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Single phase inverter using Arduino

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Abstract— ***This paper presents the research and development of a single phase inverter using Arduino looking at the scenario of Indian market as an alternative source of energy. The alternative design methodology has been proposed. The design of single phase inverter using Arduino consists of solar panel, inverter circuit, Battery, Arduino MOSFET (IRFZ44N) and transformer during this process many circuit simulation were done to fit the requirement of this project. It also shows that single phase inverter using Arduino can be highly efficient and successful in electrical UPS market. The result of our project is that we take 12V DC power from battery then by using Arduino which generate the pulse and given that pulse to MOSFET then by the reverse connection of transformer from secondary to primary induce huge primary winding and the charging of magnetic field will give a high AC voltage.***

I. INTRODUCTION

Arduino controller can be used to generate the pulse width modulation (PWM) signals for controlled semiconductor switches. The firing pulses of switches are varied .The firing pulse is given to the driver board and control the pulses. Speed control of a single phase induction motor is implemented using Arduino controller. Arduino controller is connected to the PWM inverter. The single phase inverter using Arduino output will be compared. Arduino Micro controller board and it is programmed to give PWM (Pulse Width Modulation) or can modify the code to produce different output from Arduino pins. Switching and driver stage, output pulse from the Arduino digital pins are fed into switching transistor SL100 npn and then power IRFZ44N. Output stage which is constructed by using center tapped transformer (230 VAC primary 12-0-12 VAC secondary) and it is connected reversely with driver circuit that is secondary stage (12-0-12 VAC) is connected to the power mosfet and primary side of transformer let to give output supply. When the battery connected with this circuit voltage regulator 7812 powers up the Arduino board and it starts producing output pulses depends on sketch, the pulses are drives the mosfet IRF44 and transformer secondary winding connected with the mosfet get discrete energy and mutually induce the large number of primary winding, as we know due to large numbers of winding and changing magnetic field, it produce high voltage AC output.

This work is based on the UPS system we take 12V power supply from the solar then we store that power in the battery. And design single phase inverter it makes our project more advance we use Arduino we program that and we give input to the inverter in term of pulse. This project consists of solar panel which consist solar cell which convert solar energy into electrical energy. We also have charging circuit which will charge 12V DC battery.

Here the simple and reliable inverter circuit designed with Arduino board, and we can program Arduino to obtain stepped AC output, modified sinewave AC output or pure sinewave output, and also we can program Arduino board to bring different range of frequency output.

As we did in the last semester we have used 4047chip as inverter in this semester we wanted to extend our project as per our guide view he told us to use single phase inverter with Arduino we take pulse wave from the Arduino. Its good use and easy to control. We get the 230v Ac power supply its very easy and less cost we can use in our daily life it provides much great and smoother power . The construction of this project is easy in today world its wide use.

II. SOLAR ENERGY

This paper covers how to convert 12v DC power into 230v AC power using Arduino, and transformer. Renewable energy which can used again and again like solar, wind, hydroelectric Non-renewable energy the energy which cannot be used again and again like coal, gas etc. Renewable energy is nonconventional energy and non-renewable energy is conventional energy. Solar power is energy from the sun that is converted into thermal or electrical energy.

Solar energy is the cleanest and most abundant renewable energy source available, and the U.S. has some of the richest solar resources in the world. Solar technologies can harness this energy for a variety of uses, including generating electricity, providing light or a comfortable interior environment, and heating water for domestic, commercial, or industrial use.

There are three main ways to harness solar energy.

a) Photovoltaic.
b) Solar heating.
c) Concentrating solar power.

Photovoltaics

Photovoltaics generate electricity directly from sunlight an electronic process. Photovoltaic generates electricity direct from sunlight through an electronic process. Solar panels convert the sun's light in to usable solar energy using N-type and P-type semiconductor material. When sunlight is absorbed by these materials, the solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. This process of converting light (photons) to electricity (voltage) is called the photovoltaic (PV) effect.

