

CONTROL OF WIND DIESEL HYBRID SYSTEM WITH BESS FOR OPTIMAL OPERATION

Submitted in partial fulfillment of the requirements for the award of
**Bachelor of Engineering Degree in
Electrical and Electronics Engineering**

BY

M.HARIVENKATESH (38140013)

J.JOHN YABESH (38140014)



**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

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **M.HARIVENKATESH (38140013)** and **J.JOHN YABESH(38140014)** who carried out the project entitled "**CONTROL OF WIND DIESEL HYBRID SYSTEM WITH BESS FOR OPTIMAL OPERATION**" under our supervision from November 2021 to May 2022.

Internal Guide

Dr. S. NIRMALRAJ

Head of the Department

Dr. V. SIVACHIDAMBARANATHAN

Submitted for Viva voce Examination held on_____

Internal Examiner

External Examiner

DECLARATION

We **M.HARIVENKATESH(38140013)** and **J.JOHN YABESH (38140014)** hereby declare that the Project Report entitled "**CONTROL OF WIND DIESEL HYBRID SYSTEM WITH BESS FOR OPTIMAL OPERATION**"done by us under the guidance of **Dr .S.NIRMALRAJ** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electrical and Electronics Engineering.



M.HARIVENKATESH (381440013)



J.JOHN YABESH (38140014)

DATE:20-04-2022

PLACE:CHENNAI

SIGNATURE OF THE CANDIDATES

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ABSTRACT

A wind energy conversion system (WECS) with a diesel generator is presented in this paper (DG). The suggested system adjusts DG loading for low specific fuel usage through its management. Induction generators are employed in WECS because they are twice fed (DFIG). Control of the system is accomplished by means of two voltage source convertors (VSCs). The wind turbine's maximum power point tracking is made possible by the rotor side converter (RSC). For a range of loads, the IEEE-519 standard's harmonics and balance requirements for DFIG and DG currents are met by the generator side converter (GSC). By connecting a battery bank to the DFIG's DC bus, the system envisions energy storage. Storage is provided via the battery bank. In addition, the battery bank in the GSC serves as a conduit for excess or insufficient electricity. It is shown that the suggested system performs well under various operating conditions, such as wind generator synchronisation and variations in nonlinear and unbalanced loads. In all of these instances, the currents going through the generators are equal. As a final step, a lab prototype is used to test the system's efficacy.

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LIST OF ABBREVIATIONS

DBGSs	-	Dg-Based Generation Systems
DERs	-	Distributed Energy Resources
DFIG	-	Doubly Fed Induction Generator
DG	-	Diesel Generator
DWAG	-	Double-Wound Asynchronous Generator
FEZ	-	Fuel Efficient Zone
GSC	-	Generator Side Converter
GUIs	-	Graphical User Interfaces
IDE	-	Integrated Development Environment
INC	-	Incremental Conductance
LED	-	Light Emitting Diode
RC	-	Rotor Converter
RSC	-	Rotor Side Converter
THD	-	Total Harmonic Distortion
VSC	-	Voltage Source Converter
VSCs	-	Voltage Source Converters
VSCs	-	Voltage Source Convertors
WECS	-	Wind Energy Conversion System
WEG	-	Wind Energy Generators

CHAPTER 1

INTRODUCTION

The diesel generator (DG) is the primary source of electricity in many places, such as islands and remote regions. A common application for DGs is as a backup power source in metropolitan homes and telecom towers. In India, electricity generation consumes about 13% of all petroleum products. It is possible to regulate voltage and frequency with good accuracy with DG-based generation systems (DBGSSs), which are technologically quite advanced. The biggest drawback of DBGSS is its high operating costs, which are mostly the result of the use of fossil fuels. There are three basic problems with DBGSS distribution.

Unbalanced loads are the first problem. Second, as consumer loads increasingly rely on power electronics, harmonics are being introduced into the generator circuit. Torque ripples can be caused by the flow of harmonics and unbalanced currents through a tiny generating system. In addition, the particular fuel consumption of DG increases when the DG loading deviates from the fuel-efficient zone (FEZ). Commonly used DGs have FEZ between 0.65 pesos and 1.05 pesos.

Wind energy generators (WEG) can be used to generate electricity in many of the sites where DBGSS is installed. In order to install the WEG, the land does not need to be levelled or graded, and the footprint is quite small. Wind power generation, on the other hand, is erratic and sporadic. As a result, the loading profile of the DG grid is severely affected by the integration of the wind energy system. For this reason it's compelled to work under less than ideal conditions. Nonlinear loads' harmonic current requirements can be met with power electronics control. In the absence of unbalanced and non-sinusoidal currents, the life of the DG set is increased. A DSTATCOM (Distribution Static Compensator) has been proposed by Singh et al. to compensate for harmonics and imbalanced

currents in a DG. Many writers have described an autonomous system that combines DG and WEG. Proposals for an autonomous wind-diesel hybrid system (WDHS) have been made in WDHS has received a PMSG, an induction generator, and a doubly fed induction generator (DFIG) for use in their research. In their work, these authors have shown how to regulate WEG's power output in light of its fluctuating output. In order to achieve FEZ functioning, they have not modified the DG's load regulation, which can only be done with energy storage. Power sharing between PMSG and DG has been proposed by Haruni and colleagues. However, it lacks an energy storage system and instead relies on a dump load to dissipate energy.

If the wind generator is synchronised, the nonlinear and unbalanced loads can be varied as well as altering wind speeds. In all of these instances, the currents going through the generators are equal. Finally, a lab-built prototype is used to test the system's efficacy in real-world situations.

Many writers have proposed an autonomous system that combines DG and WEG. In [3-7], a wind-diesel hybrid system without storage has been proposed as a self-sufficient system. WDHS has been demonstrated with a PMSG, a three-phase induction generator, and a doubly fed induction generator (DFIG) [4- 7]. In their work, these authors have highlighted an important method for regulating WEG's power output. To achieve Fuel Efficient Zone functioning, which can only be accomplished with an energy storage, they have not modified the DG load regulation. Power sharing between PMSG and DG has been proposed by Haruni et al. [4]. However, it lacks an energy storage system and instead relies on a dump load to dissipate energy. There is a battery energy storage system (BESS) that can be used to operate DG in a Fuel Efficient Zone (FEZ). A wind-diesel hybrid system with energy storage has been proposed by some writers [9-12]. It has been proposed that the wind-diesel hybrid system can be combined with a mechanical storage unit [12-15]. It is possible that the pumping mechanism suggested may not be suited for all locations, whereas flywheels have a constraint in energy storage capacity. To compensate for neutral and harmonic currents, the authors in [10- 11] suggested a load levelling technique utilising

BESS. Using a permanent magnet brushless DC generator, Geeta et al. [15-21] demonstrated a BESS based wind solar hybrid system.

DGs have been shown to be compatible with solar, wind, and power quality issues by the authors in their work on a wind-PV-diesel system. The goal of the project has been to supply regulated power to absorb solar and wind power variations with the use of solar PV and battery storage. With a battery storage and load regulation, a wind-PV-diesel hybrid microgrid is shown in this research (Fuel Efficient Zone).

CHAPTER 2

LITERATURE SURVEY

**Recommended Practice for
Excitation System Models for Power System Stability Studies," *IEEE Standard 421.5-1992*, August, 1992. S. Heier, *Grid Integration of Wind Energy Conversion Systems*. Hoboken, NJ, Wiley, 1998**

For large-scale studies of system stability, models of excitation and power systems' stabilisers are available. Excitation limiters and other controls are included as well, for example. The model structures provided can be utilised to obtain model parameters from field data. Because they are reduced-order models, they do not represent all of the system's control loops. These models are accurate to 5% of the rated frequency at frequencies up to 3 Hertz. Using these models in applications with subsynchronous resonance and other shaft torsional interaction features would be inappropriate. Protective and control mechanisms may be overlooked in long-term dynamic performance investigations. Each model comes with a sample set of data for at least one application.

