IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

POWER SOURCE MANAGEMENT SYSTEM WITH LOAD PRIORITY CONTROL

[1]Jidhin Poulose, [2]P Aswin Ayyappadas, [3] Sangeeth Jacob Shaji, [4]Sreenath S, [5]Ginnes K John

[1234]Under Graduate Scholars, [5]Assistant Professor

Department of Electrical and Electronics Engineering

Rajagiri School of Engineering and Technology, Kochi, India

Abstract: One of the main concerns of the world economy is unstable power supply. On the load side, many present-day services and equipment cannot tolerate even momentary interruptions of utility supply. With the emergence of renewables, there are multiple sources where the power is generated but they cannot be used efficiently due to their intermittent nature in addition to the dangers of backfeeding. The problem of backfeed and the dangers caused by backfeed current can be overcome by isolating each source by means of relays. Whenever the system senses a disturbance, these isolators, under the command of a microcontroller, automatically isolate the power supply. These isolators can be realized by relays which in addition to isolating the power supply, can also be used to transfer the source of power to load from one supply to another. To switch from one power supply to another, rapid switching between different power sources is required. In addition to enabling backfeed protection, rapid switching also maintains power supply to the load without any interruption. Thus all transfers are open transitions and the sources are never connected to each other.

Index Terms – Switching Devices, Microcontroller, Backfeed, Renewable Energy Resources, Photovoltaic, Protective Relay.

1. INTRODUCTION

For electric power generation and power supply to consumers, different power sources can be used. These include power plants using traditional types of fuel and also renewable energy resources. The automatic switching scheme is developed allowing carrying out changeover between sources in such a way that the power across the critical loads are maintained and possibilities of backfeed are avoided. In this paper three sources are considered - an electric power mains utility supply, a renewable power supply (solar, wind, etc.) and a diesel generator.

To ensure the viability of a particular power source, voltage across each power source is taken as an evaluative criterion. Based on this data, a power source can be ascertained by the microcontroller to supply to the load. This action is done by means of a relay associated with the power source. One of the issues which arise during switching among multiple sources is backfeeding.

Backfeeding is the flow of electric power in the reverse direction of the generally understood or typical flow of power. Back feeding occurs when power has not been isolated to a specific location, like residences. When a power outage occurs, commonly people pull out a portable generator and will plug it into a dryer outlet or another non-approved method to power the items in their home while the utility power is lost. In doing this, danger can occur to not only your property, but also to those working on your neighbourhood power lines. Depending on the source of power, this reverse flow may be intentional or unintentional. If not prevented (in case of unintentional backfeeding) or not properly installed (in case of intentional backfeeding), backfeeding may present unanticipated hazards to electrical grid equipment and service personnel.

In a conventional switching scheme where there are individual switches from each source connected to the load in a many-to-one order, there arises a possibility of backfeed when two sources are accidentally turned on due to a noise signal.

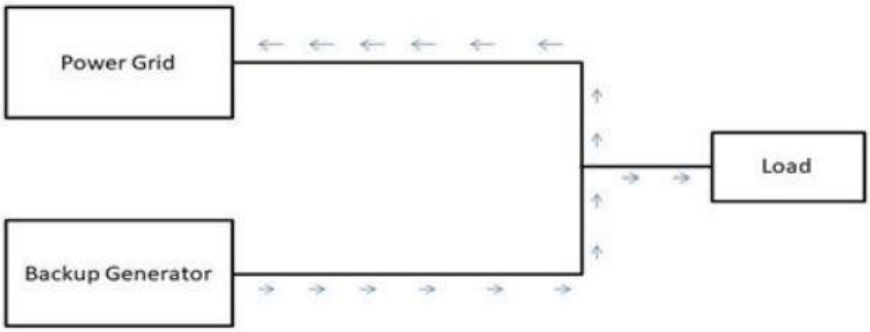

Fig. 1: power flow diagram illustrating backfeed

A switching scheme has been devised in a hierarchical tree-like order to ensure that this type of backfeed will not occur and this scheme has been achieved using relays.

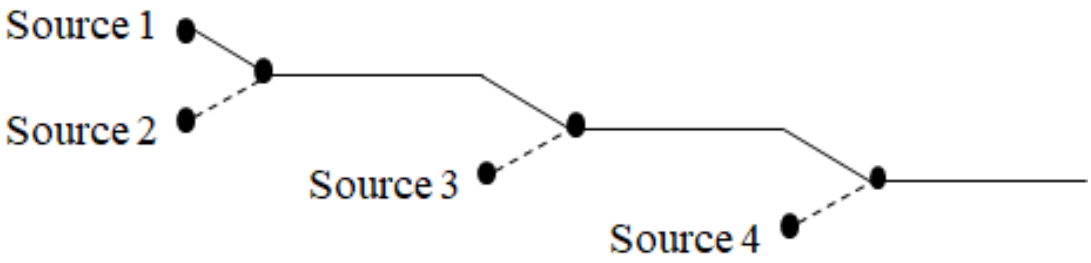

Fig. 2: switching scheme proposed

2. LITERATURE SURVEY

R. N. Hasanah, S. Soeprapto and H. P. Adi describes the design and construction of an automatic transfer switch (ATS) which is affordable to be built and used by small power customers like in the household sector. [1]