Fig.1 Solar Panels

A photovoltaic system uses solar panels to capture sunlight's photons. These solar panels each have many solar cells made up of layers of different materials. An anti-reflective coating on top helps the cell capture as much light as possible. Beneath that is a semiconductor (usually silicone) sandwiched between a negative conductor on top and a positive conductor on bottom. Once the photons are captured by the solar cell, they begin releasing the outer electrons of atoms within the semiconductor. The negative and positive conductors create a pathway for the electrons and an electric current is created. This electric current is sent to wires that capture the DC electricity [1]. These wires lead to a solar inverter, which then transforms it into the AC electricity used in homes. The more solar cells you install, the more electricity is produced.

Concentrating solar power

Concentrated solar power is generate solar power by using mirror or lenses to concentrate a large area of sunlight and it's of three types

Trough systems

Use large, U-shaped (parabolic) reflectors (focusing mirrors) that have oil-filled pipes running along their center, or focal point, as shown in Fig 1. The mirrored reflectors are tilted toward the sun, and focus sunlight on the pipes to heat the oil inside to as much as 750°F. The hot oil is then used to boil water, which makes steam to run conventional steam turbines and generators [2].

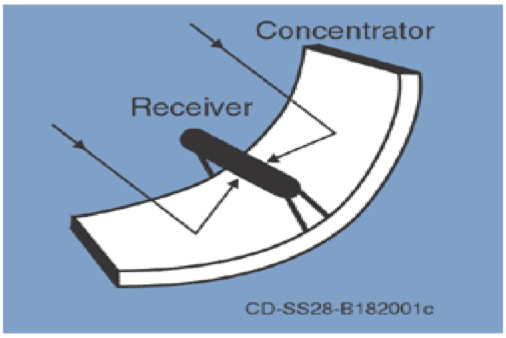

Fig.2 Parabolic Trough System Schematic Diagram

Fig.3 Parabolic trough system.

Power tower system

Also called central receivers, use many large, flat heliostats (mirrors) to track the sun and focus its rays onto a receiver. As shown in Figure 3, the receiver sits on top of a tall tower in which concentrated sunlight heats a fluid, such as molten salt, as hot as 1,050°F. The hot fluid can be used immediately to make steam for electricity generation or stored for later use. Molten salt retains heat efficiently, so it can be stored for days before being converted into electricity. That means electricity can be produced during periods of peak need on cloudy days or even several hours after sunset [3].

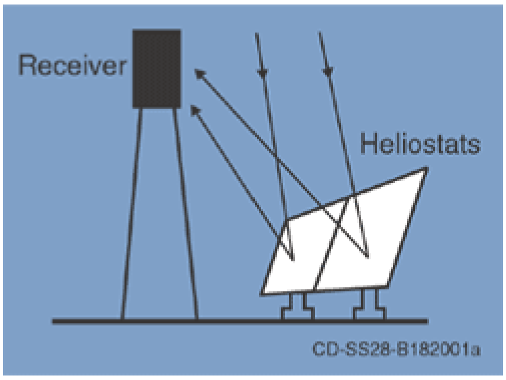

Fig.4: Power Tower Schematic Diagram

Fig.5 Power tower system

Dish/engine system

Use mirrored dishes (about 10 times larger than a backyard satellite dish) to focus and concentrate sunlight onto a receiver. As shown in Figure 5, the receiver is mounted at the focal point of the dish. To capture the maximum amount of solar energy, the dish assembly tracks the sun across the sky. The receiver is integrated into a high-efficiency "external" combustion engine. The engine has thin tubes containing hydrogen or helium gas that run along the outside of the engine's four piston cylinders and open into the cylinders. As concentrated sunlight falls on the receiver, it heats the gas in the tubes to very high temperatures, which causes hot gas to expand inside the cylinders. The expanding gas drives the pistons. The pistons turn a crankshaft, which drives an electric generator. The receiver, engine, and generator comprise a single, integrated assembly mounted at the focus of the mirrored dish.