Pena, R. Cardenas, G. M. Asher, J. C. Clare, J. Rodriguez and P. Cortes, "Vector control of a diesel-driven doubly fed induction machine for a stand-alone variable speed energy system," *IEEE 2002 28th Annual Conf. of the Ind. Elect. Society. IECON 02*, vol.2, 2002, pp. 985-990

Vector-controlled doubly-fed induction generators can be used to regulate a variable-speed energy conversion system powered by a diesel engine. Two back-to-back PWM converters connected between the rotor and the stator supply power to an isolated load when operating at sub- and super-synchronous speeds. With the stator flux in the d-Q reference frame, the rotor current is

controlled using the stator current to ensure proper orientation. An indirect method of regulating the stator voltage is possible by use the d-axis rotor current. Fuel consumption can be reduced for each given load by following an ideal operating curve while driving at a set speed. Since diesel engines have nonlinear properties, the speed controller's parameters are adjusted using a fuzzy logic framework. Step load implications and the best possible speed are shown in the results.

B Singh and J Solanki, "Load Compensation for Diesel GeneratorBased Isolated Generation System Employing DSTATCOM,"*IEEE Trans. Industry Applications*, vol. 47, no. 1, pp. 238 - 244, 2011.

As part of this study, we'll look at a distributed static compensator (DSTATCOM) to rectify reactive power, harmonics, and unbalanced load current on a diesel generator (DG). With LMS-based Adaline, Adaline is utilised to operate the DSTATCOM. PI (Proportional Integral) controller is used to maintain a steady dc bus voltage for the voltage source converter in the DSTATCOM, which extracts the true fundamental frequency component of the load current using Adaline (VSC). Switching the VSC is achieved by controlling the source currents via hysteresis-based PWM control. Linear and non-linear loads can be modelled using the Simulink and PSB block-set toolboxes in MATLAB. Synchronous generators with three phases and three wires are modelled in this study using a three-leg VSC working as a DSTATCOM. The results show that DSTATCOM's load correction and optimal DG set operation can be reliably controlled.

T. Theubou, R. Wamkeue and I. Kamwa "Dynamic model of dieselgenerator set for hybrid wind-diesel small grids applications"*25thIEEE Canadian Conference on Electrical & Computer Engineering(CCECE)*,2012 pp.1-4, April2-May2012.

In order to limit carbon emissions, wind energy conversion devices are increasingly being linked to real diesel power plants. This allows electricity to be delivered to remote settlements without electricity grids. Stability analysis, prediction, detection, control, and diagnostics in hybrid wind-diesel small grids all require accurate modelling, just as they do in traditional power systems. The state space representation is the chosen system model for simulation,

identification/diagnosis, and stability research. In this paper, a diesel generator's linear state model is described. Eigenvalues are used to determine the stability of a worldwide diesel generator model generated from the superposition principle of its components. An further evaluation method is to simulate significant transient tests like load rejections and synchronous generator automatic voltage regulation using numerical simulations. At the same time, a Field Short-Circuit Test simulates Stator Open Circuit Field Transients.

Sharma, B. Singh, A. Chandra and K. A. Haddad, "Single-phase power generation employing VFC for standalone three-phase doubly wound asynchronous generator," 2014 IEEE Industry Applications Society Annual Meeting, Vancouver, BC, 2014.

In this paper, an independent, double-wound asynchronous generator (DWAG) is described for single-phase load feeding with harmonic adjustment. Voltage source converters (VSCs) with pulse width modulation control are utilised with a battery backed common dc link. The stator converter makes use of a star-delta connected transformer (SC) with a load leveller, current balancer, and harmonics eliminator (SC). Stator voltage and frequency can be tracked and controlled precisely using a rotor converter (RC). VSCs are controlled in vector-oriented mode to guarantee a stable dynamic response. The proposed SC and RC control techniques are implemented using a digital signal processor. The system's performance under both linear and nonlinear loads is proved through modelling and experimentation".

G. Cendoya, G. M. Toccaceli, P. E. Battaiotto and R. J. Vignoni, "Microgrid for remote areas with Water Pumping, based on wind-diesel DER and Energy Storage," 2015 IEEE PES Innovative SmartGrid Technologies Latin America (ISGT LATAM), Montevideo, pp.154-159.

Without access to a main distribution grid, microgrids with distributed energy resources (DERs) come in handy. A modular Wind/Diesel Microgrid has been proposed in this regard. An AC BUS is the major source of power for residential loads and a water pumping system in this project. It is necessary to level out the unpredictable wind power supply in order to avoid pump and generator failure.

Adaptive Control Methodology This problem can be solved by using Power Control in the Storage Energy System and Water Pumping System. Monitoring and balancing generation and loads are essential for the Microgrid's smooth operation. Together with the system structure, functioning, and mathematical models, simulation and validation are explained.

G. Pathak, B. Singh and B. K. Panigrahi, "Back-Propagation Algorithm-Based Controller for Autonomous Wind-DG Microgrid,"*IEEE Trans. Industry Applications*, vol. 52, no. 5, pp. 4408-4415, Sept.-Oct. 2016.

As a voltage and frequency controller, this paper's wind-DG hybrid arrangement uses a voltage source converter (VSC) (VFC). A boost converter with incremental conductance (INC) approach is used to rectify AC power supplied by a permanent magnet brushless DC (PMBLDC) generator into DC power, and the maximum power is attained using the maximum power point technique (MPPT). The battery system provides surplus power to end users' loads (BS). VSC's DC link is connected to the BS to help balance the load when there is little or no wind. Diesel-powered squirrel cage induction generator (SCIG) supplies loads and a variable speed converter (VSC) at the point of common coupling when wind generation cannot meet demand (PCC). Back propagation feed forward (BPFF) control is used to govern VSC's VF. Controllers like this one reduce harmonics, regulate PCC voltage, and adjust for reactive power. Matlab Sim power tools are used to model the microgrid and simulation results are generated to ensure that the converters and all other components are functioning appropriately.

S. K. Tiwari, B. Singh and P. K. Goel, "Design and Control of Autonomous Wind-Solar System With DFIG Feeding 3-Phase 4- Wire Loads,"*IEEE Trans. Industry Applications*, vol. 54, no. 2, pp. 1119-1127, March-April 2018

An experimental and theoretical investigation of a three-phase, four-wire wind-solar hybrid energy system has been conducted. An MPPT algorithm, which utilises a double-fed induction generator, is put in the wind energy block (DFIG). The DFIG's dc link connects the RSC and LSC, the system's two converters, back-to-back. For the MPPT operation, the RSC implements field-oriented control via RSC. The rotor position needed for vector control is predicted using a model

reference and adaptive system method. Voltage and frequency are controlled by LSC. solar power is connected to the common DC link via a dc–dc boost converter. The dc–dc converter employs an MPPT algorithm in order to extract the maximum amount of power from the sun's rays. In MATLAB, the system's performance may be observed under various environmental conditions, such as an unbalanced nonlinear load, changing wind speeds, and solar irradiation. A low overall harmonic distortion can be achieved in the stator windings of DFIG under these conditions (THD). Total harmonic distortion (THD) of load voltage must be within prescribed limitations in all working conditions according to IEEE 519. By developing a system prototype using a 5-kW solar array simulator and a 3-kilowatt DFIG, the experimental results may be confirmed.

CHAPTER 3

EXISTING SYSTEM

The current system is intended to handle a 2 kW average load for 36 hours. The wind speed is measured in the existing algorithm, and the rotor speed (ω_r) and rotor angle (θ_r) are calculated using an MRAS-based estimating system. The current control method necessitates a large number of voltage and current sensors.

3.1 CIRCUIT DIAGRAM

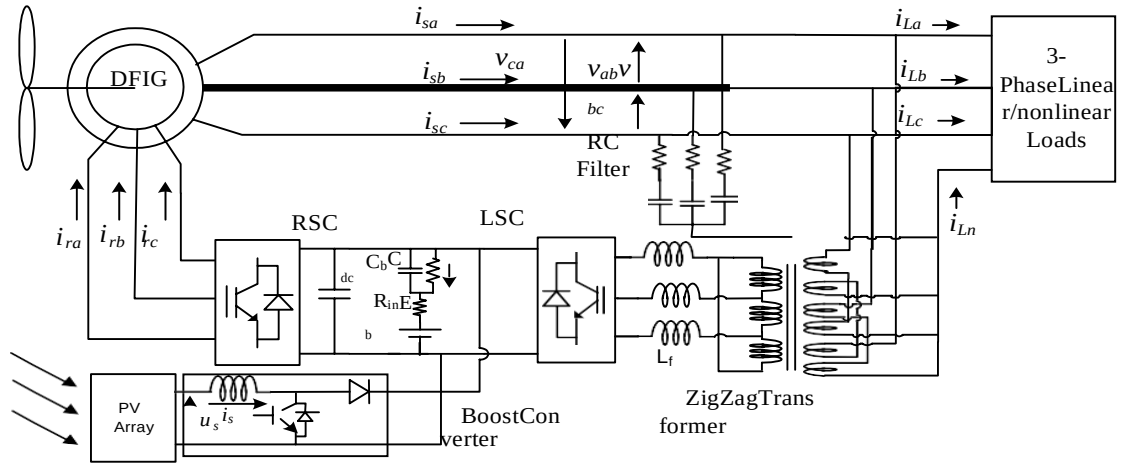


Fig. 3.1: Circuit diagram explaining the existing system of wind diesel engine

3.2 DEMERITS

- There is virtually little control or integration needed for wind turbines in the power system because they serve as a negative load.
- Wind becomes a significant part of the power system, while diesel engines still play a significant role in the system's power control..

