FAULT CURRENT LIMITATION BY USING SERIES TRANSFORMER

A main project Submitted in partial fulfilment of the requirements
for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRICAL AND ELECTRONICS ENGINEERING

Submitted by

D. KARTHIK KUMAR REDDY (17091A0226)

G. SREEDHAR REDDY (18095A0235)

B. VIJAYA BHARATHI (17091A0281)

Under the Esteemed Guidance of

Mr. P. SAI SAMPATH KUMAR M.Tech,(Ph.D)

ASSISTANT PROFESSOR in Dept. of E.E.E

(ESTD-1995)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

RAJEEV GANDHI MEMORIAL COLLEGE OF ENGINEERING & TECHNOLOGY

(AUTONOMOUS)

(Approved by AICTE New Delhi, Accredited by NAAC-A$^+$ Grade,

Accredited by NBA, Affiliated to J.N.T. University Ananthapur)

Nandyal-518501, Kurnool Dist., A.P

2017-2021

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EDUCATION FOR PEACE

(ESTD-1995)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

CERTIFICATE

This is to certify that the thesis entitled "FAULT CURRENT LIMITATION BY USING SERIES TRANSFORMER" that is being submitted by D. KARTHIK KUMAR REDDY (17091A0226), G. SREEDHAR REDDY (18095A0235), B. VIJAYA BHARATHI (17091A0281) have carried out the main project for the fulfilment of the award of Bachelor of Technology in Electrical and Electronics Engineering in Rajeev Gandhi Memorial college of Engineering & technology(Autonomous) and this is a record of bonafied record of the work done by them during 2020-2021. The results embodied in this project work have not been submitted to any other university or institute for the award of any degree.

Head of the Department

19/7/21

Dr.V. Naga Bhaskar Reddy Ph.D, MISTE
Professor
Dept. of EEE, RGMCET

Project Guide

19/7/21

Mr .P. SAI SAMPATH KUMAR M.Tech,(Ph.D)
Assistant Professor
Dept. of EEE, RGMCET

Signature of External Examiner:

Date:

20/7/21

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A heart full and sincere gratitude to our beloved parents for their tremendous motivation and moral support. Finally we express our gratitude to our friends and others who have helped us directly and indirectly in carrying our project work successfully.

Project Associates

D. KARTHIK KUMAR REDDY (17091A0226)

G. SREEDHAR REDDY (18095A0235)

B. VIJAYA BHARATHI (17091A0281)

ABSTRACT:

This paper related to fault current limitation in radial distribution of network. In order to control fault current, primary winding of an isolation transformer is connected in series with phase line and secondary winding is connected to inductive coil (reactor), which is connected in parallel with a bypass switch i.e TRIAC. This system can improve the power quality of power system. This system also gives un- interrupted power supply. The magnitude of the current is reduced due to reactor connected in secondary winding. Because of simple structure cost is very low. This system is designed for single phase 230 volts, 50Hz ac supply.

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INTRODUCTION

1.1 INTRODUCTION:

Due to expansion of power system networks complexity in the system is increased. So temporary faults in the system are increasing nowadays. Consumers are suffering from continuous interruption of supply. Transient faults having larger magnitude that may damage protective equipments which are costlier .Fault current limitation by using series transformer has lower losses than series reactor based technology. This system can reduces voltage sag in supply voltage, also improve power quality. This system can remove fault current without interrupting supply lines. A 1:1 ratio isolation transformer has primary winding is continuously connected in series with phase line. The secondary winding is connected to reactor in parallel with TRIAC. The system is designed for single phase system.

1.2 LITERATURE SURVEY:

This paper studies a fault current limitatation by using series transformer(FCLST) for radial distribution network applications. The proposed system is capable of controlling the magnitude of fault current. In order to control the fault current, primary winding of an isolating transformer is connected in series with the line and the secondary side is connected to a reactor, paralleled with a bypass switch which is made of anti-parallel TRIAC. By controlling the magnitude of ac reactor current, the fault current is reduced and voltage of the point of common coupling is kept at an acceptable level. Also, by this FCLST switching overvoltage is reduced significantly. The proposed FSCLST can improve the power quality factors and also, due to its simple structure, the cost is relatively low. Laboratory results are also presented to verify the simulation and theoretical studies. It is shown that this FCLST can limit the fault current with negligible delay, smooth the fault current waveform, and improve the power quality.

H. Radmanesh, H. Fathi and G. B. Gharehpetian, "Fault Current Limitation By Using Series Transformer," in IEEE Transactions on Smart Grid, vol. 6, no. 4, pp. 1983-1991, July 2015, doi: 10.1109/TSG.2015.2398365.

J. McAullife, D. Amin, I. Peacock and D. Durocher, "Optimizing capital costs in power-distribution upgrades," in IEEE Industry Applications Magazine, vol. 7, no. 5, pp. 41-51, Sept.-Oct. 2001, doi: 10.1109/2943.948531.

1.3 PROPOSED METHODOLOGY:

This is related to fault current limitation in radial distribution of network. In order to control fault current, primary winding of an isolation transformer is connected in series with phase line and secondary winding is connected to inductive coil (reactor), which is connected in parallel with a bypass switch i.e TRIAC. This system can improve the power quality of power system. This system also gives un- interrupted power supply. The magnitude of the current is reduced due to reactor connected in secondary winding. Because of simple structure cost is very low. This system is designed for single phase 230 volts, 50Hz ac supply.