E. A. Bekirov and S. N. Voskresenskaya "describes how electric power generation and power supply for consumers different power sources can be used.These include power plants using traditional organic types of fuel, energy of nuclear fuel division, the large rivers, and also renewable energy resources. "[2]

R. Danthakani, S. Kafumbe, E. Abd-Elrady and R. Divakaran explains how we can have a continuous power supply by using a new technology. This system can provide uninterrupted power supply that prevents energy outage or power failure due to various and different problems of the Microgrid in two ways. The first method is done in automatic mode using a hardware circuit to sense, measure and automatically switch between Microgrids. The second method employs IoT with an App on mobile phones to control the switching of the Microgrids.[3]

R. Mack, M. Sakib and S. Succar explored the system issues due to backfeeding in a multiple source system and how relays can be used to prevent it. [4]

D. R. Sevcik "developed 'back feed' protection system can be used to minimize damage in the event of fault in the source substation and subsequent 'back feed' from the network systems."[5]

3. SYSTEM ARCHITECTURE

With the availability of multiple sources of energy, the system is required to constantly monitor each source and ensure that each source of energy is optimally utilized. Automatic sensing and switching of power source from one to another based on availability makes it possible to effectively utilize each energy resource. The system takes in real-time information from voltage sensors and the relays are switched accordingly.

3.1. The Objective of the problem

3.1.1. To maintain consistent electricity supply to critical loads.
3.1.2. To switch from one energy source to another automatically without human input.
3.1.3. To prevent backfeeding from one source to another.
3.1.4. To ensure that each source is effectively utilised.
3.1.5. To reduce switching losses.
3.1.6. To make a cost effective solution of multiple sources having different characteristics connected to common loads.

3.2. Proposed system architecture

Voltage of each source is measured using the voltage sensor and this data is fed to the microcontroller. The microcontroller performs real-time monitoring of each source. This leads to automatic changeover from one source to another without manual interference. This reduces associated labor costs and this data is useful for the maintenance of the system.