CHAPTER 4

PROPOSED SYSTEM

Solar PV arrays and wind turbines form a hybrid system that is linked to a microgrid and controlled by vector control after the energy is stored in batteries in order to preserve power quality. The suggested control strategy necessitates a small number of sensors for voltage and current. A MRAS estimation technique is used to determine the rotor speed (ω_r) and rotor angle (θ_r) in the suggested algorithm.

Block Diagram

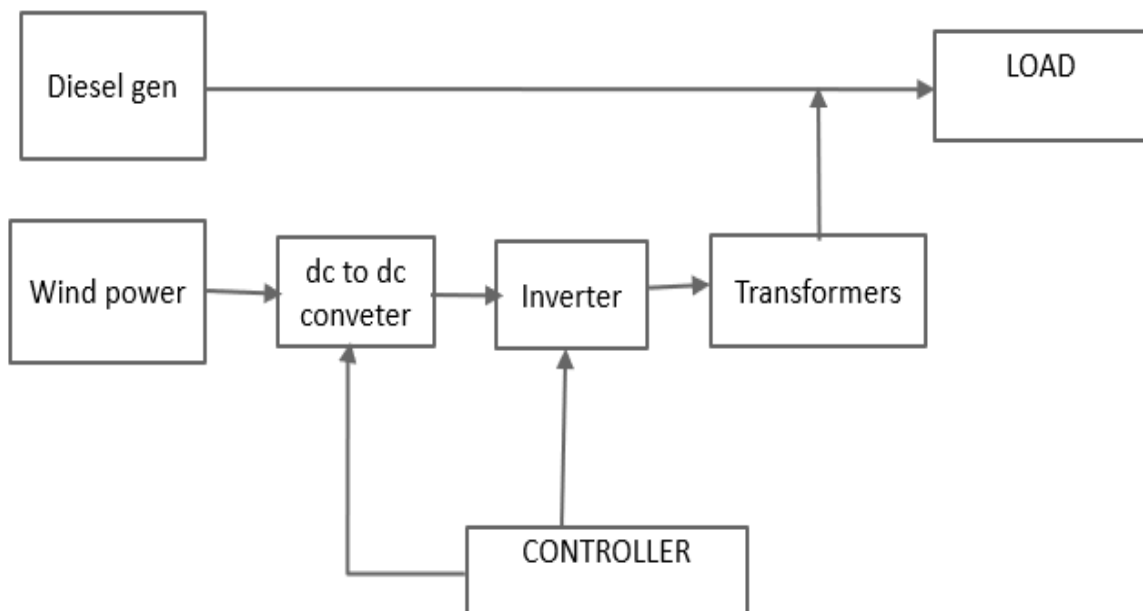


Fig. 4.1: Block diagram explaining the proposed system

Circuit Diagram

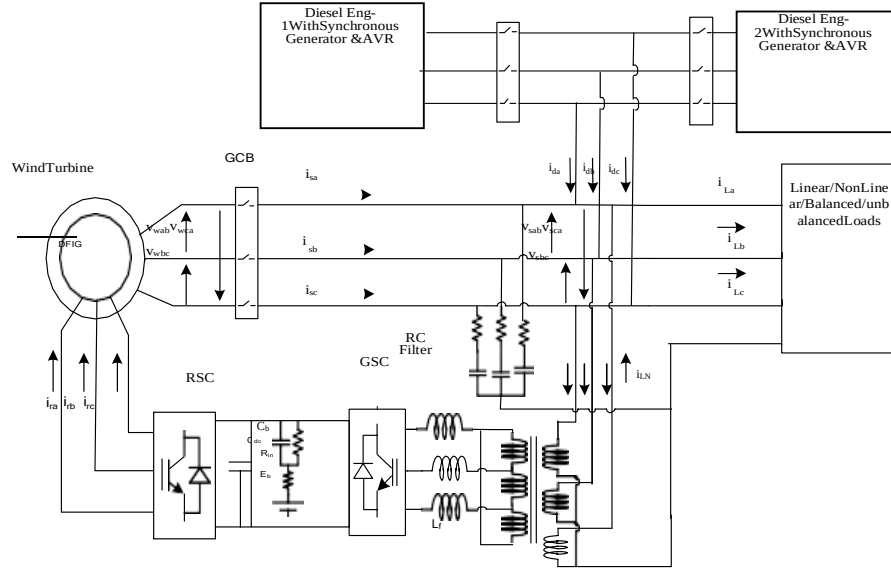


Fig. 4.2: Circuit diagram explain the proposed system of the wind diesel engine

Control of GSC

- It helps to keep generator currents sinusoidal and in balance.
- For nonlinear loads, it fulfils the non-fundamental current condition.
- A battery is used to keep each DG operating within 0.65 p.u. to 1.05 p.u.
- The indirect vector control of DFIG's GSC with BESS is discussed in [18-19]. The combined currents of DFIG and diesel generators are managed utilising modified indirect vector control of GSC in order to draw optimum power from the wind generator and maintain appropriate DG loading. The harmonics and neutral current requirements of the loads are met by GSC when using this control method. The three sub-controls of this scheme are as follows.

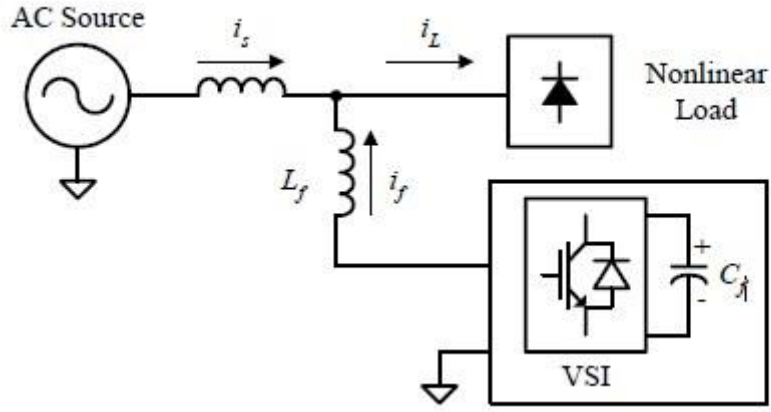


Fig.4.5: Principal configuration of VSI based shunt APF

If the nonlinear load current can be written as the sum of the fundamental current component ($i_{L,f}$) and the current harmonics ($i_{L,h}$) according to

$$i_L = i_{L,f} + i_{L,h} \quad (4.1)$$

then the compensation current injected by the shunt APF should be

$$i_f = i_{L,h} \quad (4.2)$$

the resulting source current is

$$i_s = i_L - i_f = i_{L,f} \quad (4.3)$$

Harmonics are not present in the source current, as shown in Equation (4.3), because it only contains the nonlinear load's fundamental component. Shunt APF harmonic filtering provides the appropriate source current for a nonlinear load, as seen in Figure 4.5. For example, the shunt APF entirely cancels the nonlinear load's current harmonics such that the source current is free of harmonics.

For greater currents, a series of shunt APFs is used.