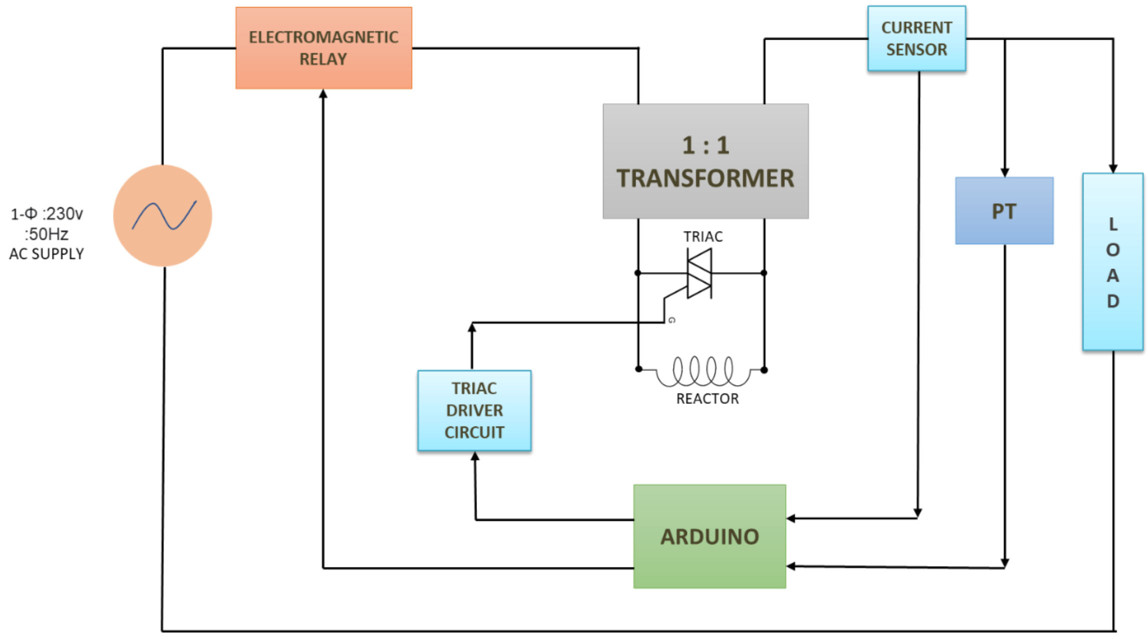

Figure 1.1 circuit diagram

As shown in the figure 1.1 it consists of two modes of operation.

In Normal Mode: - The line or load current flows through primary winding and secondary winding is shirt circuited. The primary winding is continuously in operation. In normal mode safe current range is 1Amp.

In Abnormal Mode: - The primary winding can carry line or load current but secondary winding is connected to Reactor with opening TRIAC switch to limit magnitude of fault current to greater level. When current greater than 1 Amp system goes to faulty mode. Transformer Secondary side reactor added to circuit & fault current chopped. If fault current greater than 60 Seconds then main supply directly give signal through relay by glowing lamp. In order to control the fault current, primary winding of an isolating transformer is connected in series with the line and the secondary side is connected to a reactor, paralleled with a bypass switch which is made of anti-parallel TRIAC. By controlling the magnitude of ac reactor current, the fault current is reduced and voltage of the terminal point is kept at a reference level (230 volts). Also, by this switching overvoltage is reduced significantly. It can improve the power quality and also, due to its simple construction, the cost is very low. This system limits the fault current without negligible delay, smooth the fault current waveform, and improve the power quality.

1.4 THESIS OVERVIEW:

The thesis explains the implementation of "**FAULT CURRENT LIMITATION BY USING SERIES TRANSFORMER"**.The organization of the thesis is explained here with:

Chapter 1 Presents introduction to the overall thesis and the project.

Chapter 2 Presents the hardware description. It explains each every component involved in the project.

Chapter 3 Presents the circuit design,and hardware description of project.

Chapter 4 Presents the advantages, and applications of project.

Chapter 5 Presents the result, conclusion and future scope of the project.

Chapter 6 presents the References of the project.

Chapter 7 presents the appendix of the project.

CHAPTER -2

CHAPTER-2

HARDWARE DESCRIPTION

2.1 COMPONENTS

In this project, I will show you how to achieve Fault Current Limitation by using Serires Transformer. It is a simple project using Arduino UNO,Current sensor,Relay,Step down Transformer and a few easily available components to limit fault current.
In this project major components are 8.

- Arduino UNO
- Current Sensor
- Isolation transformer
- TRIAC
- Relay
- LCD Display
- Stepdown Transformer
- Reactor

2.2 ARDUINO UNO:

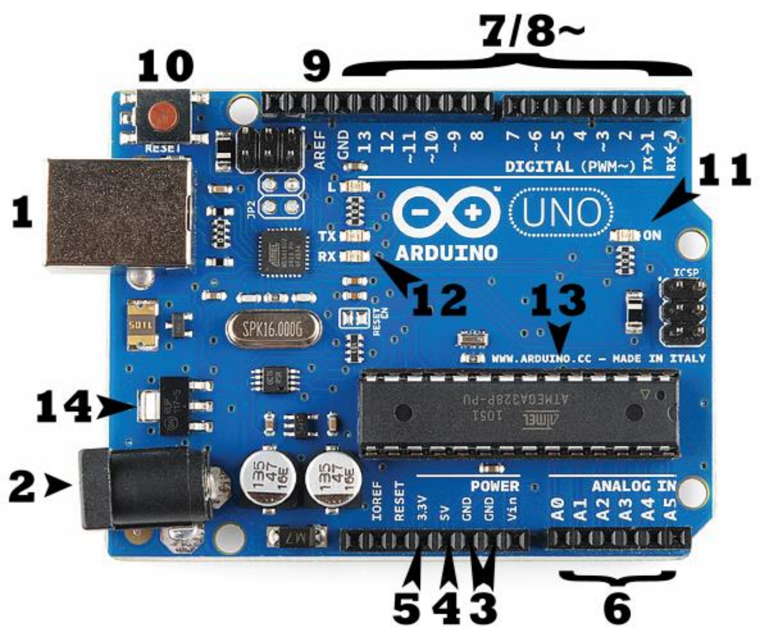

Figure:2.2.1 ARDUINO UNO

As shown in the figure:2.2.1 every Arduino board needs a way to be connected to a power source. The Arduino UNO can be powered from a USB cable coming from your computer or a wall power supply (like this) that is terminated in a barrel jack. In the picture above the USB connection is labeled (1) and the barrel jack is labeled (2).

The USB connection is also how you will load code onto your Arduino board. More on how to program with Arduino can be found in our Installing and Programming Arduino tutorial.

NOTE: Do NOT use a power supply greater than 20 Volts as you will overpower (and thereby destroy) your Arduino. The recommended voltage for most Arduino models is between 6 and 12 Volts.

Pins (5V, 3.3V, GND, Analog, Digital, PWM, AREF)

The pins on your Arduino are the places where you connect wires to construct a circuit (probably in conjuction with a breadboard and some wire. They usually have black plastic 'headers' that allow you to just plug a wire right into the board. The Arduino has several different kinds of pins, each of which is labeled on the board and used for different functions.