3.3. Basic Block Diagram of the System

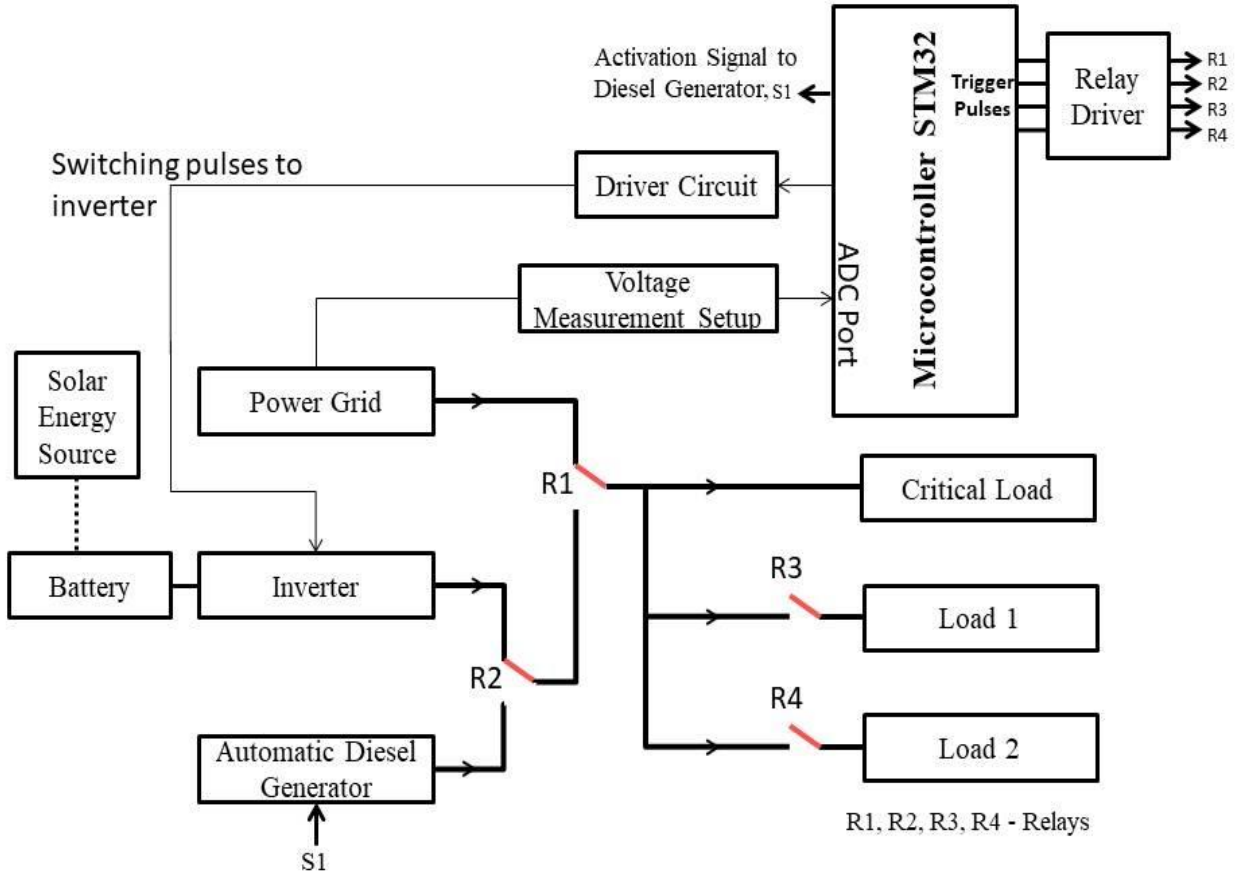

Fig. 3: block diagram of the proposed system.

