

LANDSMAN CONVERTER BASED GRID CONNECTED HOME ENERGY MANAGEMENT SYSTEM

Submitted in partial fulfillment of the requirements for the award of

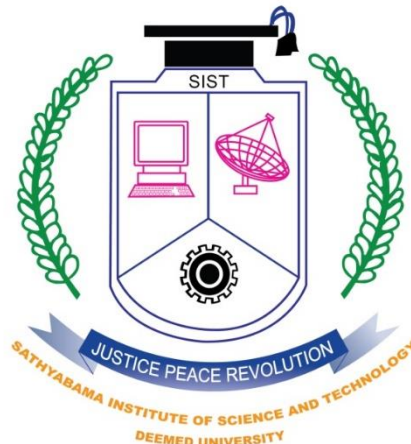
Bachelor of Engineering Degree in

Electrical and Electronics Engineering

By

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**DEPARTMENT OF ELECTRICAL AND ELECTRONICS
ENGINEERING**

SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

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APRIL 2021



SATHYABAMA

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **DHIVYADHARSHINI.M** (Reg. No. 37140027) and **JAYASRI.M** (Reg. No. 37140037) who carried out the project entitled "**LANDSMAN CONVERTER BASED GRID CONNECTED HOME ENERGY MANAGEMENT SYSTEM**" under our supervision from December 2020 to April 2021.

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DECLARATION

We **DHIVYADHARSHINI.M** (Reg. No. 37140027) and **JAYASRI.M** (Reg. No. 37140037) hereby declare that the Project Report entitled “**LANDSMAN CONVERTER BASED GRID CONNECTED HOME ENERGY MANAGEMENT SYSTEM**” done by us under the guidance of Dr. **G. T. SUNDAR RAJAN** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electrical and Electronics Engineering.

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ABSTRACT

This project presents a control of a micro-grid at an isolated location fed from wind and solar based hybrid energy sources. The machine utilized for wind vitality transformation is doubly fed induction generator (DFIG) and a battery bank is associated with a typical DC transport of them. A solar photovoltaic (PV) array is used to convert solar power, which is evacuated at the common DC bus of DFIG using a DC-DC Landsman converter in a cost effective way. It alters the frequency set point based on the energy level of the battery, which slows down over charging or discharging of the battery. The framework is additionally ready to work when wind control source is unavailable. It is high efficient and noiseless operation. A simulation results are presented for various conditions.

TABLE OF CONTENTS

CHAPTER NO.	TITLE	PAGENO.
	ABSTRACT	v
	LIST OF FIGURES	ix
	LIST OF TABLES	xii
	LIST OF SYMBOLS AND ABBREVIATIONS	xiii
1	INTRODUCTION	
	1.1 General introduction	1
	1.2 Scope of project	2
	1.3 Motivation	2
	1.4 Literature survey	3
2	PROJECT DESCRIPTION	
	2.1 Block diagram	7
	2.2 Circuit diagram	8
	2.3 Concept explanation	8

3 PROPOSED SYSTEM

3.1	Line frequency transformer	9
3.2	HIGH FREQUENCY TRANSFORMER	10
3.2.1	Drawbacks of existing system	11
3.2.2	Landsman converter	11
3.2.2.1	Design	12
3.2.2.2	Operation	12
3.2.3	Continuous conduction mode	13
3.2.4	When switch is Opened	15
3.2.5	Discontinuous conduction mode	16
4	HARDWARE DESCRIPTION	
4.1	INTRODUCTION	27
4.2	Power supply	27
4.2.1	Bridge rectifier	28
4.2.2	Regulator	29
4.2.3	Multi output power supply	30
4.2.3.1	MOSFET	31

	4.2.3.2	Working of MOSFET	32
	4.2.3.3	IRF80 MOSFET	33
	4.2.3.4	Microcontroller	33
	4.2.3.5	Digital signal controller	35
	4.2.3.6	PIN Configuration	36
5	RESULT AND DISCUSSION		42
	5.1	Hardware view and results	
6	Conclusion		44

LIST OF FIGURE

FIGURE No.	TITLE	PAGE No.
2.1	Block Diagram	7
2.2	Proposed circuit diagram	8
3.1	Line frequency transformer	9
3.2	High frequency transformer	10
3.3	Switch on condition	15
3.4	Switch off condition	15
3.5	PI Controller	16
3.6	Waveform of PWM	18
3.7	Traditional VSI	20
3.8	VSI	22
3.9	Principle of PWM	23
3.10	SPWM with $f_c/f_m = 48$, $L/R = T/3$	24
3.11	Over modulation	25
3.12	Grid side converter control	26
4.1	Block diagram of RPS	27
4.2	Bridge Rectifier	28

4.3	FW varying DC smoothing	28
4.4	Capacitor Charging and Discharging	28
4.5	Regulator	29
4.6	Regulator IC	29
4.7	Rectifier circuit diagram and wave form	30
4.8	Multiple Power Supply	31
4.9	MOSFET Block Diagram	32
4.10	IRF840 MOSFET	33
4.11	DSPIC 30F2010pin Configuration	36
4.12	Dspic30f2010 Architecture Functional Block Diagram	37
4.13	Opto Isolator Circuit Diagram	39
4.14	TLP 240	40
4.15	Pin Configurations	40
5.1	Hardware view	42
5.2	output voltage waveform of SEPIC	42
5.3	switching pulse to SEPIC at 60% duty cycle	43

5.4	Inverter output voltage waveform	43
5.5	Filtered sinusoidal voltage waveform	44

List of Table

TABLE No.	TITLE	PAGE No.
4.1	Opto Coupler Truth Table	41

LIST OF SYMBOLS AND ABBREVIATIONS

ω_0	-	Resonant Angular Frequency
C_r	-	Resonant Capacitor
C_s	-	Series Resonant Capacitor
L_r	-	Resonant Inductor
L_s	-	Series Resonant Inductor
I_r	-	Resistance Current
R	-	Resistor
V_C	-	Capacitor Voltage
V_{ds}	-	Drain to Source Voltage
V_{in}	-	Input Voltage
V_{out}	-	Output Voltage
X_c	-	Capacitive Reactance
X_l	-	Inductance Reactance
Z	-	Impedance
AC	-	Alternating Current
API	-	Application Program Interface
CCM	-	Continuous Conduction Mode
DCM	-	DisContinuous Conduction Mode
CISC	-	Complex Instruction Set Computer
CPU	-	Central Processing Unit
CTR	-	Current Transfer Ratio

DC	-	Direct Current		
DCM	-	Discontinuous Current Mode		
DIAC	-	Diode Alternating Current		
DVM	-	Discontinuous Voltage Mode		
ESR	-	Equivalent Series Resistance		
ICSP	-	In Circuit Serial Programming		
IGBT	-	Insulated Gate Bi-Polar Transistor		
ILBC	-	Interleaved Boost Converter		
MCLR	-	Master Clear		
PFC	-	Power Factor Correction		
PIC	-	Peripheral Interface Controller		
SIM	-	Simulator		
THD	-	Total	Harmonic	Distortion

CHAPTER 1

INTRODUCTION

1.1 GENERAL INTRODUCTION

Perpetually growing energy demand has created grid-connected electrical phenomenon (PV) systems additional widespread, and lots of countries have allowable, encouraged, and even funded distributed-power-generation systems. Currently, star panels aren't terribly economical with solely regarding 12–20% potency in their ability to convert daylight to electric power. The potency will drop additional because of alternative factors like solar battery temperature and cargo conditions. so as to maximise the facility derived from the solar battery, it's necessary to work the panel at its best wall plug. to realize this, a most wall plug hunter are designed and enforced.

The electrical phenomenon energy system has the benefits of absence of fuel price, no environmental impacts, low maintenance and lack of noise and conjointly it's a sort of renewable energy system. therefore it's turning into widespread within the recent years, as a resource of energy. Modeling and simulation of PV array supported circuit model and mathematical equations is projected. because the electrical phenomenon (PV) cell exhibits the nonlinear behavior, whereas matching the load to the electrical phenomenon modules, DC-DC power converters ar required. There ar many convertor configurations like Buck, Boost, Buck-Boost, Landsman, Fly-back, etc. Buck and Boost configurations will decrease and increase the output voltages severally, whereas the others will do each functions. Buck, Boost, Buck Boost converters as interface circuits ar projected and analyzed. once the star insolation and temperature is variable, the PV module output power is additionally obtaining modified. However, to get the most the utmost|the most} potency of PV module it should be operated at maximum wall plug. therefore it's necessary to work the PV module at its most wall plug for all irradiance and temperature conditions. For this purpose changed Perturb and Observe MPPT algorithmic program is projected. in line with this MPPT output, the duty magnitude relation of Landsman convertor is varied, that results in changes in output voltage. The

operate of Associate in Nursing electrical converter is to vary a dc input voltage to a regular AC output voltage of desired magnitude and frequency.

1.2 SCOPE OF THE PROJECT

The projected system illustrates the reduction in power quality issues visaged within the facility and the facility electronic devices that causes current harmonics, unbalanced loading and voltage unbalance.

Due to increase in reactive power. to resolve these issues, grid current ought to be maintained, harmonics ought to be reduced, energy systems ought to be maintained, reactive power compensation ought to be maintained and the facility demand ought to be happy. this method specialize in the look of the star PV with Landsman convertor (DC – DC) hooked up to the AC grid. together with star PV, battery Energy Storage System (BESS) is gift to balance the facility run within the projected model. A globalized MPPT is achieved through the symbolic logic Controller to abstract the most power from the star PV system regardless of amendment within the input obtained. Power flow Management System is earned by the biface convertor with BESS. The dc voltage from the Landsman convertor are fed to the Voltage supply electrical converter (VSI) and also the output AC voltage is related to the 3 section AC grid. This projected model are simulated victimization MATLAB and its economical performance will be known.

1.3 MOTIVATION

The small grid thought acts as an answer to the brain-teaser of integration massive amounts of small generation while not disrupting the operation of the utility network. With intelligent coordination of masses and micro-generation, the distribution network scheme (or 'microgrid') would be less hard to the utility network, than typical small generation. cyberspace microgrid may even give auxiliary services like native voltage management. just in case of disturbances on the most network, microgrids may doubtless disconnect and still operate individually. This operation improves power quality to the client. From the grid's perception, the good thing about a microgrid is

which will be thought-about as a controlled entity inside the ability system which will be functioned as one mass load. Customers will get edges from a microgrid as a result of it's designed and operated to satisfy their native wants for warmth and power moreover as give uninterruptible power, enhance native reliableness, scale back feeder losses, and support native voltages/correct voltage sag. additionally to generating technologies, microgrid conjointly includes storage, load management and warmth recovery instrumentality. the flexibility of the microgrid to work once connected to the grid moreover as swish transition to and from the island mode is another vital operate.

1.4 LITERATURE SURVEY

B. Subudhi, R. Pradhan (2013) proposes that a Comparative Study on Maximum Power Point Tracking Techniques for Photovoltaic Power Systems. Here, solar output is given to the DC to DC converter, because of this it provides constant voltage to the load. Different MPPT techniques are compared in this paper, finally hills clamping algorithm extracts maximum power from the panel. Without DC to DC converter it is not a efficient one also its ripple factor is high. Only solar network is not sufficient to provide voltage to the grid.