- GND (3):Short for 'Ground'. There are several GND pins on the Arduino, any of which can be used to ground your circuit.
- 5V (4) & 3.3V (5): As you might guess, the 5V pin supplies 5 volts of power, and the 3.3V pin supplies 3.3 volts of power. Most of the simple components used with the Arduino run happily off of 5 or 3.3 volts.
- Analog (6): The area of pins under the 'Analog In' label (A0 through A5 on the UNO) are Analog In pins. These pins can read the signal from an analog sensor (like a temperature sensor) and convert it into a digital value that we can read.
- Digital (7): Across from the analog pins are the digital pins (0 through 13 on the UNO). These pins can be used for both digital input (like telling if a button is pushed) and digital output (like powering an LED).
- PWM (8): You may have noticed the tilde (~) next to some of the digital pins (3, 5, 6, 9, 10, and 11 on the UNO). These pins act as normal digital pins, but can also be used for something called Pulse-Width Modulation (PWM). We have a tutorial on PWM, but for

now, think of these pins as being able to simulate analog output (like fading an LED in and out).

- AREF (9): Stands for Analog Reference. Most of the time you can leave this pin alone. It is sometimes used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins.

Reset Button

Just like the original Nintendo, the Arduino has a reset button **(10)**. Pushing it will temporarily connect the reset pin to ground and restart any code that is loaded on the Arduino. This can be very useful if your code doesn't repeat, but you want to test it multiple times. Unlike the original Nintendo however, blowing on the Arduino doesn't usually fix any problems.

TX RX LEDs

TX is short for transmit, RX is short for receive. These markings appear quite a bit in electronics to indicate the pins responsible for serial communication. In our case, there are two places on the Arduino UNO where TX and RX appear – once by digital pins 0 and 1, and a second time next to the TX and RX indicator LEDs .

Main IC

The black thing with all the metal legs is an IC, or Integrated Circuit . Think of it as the brains of our Arduino. The main IC on the Arduino is slightly different from board type to board type, but is usually from the ATmega line of IC's from the ATMEL company. This can be important, as you may need to know the IC type (along with your board type) before loading up a new program from the Arduino software. This information can usually be found in writing on the top side of the IC. If you want to know more about the difference between various IC's, reading the datasheets is often a good idea.

Voltage Regulator

The voltage regulator is not actually something you can (or should) interact with on the Arduino. But it is potentially useful to know that it is there and what it's for. The voltage regulator does exactly what it says – it controls the amount of voltage that is let into the Arduino board. Think of it as a kind of gatekeeper; it will turn away an extra voltage that might harm the circuit. Of course, it has its limits, so don’t hook up your Arduino to anything greater than 20 volts.

MICRO CONTROLLER IN ARDUINO

ATMEGA328P is high performance, low power controller from Microchip. ATMEGA328P is an 8-bit microcontroller based on AVR RISC architecture. It is the most popular of all AVR controllers as it is used in ARDUINO boards.

Atmega328 is an Atmel microcontroller, which is used in Arduino UNO board. Here's its image: Here are few of its features: Atmega328 has 28 pins in total. It has 3 Ports in total which are named as Port B, Port C and Port D

Actually Arduino UNO is a Single Micro-controller board. And the name of this Micro Controller is ATmega328p which is a product of ATmel. 32 - represents it's flash memory capacity that is 32KB. 8 - represents it's cpu type that is of 8 bit. p - simply denotes that it needs less power to work than it earlier version.The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button as shown in the figure 2.2.2 .

Figure:2.2.2 ATmega328

FEATURES

These features consist of advanced RISC architecture,

- Good performance,
- Low power consumption,
- Real timer counter having separate oscillator,
- 6 PWM pins,
- Programmable Serial USART,
- Programming lock for software security,
- Throughput up to 20 MIPS etc.

PIN DIAGRAM OF ATMEGA 328P:

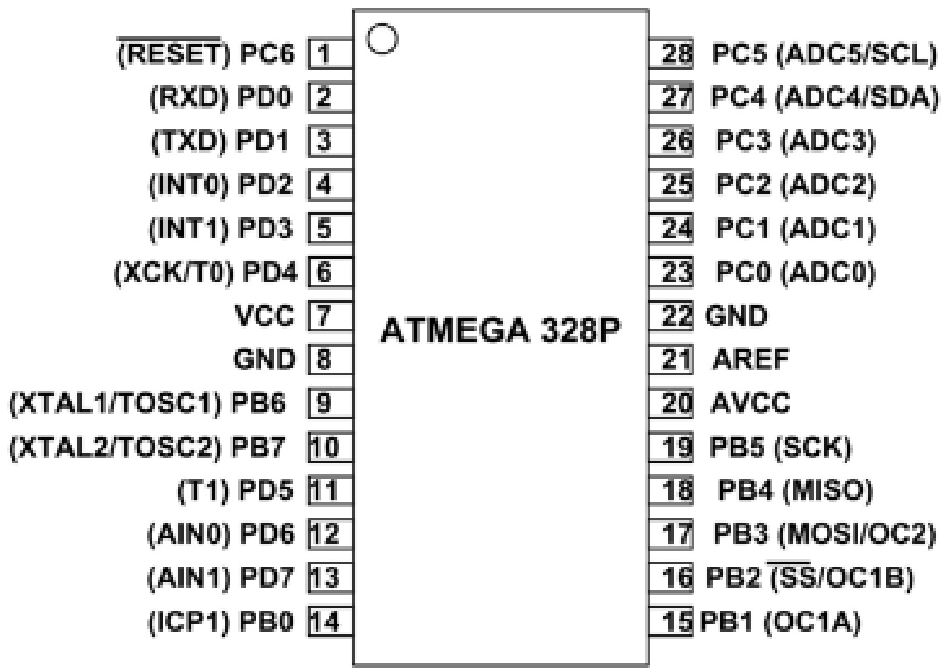

Figure:2.2.3 pin diagram of ATmega 328p

As shown in the figure 2.2.3 the Atmega328 is a very popular microcontroller chip produced by Atmel. It is an 8-bit microcontroller that has 32K of flash memory, 1K of EEPROM, and 2K of internal SRAM. The Atmega328 is one of the microcontroller chips that are used with the popular Arduino Duemilanove boards.