3.4. The Flowchart of the Proposed System

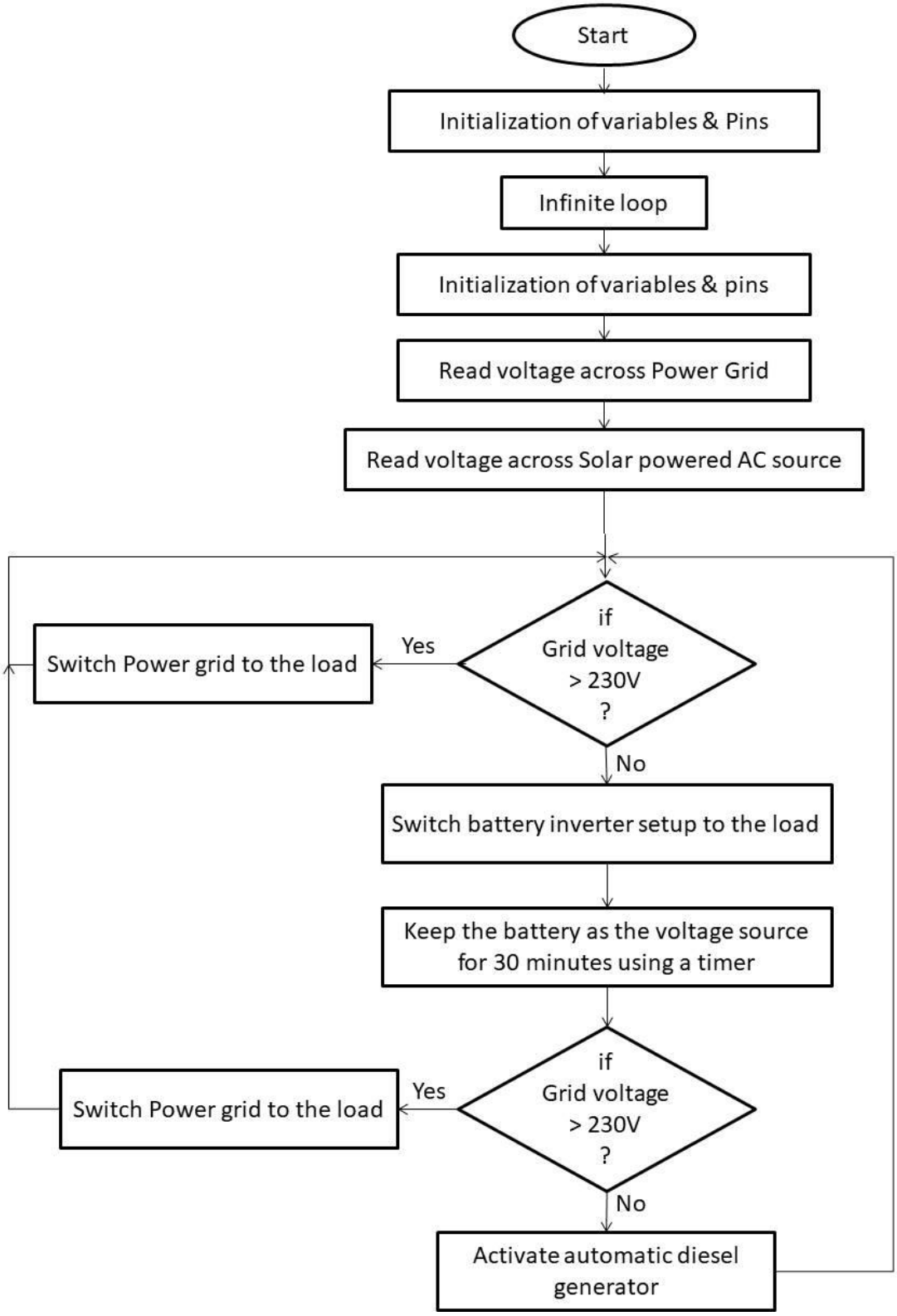

Fig. 4: flow chat of the proposed system

3.5. Schematic Diagram of the system

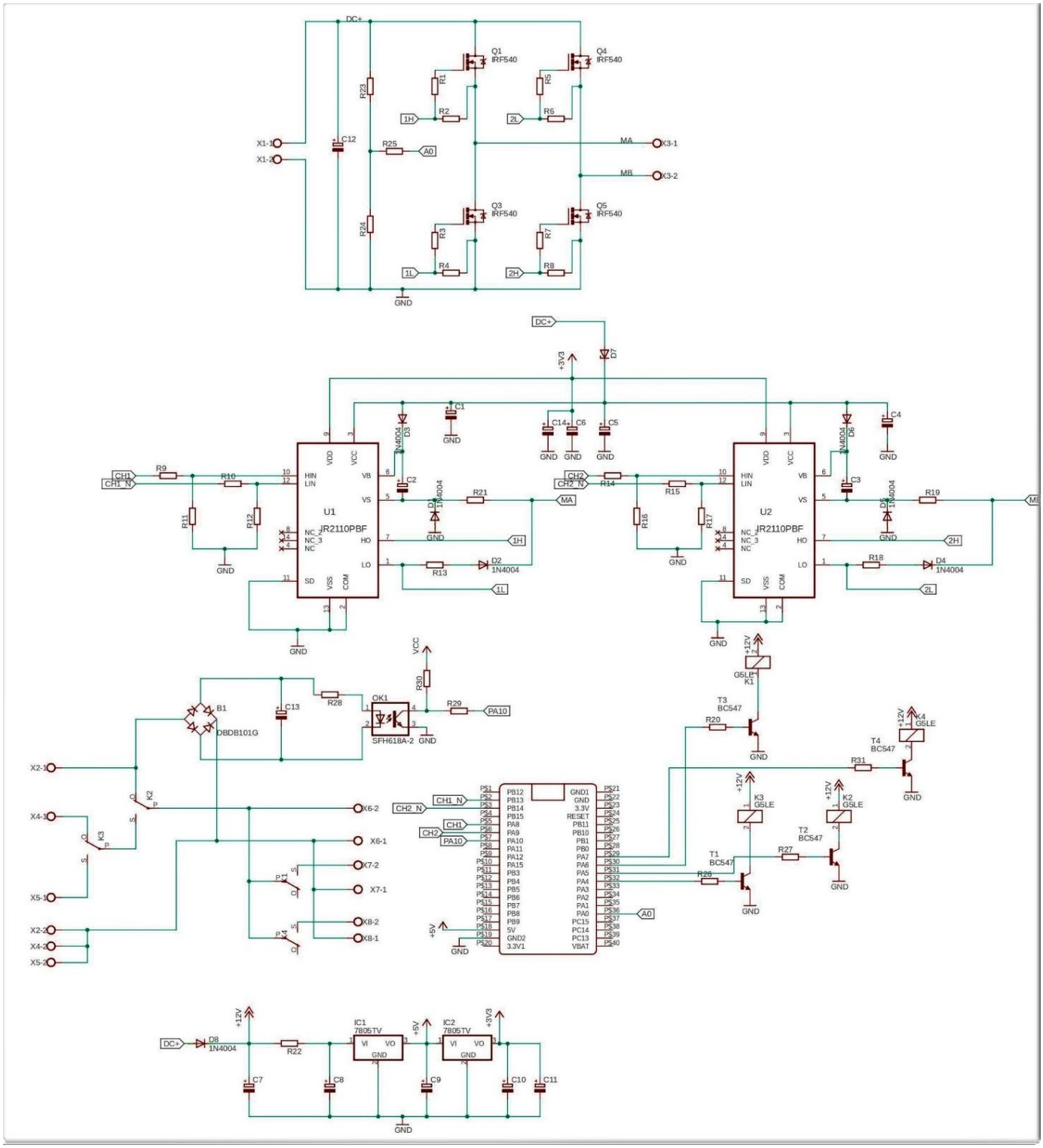

Fig. 5: schematic diagram of the proposed system

4. HARDWARE COMPONENTS

4.1. Supply Circuit

A 230V,50Hz AC supply in the power circuit is used to operate the final load but since the microcontrollers and driver circuits require a much lower voltage rating the supply for such devices are taken from the 12V inverter battery . The microcontroller operates at 5V DC supply voltage and 3.3V DC for mosfet driver circuit. This is achieved by using the supply circuit. It uses IC7805 coupled with capacitors and resistors of corresponding ratings to achieve the desired output voltage.