Jia-Min Shen, 2012, proposes Novel Transformer less Grid-Connected Power Converter with Negative Grounding for Photovoltaic Generation System. Here, a novel transformer less grid connected power converter with negative grounding for a photovoltaic generation system. The salient features of the proposed power converter are that some power electronic switches are simultaneously used in both the dc–dc power converter and dc–ac inverter Switching losses are too high and boost ratio is very less in this paper. Then grid compensation is not implemented.

Jinsung Byun, Sunghoi Park, Byeongkwan Kang, Insung Hong, and Sehyun Park, 2013 proposes Design and Implementation of an Intelligent Energy Saving System based on Standby Power Reduction for a Future Zero-Energy Home Environment. Here,

Energy saving has attracted great attention as a global issue because of recent environmental problems. As a part of energy saving efforts, governments are operating

policies that encourage the distribution of energy saving systems. Also, individual households are voluntarily installing energy saving systems to reduce electric power consumption. However, due to fixed system architecture, the existing systems have a disadvantage, lacking in scalability and usability. In addition, the existing systems bring up immense inconvenience as it returns to standby mode after automatic standby power cut-off. Therefore, we propose an intelligent energy saving system to solve these problems.

Jinwei He, YunWeiLi, Frede Blaabjerg , 2014, proposes Flexible Microgrid Power Quality Enhancement Using Adaptive Hybrid Voltage and Current Controller. The aim is to accomplish superior harmonic compensation performance using distributed generation (DG) unit power electronics interfaces, an adaptive hybrid voltage and current controlled method (HCM) is proposed in this paper. It shows that the proposed adaptive HCM can reduce the numbers of low-pass/ bandpass filters in the DG unit digital controller. Moreover, phase-locked loops are not necessary as the microgrid frequency deviation can be automatically identified by the power control loop.

Weiwei Li, Xinbo Ruan, Chenlei Bao, Donghua Pan, Xuehua Wang, 2014 proposes Grid Synchronization Systems of Three-Phase Grid-Connected Power Converters. A Complex-Vector-Filter Perspective. Due to the significance of extracting the grid voltage information, the grid synchronization system plays an important role in the control of grid-connected power converters, and various grid voltage synchronization schemes have been proposed. This paper adopts the complex-vector-filter method (CVFM) to analyze the grid synchronization systems. With this method, the pairs of scalar signals, for example, α -and β -axis components in the stationary α - β frame, are combined into one complex vector. As a consequence, the grid synchronization systems can be described with the complex transfer functions, which is very convenient to evaluate the steady-state performance.

S. Arul Daniel, N. Ammasai Gounden 2004, proposes a Novel Hybrid Isolated Generating System Based on PV Fed Inverter-Assisted Wind-driven induction

Generator. Isolated renewable energy systems based on hybrid wind-solar sources are considered as feasible and reliable options instead of wind-diesel systems. An isolated hybrid scheme employing a simple three-phase square-wave inverter to integrate a photovoltaic array with a wind-driven induction generator has been proposed for the first time. A dynamic mathematical model of the hybrid scheme with variables expressed in $d-q$ synchronous reference frame has been developed. The model is implemented in the power system blockset platform and a comparison has been made between transients simulated and transients obtained in an experimental prototype.

Henk Polinder, Frank F. A. van der Pijl, Gert-Jan de Vilder, Peter J. Tavner, 2006 proposes Comparison of Direct-Drive and Geared Generator Concepts for Wind Turbines. The objective of this paper is to compare five different generator systems for wind turbines, namely the doubly-fed induction generator with three-stage gearbox (DFIG3G), the direct-drive synchronous generator with electrical excitation (DDSG), the direct-drive permanent-magnet generator (DDPMG), the permanent-magnet generator with single stage gearbox (PMG1G), and the doubly-fed induction generator with single-stage gearbox (DFIG1G). The comparison is based on cost and annual energy yield for a given wind climate. The DFIG3G is a cheap solution using standard components.

C. Liu, K.T. Chau, X. Zhang, 2010 proposes an Efficient Wind-Photovoltaic Hybrid Generation System Using Doubly Excited Permanent-Magnet Brushless Machine. Here, due to PMBLDC machine efficiency of the AC source system is high. Also copper losses are very less because of permanent magnet nature. The hybrid energy is fed to the DC to DC converter and the voltage is given to the load. The load voltage is almost constant because of the hybrid system. The PMBLDC output is not sinusoidal nature due to permanent magnet. It requires sensor alignment. Power quality issues are not considered in this paper clearly. Boost converter is used so still ripples and THDs are high.

C. N. Bhende, S. Mishra, Siva Ganesh Malla, 2011 proposes Permanent Magnet Synchronous Generator-Based Standalone Wind Energy Supply System. Here, the PMSG provides constant voltage to the load through three phase uncontrolled rectifier.

Additional boost DC to DC converters are not required in this concept. Here the load is standalone load because of this load compensation is not required. Only wind generation is included in this topology, due to this it required additional capacitor bank to store the energy. Power qualities problems are not compensated so performance of the system is poor. Only standalone systems are discussed.

CHAPTER 2

PROJECT DESCRIPTION

2.1 BLOCK DIAGRAM

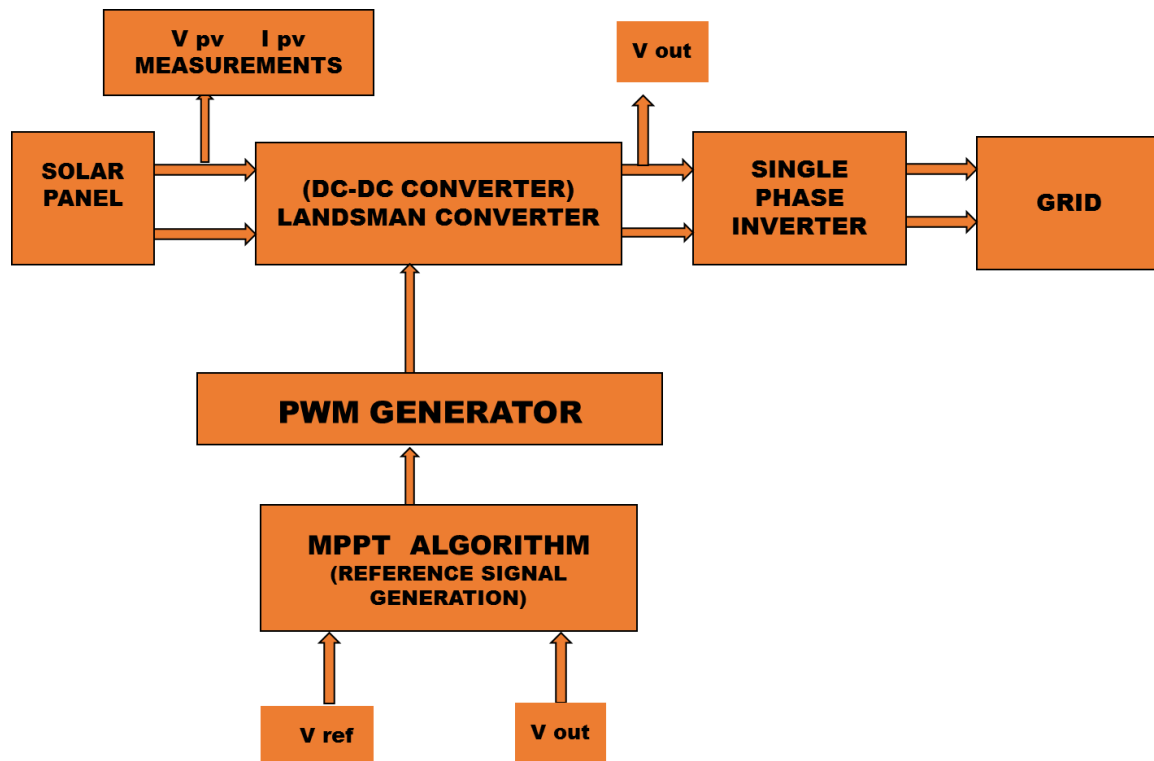


Figure 2.1 Block diagram

2.2 CIRCUIT DIGRAM

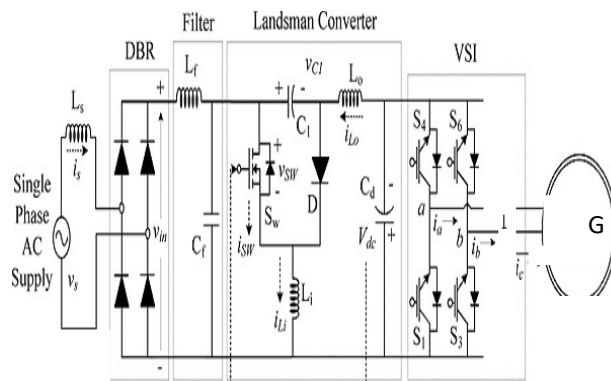


Figure 2.2 Proposed circuit diagram

2.3 CONCEPT EXPLANATION

The block diagram of the proposed power generation system is shown in figure 4.2. The piezoelectric transducers capture the strain due to the vibrations as its input source of energy. The “piezoelectric generator” block then converts this input mechanical input (strain) energy source into electrical power output. Then this power is rectified into DC power source via the “rectifier”. These blocks together form the piezoelectric transducer stage as observed from. Then the rectified output from the piezoelectric generator is stored in a battery. This voltage is maintained by” SEPI converter” which is a buck boost converter and feed to a single phase inverter and converted to AC voltage the load.

CHAPTER 3

PROPOSED SYSTEM

Using an isolation transformer in the grid-connected inverter can solve the Problem of the leakage current caused by the earth parasitic capacitance in solar modules. There are two types of grid-connected inverter with an isolation transformer.

- a) Line frequency transformer
- b) High-frequency transformer

3.1 LINE FREQUENCY TRANSFORMER

Fig. 1.1 shows a grid-connected electrical phenomenon generation system with a line frequency electrical device. The star modules will be grounded directly and there's no current path for run current as a result of the road frequency electrical device is isolated. this technique provides no dc current to the grid and has the advantage of an easy negative feedback circuit.