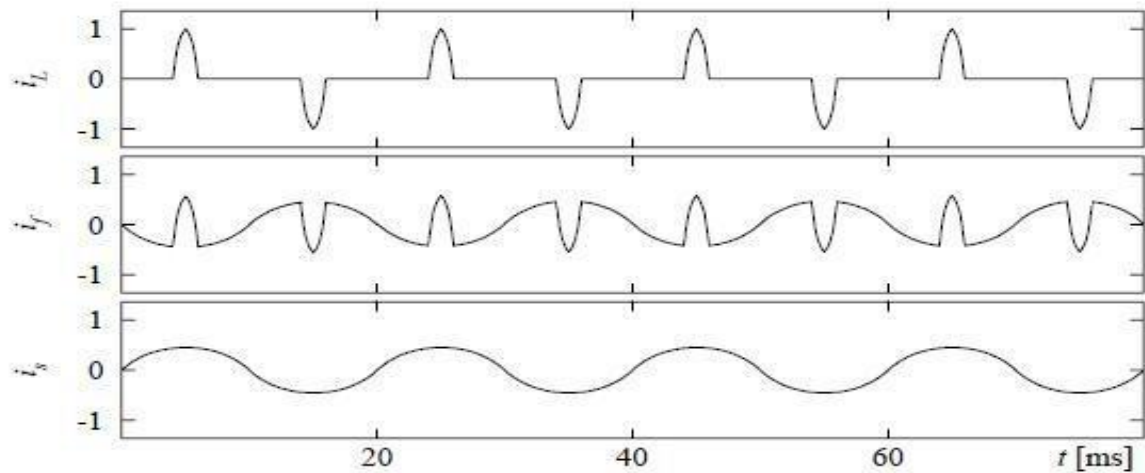


Fig 4.6 Operating principle of Shunt APF for harmonic filtering

Series Active Power Filter

Fig. 4.7 depicts the basic APF series connection diagram. The basic goal of a series active filter is to keep the voltage waveform across the load as sinusoidal as possible. A PWM voltage waveform is generated and then added or subtracted from the supply voltage waveform to achieve this result. In most circumstances, the voltage-fed PWM inverter without a current minor loop is the preferred power circuit. The series circuit, unlike the shunt filter, has to deal with high load currents, unlike the shunt filter. This results in a higher filter grade that can handle the additional current. Since voltage-waveform harmonics are eliminated, series filters outperform shunt filters when it comes to regulating ac voltage. Pure sinusoidal waveforms are all that are there in the load. As a harmonic insulator, the APF series can be considered. In order to prevent current harmonics from flowing from a nonlinear load to its source, this Series APF must be properly controlled.

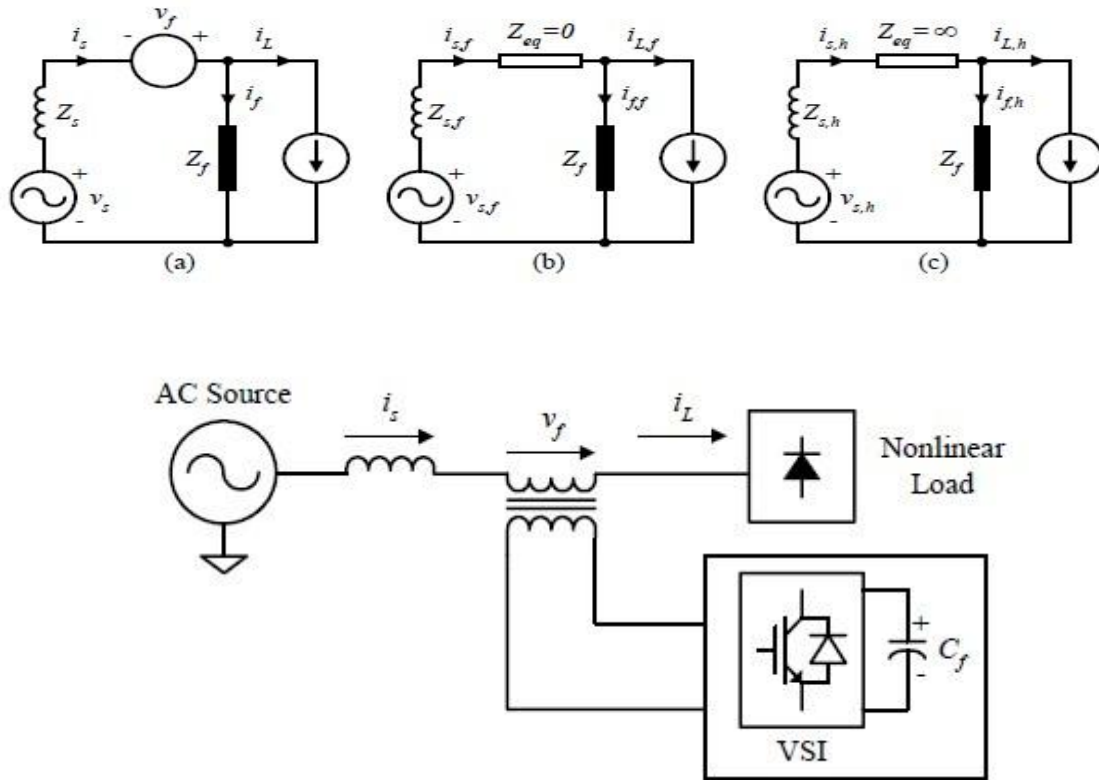


Fig. 4.7: Principle configuration of VSI based Series

Unlike the shunt APF [10], these Series APFs are rarely used in power systems [11, 12]. As the series APF handles huge currents. Compared to shunt APF, the current ratings of series APF, particularly in the secondary side of the interface transformer, are significantly higher. Losses will rise as a result of I^2R . Series APFs, as opposed to shunt ones, have the major advantage of being perfect for mitigating voltage harmonics. Devices like power system protection devices require a clean sinusoidal waveform, which is provided by this device. Series APFs are extensively used to improve the quality of the source voltage because of this property.

Hybrid Active Power Filter

APF controllers have traditionally been implemented using analogue circuits [7] for their operation. [9] As a result, the APF's performance is impacted by signal drift. The flexibility and noise immunity of digital controllers based on DSPs or microcontrollers make them the preferred choice. In contrast, digital

approaches cannot successfully filter high-order harmonics. Real-time applications encounter sampling rate limitations because to hardware [9]. An further problem is the use of rapid switching power electronic switches (such MOSFETs and IGBTs) in APF applications, which can cause the compensation source current to have a high switching frequency noise level. In order to minimise switching frequency noise and avoid interfering with other sensitive equipment, an additional filtering circuit is required.

The problems with APFs that have been raised can be addressed by using a hybrid APF setup. Hybrid APFs combine APFs and passive filters into a single unit. Hybrid APFs provide higher performance at a lower cost than traditional APFs because they incorporate both passive and active protective elements.

To avoid excessive switching costs, hybrid APFs can be used to compensate for an increase in power. Active filters on the other hand can only be tuned for one specific harmonic frequency, making it impossible to respond to a wide range of harmonic loads. This hybrid APF joins a shunt APF with a passive filter in a straight line parallel to the nonlinear load. Due to these two filters, the Hybrid APF's objective function is split in half, with the lower-order harmonics being removed by the shunt and the higher-order harmonics being removed by the passive High Pass filter. To make the hybrid series APF, a series APF and a shunt passive filter are utilised together. In order to isolate the source from the nonlinear load, a controller harmonic voltage source is injected into the hybrid series active filter.. At the fundamental frequency, this sort of hybrid active filter has zero impedance and high impedance for all unwanted harmonic frequencies. Because they don't require a control circuit, passive filters are frequently the simplest to install. This ought to be of the utmost benefit.

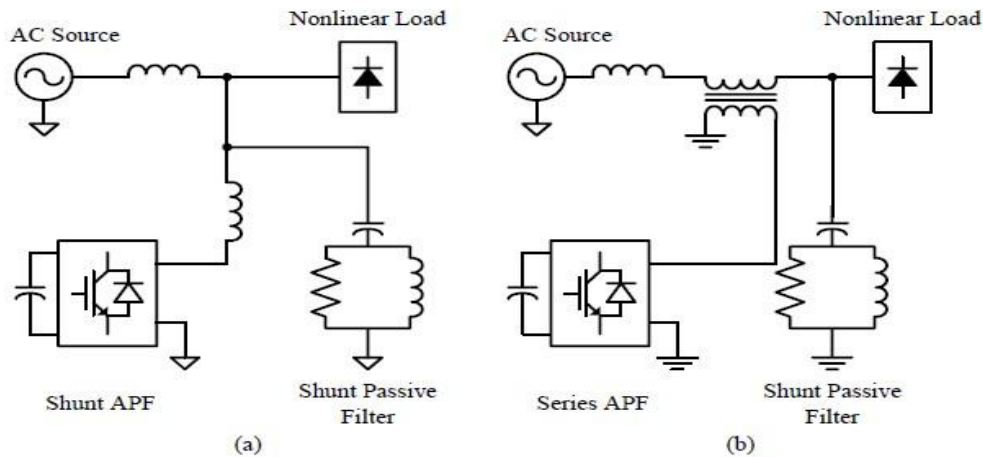


Fig. 4.8 Hybrid APFs: (a) Combination of Shunt APF and Shunt Passive Filter and (b) Combination of Series APF and Shunt passive Filter

Active filter application depending on power quality problems

It is possible to use active power filters in either the shunt or series configuration, or a hybrid of the two configurations, depending on the particular application or electrical problem being addressed (shunt-series type). Hybrid power filters can be made by combining these filters with passive ones, as shown in the Table (4.1).