ATMEGA328P is high performance, low power controller from Microchip. ATMEGA328P is an 8-bit microcontroller based on AVR RISC architecture. It is the most popular of all AVR controllers as it is used in ARDUINO boards. It is an 8-bit and 28 Pins AVR Microcontroller, manufactured by Microchip, follows RISC Architecure and has a flash type program memory of 32KB. It has an EEPROM memory of 1KB and its SRAM memory is of 2KB. ... It also has 3 builtin Timers, two of them are 8 Bit timers while the third one is 16-Bit Timer.

The ATmega328/P is a low-power CMOS 8-bit microcontroller based on the AVR® enhanced RISC (reduced instruction set computer) architecture. In Order to maximize performance and parallelism, the AVR uses Harvard architecture – with separate memories and buses for program and data

1: Atmega328P and Atmega328 are the same every sense architecturally.

2: Atmega328P just consumes lower power than Atmega328.

Look up the numbers in the datasheet. This means that the 328P is manufactured in a finer process than the 328Actually Arduino UNO is a Single Micro-controller board. And the name of this Micro Controller is ATmega328p which is a product of ATmel. 32 - represents it's flash memory capacity that is 32KB. 8 - represents it's cpu type that is of 8 bit. p - simply denotes that it needs less power to work than it earlier version.

TYPES OF MEMORY

The ATmega328P has three types of memory hardware:

- 32 KB of In-System Programmable (ISP) Flash program memory.
- 2 KB of SRAM (Static Random-Access Memory)
- 1 KB of EEPROM (Electrically Erasable Programmable Read-Only Memory)

ISP MEMORY

In-system programming (ISP), also called in-circuit serial programming (ICSP), is the ability of some programmable logic devices, microcontrollers, and other embedded devices to be programmed while installed in a complete system, rather than requiring the chip to be programmed prior to installing it into the system.

SRAM

SRAM (static RAM) is random access memory (RAM) that retains data bits in its memory as long as power is being supplied. Unlike dynamic RAM (DRAM), which stores bits in cells consisting of a capacitor and a transistor, SRAM does not have to be periodically refreshed.

EEPROM

EEPROM (electrically erasable programmable read-only memory) is user-modifiable read-only memory (ROM) that can be erased and reprogrammed (written to) repeatedly through the application of higher than normal electrical voltage. Unlike EPROM chips, EEPROMs do not need to be removed from the computer to be modified.

ARDUINO MEGA

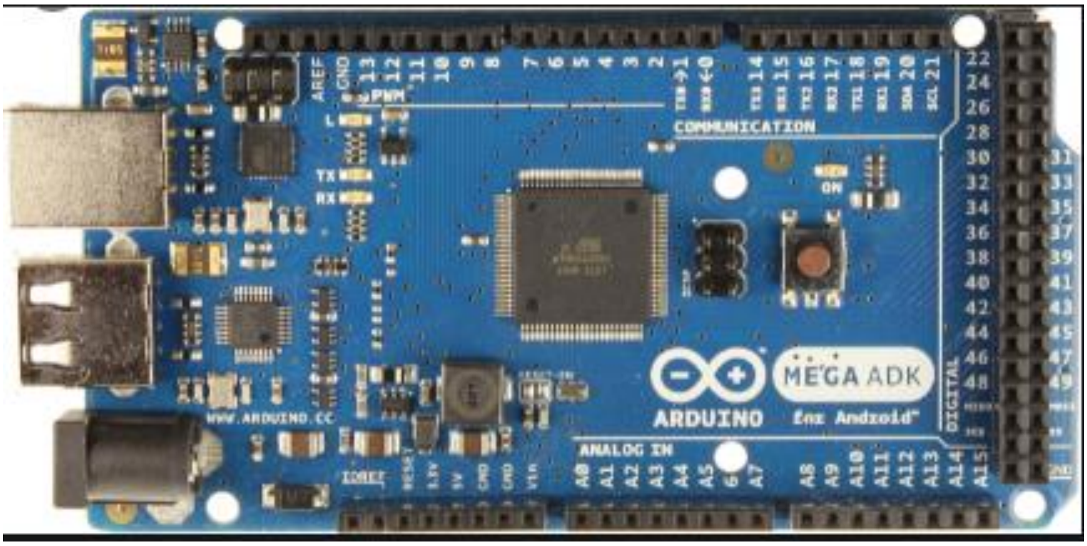

Figure 2.2.4: ARDUINO MEGA BOARD

As shown in the figure2.2.4 the Arduino Mega is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

Designing of a project using Arduino Mega gives you the flexibility of working with more memory space and processing power that allows you to work with a number of sensors at once. This board is physically larger than other Arduino boards.

The Arduino MEGA 2560 is designed for projects that require more I/O lines, more sketch memory and more RAM. With 54 digital I/O pins, 16 analog inputs and a larger space for your sketch it is the recommended board for 3D printers and robotics projects.

The Flash memory on the Uno and Micro are the same at 32 kB, while the Mega 2560 has 256 kB, giving it 8x more memory space! Arduino boards use SRAM (Static Random-Access Memory). The Mega 2560 has the most SRAM space with 8 kB, which is 4x more than the Uno, and 3.2x more than the Micro.

The 8-bit board with 54 digital pins, 16 analog inputs,and 4 serial ports. The Arduino Mega 2560 is a microcontroller board based on the ATmega2560.

In fact, you already are; the Arduino language is merely a set of C/C++ functions that can be called from your code. Your sketch undergoes minor changes (e.g. automatic generation of function prototypes) and then is passed directly to a C/C++ compiler (avr-g++).

The name Arduino comes from a bar in Ivrea, Italy, where some of the founders of the project used to meet. The bar was named after Arduin of Ivrea, who was the margrave of the March of Ivrea and King of Italy from 1002 to 1014.

Arduino projects can be stand- alone or they can communicate with software on running on a computer. Arduino serves many applications such as robot/motor control, miniaturized applications, UAVs, sensor networks, etc.

The main advantage of the Arduino technology is, you can directly load the programs into the device without the need of a hardware programmer to burn the program. This is done because of the presence of the 0.5KB of boot loader, that allows the program to be dumped into the circuit.

In 2005, building upon the work of Hernando Barragán (creator of Wiring), Massimo Banzi and David Cuartielles created Arduino, an easy-to-use programmable device for interactive art design projects, at the Interaction Design Institute Ivrea in Ivrea, Italy. Arduinos are made in Scarmagno, Italy, a small town near the Olivetti factories on the outskirts of Torino. All of the circuit board fabrication, board stuffing and distribution is handled out of that small town.