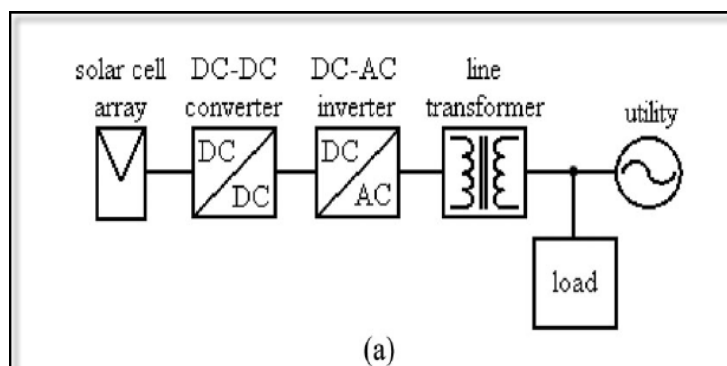


Figure 3.1 Existing Grid-connected photovoltaic generation system with isolation transformer

3.2 HIGH FREQUENCY TRANSFORMER

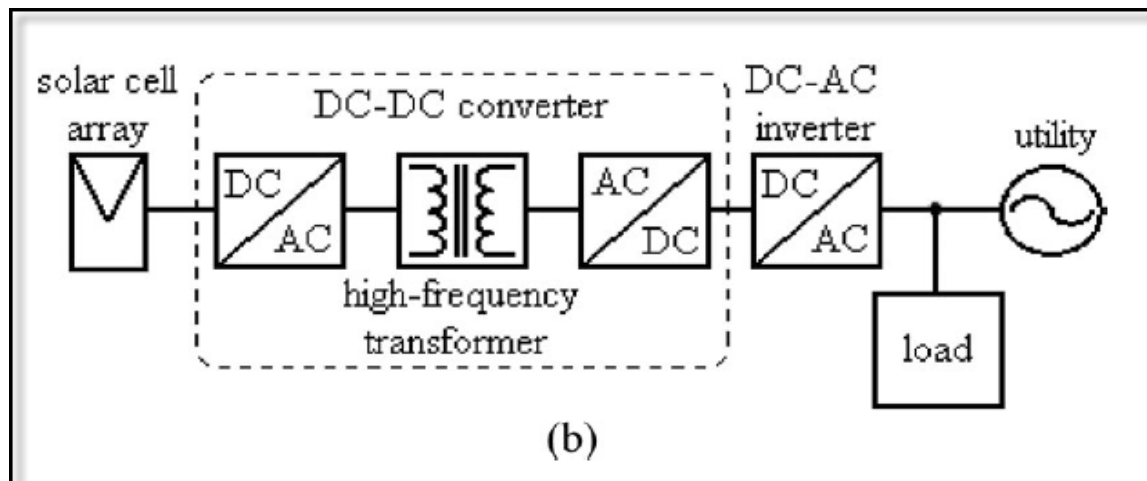


Figure 3.2 Existing Grid-connected photovoltaic generation system with an isolation

Figure. 3. shows a grid-connected electrical phenomenon generation system with a high frequency electrical device. The electrical device is incorporated during a dc–dc device and is operated at high frequency to cut back volume and value. However, the negative feedback circuit of this grid-connected electrical phenomenon generation system is sophisticated thanks to the employment of a transformer-isolated dc–dc device. Besides, the high frequency electrical device isn't placed at the output of the grid-connected electrical phenomenon generation system, thus it cannot forestall the dc current from injecting the grid.

The use of Associate in Nursing isolation electrical device within the grid-connected electrical phenomenon generation system ought to be avoided thanks to value, size, and potency. In general, the bridge-type dc–ac electrical converter is employed within the grid-connected electrical phenomenon generation system.

3.2.1 DRAWBACKS OF EXISTING SYSTEM

- Efficiency of the system low.
- Output voltage not constant in utility side.
- Cost of the system increase
- Transformer losses also increase the total losses of the system
- Complex in circuit
- Modes of operation is high

The diagram of the planned power generation system is shown in figure four.2. The electricity transducers capture the strain because of the vibrations as its input supply of energy. The “piezoelectric generator” block then converts this input mechanical input (strain) energy supply into electric power output. Then this power is corrected into DC power supply via the “rectifier”. These blocks along kind the electricity electrical device stage as discovered from. Then the corrected output from the electricity generator is keep during a battery. This voltage is maintained by “Landsman device” that may be a buck boost converter and feed to one part electrical converter and reborn to AC voltage the load.

3.2.2 LANDSMAN CONVERTER

DC-to-DC converters are unit utilized in transportable electronic devices like cellular phones and portable computer that are unit furnished power from batteries primarily. Such electronic devices typically contain many sub-circuits, every with its own voltage level demand totally different from that provided by the battery or Associate in Nursing external offer (sometimes higher or not up to the availability voltage). to boot, the battery voltage declines as its keep energy is drained. Switched DC to DC converters provide a technique to extend voltage from a partly lowered battery voltage thereby saving house rather than exploitation multiple batteries to accomplish constant factor.

Most DC-to-DC device circuits conjointly regulate the output voltage. Some exceptions embody high-efficiency LED power resources, that are unit a form of DC to DC device that regulates this through the LEDs, and straightforward charge pumps that double or triple the output voltage.

DC-to-DC converters that are unit designed to maximise the energy harvest for electrical phenomenon system and for wind turbines are unit referred to as power optimizers.

Transformers used for voltage conversion at mains frequencies of 50–60 cps should be massive and serious for powers olympian some watts. This makes them dear, and that they are unit subject to energy losses in their windings and because of eddy currents in their cores. DC-to-DC techniques that use transformers or inductors work on abundant higher frequencies, requiring solely abundant smaller, lighter, and cheaper wound elements. Consequently these techniques are unit used even wherever a mains electrical device can be used; as an example, for domestic electronic appliances it's desirable to rectify mains voltage to DC, use switch-mode techniques to convert it to high-frequency AC at the specified voltage, then, usually, rectify to DC. the complete advanced circuit is cheaper and additional economical than a straightforward mains electrical device circuit of constant output. DC-to-DC converters are unit wide used for DC microgrid applications, within the context of various voltage levels.

The basic landsman performs DC-DC voltage conversion through energy exchange between its coupling electrical device and switch inductors (C_{in} , L_1 and L_2). The switch controls the energy exchange quantity between the electrical device and inductors. Maximising energy exchange potency and overall device potency needs this landsman style operative in continuous conductivity mode (CCM).

The circuit diagram of a landsman device. There are unit 2 modes of operation in landsman. They are

1. Continuous conductivity Mode
2. Discontinuous conductivity Mode

3.2.3 CONTINUOUS CONDUCTION MODE

In continuous conductivity mode of operation, the electrical device current are going to be continuous and never reaches to zero. means that meaning which means operative the landsman in CCM means never property the currents through L_1 and L_2 cut back to 0A – i.e. never property L_1 and L_2 utterly discharge. once the SEPIC Reaches steady-state operation, the common voltage across C_{in} are going to be up to that of V_{in} . to boot, the common current through C_{in} is 0A in steady-state. once this steady-state development happens, L_2 is that the solely supply of current to the output load. Thus, L_2 's average current equals that of the output load, and is freelance of V_{in} .

In CCM, the add of the common voltages across the SEPIC's energy storage components (excluding input and output filter capacitors caesium and C_o) equal that of the SEPIC's input voltage delineate as follows,

$$V_{in} = V_{L1} + V_{Cin} + V_{L2} \quad (3.1)$$

Since the average voltage across C_{in} equals that of V_{in} , V_{Cin} equals V_{in} , leading to

$$V_{L1} = V_{L2} \quad (3.2)$$

Under CCM in steady-state, the SEPIC's operation more splits into 2 operation modes: once switch S conducts and once it doesn't conduct. Analyzing the landsman's entire operation in CCM needs analyzing it in switch S's conductivity and non-conduction modes.

When switch is closed

Figure 3.3 shows the landsman operation once switch S conducts. Filter capacitors caesium and C_o area unit assumed to be in steady-state, therefore no current flows through these 2 elements till they discharge. moreover, caesium and C_o also are assumed to be massive enough in capacitance such the landsman's input and output ripple voltages nearly involves zero.

When switch S conducts throughout the primary half-switching cycle, this through L_1 will increase within the positive direction whereas this through L_2 will increase within the negative direction. thence L_1 charges via V_{in} , whereas L_2 discharges (acting as a source) through C_{in} . S remains closed for a brief amount period of time period fundamental quantity fundamental measure} and through now period the instant voltage across C_{in} equals V_{in} . Thus, V_{L1} and V_{L2} each equal some V_{in} in magnitude.

The only distinction between the 2 voltages is that V_{L2} 's polarity is reversed (i.e. negative) as a result of L_2 is discharging. C_{in} successively discharges and provides current to L_2 so as to store energy in it, in order that L_2 will offer current to the output load throughout consequent half-switching cycle once switch S now not conducts. throughout this whole half-switching cycle, diode D doesn't conduct i.e. in different

words, it's reverse-biased. Therefore C_o discharges and thence is that the solely part that helps maintain the output load current once switch S is conducting. throughout the second half-switching cycle, switch S turns off.

Figure 3.3 Switch on condition

3.2.4 WHEN SWITCH IS OPENED

Figure 3.4 Switch off condition

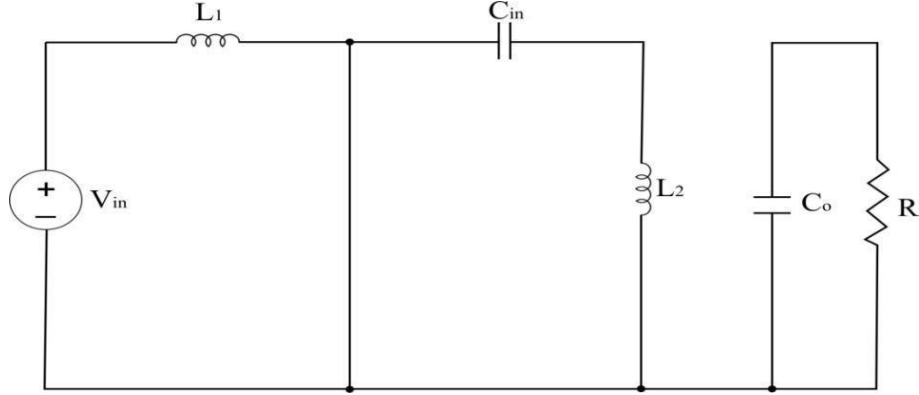
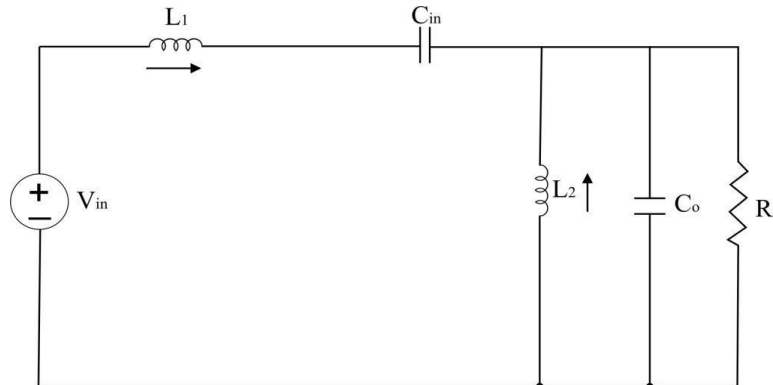


Figure 3.6 shows the landsman operation once the switch is opened. At the tip of 1 half-switching cycle, switch S turns off. The new path for the input current is thru L1 and C_{in} . as a result of current cannot modification in a flash through associate degree electrical



device, electrical device Currents don't forthwith modification. Thus, capacitance current C_{in} equals $L1$ current. $L2$ continues to discharge, however throughout this half-switching cycle it discharges into C_o , therefore turning on D i.e., forward biased and supply current to the output load.

However, the direction of $L2$ current causes it to feature to the input current that already flows to the output load. Thus, once S doesn't conduct, each $L1$ and $L2$ provide current to the output load. V_{in} and $L1$ charge C_{in} (which discharged throughout the half-switching cycle once switch S conducted), and $L2$ continues discharging to the output load till switch S conducts once more at the start of succeeding half-switching cycle (when C_{in} provides current to charge $L2$).