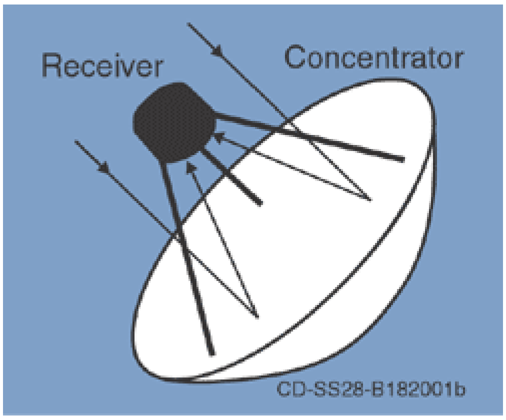

Fig.6 Dish/engine System Schematic Diagram

Fig.7 Solar dish-engine system**.**

III. ARDUINO UNO

The microcontroller development board that will be at the heart of your projects. It's a simple computer, but one that has no way for you to interact with it yet. You will be building the circuits and interfaces for interaction, and telling the microcontroller how to interface with other components. + - + - + - + - Battery Snap - Used to connect a 9V battery to power leads that can be easily plugged into a breadboard or your Arduino. Breadboard - A board on which you can build electronic circuits. It's like a patch panel, with rows of holes that allow you to connect wires and components together. Versions that require soldering are available, as well as the solder-less type used here. Capacitors - These components store and release electrical energy in a circuit. When the circuit's voltage is higher than what is stored in the capacitor, it allows current to flow in, giving the capacitor a charge. When the circuit's voltage is lower, the stored charge is released. Often placed across power and ground close to a sensor or motor to help smooth fluctuations in voltage. DC motor - Converts electrical energy into mechanical energy when electricity is applied to its leads. Coils of wire inside the motor become magnetized when current flows through them.

These magnetic fields attract and repel magnets, causing the shaft to spin. If the direction of the electricity is reversed, the motor will spin in the opposite direction. Diode - Ensures electricity only flows in one direction. Useful when you have a motor or other high current/voltage load in your circuit. Diodes are polarized, meaning that the direction that they're placed in a circuit maters. Placed one way, they allow current to pass through. Placed the other way, they block it. The anode side generally connects to the point of higher energy in your circuit. The cathode typically connects to the point of lower energy, or to ground. The cathode is usually marked with a band on one side of the component's body. Gels (red, green, blue) - These filter out different wavelengths of light. When used in conjunction with photo resistors, they cause the sensor to only react to the amount of light in the filtered color. H-bridge - A circuit that allows you to control the polarity of the voltage applied to a load, usually a motor. The H-bridge in the kit is an integrated circuit, but it could also be constructed with a number of discrete components. Jumper wires - Use these to connect components to each other on the breadboard, and to the Arduino. Light Emitting Diodes (LEDs) - A type of diode that illuminates when electricity passes through it. Like all diodes, electricity only flows in one direction through these components. You're probably familiar with these as indicators on a variety of electronic devices. The anode, which typically connects to power, is usually the longer leg, and the cathode is the shorter leg. Liquid Crystal Display (LCD) - A type of alphanumeric or graphic display based on liquid crystals. LCDs are available in a many sizes, shapes, and styles. Yours has 2 rows with 16 characters each. - + - + 7 Resistors - Resist the flow of electrical energy in a circuit, changing the voltage and current as a result. Resistor values are measured in ohms (represented by the Greek omega character: Ω). The colored stripes on the sides of resistors indicate their value (see resistor color code table). Opt coupler - This allows you to connect two circuits that do not share a common power supply. Internally there is a small LED that, when illuminated, causes a photoreceptor inside to close an internal switch. When you apply voltage to the + pin, the LED lights and the internal switch closes. The two outputs replace a switch in the second circuit. Piezo - An electrical component that can be used to detect vibrations and create noises. Photoresist or - (also called a photocell, or light dependent resistor).