Arduino is a micro-controller board which runs dedicated program, there's no OS, just your code.

MICRO CONTROLLER IN ARDUINO MEGA:

A microcontroller is a computer present in a single integrated circuit which is dedicated to perform one task and execute one specific application. It contains memory, programmable input/output peripherals as well a processor.

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

Arduino is neither a microcontroller nor a micro processor.It is just a development board which contains a microcontroller mainly 8 bit AVR such as ATmega8,ATmega168,ATmega328,ATmega1280,http://ATmega2560.It is used to make so many college based projects easily.

Designing of a project using Arduino Mega gives you the flexibility of working with more memory space and processing power that allows you to work with a number of sensors at once. This board is physically larger than other Arduino boards.

An Arduino Uno board is best suited for beginners who have just started using microcontrollers, on the other hand, Arduino Mega board is for enthusiasts who require a lot of I/O pins for their projects as shown in figure 2.2.5

FIG : 2.2.5 MICRO CONTROLLER

FEATURES

These features consist of advanced RISC architecture,

- Good performance,
- Low power consumption,
- Real timer counter having separate oscillator,
- Programmable Serial USART,
- Programming lock for software security,
- Throughput up to 20 MIPS etc.

2.3 CURRENT SENSOR:

Figure : 2.3.1 current sensor

As shown in figure 2.3.1 the Allegro® ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems. The device package allows for easy implementation by the customer.Typical applications include motor control, load detection and management, Switched mode power supplies, and overcurrent fault protection.

The device consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper-stabilized BiCMOS Hall IC, which is programmed for accuracy after packaging.The output of the device has a positive slope (>VIOUT(Q)) when an increasing current flows through the primary copper conduction path (from pins 1 and 2, to pins 3 and 4), which is the path used for current sensing. The internal resistance of this conductive path is 1.2 mΩ typical, providing low power loss. The thickness of the copper conductor allows survival of the device up to 5× overcurrent conditions. The terminals of the conductive path are electrically isolated from the sensor leads (pins 5 through 8). This allows the ACS712 current sensor to be used in applications requiring electrical isolation without the use of opto-isolators or other costly isolation techniques.

The ACS712 is provided in a small, surface mount SOIC8 package.The leadframe is plated with 100% matte tin, which is compatible with standard lead (Pb) free printed circuit board assembly processes. Internally, the device is Pb-free, except for flip-chip high-temperature Pb-based solder balls, currently exempt from RoHS. The device is fully calibrated prior to shipment from the factory.

Features and Benefits

▪ Low-noise analog signal path

▪ Device bandwidth is set via the new FILTER pin

▪ 5 µs output rise time in response to step input current

▪ 80 kHz bandwidth

▪ Total output error 1.5% at TA = 25°C

▪ Small footprint, low-profile SOIC8 package

- 1.2 mΩ internal conductor resistance
- 2.1 kVRMS minimum isolation voltage from pins 1-4 to pins 5-8
- 5.0 V, single supply operation
- 66 to 185 mV/A output sensitivity
- Output voltage proportional to AC or DC currents
- Factory-trimmed for accuracy
- Extremely stable output offset voltage
- Nearly zero magnetic hysteresis
- Ratiometric output from supply voltage

2.4 ISOLATION TRANSFORMER:

Figure: 2.4.1 isolation transformer

Transformers are electromagnetic devices which transform alternating current (AC) electrical energy from primary to secondary side. The energy is transformed with equal frequency and approximately equal power by means of the transformer core magnetic field. Thus they provide galvanic isolation in the electrical system. The ***isolation transformer as in figure 2.4.1*** operate in the same way as other transformer types. But the main task is to provide the galvanic isolation in the electrical system. They can work as step-up transformer or step-down transformers

but often operate with turns ratio . This means that the primary and secondary

voltage values are equal. This is obtained with an same number of turns on the primary and secondary windings.
The **isolation transformers** are used in many electrical devices as computers, measurement devices or specific industry power electronic devices.

It is very important to use isolating transformers when an oscilloscope measures signals in an electrical circuit which is not galvanically isolated from the network. Because the current circuit can be closed (short-circuited) between oscilloscope common point and grounding. The main purpose of the isolation transformer is safety and protection of electronic components and the persons against electrical shock. It physically separates the power supplying from primary side and a secondary side circuit connected to electronic components and grounded metal parts which are in contact with the person. Basically, the transformer secondary side is isolated from the grounding.
This means that the isolation transformer secondary side must not be grounded. It would create a physical connection between the primary and secondary transformer side. The auto transformer with common winding can not be used as **isolation transformer** because it has a connection between primary and secondary side. Isolation transformer provides available supplying even if the device is broken. The primary side remains under voltage which can be used to supply some alarm or warning beep circuits when the device is broken.
The transformers suppress the electrical noise from supplying or electromagnetic induction. That is very important incase of sensitive devices as measurement or medical devices. This transformer is built with electrostatic shields which additionally increase the electrical noise suppression. The proper isolation transformer design avoids ground loops. Ground loops create an additional current path where the current created by electromagnetic induction can flow. This is the main reason for noise and interference in the signal.
When the isolation transformer is designed it is very important to pay attention to windings capacitance values which create capacitive coupling. This enables AC signal to pass from primary to the secondary side which significantly increased the noise level. For this purpose, the windings are surrounded by a metal strip which is grounded (creating a Faraday shield).
The **isolation transformers** are used as instrument transformers when the high voltage should be measured. The high voltage is dangerous for the person who tries to measure high voltage but it can also harm the

measurement circuits. In this case, the step-down isolation transformer is used to reduce the high voltage to the safe level and for measurement range.

Application of Isolation Transformer:

There is also some special **application of isolating transformers,** such us pulse transformers which transmit rectangular pulse signals and provide the electrical isolation. This type is suitable in some computer network designs.