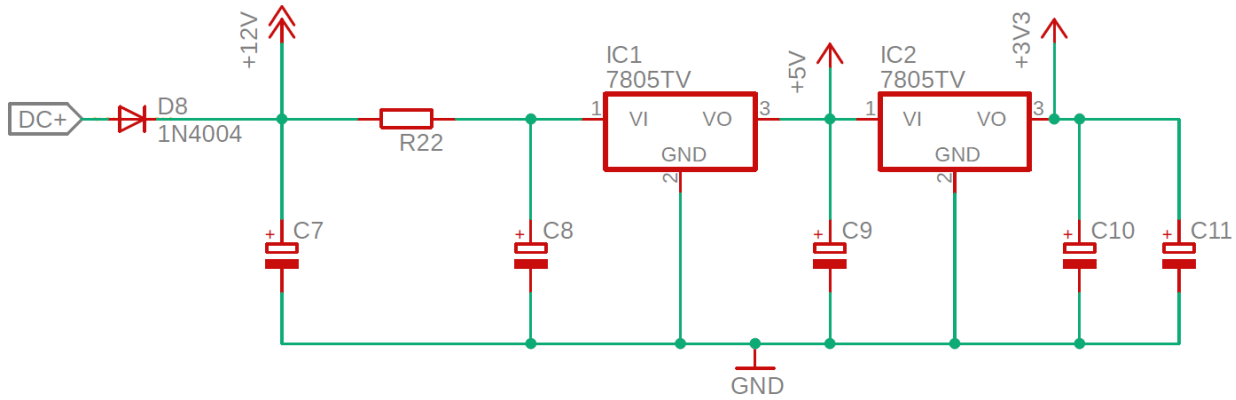

Fig. 6: Supply Voltage Circuit

4.2. Voltage Sensor

The voltage sensor is used to measure and monitor the voltage in the grid. The sensor provided at the power line of the grid measures the voltage value regularly and checks whether or not the value drops below a certain threshold. The sensor comprises a rectification element in the form of a bridge rectifier circuit with filter capacitor and current limiting resistor before reaching the sensor which is an optocoupler. 4N35 Optocoupler IC senses the grid and sends a signal to the microprocessor.

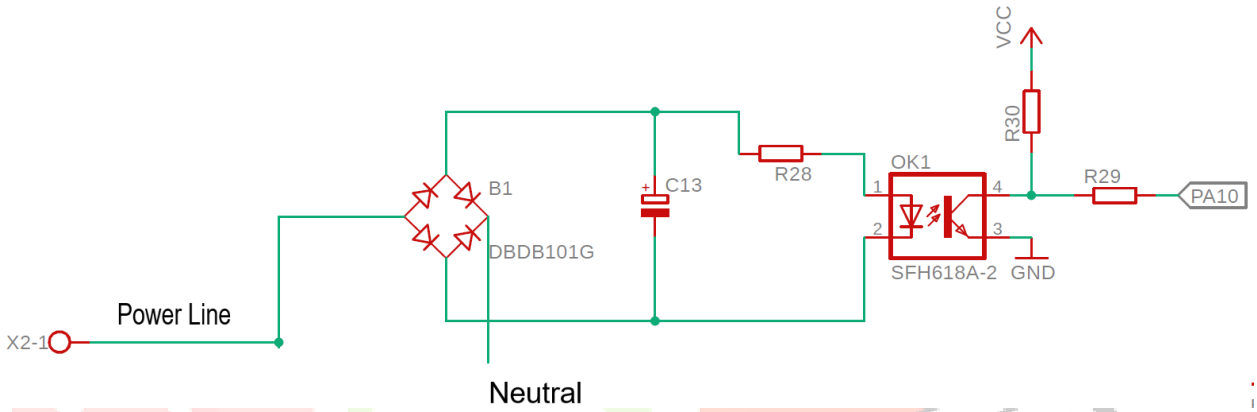

Fig. 7: Voltage Sensor circuit

4.3. Relay Module

SRD-12VDC-SL-C is the relay used. The contact points of this relay are Normally Closed (NC), Normally Open (NO) and Common(C) points. The coil of the relay is energized by the relay driver circuit to toggle the contact point from NO to NC points or vice versa.

Fig. 8: SRD-12VDC-SL-C Relay

4.4. Relay Driver

The relay module is driven by a transistor based relay driver. When current flows through the coil of the relay, a magnetic field is formed that causes a ferrous armature to change position. This can be used to either make or break the electrical connection. The relay used in this project has two purposes: to switch among three different sources and to control the power supply to the load. The relay action is controlled by the microcontroller by sending signals to the relay driver which contains transistors BC547 connected to relay coils with appropriate resistors.