A variable resistor that changes its resistance based on the amount of light that falls on its face. Potentiometer - A variable resistor with three pins. Two of the pins are connected to the ends of a fixed resistor. The middle pin, or wiper, moves across the resistor, dividing it into two halves. When the external sides of the potentiometer are connected to voltage and ground, the middle leg will give the difference in voltage as you turn the knob. Often referred to as a pot. Pushbuttons - Momentary switches that close a circuit when pressed. They snap into breadboards easily. These are good for detecting on/ off signals. Male header pins - These pins fit into female sockets, like those on a breadboard. They help make connecting things much easier. 8 Welcome to Arduino! Introduction USB Cable - This allows you to connect your Arduino Uno to your personal computer for programming. It also provides power to the Arduino for most of the projects in the kit. Temperature sensor - Changes its voltage output depending on the temperature of the component. The outside legs connect to power and ground. The voltage on the center pin changes as it gets warmer or cooler. Tilt sensor - A type of switch that will open or close depending on its orientation. Typically they are hollow cylinders with a metal ball inside that will make a connection across two leads when tilted in the proper direction. Transistor - A three legged device that can operate as an electronic switch. Useful for control.

IV. MOSFET

The MOSFET (Metal Oxide Semiconductor Field Effect Transistor) transistor is a semiconductor device which is widely used for switching and amplifying electronic signals in the electronic devices. The MOSFET is a core of integrated circuit and it can be designed and fabricated in a single chip because of these very small sizes. The MOSFET is a four terminal device with source(S), gate (G), drain (D) and body (B) terminals. The body of the MOSFET is frequently connected to the source terminal so making it a three terminal device like field effect transistor. The MOSFET is very far the most common transistor and can be used in both analog and digital circuits.

The MOSFET works by electronically varying the width of a channel along which charge carriers flow The charge carriers enter the channel at source and exit via the drain. The width of the channel is controlled by the voltage on an electrode is called gate which is located between source and drain. It is insulated from the channel near an extremely thin layer of metal oxide. The MOS capacity present in the device is the main part.