Table 4.1 Active filter application depending on power quality problems

Active Filter Connection	Source of Problem	
	Load effect on AC Supply	AC Supply effect on Load
Shunt	Current Harmonic Filtering	
	Reactive current Compensation	
	Current Unbalance	
	Voltage Flicker	
Series	Current Harmonic Filtering	Voltage Sag/Swell
	Reactive Current Compensation	Voltage Unbalance
	Current Unbalance	Voltage interruption
	Voltage Flicker	Voltage flicker

4.2 POWER SUPPLY

The AC output voltage is reduced to the appropriate DC output voltage, which is commonly 220 volts at 220 revolutions per minute, by using transformers. " (rpm). To begin, portion of the full-wave rectified voltage's harmonics are filtered out using a simple capacitance filter. However, the final dc voltage will have a little amount of ripple or ac voltage shift. A regulator circuit removes ripples while maintaining the same dc value whether the input dc voltage or the load connected to the output dc voltage fluctuates. To achieve this level of voltage regulation, voltage regulator IC chips are often employed.

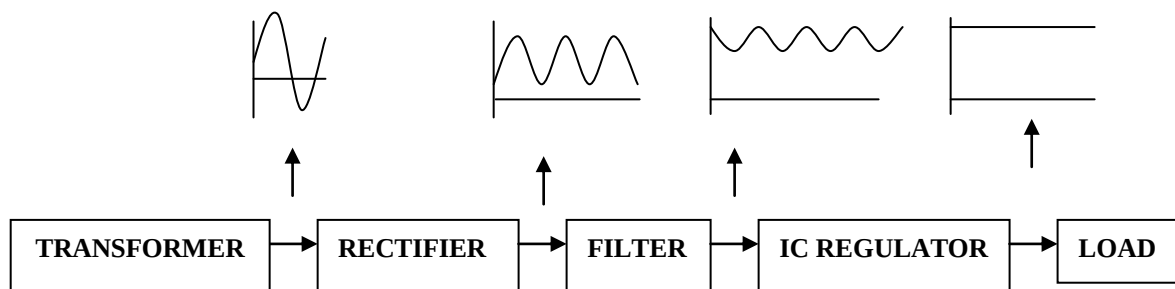


Fig. 4.9:Block Diagram of Power supply

4.3 TRANSFORMER

The voltage supplied by the potential transformer will be lowered from (0-230V) to (0-6V). A precision rectifier, built using an op-amp, will then be linked to the secondary of the potential transformer. Precision rectifiers have the advantage of providing DC peak voltage output while the remainder of the circuitry simply provides RMS output.

4.4 BRIDGE RECTIFIER

A bridge rectifier is a circuit that has four diodes connected in the same way as illustrated in the diagram. The input and output of the circuit are provided by the network's diagonally opposing corners, respectively. At A, we have a positive potential; let's suppose the transformer is working properly. There's a lot of room for improvement at B. Because of the positive potential of Point A, D3 will

advance and D4 will regress. D1 will be moved ahead and D2 will be pushed back due to the negative potential at point B. DC current can flow freely through D3, but it cannot pass freely through D4 and D2. Consequently, they have been biased in the opposite direction.. Through D1, RL, D3, and the secondary of the transformer, current travels from point B to point A. The arrows with a firm outline show you the way. Across D1 and D3, waveforms 1 and 2 can be seen. It takes one-half cycle for the transformer's secondary polarity to switch, causing D1 and a reverse bias on D2 and a forward bias on the other two. Point A will now be the starting point for the new direction of flow, which will go through D4, RL, D2, T1, and finally D2. This path is indicated by the broken arrows. There is a constant flow of RL's current in the same direction at all times. RL generates a voltage that matches the waveform seen when this current flows through it (5). In a full-wave rectifier, current flows through the load (RL) on both half cycles of the voltage supplied.

It is roughly twice as powerful as a standard full-wave rectifier with the same transformer if you use a bridge rectifier. It is possible to use the same transformer in both circuits (A and B) simply by altering the values of various components. The maximum voltage in both circuits is 1000 volts between X and Y. For a given time period, the maximum rectified voltage is 500 volts. Because of the diode's low voltage drop, the maximum voltage across the load resistor never approaches 500 volts. Current passes through the load during both half of the applied voltage. The bridge rectifier shown in view B can rectify the entire secondary voltage. Maximum voltage across the load resistor is over 1000 volts. The output voltage from the bridge rectifier is increased since both circuits share the same transformer. A normal full-wave circuit's peak voltage is 500 volts from the centre tap to one of the outputs. The current path from A to B is depicted by the solid arrows and includes the secondary of the transformer, D1, RL, and D3. D1 and D3 waveforms 1 and 2 are clearly visible.. Half a cycle later, the secondary of the transformer has its polarity reversed, causing D2 and D4 to be biased forward and D1 and D3 to be biased backward. Point A will now be the starting point for the new direction of flow, which will go through D4, RL, D2, T1, and finally D2. The broken arrows point to this route. There is a constant flow of RL's current in the same direction at all times. RL generates a voltage that matches the waveform seen when this current flows through it (5). Because current flows

through the load (R_L) through both half cycles of applied voltage, bridge rectifiers are full-wave rectifiers.

4.5 VOLTAGE REGULATOR

Each regulator's circuitry has overload protection and overload detection. The regulators can handle loads ranging from hundreds of mA to tens of mA, which corresponds to power ratings of milliwatts to tens of watts. The series 78 regulators produce voltages ranging from 5 to 24 volts. The series 79 regulators can handle voltages between 5 and 24 volts. In a fixed three-terminal regulator, the unregulated dc input voltage, V_i , is linked to one of the input terminals; the regulated dc output voltage, V_o , is attached to the other; and ground is connected to the third.. Voltage regulators from 5 to 24 volt are available in the series 78. Same goes for voltage regulation in the series 79 regulators, which range in output from 5 to 24 volts. It need 5 volts to run the microcontroller and LCD. -12 volts for the alarm, op-amp, and relay circuits.

4.6 DRIVER CIRCUIT

Devices like high-power transistors and liquid-crystal displays can be controlled by this type of electronic component (LCD).

Controlling the amount of current flowing through a circuit or other circuit parts, such as other components or devices, is a common application for resistors. When discussing switched-mode power converters, the term is usually used to describe an integrated circuit that is responsible for managing high-power switches.. It is also possible to think of an amplifier as a loudspeaker driver, or as a constant voltage circuit that maintains a wide range of input voltages for an attached component.

When compared to other parts of the circuit, the driver stage is typically more demanding in terms of specifications. Low output impedance and the ability to rapidly discharge the following transistor bases are also essential in a transistor power amplifier in order to avoid or reduce distortion. Microcontroller or controller signals are amplified by driver circuitry to control power switches in semiconductor

devices. To prevent power spikes in the event of a malfunction, driver circuits may undertake additional functions, such as reporting failures to the control system and assessing sensor signals.

Thyristor Driver Circuits

It is necessary to apply the correct control signals to generate gate current to activate the thyristor when using thyristor drivers. It's common for a transformer to separate the power circuit's high voltages from the control circuit.