3.2.5 DISCONTINUOUS CONDUCTION MODE

In discontinuous conductivity mode of operation, the electrical device current reaches to zero. The discontinuous conductivity mode happens if the currents through $L1$ and $L2$ stay at 0A for any important amount[period of time|period|fundamental quantity|fundamental measure} relative to modify change period. operational a landsman in DCM yields higher

potency at lighter current hundreds, however needs operational at high current hundreds. Therefore, operational in CCM ought to yield higher overall device potency.

PI CONTROLLER

The below fig shows the diagram of PI Controller. The DC aspect capacitance voltage is perceived and compared with a reference voltage. This error $e = V_{dc, referee} - V_{dc}$ is employed because the input for PI Controller. The error signal is more experienced Butterworth style based mostly Low Pass Filter (LPF).

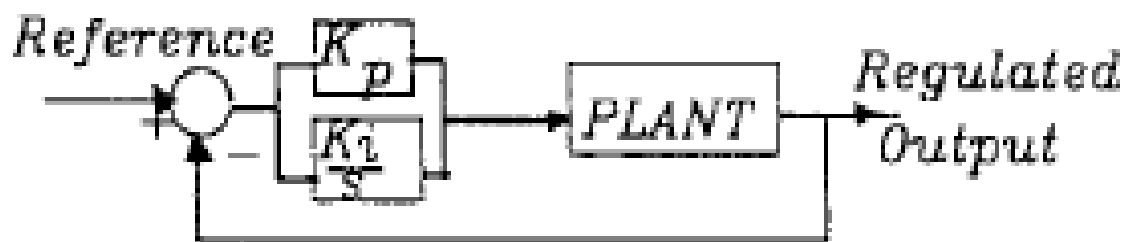


Figure 3.5 PI Controller

The LPF filter has cutoff frequency at 50Hz which will suppress the upper order elements and permit solely basic elements. The transfer operate of the PI Controller is described as $H(s) = K_p + K_i/s$ (4.1)

Where K_p is that the proportional constant that determines the dynamic response of the DC-side voltage management and K_i is that the integration constant that determines its sinking time. The proportional integral controller is eliminating study state error within the DC- aspect voltage.

Advantages and Disadvantages of PI Controllers:

i) The integral term in an exceedingly PI controller causes the steady-state error to cut back to zero, that 0000000is not the case for proportional-only management generally. ii) The shortage of by-product action might create the system steadier within the steady state within

the case of creaking information. this can be as a result of by-product action is a lot of sensitive to higher-frequency terms within the inputs.

iii) While not by-product action, a PI-controlled system is a smaller amount tuned in to real (non-noise) and comparatively quick alterations in state so the system are slower to achieve set point and slower to reply to perturbations than a well-tuned PID system.

PI compensator is select for this feedback circuit because of the unpaid system containing one pole. PI compensator will increase the gain at low frequency , such the output is best regulated at DC and at frequencies well below the crossover frequency. The transfer operate of the compensator is,

$$G_c(s) = \frac{\hat{v}_c(s)}{\hat{v}_e(s)} = G_g \left(1 + \frac{\omega_L}{s} \right)$$

If the is sufficiently below the crossover frequency of the unpaid loop, the section margin won't be modified. At low frequency, the inverted zero causes the compensator integrate the error signal. Lfcf The DC gain of the stipendiary loop is proportional thereto of the PI compensator; therefore, the DC part of the error between the reference and feedback current can approach to zero once willy-nilly massive gain of the PI compensator is intended. meaning the steady-state output current is utterly regulated though the PI compensator is beneficial in nearly all kinds of the feedback system, it's associate degree particularly easy and effective approach for systems originally containing one pole. The operate of the pulse-width modulator is to provide the duty-cycle $d(t)$ that's proportional to the output voltage of the compensator.

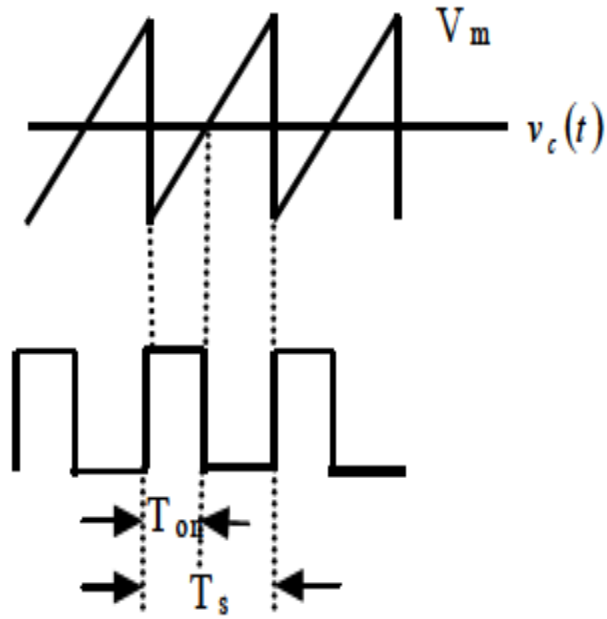


Figure 3.6 waveform of the pulse-width modulator

In terms of the wave, the input to output transfer operate equals to:

$$d(t) = \frac{t_{on}}{T_s} = \frac{v_c(t)}{V_m}$$

Perturbation and linearization of, the transfer operate of the pulse-width modulator is:

$$F_m(s) = \frac{\tilde{d}(s)}{v_c(s)} = \frac{1}{V_m}$$

Although the pulse-width modulator is sufficiently correct for nearly all the applying, it additionally introduces sampling of the wave. Pulse-width modulator samples the management voltage of the compensator output with the rate that equals to the change frequency. Hence, a a lot of correct ac tiny signal model for the PWM current controller ought to embrace the sampling model.

3.5 INVERTER

Inversion is that the modification of dc power to ac power at a desired output voltage or current and frequency. A static semiconductor electrical converter circuit will this voltage inverting transformation. The terms voltage-fed and current-fed square measure employed in relation with the output from electrical converter circuits. Conventionally, electrical converters square measure classified into 2 broad classes – voltage supply electrical converter (VSI) and current supply inverter.

3.5.1 VOLTAGE SOURCE INVERTER

A VSI is one within which the dc input voltage would ought to keep constant and freelance of the load current drawn. The electrical converter dictates the load voltage whereas the drawn current form is such as by the load.

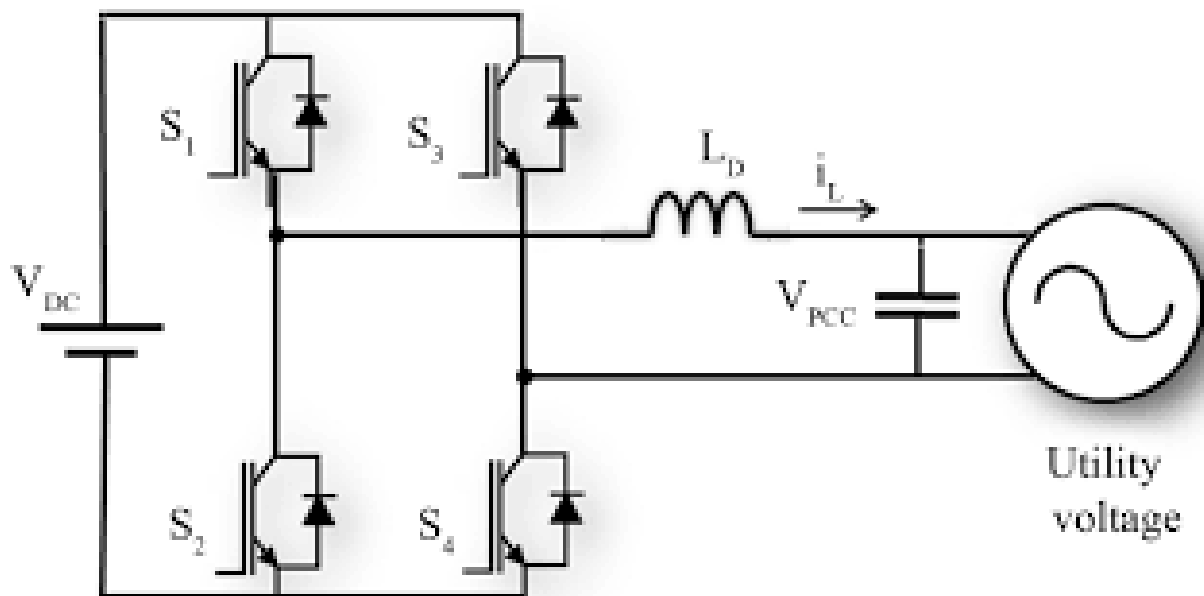


Figure 3.7: Traditional VSI

These topologies square wave are widely used as a result of they behave as voltage sources naturally as needed in several industrial applications, like adjustable speed drives (ASDs), that square wave is the foremost renowned application of inverters. Similarly, these structures may be used as CSIs, wherever the severally controlled ac output may be a current undulation. These structures square wave are widely utilized in medium-voltage applications, wherever good-quality voltage waveforms square wave are needed. Static power converters, chiefly inverters, square wave are created from power switches so and also the ac output waveforms square wave are therefore created of distinct values. This ends up in the formation of waveforms that options quick transition instead of swish ones. Figure 4.6 depicts the standard or standard three-phase voltage-source device (that may be abbreviated as VSC) structure. A dc voltage supply that is supported by an oversized electrical device feeds the most device circuit, a three-phase bridge. This dc voltage supply may be electric battery, fuel-cell stack, diode rectifier, or electrical device. Six switches that square wave are painted by IGBTs with associate degree anti-parallel diode square wave are utilized in the most circuit; to supply bidirectional current flow and simplex voltage block capability. The VSC is usually used, but it's following limitations. The ac output voltage is proscribed below and can't cross the dc-rail voltage. Therefore, the VSC may be a buck electrical converter for dc-to-ac power conversion and also the VSC may be a boost rectifier for ac to dc power conversion. □ For applications wherever over drive is needed and also the offered dc voltage isn't enough then a further dc-dc boost device is needed to urge the required ac output. These further device stages raise the system value and lower down the potency. □ The higher and lower devices of every section leg can't be gated on at the same time otherwise, a shoot-through would occur which might destroy the devices. The shoot-through downside by magnetic attraction interference (EMI) noise's miss-gating-on is one among the most issues in terms of responsibility of the device. An output LC filter is needed to supply a curved voltage compared with the CSI, that causes further power loss. A CSI is one within which the supply and thus the load current is planned and also the load electrical resistance decides the output voltage. the provision current cannot modification chop-chop. This current is managemented by series inductance that control abrupt changes in current. The magnitude of load current is

controlled by varied the input dc voltage to the massive inductance, thence electrical converter response to dynamic load is slow. Being a current supply, the electrical converter could survive a brief circuit thereby giving fault ride-through properties

3.5.2 SINUSOIDAL PULSE WIDTH MODULATION

The switches within the voltage supply electrical converter (See Fig. 4.9) can be turned on and off as needed. within the simplest approach, the highest switch is turned on If turned on and off just one occasion in every cycle, a sq. wave undulation results. However, if turned on many times {in a|during a|in associate degree exceedingly|in a very} cycle an improved harmonic profile could also be achieved. Figure 3.8 Voltage supply electrical converter within the most easy implementation, generation of the required output voltage is achieved by examination the required reference undulation (modulating signal) with a high-frequency triangular 'carrier' wave as portrayed schematically in Fig.4.11. looking on whether or not the signal voltage is larger or smaller than the carrier undulation, either the positive or negative dc bus voltage is applied at the output.