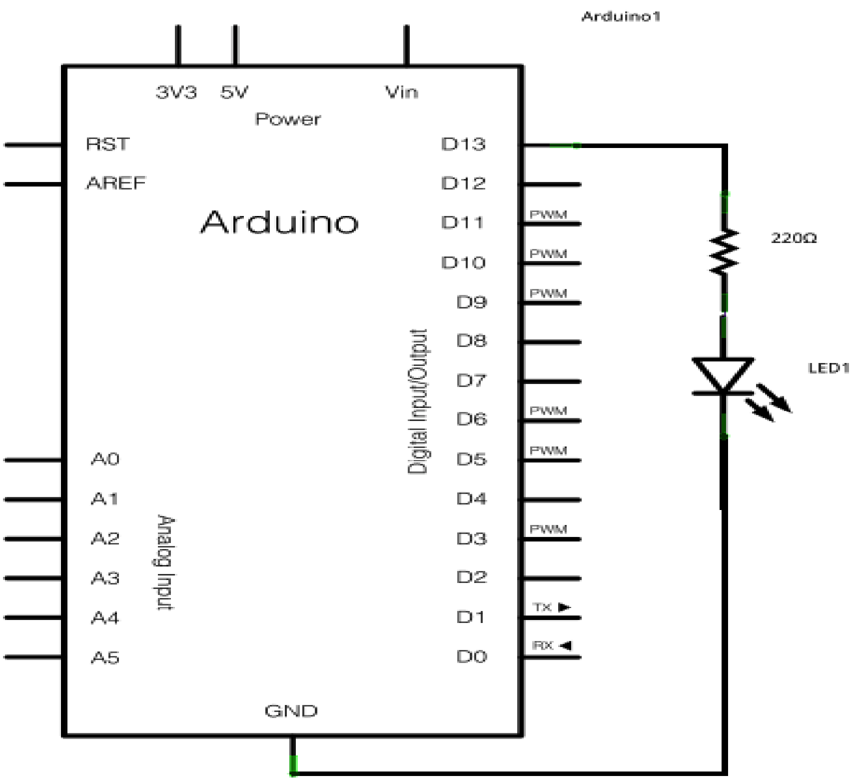

Fig.8 Pin diagram of Arduino

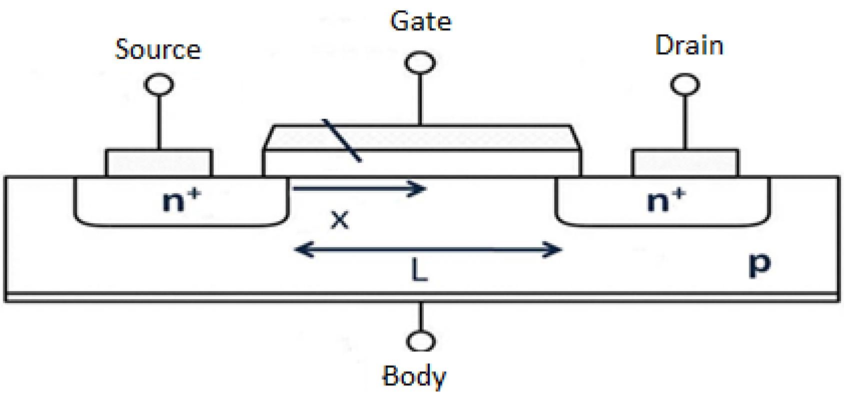

Fig.9 MOSFET

IRFZ44N belongs to the family of N-channel Power misfits, covered in plastic body and uses "Trench" technology.

Similar to other transistors, it has three terminals named as Gate, Drain and source. They are denoted by the alphabets G, D and S respectively. Its features include very low on state resistance, high speed processing technology, completely avalanche rated etc.

- Push pull systems and full bridge are few of its real life applications.
- IRF-Z44N is given in the figure shown below.

Fig.10 IRFZ44N

IRFZ44N Pin Name	
SI.No	Pin Name
1	Gate
2	Drain
3	Source

- Pin configuration of any device can be understood through pinout diagram.
- IRF-Z44N pinout diagram is given in the fig.11 shown below.

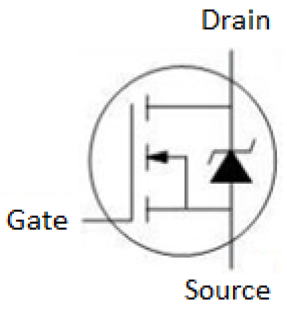

Fig.11 MOSFET SYMBOL

V. RESULTS

Arduino controller is connected to the PWM inverter. The single phase inverter using Arduino output will be compared.

We can clarify our work in four stages easily as below we can see it in details.

I. Arduino Micro controller board and it is programmed to give PWM (Pulse Width Modulation) or you can modify the code to produce different output from Arduino pins.

II. Switching and driver stage, output pulse from the Arduino digital pins are fed into switching transistor SL100 npn and then power IRF44.

III. Output stage which is constructed by using center tapped transformer (230 VAC primary / 12-0-12 VAC secondary) and it is connected reversely with driver circuit that is secondary stage (12-0-12 VAC) is connected to the power mosfet and primary side of transformer let to give output supply.

When the battery connected with this circuit voltage regulator 7812 powers up the Arduino board and it starts producing output pulses depends on sketch, the pulses are drives the transistor SL100 and power mosfet IRF44 and transformer secondary winding connected with the mosfet get discrete energy and mutually induce the large number of primary winding, as we know due to large numbers of winding and changing magnetic field, it produce high voltage AC output.

Our project is based on the UPS system we take 12V power supply from the solar then we store that power in the battery. And design single phase inverter it makes our project more advance we use Arduino we program that and we give input to the inverter in term of pulse.

We couldn't print the graph of our project result because we couldn't had access to our project.