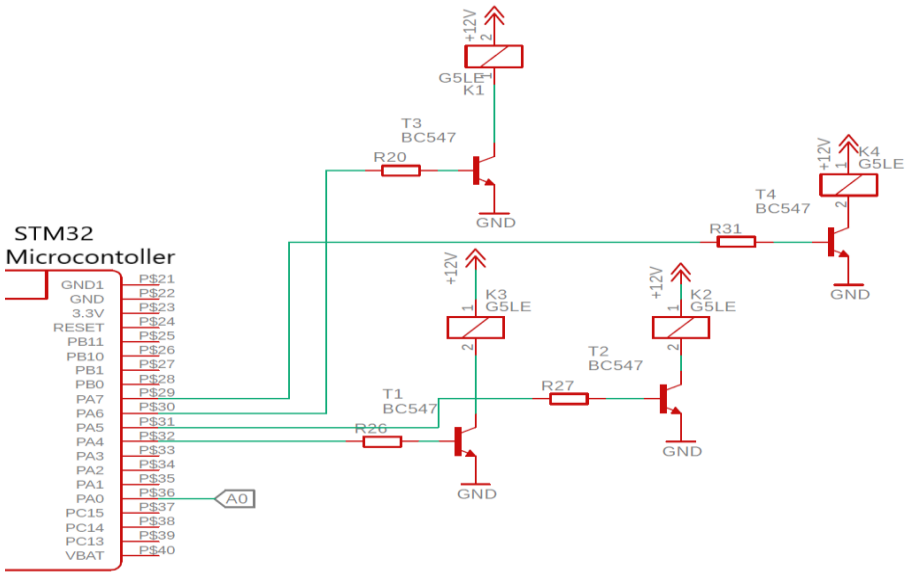

Fig. 9: Relay Driver circuit

4.5. MOSFET

IRF540 Power MOSFET is the best combination of fast switching, Rugged design, low internal resistance and cost effectiveness. It has simple driver requirements and easy paralleling. The drain and source breakdown voltage is 100V and has a drain current of 100A.

Fig. 10: IRF540 Power MOSFET

4.6. MOSFET Driver

The MOSFET Driver used is IR2110. This power MOSFET driver can handle high voltage at high speed switching. It also has independent low and high output channels. IR2110 has an operating voltage of 10 to 20 volts and an operating current of 2.5A. The 12 V zener diodes are added for stabilization. Stabilized DC is used to power the oscillator circuit to ensure that its working is not affected by the switching transients from the inverter.

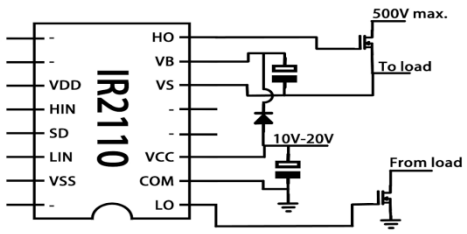

Fig. 11: IR2110 MOSFET Driver

4.7. STM32 Microcontroller

STM32F103C8T6 microcontroller incorporated on Blue Pill development board is used. It has a Clock Speed of 72MHz and an operating voltage of 3.3V. It consists of 10 Analog input pins and 37 digital I/O pins.

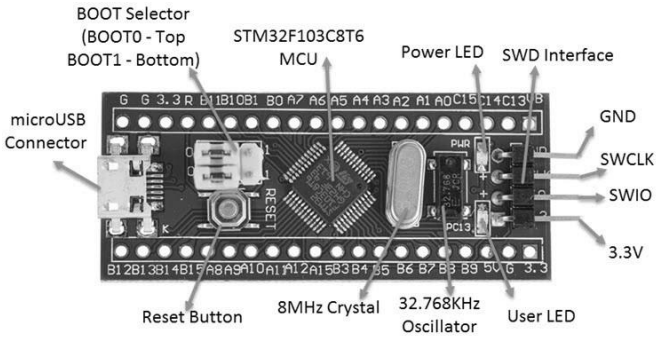

Fig. 12: STM32F103C8T6 Microcontroller

4.8. Single Phase sine wave Inverter

In this project, a single phase sine wave inverter is constructed using four MOSFETs. The gate pulse for MOSFETs 1 & 4 are the same. Both the switches operate at the same time. Similarly MOSFETs 2 & 3 have the same gate pulse and operate at the same time. But MOSFETs 1 & 2 must never operate at the same time, if this happens then DC voltage source will be short circuited. IRF540N is an N-Channel Mosfet that can drive loads up to 23A and withstand peak current up to 110A. It also has a threshold voltage of 4V, which means it can be easily driven by low voltages like 5V. Hence it is widely used for microcontrollers like STM32 Microcontroller.