Note that over the amount of 1 triangle wave, the common voltage applied to the load is proportional to the amplitude of the signal (assumed constant) throughout this era. The ensuing shredded sq. undulation contains a reproduction of the required undulation in its low fre-quency parts, with the upper frequency parts being at frequencies of associate degree on

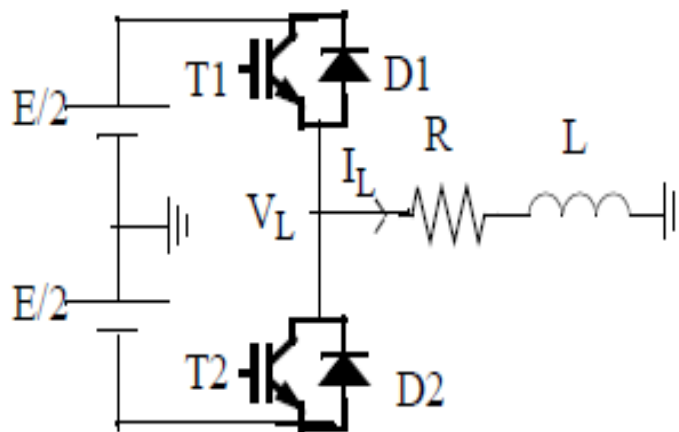


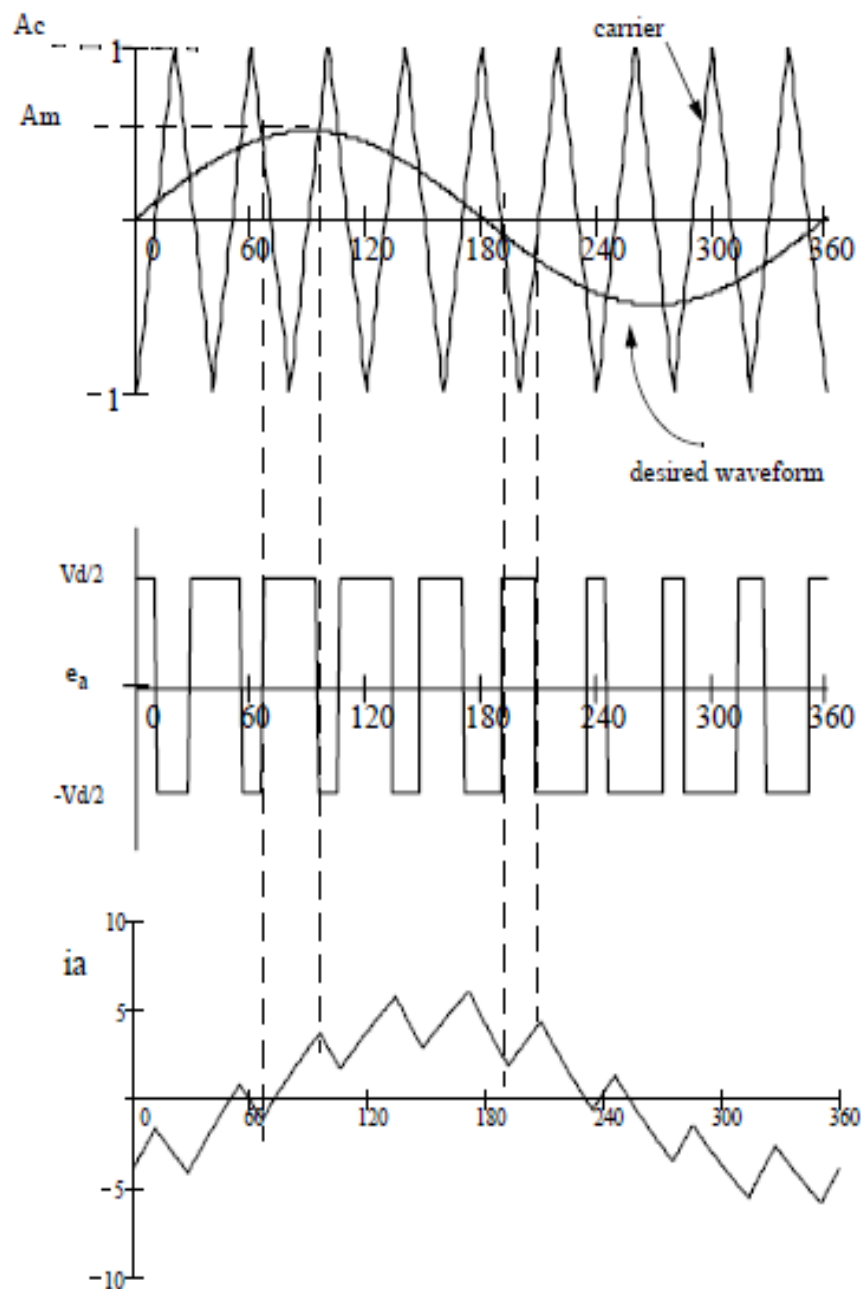
Figure 3.8 Voltage Source Inverter

the brink of the carrier frequency. Notice that the basis mean sq. worth of the ac voltage undulation remains up to the dc bus voltage, and thence the overall harmonic distortion isn't laid low with the PWM method. The harmonic parts square measure simply shifted into the upper frequency vary and square measure mechanically filtered thanks to inductances within the ac system. When the modulating signal may be a sinusoid of amplitude A_m , and also the amplitude of the triangular carrier is A_c , the magnitude relation $m=A_m/A_c$ is thought because the modulation index.

Note that dominant the modulation index therefor controls the amplitude of the applied output voltage. With a sufficiently high carrier frequency (see Fig. 4.9 drawn for $f_c/f_m =$

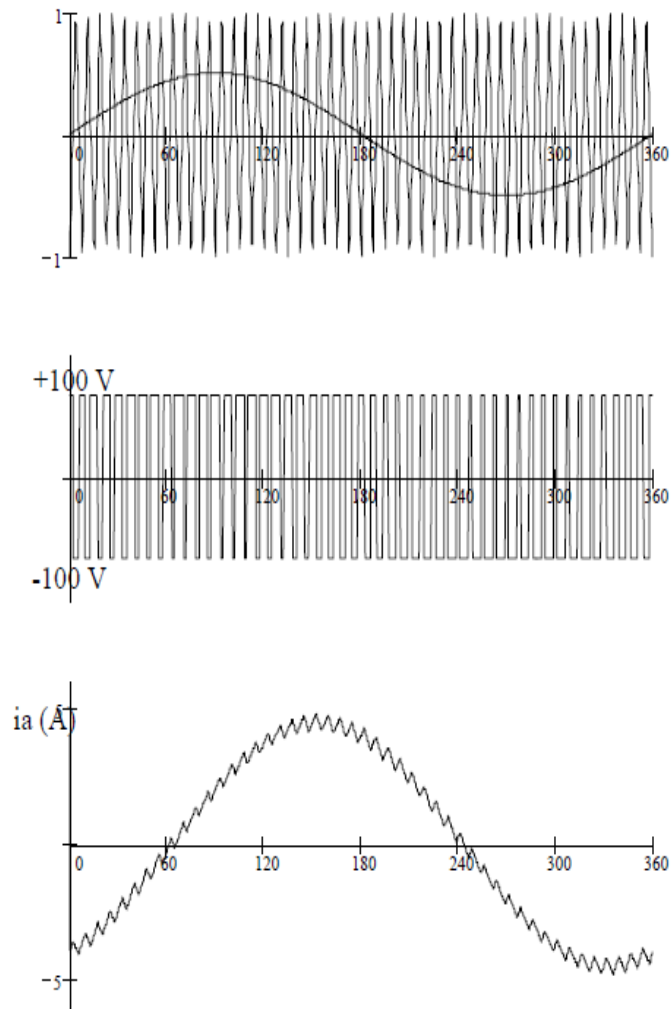
Figure 3.9 Principal of Pulse Width Modulation

amount of fundamental), the high frequency parts don't propagate considerably within the ac network (or load) due the presence of the inductive components. However, the next carrier frequency will lead to a bigger variety of switching's per cycle associate degree thence in an enhanced power loss. usually shift frequencies within the 2-15 rate vary square measure thought of adequate for power systems applications. conjointly in three-phase systems it's



advisable to use $f_c/f_m = 3k, (k \in \mathbb{N})$, so all 3 waveforms are symmetric.

Figure 3.10 SPWM with $f_c/f_m = 48$, $L/R = T/3$



Note that process works well for $m \leq 1$. For $m > 1$, there are periods of the triangle wave in which there is no intersection of the carrier and the signal as in Fig. 3.11. However, a certain amount of this “over modulation” is often allowed in the interest of obtaining a larger ac voltage magnitude even though the spectral content of the voltage is rendered somewhat poorer.

Note that with an odd ratio for f_c/f_m , the waveform is anti-symmetric over a 360 degree cycle. With an even number, there are harmonics of even order, but in particular also a small dc component

Hence an even number is not recommended for single phase inverters, particularly for small ratios of f_c/f_m .

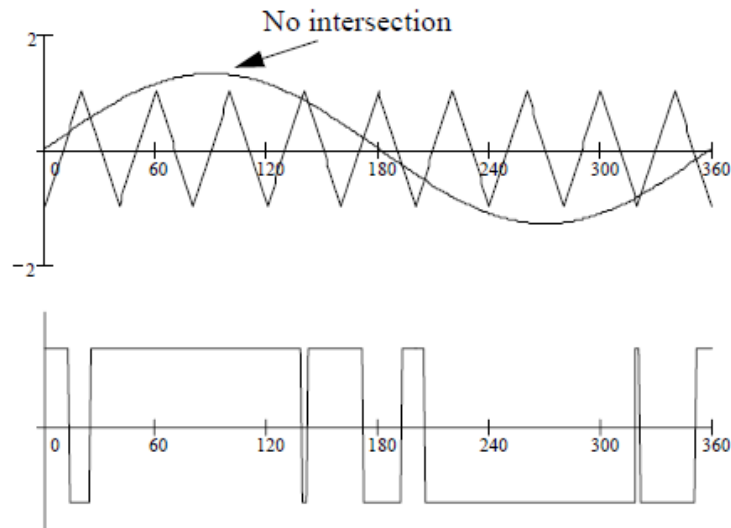


Figure 3.11 Overmodulation: $m = 1.3$

3.6 GRID SIDE CONVERTER CONTROL SYSTEM

The Grid aspect convertor is employed to manage the voltage of the DC bus electrical condenser and it's shown in figure three.12. For the grid-side controller the d-axis of the rotating coordinate system used for d-q transformation is aligned with the positive sequence of grid voltage. This controller consists of

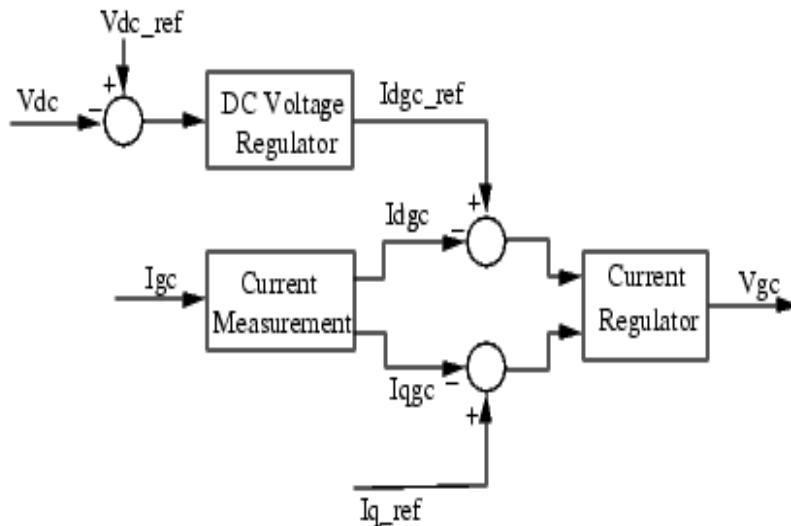


Figure 3.12 Grid side converter control

1. A measuring system mensuration the d and Q parts of AC currents to be controlled further because the DC voltage V_{dc} .
2. associate degree outer regulation loop consisting of a DC transformer.
3. associate degree inner current regulation loop consisting of a current Regulator. the present regulator controls the magnitude and part of the voltage generated by convertor Cgrid (V_{gc}) from the I_{dgc} nine official made by the DC transformer and such as I_{q_ref} reference. the present regulator is power-assisted by feed forward terms that predict the Cgrid output voltage.