Transformers are used in a power system that is capable to step up the power generated at low voltages to extra high voltages for transmission over long distances and then it could be transformed at low voltages In order to utilize it at load centers. It can transform power from one circuit to others by stepping up or down the primary voltage without any change in frequency. Current in the primary winding will create a varying magnetic flux in the transformer's core and thus it will create a varying magnetic field in the secondary windings and this is done by mutual inductance

What is an Isolation transformer

An isolation transformer is a kind of current transformer which is used to supply power to equipment. It is not used to increase or decrease the voltage, they are used for other purposes like breaking a circuit into a primary and a secondary, so direct current noise can't get through, it can prevent capacitance build-up by high-frequency noise, it also prevents unconditional ground connection between the primary and secondary and thus prevents high voltage discharge. It can provide galvanic isolation to the electrical system. Any transformer which is used to transfer signals or power is isolating because the primary or secondary is not connected by conductors instead of that it is done by induction. The transformers which have its main function to isolate circuits can be called as isolation transformers. In isolation transformer, the primary voltage value will be equal to the secondary voltage and the two windings will have the same number of turns to compensate for losses.

2.5 TRIAC:

The triac is an important member of the thyristor family of devices. It is a bidirectional device that can pass the current in both forward and reverse biased conditions and hence it is an AC control device. The triac is equivalent to two back to back SCRs connected with one gate terminal as shown in figure 2.5.1 .

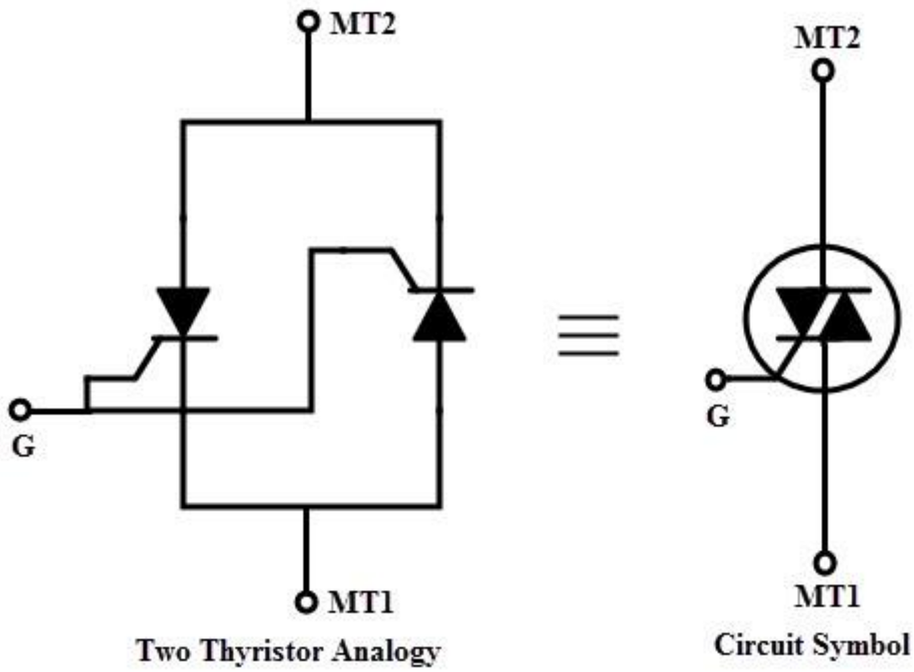

Figure: 2.5.1 symbol of TRIAC

The triac has three terminals namely Main Terminal 1(MT1), Main Terminal 2 (MT2) and Gate (G) as shown in figure. If MT1 is forward biased with respect to MT2, then the current flows from MT1 to MT2. Similarly, if the MT2 is forward biased with respect to MT1, then the current flows from MT2 to MT1.

The above two conditions are achieved whenever the gate is triggered with an appropriate gate pulse. Similar to the SCR, triac is also turned by injecting appropriate current pulses into the gate terminal. Once it is turned ON, it looses its gate control over its conduction. So traic can be turned OFF by reducing the current to zero through the main terminals.

Construction of TRIAC

A triac is a five layer, three terminal semiconductor device. The terminals are marked as MT1, MT2 as anode and cathode terminals in case of SCR. And the gate is represented as G similar to the thyristor. The gate terminal is connected to both N4 and P2 regions by a metallic contact and it is near to the MT1 terminal.

The terminal MT1 is connected to both N2 and P2 regions, while MT2 is connected to both N3 and P1 regions. Hence, the terminals MT1 and MT2 connected to both P and N regions of the device and thus the polarity of applied voltage between these two terminals decides the current flow through the layers of the device as shown in figure 2.5.2 .

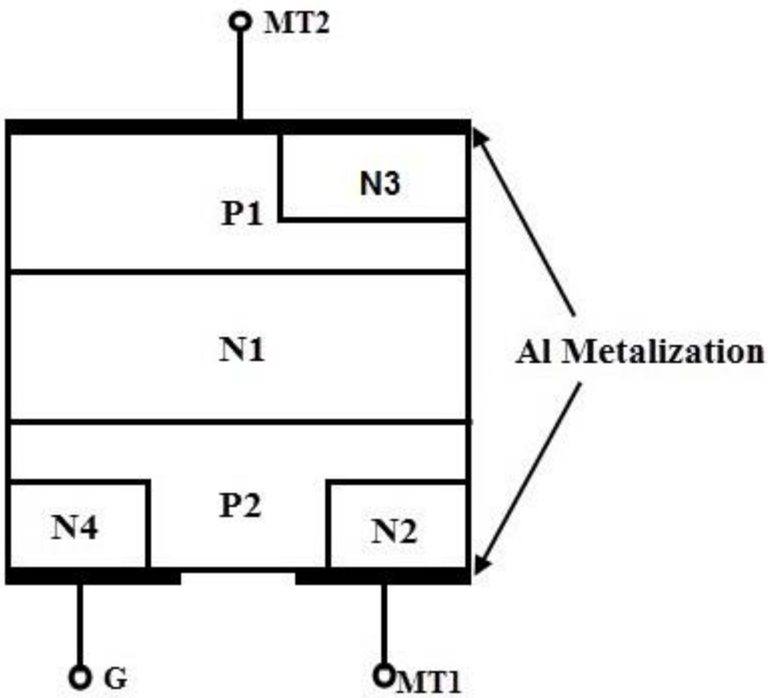

Figure: 2.5.2 construction model of TRIAC

With the gate open, MT2 is made positive with respect to MT1 for a forward biased traic. Hence traic operates in forward blocking mode until the voltage across the triac is less than the forward breakover voltage. Similarly for a reverse biased triac, MT2 is made negative with respect to MT1 with gate open.

Until the voltage across the triac is less than the reverse breakover voltage, device operates in a reverse blocking mode. A traic can be made conductive by either positive or negative voltage at the gate terminal.