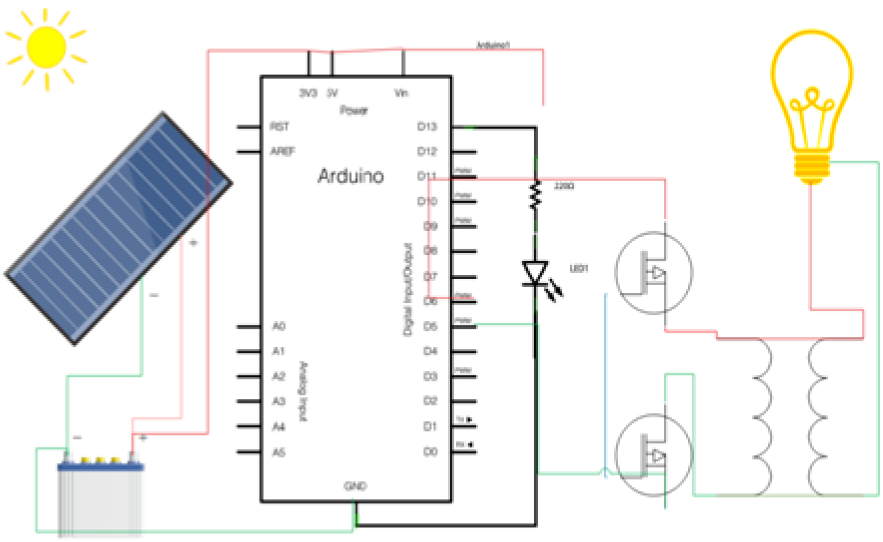

Fig.12 Block Diagram of Single Phase Inverter Using Arduino.

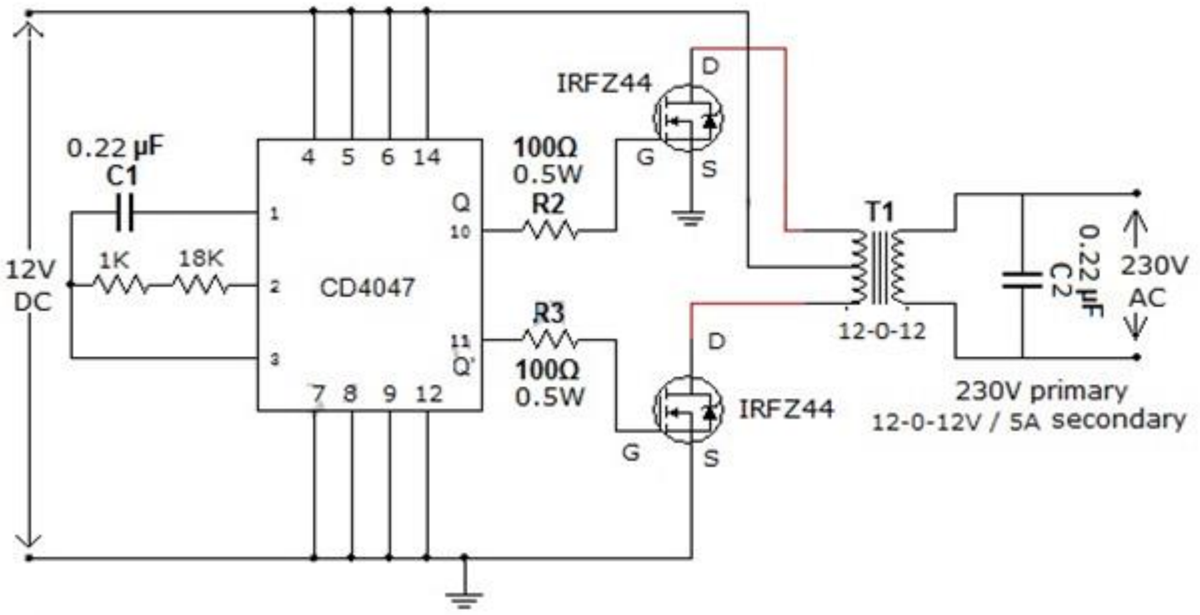

Fig.13 Inverter Circuit.

VI. CONCLUSION

Single phase inverter using Arduino is one of the easiest way to produce Ac power supply and it's widely use today mostly for the office and for away places from the power. We can generate Ac power when we have DC power and design of inverter is pretty much easy we can developed it very easy. Thus the single phase inverter using Arduino control is gives an energy efficient and environment friendly solution. The Arduino pulse will be given to the IRFZ44N so the switching speed will be controlled by using pulse width modulation (pwm).

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