CHAPTER 4

HARDWARE DETAILS

4.1 POWER SUPPLY

There square measure many varieties of power provide. Most square measure designed to convert Voltage AC Mains electricity to an acceptable low voltage provide for electronic Circuits and different Devices. an influence provide will by counteracted into a series of blocks, every of that performs a selected perform.

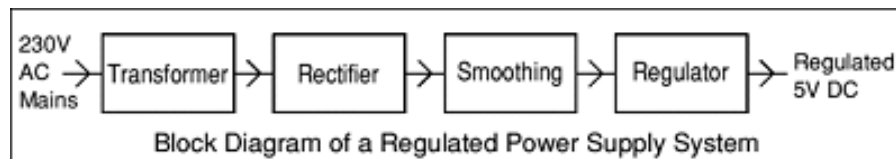


Figure.4.1 Block diagram of a regulated power supply

- Transformer - steps down high voltage AC mains to low voltage AC.
- Rectifier - converts AC to DC, however the DC output is variable.
- Smoothing - smoothes the DC from variable greatly to a very low ripple.
- Regulator - eliminates ripple by setting DC output to a set voltage.

4.1.1 BRIDGE RECTIFIER

A bridge rectifier may be created mistreatment four individual diodes, however it's conjointly out there in special packages containing the four diodes needed. it's known as a rectifier. Smoothing is performed by an oversized price capacitor connected across the DC provide to act as a reservoir, provision current to the output once the variable DC Voltage from the rectifier is falling.

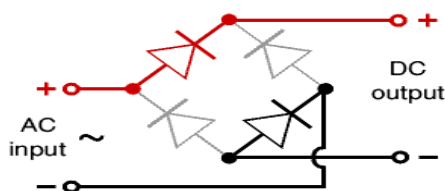


Figure.4.2 Bridge rectifier

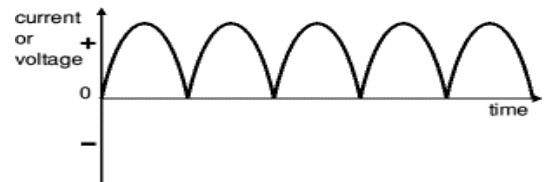


Figure 4.3 FW Varying DC

The diagram shows the wrinkled DC (Dotted line) and therefore the smoothened DC (solid line). The electrical condenser charges quickly close to the height of the variable DC, and so discharges because it provides current to the output.

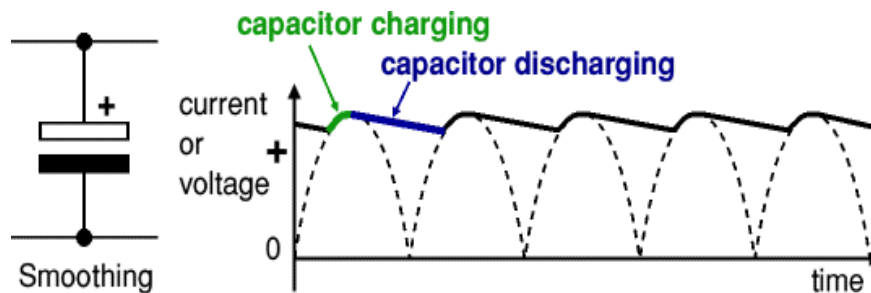


Figure.4.4 Capacitor Charging and Discharging

Note that smoothing considerably will increase the common DC voltage to virtually the height price ($1.4 \times$ RMS value). for instance, 6V RMS AC is corrected to full wave DC of concerning four.6V RMS (1.4V is lost within the bridge rectifier), with smoothing this will increase to virtually the height price giving $1.4 \times 4.6 = 6.4V$ swish DC. Smoothing isn't good thanks to the electrical condenser voltage falling a touch because it discharges, giving atiny low ripple voltage. for several circuits a ripple that is 100 percent of the provision Voltage is satisfactory and therefore the equation below offers the specified price for the Smoothing electrical condenser. a bigger electrical condenser can provide fewer ripples. The electrical condenser price should be doubled once smoothing half-wave DC.

4.1.2 REGULATOR

Voltage regulators ICs square measure out there with fastened (typically five, twelve and 15V) or variable Output voltages. they're conjointly rated by the most current they will pass. Negative Voltage regulators square measure out there, chiefly to be used in twin provides. Most regulators embrace some automatic protection from excessive current ('overload protection') and warming ('thermal protection').

Figure 4.5 regulator

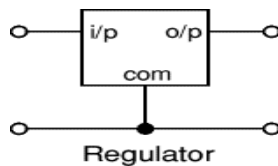
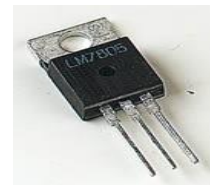


Figure 4.6 regulator IC



Many of the fastened transformer ICs has three leads and appearance like power transistors, like the 7804 +4V 1A regulator shown on the proper. They embrace a hole for attaching a sink if necessary.

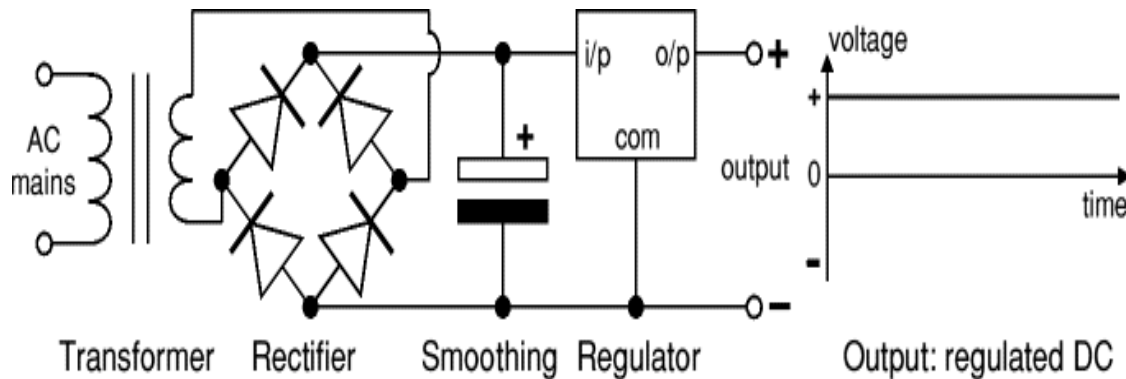


Figure.4.7 Rectifier circuit diagram and wave form

The regulated DC output is incredibly swish with no ripple. it's appropriate for all electronic circuits.

4.1.3 MULTI OUTPUT POWER

Multi output power provide outputs square measure +4V, +12V and –12V. Input AC signal is applied to primary of electrical device, electrical device secondary is 2 outputs; one is 0-9V AC and another is 18-0-18V. electrical device secondary output is connected to regulator through Full bridge rectifier and filtering electrical condenser. Diode is employed for convert the AC voltage to DC Voltage with AC ripples; electrical condenser is employed for take away the AC ripples. Regulator output is regulation the DC output voltage

Transformer

Primary Voltage = 230V AC

Secondary Voltage = 0-9V AC and 18-0-18V AC

Regulator

IC - 7804 and 7812 = Positive Voltage Regulator (+4v and +12V).

IC - 7812	=	Negative Voltage Regulator (-12V)
Diode	=	1N4007
Capacitor	=	4700 μ f/16V, 4700 μ f/24V and 10 μ f/63V

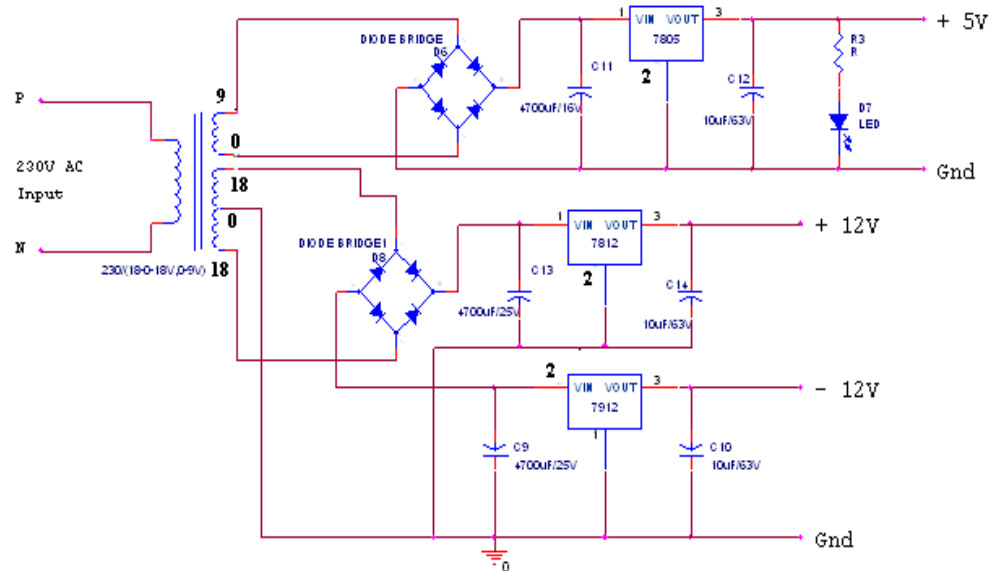


Figure.4.8 Multiple Power Supply (+4V, +12V and -12V)

4.2 MOSFET

The MOSFET (Metal compound Semiconductor Field impact Transistor) semiconductor unit may be a semiconductor unit that is wide used for change and amplifying electronic signals within the electronic devices. The MOSFET may be a core of computer circuit and it may be designed and fictitious during a) single chip as a result of these very little sizes. The MOSFET may be a four terminal device with source(S), gate (G), drain (D) and body (B) terminals. The body of the MOSFET is often connected to the supply terminal thus creating it a 3 terminal device like field impact semiconductor unit. The MOSFET is incredibly way the foremost common semiconductor unit and may be employed in each analog and digital circuits. The MOSFET works by electronically variable the breadth of a channel on that charge carriers flow (electrons or holes). The charge carriers enter the channel at supply and exit via the

drain. The breadth of the channel is controlled by the voltage on associated conductor is named gate that is found between supply and drain. It's insulated from the channel close to an especially skinny layer of metal compound. The MOS capability gift within the device is that the main part.