V-I Characteristics of TRIAC

The traic function like a two thyristors connected in anti-parallel and hence the VI characteristics of triac in the 1st and 3rd quadrants will be similar to the VI characteristics of a thyristors. When the terminal MT2 is positive with respect to MT1 terminal, the traic is said to be in forward blocking mode.

A small leakage current flows through the device provided that voltage across the device is lower than the breakover voltage. Once the breakover voltage of the device is reached, then the triac turns ON as shown in below figure.However, it is also possible to turn ON the triac below the VBO by applying a gate pulse in such that the current through the device should be more than the latching current of the triac as shown in figure 2.5.3

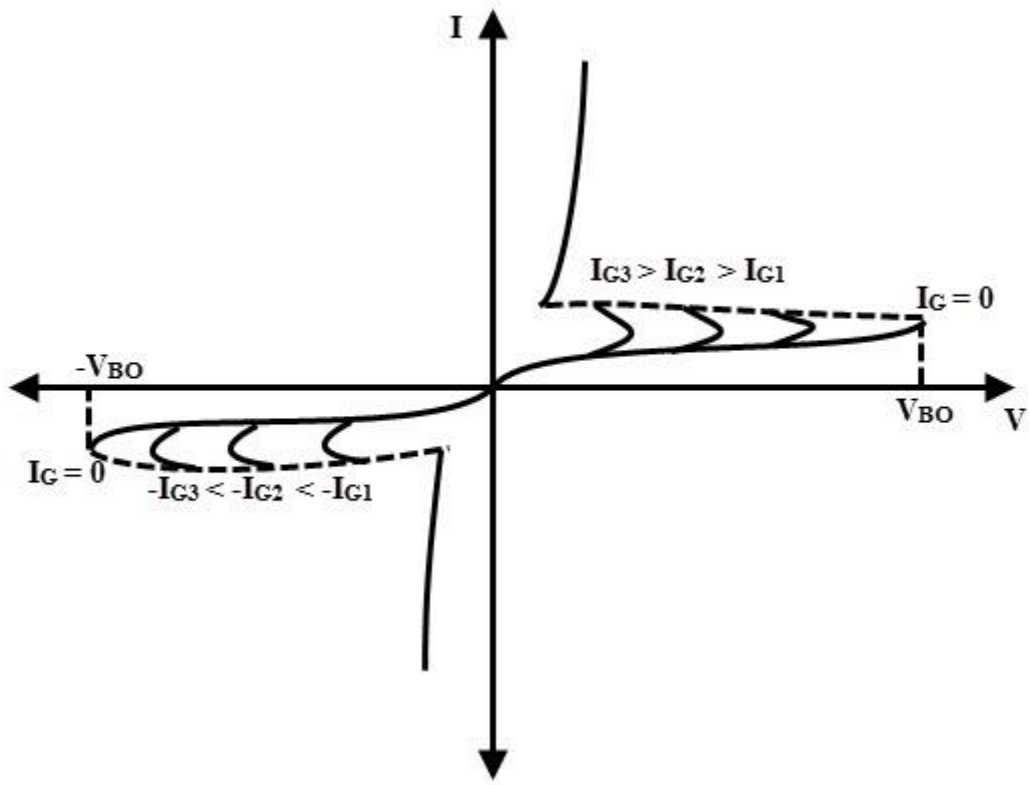

Figure:2.5.3 characteristics of TRIAC

Similarly, when the terminal MT2 is made negative with respect to MT1, the traic is in reverse blocking mode. A small leakage current flows through the device until it is triggered by breakover voltage or gate triggering method. Hence the positive or negative pulse to the gate triggers the triac in both directions.

The supply voltage at which the triac starts conducting depends on the gate current. If the gate is current is being greater, lesser will be the supply voltage at which the triac is turned ON. Above discussed mode -1 triggering is used in the first quadrant whereas mode-3 triggering is used in 3rd quadrant.

Due to the internal structure of the triac, the actual values of latching current, gate trigger current and holding current may be slightly different in different operating modes. Therefore, the ratings of the traics considerably lower than the thyristors.

Advantages

Triac can be triggered by both positive and negative polarity voltages applied at the gate.

- It can operate and switch both half cycles of an AC waveform.
- As compared with the anti-parallel thyristor configuration which requires two heat sinks of slightly smaller size, a triac needs a single heat sink of slightly larger size. Hence the triac saves both space and cost in AC power applications.
- In DC applications, SCRs are required to be connected with a parallel diode to protect against reverse voltage. But the triac may work without a diode, a safe breakdown is possible in either direction.

Disadvantages

- These are available in lower ratings as compared with thyristors.
- A careful consideration is required while selecting a gate trigger circuit since a triac can be triggered in both forward and reverse biased conditions.
- These have low dv/dt rating as compared with thyristors.
- These have very small switching frequencies.
- Triacs are less reliable than thyristors.

Applications

Due to the bidirectional control of AC, triacs are used as AC power controllers, fan controllers, heater controllers, triggering devices for SCRs, three position static switch, light dimmers, etc

2.6 RELAY:

Features

Works on 5V 240V Appliances can be controlled from a ARM Processor with a 5V signal .High power loads which cannot be directly controled from ARM Processors can be switched on/off with this relay module. Loads like 12V DC Motors, Solenoids, LEDs, etc can be controlled with this module. Relay board uses high quality relays with a maximum load of 7A/240 V AC or 7A/24V DC Board comes with connectors for easy connections to both the ARM Processor and the load The board uses high quality relays, which can handle a maximum of 7A/240 V AC or 7A/24V DC. Each relay has all three connections - Common, Normally Open, Normally Closed brought out to 3 pin screw terminals which makes it easy to make and remove connections. The board has a power indication and a relay status LED to ease debugging. The board requires a 5V to power supply to power the relay. The relay can then be turned on and off with 5V HIGH Signal from a ARM Processor. Power input and relay control signals are brought to header pins on the board. Hence, the board can be easily interface with our Arduino and development boards using our female to female jumper wires. The relay takes advantage of the fact that when electricity flows through a coil, it becomes an electromagnet. The electromagnetic coil attracts a steel plate, which is attached to a switch. So the switch's motion (ON and OFF) is controlled by the current flowing to the coil, or not, respectively.

