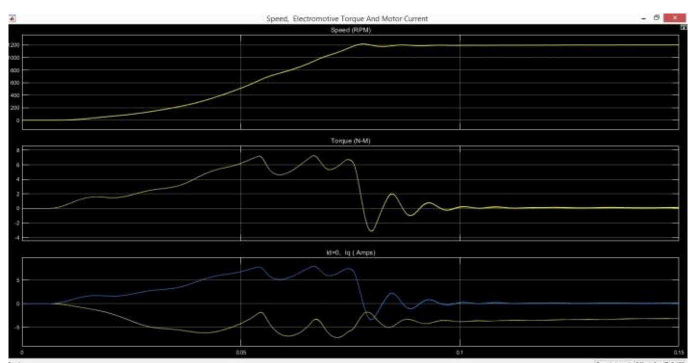


Fig. 4.5 Comparison between the Speed and Electromotive Torque

In Fig.4.5 shows the PV (Photo Voltaic) provided PMSM (Permanent Magnet Synchronous Motor) drive for refrigerator compressor system and PV provided grid connected system. Refrigerator compressor may be a universal would like for agriculture and therefore the use of PV panels may be a natural selection for such applications. The high speed photo voltaic (PV) hopped-up static magnet electric motor (PMSM) drive is investigated in one case and in alternative case the facility is transferred to Grid. 3 part VSI-one (Voltage supply Inverter) is controlled to produce PMSM, to manage discharge of VSI-2 is controlled to produce power to the grid through PLL (PHASE secured LOOP).Vector management is employed for the sleek operation. PV - refrigerator compressors extremely competitive compared to ancient energy technologies and best fitted to remote website applications that have little to moderate power necessities and may yield revenue for provision power to the grid.

V. CONCLUSION

The proposed QRBC based SPMSM drive has been designed, modeled and implemented. Alaboratory prototype of proposed system has been developed for the compressor load of a refrigeration system. The VSI has been controlled in field oriented control with MTPA operation to get fast transient response. The proposed solar PV based cooling system is simple in structure, easy in control with short response time, reduces environment pollution and energy efficient. It has been shown that developed system provides excellent control on SPMSM coupled with compressor loads under wide variation in solar irradiation. The performance of developed approach has been found satisfactory under various conditions.

VI. FUTURE SCOPES

- In the proposed method, we implemented the solar energy Photo voltaic panel with Permanent Magnet Synchronous Motor drive employing in the refrigeration system in Residential, Commercial, Industrial purposes which we have to improvise into multiple applications.
- This system can be implemented in the application of renewable energy source solar, fuel cell, wind.
- This system can also implement in the three phase applications.

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