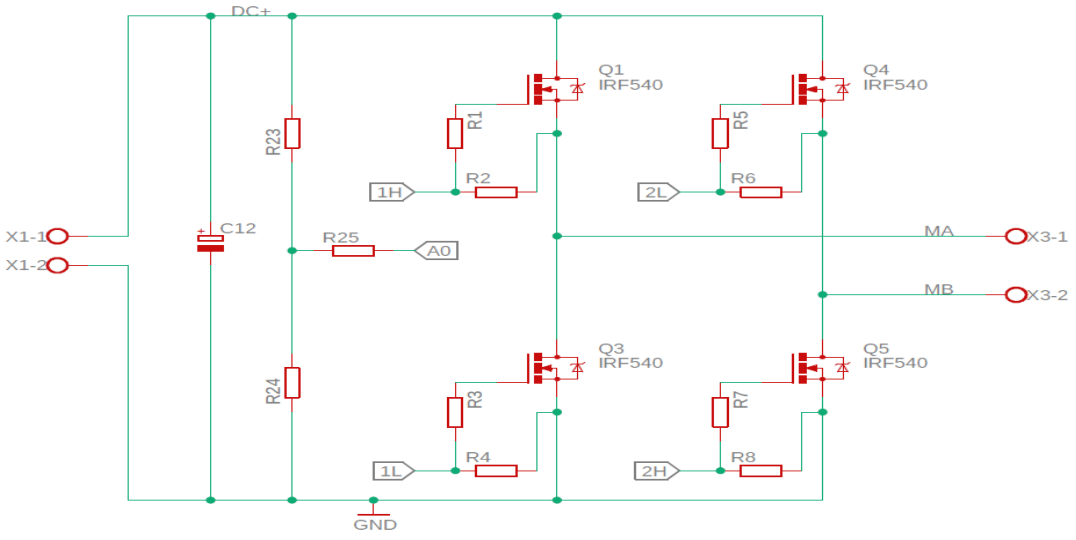

Fig. 13: Single Phase Inverter circuit

5. SOFTWARE REQUIREMENTS

5.1. Proteus

The Proteus Design Suite is a proprietary software tool suite used for electronic design automation. This software is used mainly to create schematics for manufacturing and printing circuit boards. Here the software was used to design the primary simulation of the project prototype.

5.2. MATLAB

MATLAB is a widely used numerical computation package. It serves both as a simple calculator and as a sophisticated tool for making long complicated calculations and plot graphs of different functions depending upon requirement. Here the MATLAB software is used to design the simulation of the project prototype.

5.3. AUTODESK EAGLE

EAGLE is a scriptable electronic design automation application with schematic capture, printed circuit board layout, auto-routing and computer-aided manufacturing features. Here the software was used to design the PCB of the project prototype.

6. WORKING PRINCIPLE

The working principle of this system is the switching of multiple sources to a common load without external interference to ensure that every source gets effectively utilised but at the same time without interfering with the functioning of other sources.

The switching of multiple sources is achieved by means of relays. In case of the three sources (utility grid supply, solar powered inverter and diesel generator), two relays R1 and R2 are used to switch among these sources. When the utility grid is used to supply the load, relay R1 is in the normally closed (NC) position. When relay R1 is toggled to the normally open (NO) position, the load is in contact with the common (C) point of relay R2. Once the common (C) point of relay R2 is in contact with the load, the load is powered by the Solar powered inverter (NC point) or Diesel Generator (NO point), depending upon the contact point. This arrangement ensures that two sources will not come into contact with the load at the same time and prevents the possibility of backfeed.

When any interruption occurs in the utility grid, this interruption is sensed by the microcontroller. At the point of failure, upon sensing the fault the microcontroller activates the inverter. The inverter supplies power to the load for a prescribed amount of time. Within this time, the microcontroller keeps checking whether the supply is restored. The failure upon which, in this given time, the diesel generator gets activated. The diesel generator will supply the load until the utility power is restored.

If utility power is not restored at the point where generator fuel depletes or by any chance the generator does not start due to fault in the gen-set, the microcontroller makes the inverter the energy source for critical loads. At this point power is diverted to the critical load, while other non-critical loads are disconnected by the relays R3 and R4. When the utility supply is restored, the microcontroller activates the relay to make it the primary supply again. Once the utility starts supplying the critical load, the non-critical loads are gradually reconnected to the system.