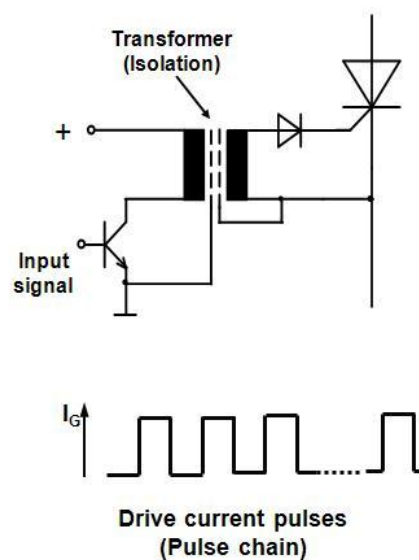


Fig.4.10: Principle of a thyristor driver circuit

Pulses are fired repeatedly so that thyristor's latching current can be exceeded. Locking current is the thyristor's bare minimum activation charge. Until the thyristor's current hits the "holding current," which is the minimum current required to keep it in an on-state (i.e., on), the gate pulse must continue.

MOSFET and IGBT Driver Circuits

When it comes to controlling IGBTs and MOSFETs, they're pretty comparable (charging the gate capacitor). Both types of drivers' usual control voltages are shown in the following table.:

Table 4.2: Voltages that are commonly used to operate MOSFETs and IGBTs

	MOSFET	IGBT
Switch On	+10 V	+15 V
Switch Off	0 V	-8 V (-15 V)

Because of this, the IGBT gate voltage in switch-off mode is typically between -8 and 15 volts. A small layer of silicon oxide serves as an insulator between the gate and the emitter. To keep the oxide layers intact, a voltage limit of 20 to 25 volts should never be exceeded.

Functions of Typical Driver Circuits

IGBT half-bridge driver circuits are shown in the diagram below..

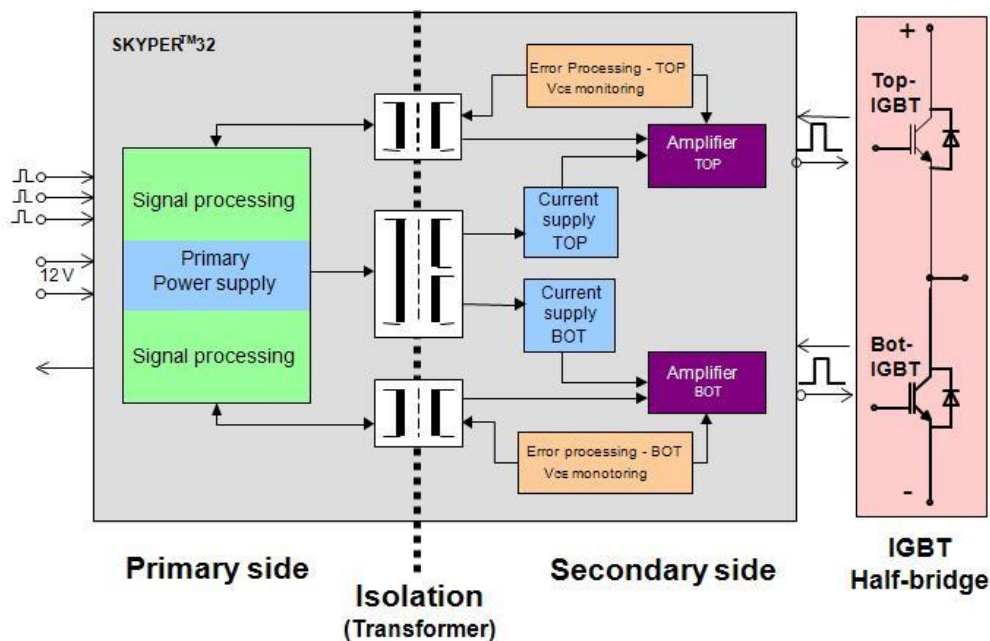


Fig.4.11: Outline of IGBT half-bridge driver circuit

Primary side of driver circuit

The primary side of the IGBT half-bridge driver circuit above provides input signals to the controller, which in turn provides error signals back.

Signal processing on the primary side of the driver circuit can suppress short pulses, prevent the half-IGBTs bridge's from turning on at the same time, monitor temperature, and detect undervoltage.

Isolation between primary and secondary sides

Driver circuit isolation is often achieved through the use of transformers or optocouplers (LEDs and phototransistors). 2500 V is the maximum voltage that a typical driver circuit can handle between the primary and secondary sides.

There are basic driver circuits that do not isolate the primary and secondary sides, so the user must perform this step on their own.

Secondary side of driver circuit

IGBT switching is controlled by amplified input signals from the driver circuit's secondary side. Surveillance of overcurrents can reveal power circuit shorts. There are two ways to monitor the collector-emitter voltage (VCE): a predetermined threshold or a current sensor's signal.

The IGBTs on the primary side of the driver are turned off and an error signal is sent if there is an overcurrent.

Isolation of the triggering signal using an optocoupler

In place of transformers, optocouplers can be used to segregate signals. LED (Light Emitting Diode) and phototransistor (phototransistor) combined in one package make up an optocoupler.

Due to higher susceptibility, lower durability, limited performance, and lower isolation voltage, optocouplers are often less reliable than transformers. Low-cost optocouplers are particularly susceptible to these flaws.

Output Stage of Driver Circuits

By driving the gate resistor, the driver charges and discharges the gate emitter capacitor through it. The IGBT's switching rate is determined by this.

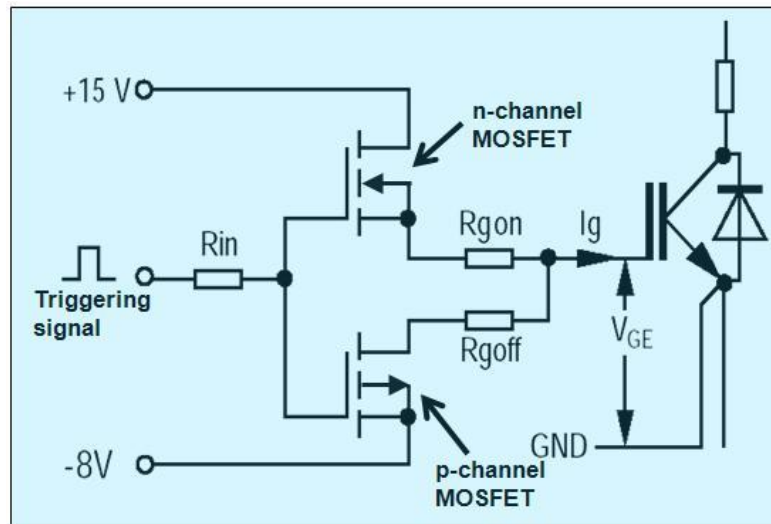


Fig.4.12: Output stage of a gate driver

$R_{g_{on}}$ and $R_{g_{off}}$ in the schematic above represent the external gate series resistance during power on and power off, respectively. The greater the R_g , the longer it takes to move between modes.

Soft turn off

Many driver circuits use a greater $R_{g_{off}}$ when a short circuit occurs, resulting in a more gradual or gentle shutdown. Avoiding excessive currents and parasitic inductances caused by overvoltages is done in this manner.

Maximum and average gate current

To charge or discharge the gate capacitor, high currents must flow in a short period of time. The greater the switching frequency and the larger the surface area of the IGBT, the higher the peak gate current (up to 10A).

The clock frequency, or the number of switching operations per second, affects the average driver current as well.

A driver circuit's maximum and average gate currents must be taken into account when designing the circuit.

Merits

- 1] A smooth connection of the wind generator to the DG grid.
- 2] A smooth stopping of one of the diesel generators in case of the sub-optimal loading

CHAPTER 5

SIMULATION AND HARDWARE

Simulating in the workplace and in academia has become a strong tool in recent years. Electrical engineers must now be well-versed in simulation and be able to apply it in a variety of settings. The greatest way to learn about a system's or circuit's behaviour without causing damage is through simulation. Engineers have access to a wide range of simulation tools on the market today. There is a lot of money and time being spent on simulations in many businesses before to the manufacturing of products. In the vast majority of R&D projects, simulation is a critical component. Is it possible to move forward if we don't simulate? In the field of power electronics, computer simulations and laboratory prototypes complement each other perfectly. Computer simulation, on the other hand, should not be viewed as a replacement for a hardware prototype. An impedance source inverter with R, R-L and RLE loads is the focus of this chapter's MATLAB simulations.