4.2.1 WORKING PRINCIPLE OF MOSFET:

The aim of the MOSFET is to be ready to management the voltage and current flow between the supply and drain. It works nearly as a switch. The operating of MOSFET depends upon the MOS capacitance. The MOS capacitance is that the main a part of MOSFET. The semiconductor surface at the below chemical compound layer that is found between supply and drain terminal. It will be inverted from p-type to n-type by applying a positive or negative gate voltages severally. once we apply the positive gate voltage the holes gift beneath the chemical compound layer with a repulsion and holes square measure pushed downward with the substrate. The depletion region inhabited by the certain negative charges that square measure related to the acceptor atoms. The electrons reach channel is created. The positive voltage conjointly attracts electrons from the n⁺ supply and drain regions into the channel. Now, if a voltage is applied between the drain and supply, the present flows freely between the supply and drain and also the gate voltage controls the electrons within the channel. rather than positive voltage if we tend to apply negative voltage, a hole channel are fashioned beneath the oxide layer.

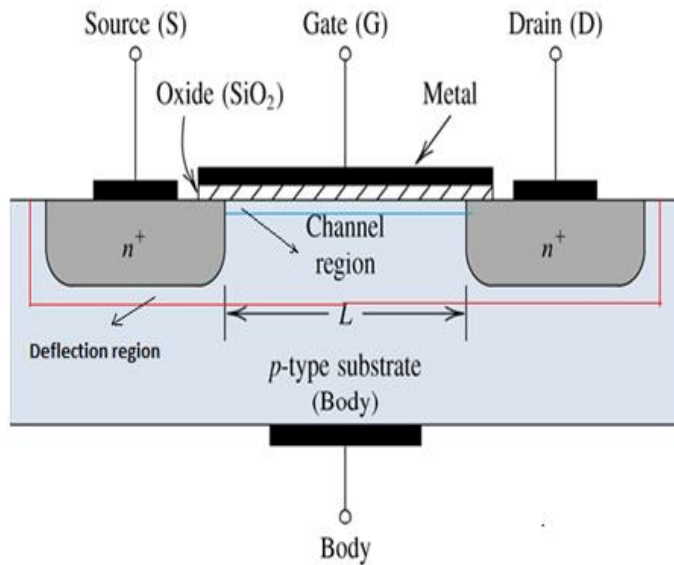


Figure 4.9 MOSFET Block Diagram

4.2.3 IRF840 MOSFET

IRF840 is rated for 8A, 400A, 0.840 ohm, n-channel power mosfet this n-channel improvement mode atomic number 14 gate power field impact semiconductor device is a sophisticated power mosfet designed, tested, and certain to stand up to a such as level of energy within the breakdown avalanche mode of operation. All of those power mosfets square measure designed for applications like shift regulators, shift converters, motor drivers, relay drivers, and drivers for prime power bipolar shift transistors requiring high speed and low gate drive power. These varieties will be operated directly from integrated circuits. erstwhile organic process sort ta17424.

Figure 4.10 IRF840 MOSFET



4.3 MICROCONTROLLER

A microcontroller may be a pc. All computers whether or not we tend to square measure talking a couple of notebook computer or an outsized mainframe or a microcontroller have many things in common:

- All computers have a central {processing unit|CPU|C.P.U.|central processor|processor|mainframe|electronic equipment|hardware|computer hardware} (central processing unit) that executes programs. If you're sitting at a personal computer at once reading this text, the central processor in this machine is death penalty a program that implements the online browser that's displaying this page.
- The central processor hundreds the program from somewhere. On your desktop machine, the browser program is loaded from the hard disc.
- The pc has some RAM (random-access memory) wherever it will store "variables."
- And the pc has thereforeme input and output devices so it will confer with individuals. On your desktop machine, the keyboard and mouse square measure input devices and also the monitor and printer square measure output devices. a tough disk is AN I/O device -- it handles each input and output. The personal computer you're mistreatment may be a "general purpose computer" that may run any of thousands of programs. Microcontrollers square measure "special purpose computers." Microcontrollers do one factor well. There square measure variety of alternative common characteristics that outline microcontrollers. If

a pc matches a majority of those characteristics, then you'll be able to decision it a "microcontroller":

- Microcontrollers square measure "embedded" within another device (often a client product) so they'll management the options or actions of the merchandise. Another name for a microcontroller, therefore, is "embedded controller."
- Microcontrollers square measure dedicated to 1 task and run one specific program. The program is keep in storage (read-only memory) and usually doesn't modification.
- Microcontrollers square measure usually low-power devices. A personal computer is sort of continuously obstructed into a electrical outlet and may consume forty watts of electricity. A battery-operated microcontroller may consume forty milliwatts.
- A microcontroller encompasses a dedicated data input device and sometimes (but not always) encompasses a little light-emitting diode or show|LCD|digital display|alphanumeric display} display for output. A microcontroller conjointly takes input from the device it's dominant and controls the device by causing signals to completely different parts within the device.

4.3.1 DIGITAL SIGNAL CONTROLLER

Microchip Technology's control & Power Conversion family of dsPIC Digital Signal Controllers provides AN easy-to-use answer for applications requiring control. micro chip Technology introduced twenty 16-bit Flash small controllers that give the industry's highest performance. The DSPIC family of Digital Signal Controllers options a fully- enforced digital signal processor (DSP) engine, thirty unit non-pipelined performance, compiling program friendly style, and a well-known Microcontroller design and style atmosphere. The twenty new dsPIC30F2010 devices type 3 product families targeting control and power conversion, sensor, and all-purpose applications. The DSPIC core may be a 16-bit (data) non-pipelined changed Harvard machine that mixes the management benefits of a superior 16-bit

Microcontroller with the high computation speed of a totally enforced DSP to provide a tightly coupled, single-chip single-instruction stream answer for embedded systems styles. The initial 20-dsPIC30F2010 devices feature twelve Kbytes to one hundred forty four Kbytes of on-chip secure Flash program memory house and up to eight Kbytes of information house operative voltage appeals to several Microcontroller applications that stay at four volts, whereas several DSPs square measure restricted to three.3-supply V most. Devices square measure planned in 40-pin package.

4.2.2 DSPIC 30F2010 PIN CONFIGURATION

The design of dspic30f2010 is shown in fig.4.4 and pin diagram in shown in fig.4.11

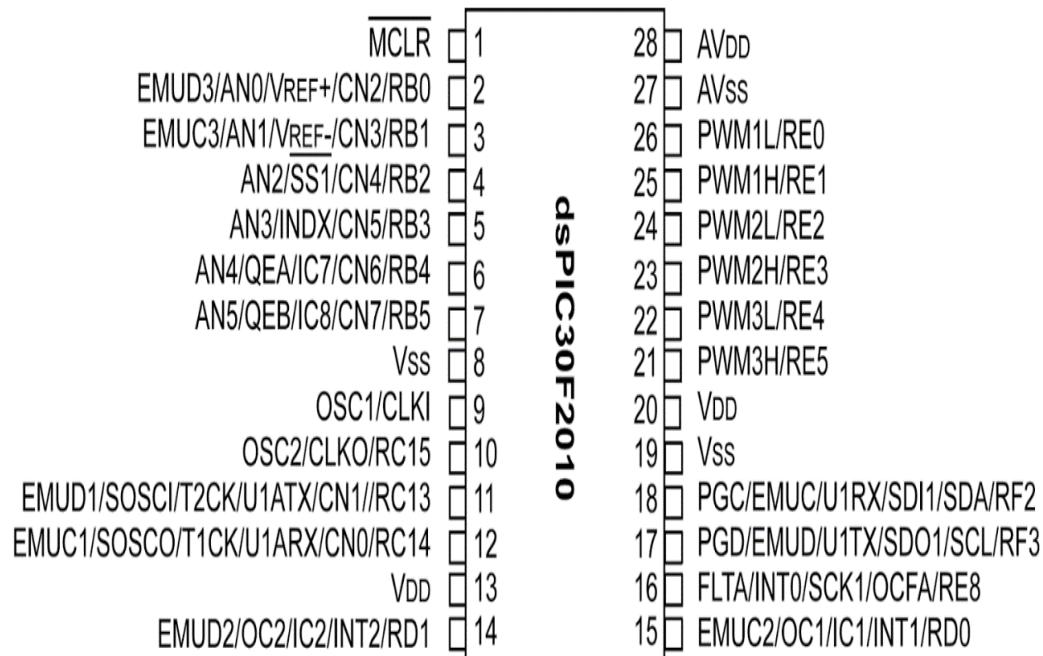


Figure 4.11 DSPIC 30F2010pin Configuration

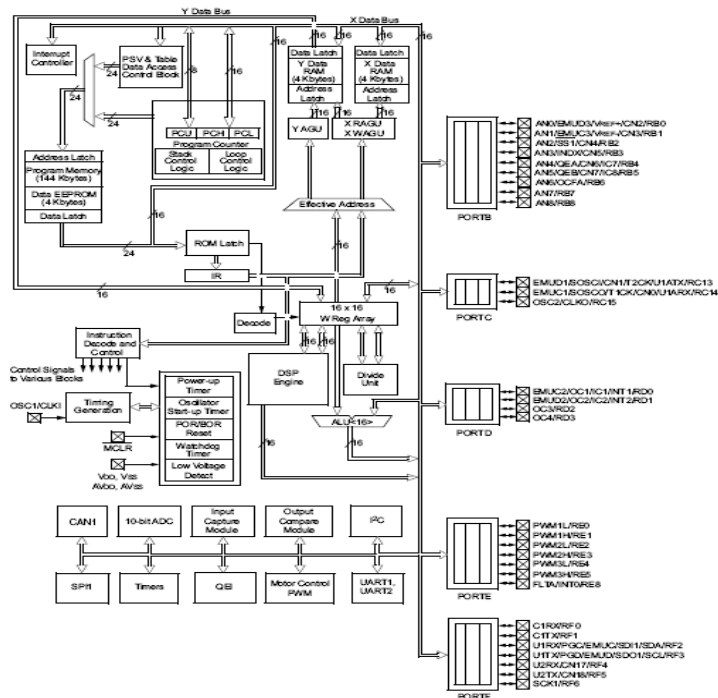


Figure 4.12 Dspic30f2010 Architecture Functional Block Diagram

DSPIC 30F2010pin Configuration Figure 4.12 Dspic30f2010 design useful diagram The DSPIC control PWM module is optimized for applications, like 3-phase AC induction motors, 3-phase brushless DC motors, and switched reluctance motors. The control PWM module has either half dozen or eight output pins and three or four PWM generators, relying upon the device. The output pins could also be designed as complementary output pairs or as freelance outputs. Critical PWM operative parameters, like output polarity, square measure programmed in non-volatile memory for safety. The non-volatile choices scale back the danger of inserting the PWM outputs during a state that may harm the ability devices connected to Peripheral.