7. SIMULATION RESULTS

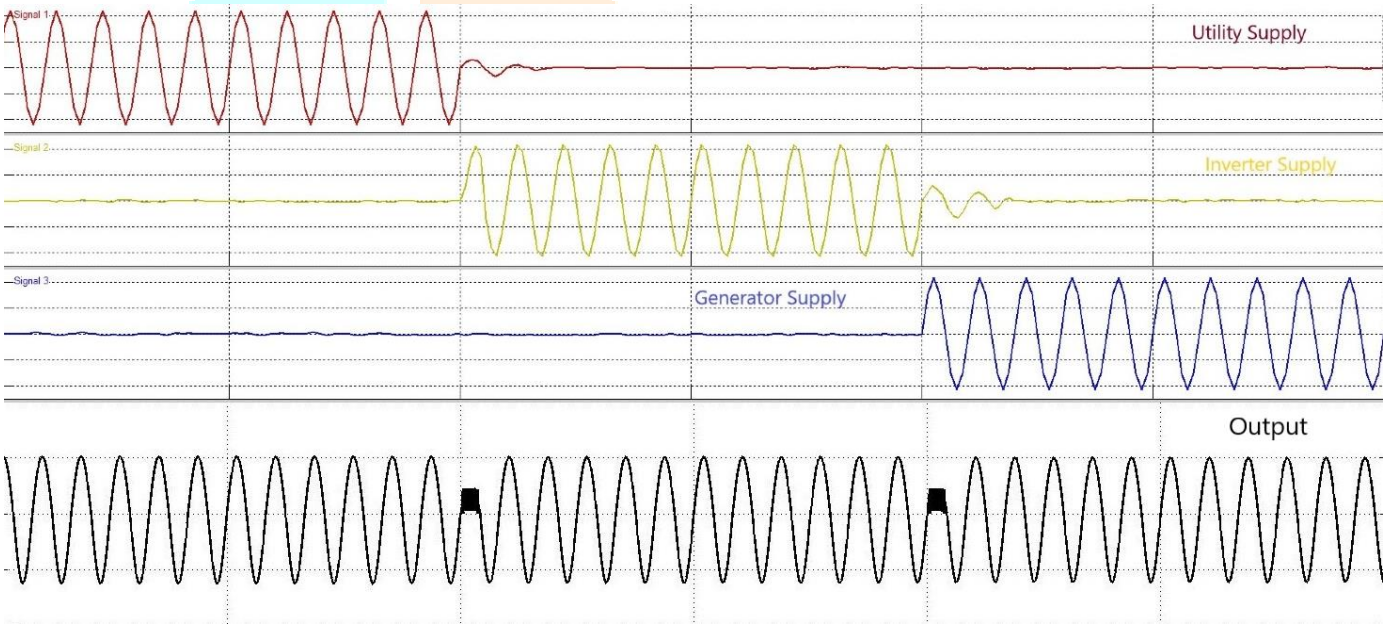

Fig. 14: MATLAB simulation result

The above figure shows the simulated result of the proposed system on MATLAB. The main intention behind the simulation is to show the working of the switching scheme and to obtain the resulting load waveform. The simulation is setup in such a way that the utility is allowed to function from 0-0.2sec.At this instant the inverter gets switched ON for another 0.2sec,the fault in the utility grid is confirmed and the Diesel Generator is activated after 0.4sec.As the voltage across each source changes the microcontroller switches the load to another available source. This results in uninterrupted supply to the load.

8. ACKNOWLEDGEMENT

We would like to express our deep and sincere gratitude to all the teachers and staff of the Department of Electrical and Electronics Engineering, for guiding us throughout the process. They have taught us the methodology to carry out the research works as clearly as possible. It was a great privilege and honor to work and study under their guidance. We are extremely grateful for what they have offered us. We are also thankful to our friends and well-wishers for their support and prayers. With a heart full of gratitude we submit this paper.

9. CONCLUSION

In the future, Renewable Energy Sources like Rooftop Solar Photovoltaics will be more common in use due to their clean and cost-effective nature. This leads to a situation of multiple sources connected to a common set of loads. The integration of multiple sources brings about new challenges. The proposed system can effectively utilize these multiple power sources and safely connect the load to each individual power source without the danger of backfeeding. These features ensure the reliability of the system and the overall safety of the sources associated with it. The real-time sensing ensures that there is a constant supply to the loads from any of the power sources. In addition to these features, the load prioritization ensures that the critical loads are available for use even in the most dire situation. This proposed system can ensure that such installations can be protected in a cost effective method. The real-time functioning of the system can be updated directly to the user if the system is interfaced to an external device via Internet of Things. By this means, the user could directly interact with the system and can effectively influence its functioning in a secure network, even from a remote location.

REFERENCES

[1] R. N. Hasanah, S. Soeprapto and H. P. Adi, "Arduino-Based Automatic Transfer Switch for Domestic Emergency Power Generator-Set," 2018 2nd IEEE Advanced Information Management, Communicates, Electronic and Automation Control Conference (IMCEC), 2018, pp. 742-746, doi: 10.1109/IMCEC.2018.8469629.

[2] E. A. Bekirov and S. N. Voskresenskaya, "Development of the Automatic Switch for Electric Power Transmission in the General," 2019 International Multi-Conference on Industrial Engineering and Modern Technologies (FarEastCon), 2019, pp. 1-5, doi: 10.1109/FarEastCon.2019.8934867.

[3] R. Danthakani, S. Kafumbe, E. Abd-Elrady and R. Divakaran, "IoT Based Switching Of Microgrid For Uninterrupted Power Supply," 2020 Advances in Science and Engineering Technology International Conferences (ASET), 2020, pp. 1-6, doi: 10.1109/ASET48392.2020.9118380.

[4] R. Mack, M. Sakib and S. Succar, "Impacts of substation transformer backfeed at high PV penetrations," 2017 IEEE Power & Energy Society General Meeting, 2017, pp. 1-5, doi: 10.1109/PESGM.2017.8274081.

[5] D. R. Sevcik, "CenterPoint Energy 12 kV network feeder 'back feed' protective relaying," 2014 67th Annual Conference for Protective Relay Engineers, 2014, pp. 186-192, doi: 10.1109/CPRE.2014.6799001.