5.1 INTRODUCTION TO MATLAB

High-performance technical computer language MATLAB. A common mathematical notation is used to represent issues and answers, making it simple for anyone to work with. Typical uses include

1. Math and computation
2. Algorithm development
3. Data acquisition
4. Modelling, simulation, and prototyping
5. Data analysis, exploration, and visualization

6. Scientific and engineering graphics

7. Application development, including graphical user interface building

Arrays are the primary data type of MATLAB, making it unnecessary to perform any kind of dimensioning operations in this interactive system. A non-interactive scalar language like C or FORTRAN would take far longer to answer many technical computing problems, especially those using matrix and vector formulations. MATLAB is abbreviated as MATLAB. MATLAB was used to make the matrices in the LINPACK and EISPACK projects available to the general audience. The LAPACK and BLAS libraries in modern MATLAB engines are the cutting-edge when it comes to matrix processing. MATLAB's development has been influenced by many people throughout the years. Mathematics, engineering, and science classes at colleges and universities commonly use this as a teaching tool. Research, development, and analysis requiring high throughput all use MATLAB. MATLAB's add-ons for various applications are called toolboxes. Because toolboxes enable access to specific information and applications, toolboxes are essential for most MATLAB users. It is possible to tailor the MATLAB environment to meet specific types of problems by combining MATLAB functions (M-files) into toolboxes. Signal processing, control systems, neural networks, fuzzy logic, wavelets, and simulation are just few of the many applications for toolboxes.

5.2 THE MATLAB SYSTEM

MATLAB is made up of five basic components: Integrated Development Environment (IDE) for the Desktop MATLAB functions and files can be used with this set of tools and capabilities. It's common to see these technologies' graphical user interfaces (GUIs). The MATLAB desktop and Command Window provide a command history, debugger, code analyzer, and browsers for viewing help, the workspace, files, and the search path. A programming language, MATLAB is a powerful tool for scientists and engineers. This is a high-level matrix and array language with control flow statements, functions, data structures, and input/output. Both tiny and large applications may be developed quickly and easily with this tool, making it ideal for both "programming in the little" and "programming in the big."

Graphics

Vectors and matrices can be displayed as graphs in MATLAB, where they can be annotated and printed. Data visualisation in two and three dimensions, as well as image processing, animation, and presentation graphics, are all included in this package. Visuals can be fully redesigned and GUIs can be built from scratch using low-level methods provided by this software. External Interfaces/APIs for MATLAB In order to programme in C and Fortran, you'll need to make use of this package. As a computational engine, it can be used to call MATLAB functions (dynamic linking), and MAT-files can be read and written using these facilities.

MATLAB Documentation

MATLAB comes with a wealth of printed and online documentation to assist you in getting the most out of the software. This Getting Started guide is a good place to start if you're a new user. It provides a high-level overview of the most important MATLAB capabilities, together with several real-world examples. Task-oriented and reference MATLAB material can be found in the online help. MATLAB manuals can be downloaded and printed out. Help with MATLAB Select MATLAB Help from the Help menu in MATLAB to access the online documentation. Documentation for MATLAB is broken down into five key categories:

The Role of Simulation in Design

Combinations of electrical circuits and electromechanical devices like motors and generators make up the electrical power systems we use today. The systems' performance is continually being improved by the engineers who operate in this field. Design engineers of power systems are being compelled to adopt power electronics devices and advanced control system concepts because efficiency requirements have increased dramatically. To make matters more difficult for the analyst, many systems are so nonlinear that they can only be understood by simulating them. The usage of power systems is not limited to land-based hydroelectric, steam, or other devices. In order to achieve their performance

5.3 MATLAB LIBRARY

In addition to the expertise of Ecolede Technologies and the University of Laval, this American utility is based in Canada. A typical electrical system can be modelled using Sim Power Systems' demo files. Self-study case studies are available to individuals who want to brush up on their knowledge of power system theory. There are separate libraries for each type of block in the Sim Power System's principal library (power lib). Window with block library icon and name in the power lib. To access the library's blocks, simply double-click the library's icon. For steady-state study of electrical circuits, Sim Power Systems' primary power library window includes the powerful block.

5.4 SIMULATION DIAGRAM

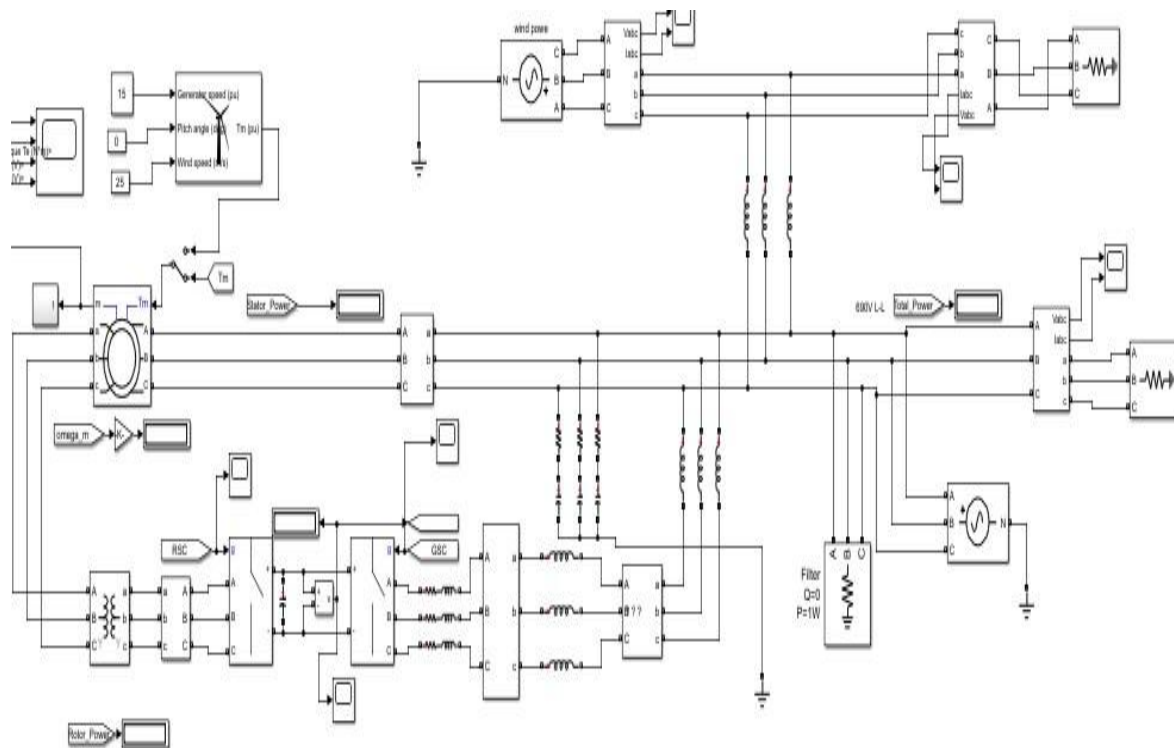


Fig. 5.1: Simulation output of the system

5.5 WIND OUTPUT

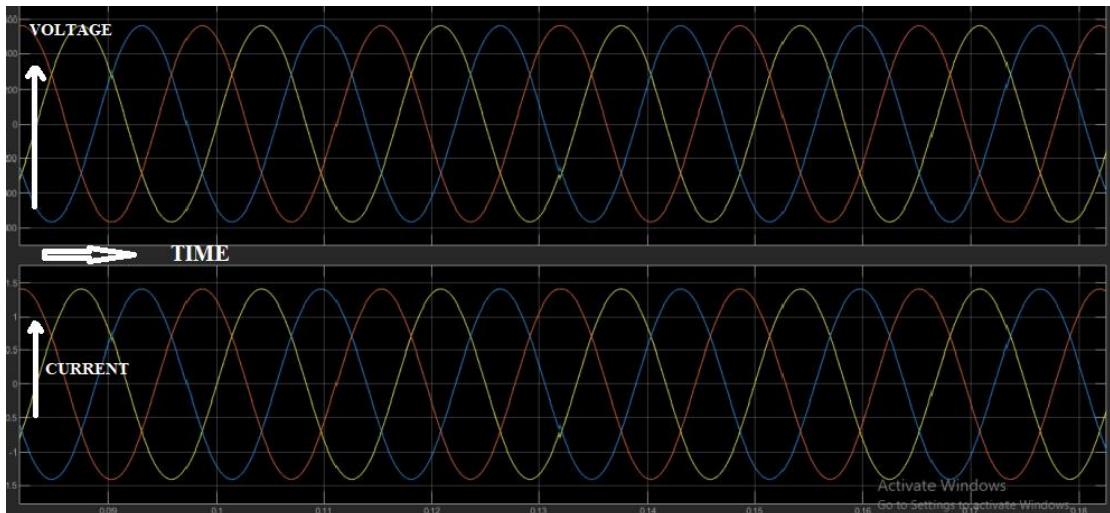


Fig.5.2: Wind output of the system producing sine wave with current and voltage on y-axis and time on x-axis