4.3.3 DSPIC MICRO CONTROLLER FEATURES

High Performance Modified RISC CPU

- Modified Harvard design
- C compiler optimized instruction set design with versatile addressing modes
- 24-bit wide directions, 16-bit wide knowledge path
- 48 Kbytes on-chip Flash program house (16K Instruction words)
- 2 Kbytes of on-chip knowledge RAM
- 1 Kbytes of non-volatile knowledge EEPROM

4.4 DRIVER CIRCUIT

MOSFET gate driver could be a power electronic equipment that accepts a low-power input from a controller IC and produces the acceptable high-current gate drive for an influence MOSFET. A gate driver is employed once a pulse-width-modulation (PWM) controller cannot give the output current needed to drive the gate capacitance of the associated MOSFET. Gate drivers is also enforced as dedicated ICs, separate transistors, or transformers. they'll even be integrated at intervals a controller IC. Partitioning the gate-drive operate off the PWM controller permits the controller to run cooler and be a lot of stable by eliminating the high peak currents and warmth dissipation required to drive an influence MOSFET at terribly high frequencies.

4.4.1 TLP240 OPTO-DRIVER IC

Figure 4.13 Opto Isolator Circuit Diagram

Figure 4.13 Opto Isolator Circuit Diagram Gate driver circuit is circuit integral a part of power physical science converters that is employed to drive power semiconductor devices like BJT's, IGBT's and MOSFETs. Output of DC DC converters chiefly depend upon behavior of gate driver circuits. Its mean if gate driver circuit doesn't drive gate of MOSFET device properly, your designed DC DC device output won't be in line with your demand. so style of gate driver circuit is critically vital in coming up with of power physical science converters.

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Figure 4.14 TLP 240

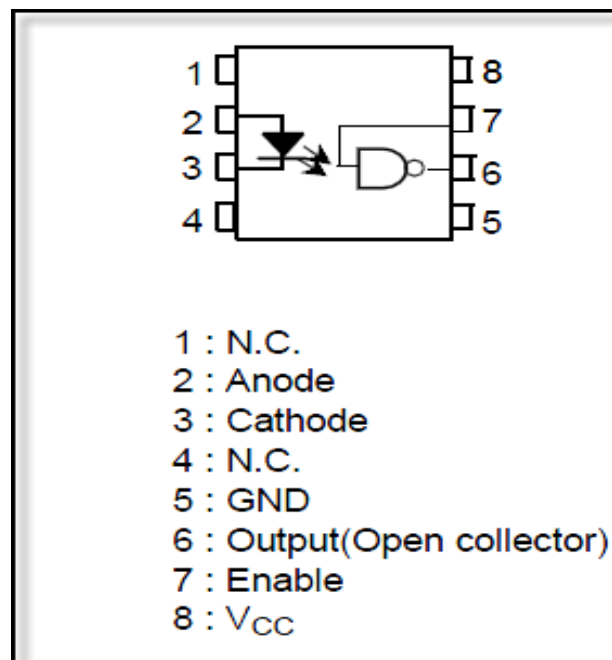


Figure 4.15 Pin Configurations

The TOSHIBA TLP240 consists of a GaAlAs light emitting diode and a integrated photo detector. This unit is 8-lead DIP package. TLP240 is suitable for gate driving circuit of IGBT or power MOS FET.

- Input threshold current: 4mA (max)

- Supply current: 11mA (max)
- Supply voltage: 10-34V
- Output current: $\pm 1.4\text{A}$ (max)
- Switching time t_{pLH}/t_{pHL} : $0.4\mu\text{s}$ (max)
- Isolation voltage: 2400Vrms (min)

The function of Opto Coupler is isolate to the control circuit from power circuit. Pulse width modulation signal (PWM 1 to PWM 12) comes from DSPIC Processor. This signal is not directly fed through a power circuit. Suppose Control Circuit (DSPIC) is connected to power circuit without isolation circuit, the control circuit may get affected. So we need to isolation circuit interface between power circuit and control circuit

Table 4. 1 Opto Coupler Truth Table

Input	Enable	Output
H	H	L
L	H	H
H	L	H
L	L	H

CHAPTER 5

RESULT AND DISCUSSION

5.1 HARDWARE VIEW AND RESULTS

The hardware prototype of the proposed system was developed. The developed hardware is shown in figure 6.1

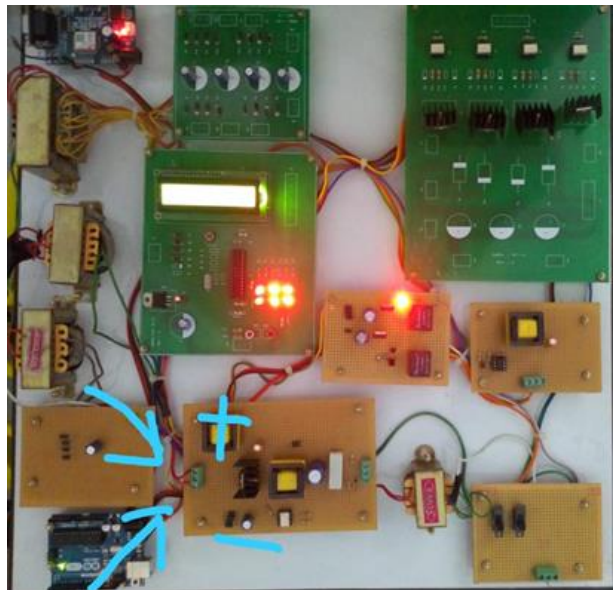


Figure 5.1 Photocopy of Hardware kit

The hardware was tested under laboratory conditions and the output waveforms collected and are shown in the following figures.

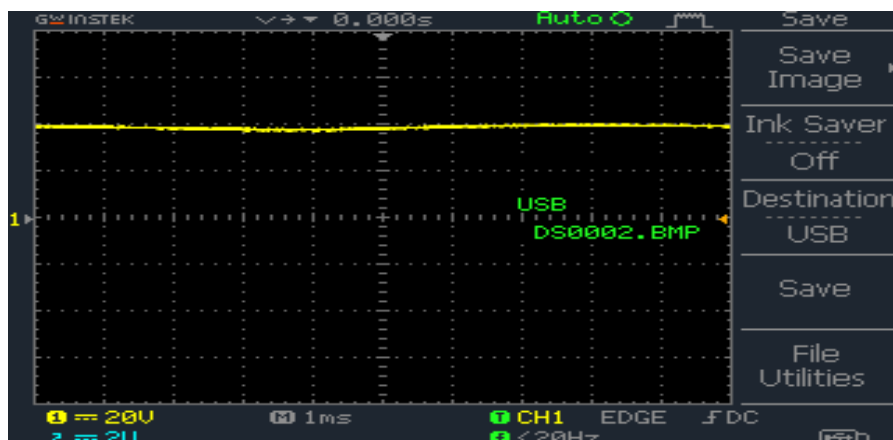


Figure 5.2 Photocopy of output voltage waveform of SEPIC

The constant DC output voltage of the SEPIC which is of 90V in amplitude is observed in the fig 6.2

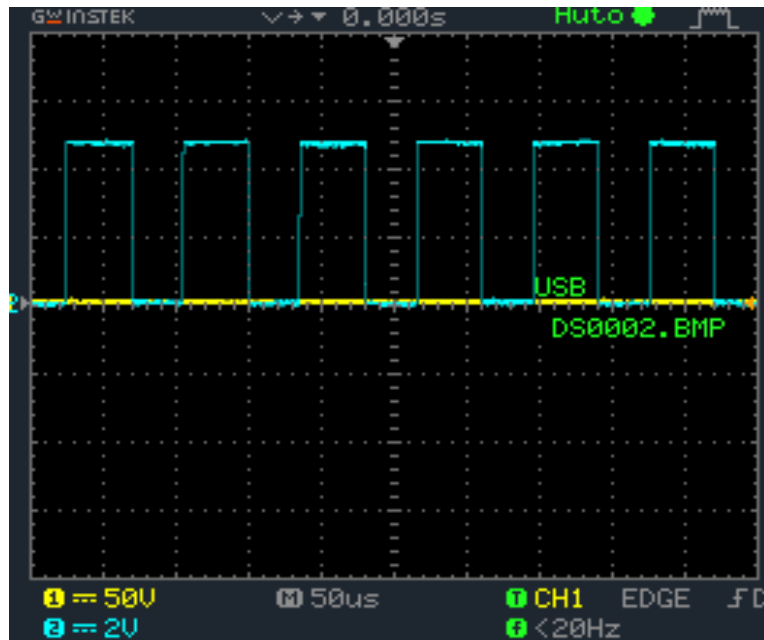


Figure 5.3 Photocopy of switching pulse to SEPIC at 60% duty cycle

Figure 6.3 shows the switching pulse provided to the SEPIC. The duty cycle is 60%

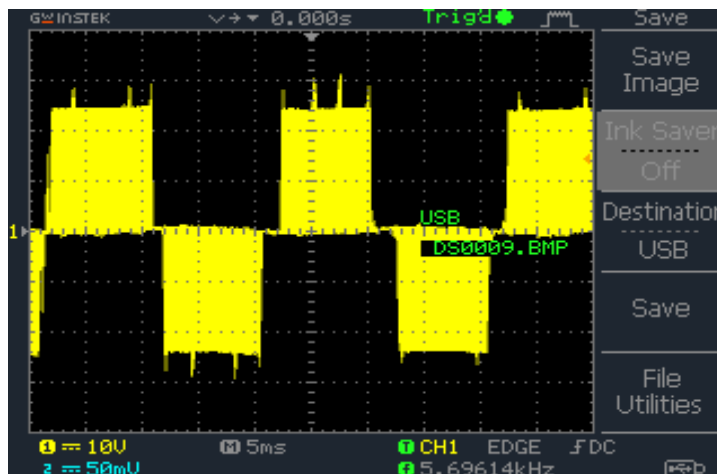


Figure 5.4 Inverter output voltage waveform

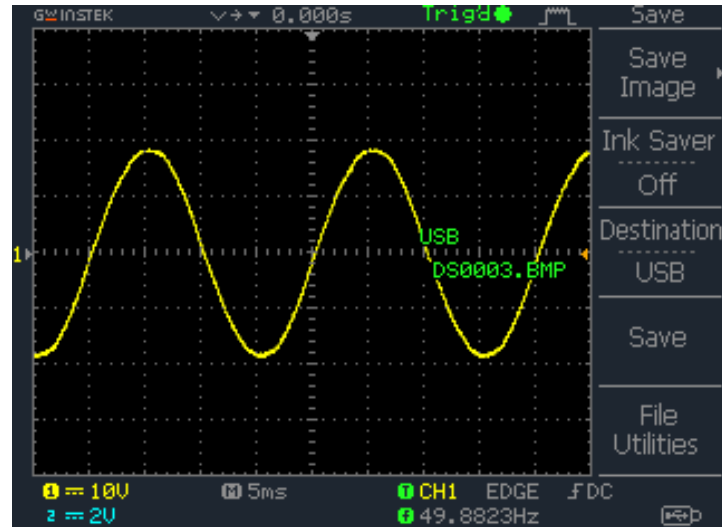


Figure 5.5 Filtered sinusoidal voltage waveform

CHAPTER 6

CONCLUSION

In proposed system where it discussed Landsman converter based grid integrated PV system. The proposed Landsman converter has provides constant DC voltage to the single phase three level inverter. The PI controller makes the inverter output voltage is equal to the grid voltage. The proposed system techniques to reduces the grid connected issues like power disturbance, total harmonics etc. This system has lower operating cost and finds applications in remote area power generation, constant speed and variable speed energy conversion systems and rural electrification.

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