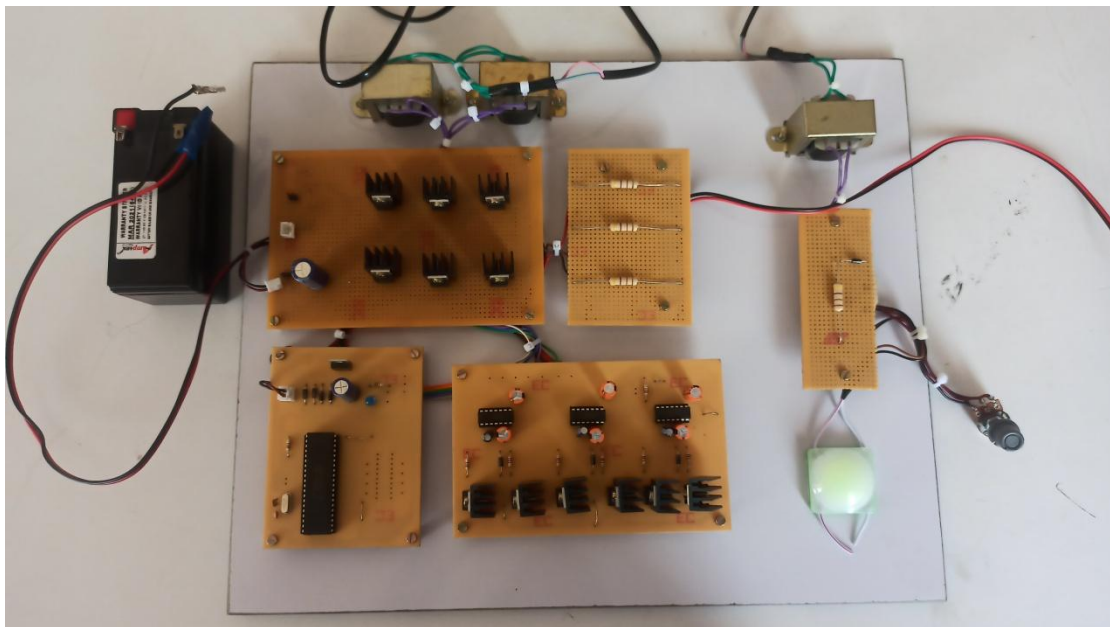


Fig. 5.3: Hardware

In our hardware we are showing two condition one fault conditions and fault compensation.

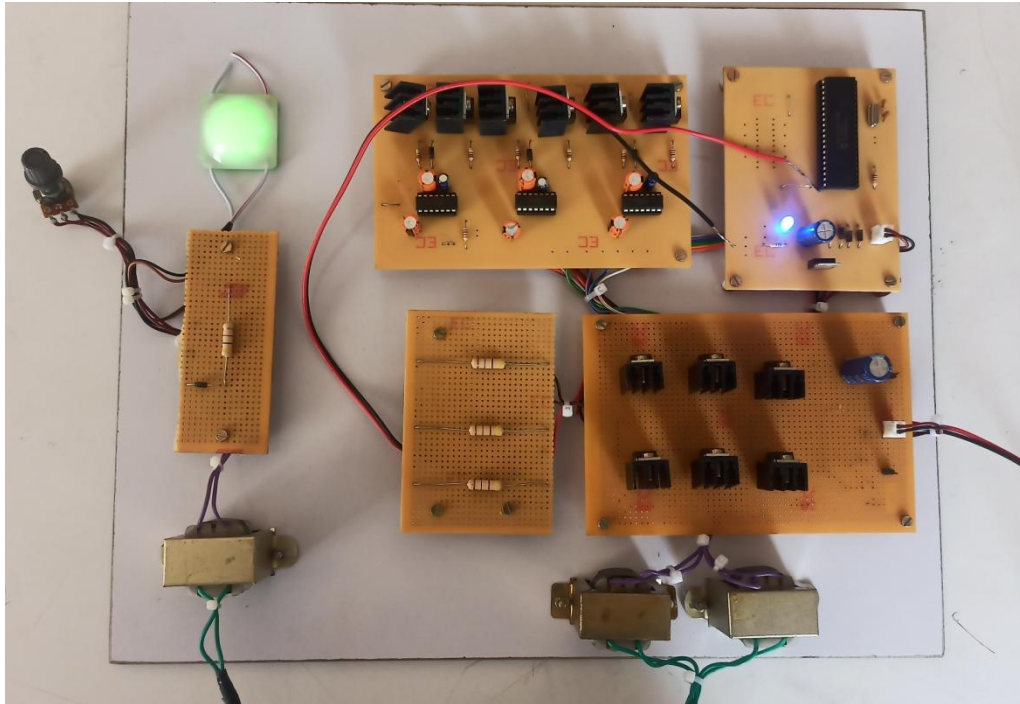


Fig.5.4 Fault Occur

In fault conditions grid voltage is low and harmonics will occur the fault that we need.

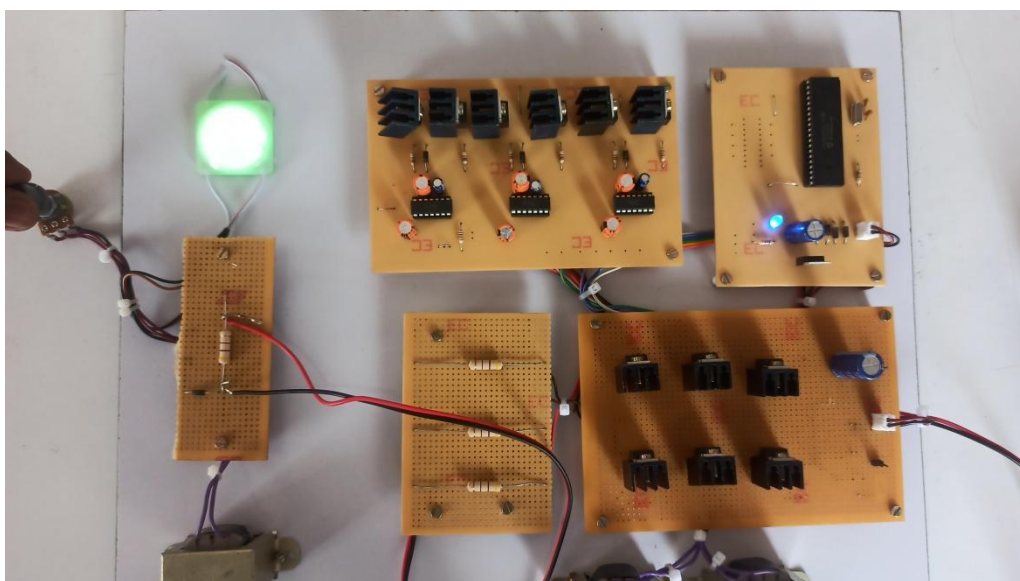


Fig. 5.5: Fault Reduction

We want to create no fault using compensation technique so we are feeding the same frequency voltage from our system. So that we can reduce the harmonic and low voltage compensation required.

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

For islands that are currently solely reliant on diesel-based electricity generation, the suggested method holds great promise. The diesel generator's FEZ fuel consumption is reduced by its load regulating capability. The MPPT control feature of WECS helps to maximise generation while also lowering energy costs. The system is also capable of maintaining balanced phase currents and acceptable current harmonics for a wide variety of loads. Overall, the system's quality of power is found to be within acceptable bounds in all practical conditions, indicating its usefulness.

Wind-diesel applications can be economically viable in many places throughout the world (already, more than 50 locations in Alaska have been found). This number will only rise if fuel prices return to their pre-recession levels. However, this does not guarantee that wind-diesel applications will continue to grow, as there are other policy and technological hurdles that must be overcome.

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