A very useful feature of a relay is that it can be used to electrically isolate different parts of a circuit. It will allow a low voltage circuit (e.g. 5VDC) to switch the power in a high voltage circuit (e.g. 100 VAC or more) as shown in figure 2.6.1

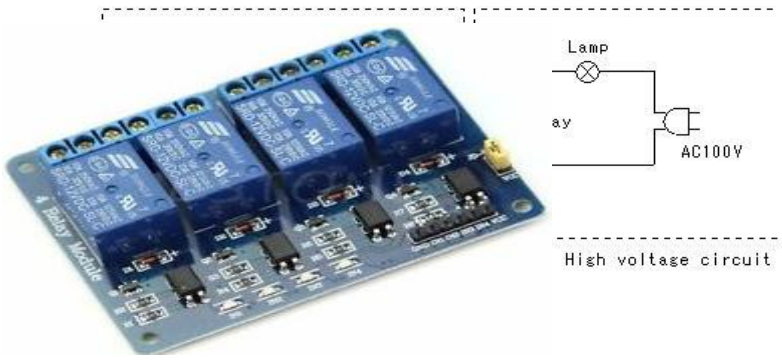

Fig.2.6.1. Electromagnetic Relay

There are many kind of relays. You can select one according to your needs. The various things to consider when selecting a relay are its size, voltage and current capacity of the contact points, drive voltage, impedance, number of contacts, resistance of the contacts, etc. The resistance voltage of the contacts is the maximum voltage that can be conducted at the point of contact in the switch. When the maximum is exceeded, the contacts will spark and melt, sometimes fusing together. The relay will fail. The value is printed on the relay.

System Design:

Relay Driver Circuit In relay driver circuit there are transistors, diodes and the relays. Relay driver circuit is used to control the light. This block can drive the various controlled devices. We are using +12V dc relay. As µC cannot drive relay directly so output signal from microcontroller is passed to the base of the transistor, which activates the particular relay so that it can select particular device to operate. Relays can control the charge flowing to the load. Load may be and AC device such as light, fan, Bulb etc.

Load Relays control the flow of charge to the load. In this project we have used four bulbs of 10 Watt each as a load. But we can use any electronic object like tubelight, CFL, fans, cooler etc in place of bulbs.

Working:

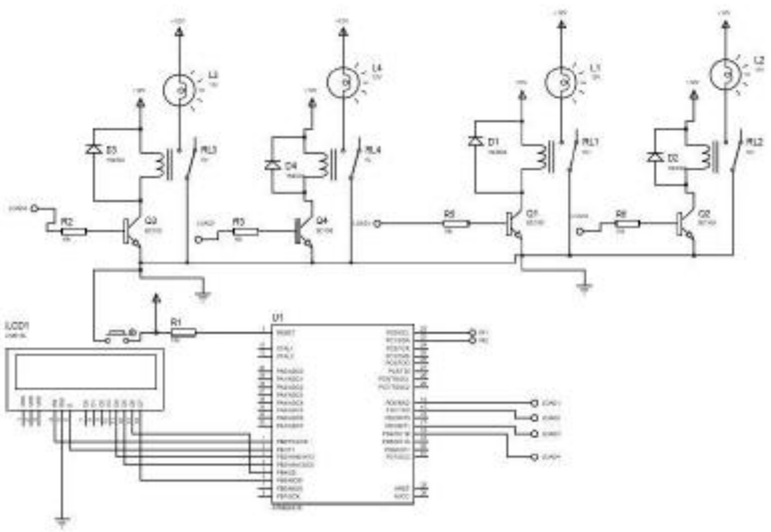

Figure.2.6.2: Circuit Diagram of realy

As shown in figure 2.6.2 In this setup IR sensors transmit 40 kHz IR signal to receiver. The µController continuously monitors the signal transmitted by IR sensors.IR1 is connected to PortC.6 and IR2 is connected to PortC.7 of µC . Initially we kept PC6=1 and PC7=1.When any object passes from entry sensor a signal is generated and output of IR sensor gives low trigger to µC pin PC6 then the counter on display will be incremented by one. When any object passes from exit sensor a signal is generated and output of IR sensor gives low trigger to µC pin PC7 then the counter on display will be decremented by one. When there is nobody in a Street counter displays „00‟ then relays are OFF & lights are OFF.

2.7 Liquid crystal display (LCD):

As shown in the figure 2.7.1 shows about Liquid Crystal Display

Figure.2.7.1. Liquid Crystal Display

Vcc, at pin 16 controls the background contrast.

· Vcc, at pin 2 controls the display contrast.

· Pin 7 - 14 gets input data.

· Pin 1 and pin 3 controls the brightness of the display.

· Pin 5, gets a read/write signal.

· Pin 6, enable signal.

· Pin 4, data register select as shown in figure 2.7.2.

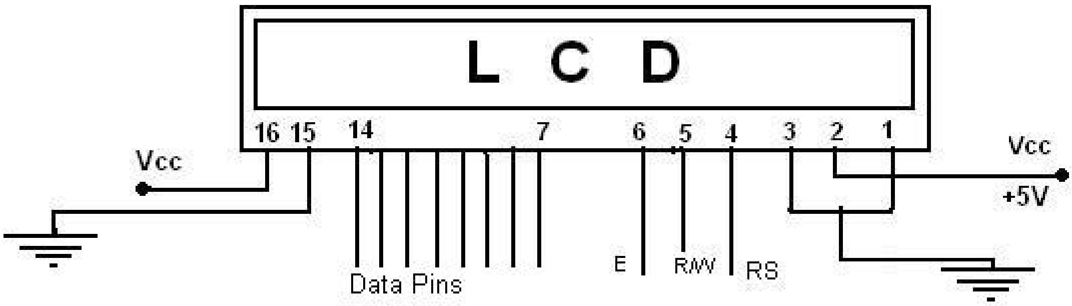

Figure: 2.7.2 pin diagram of LCD

Interfacing Example - 16 Character x 2 Line LCD

Description:

This is the first interfacing example for the Parallel Port. We will start with something simple. This example doesn't use the Bi-directional feature found on newer ports, thus it should work with most, if no all Parallel Ports. It however doesn't show the use of the Status Port as an input. So what are we interfacing? A 16 Character x 2 Line LCD Module to the Parallel Port. These LCD Modules are very common these days, and are quite simple to work with, as all the logic required running them is on board.

Schematic:

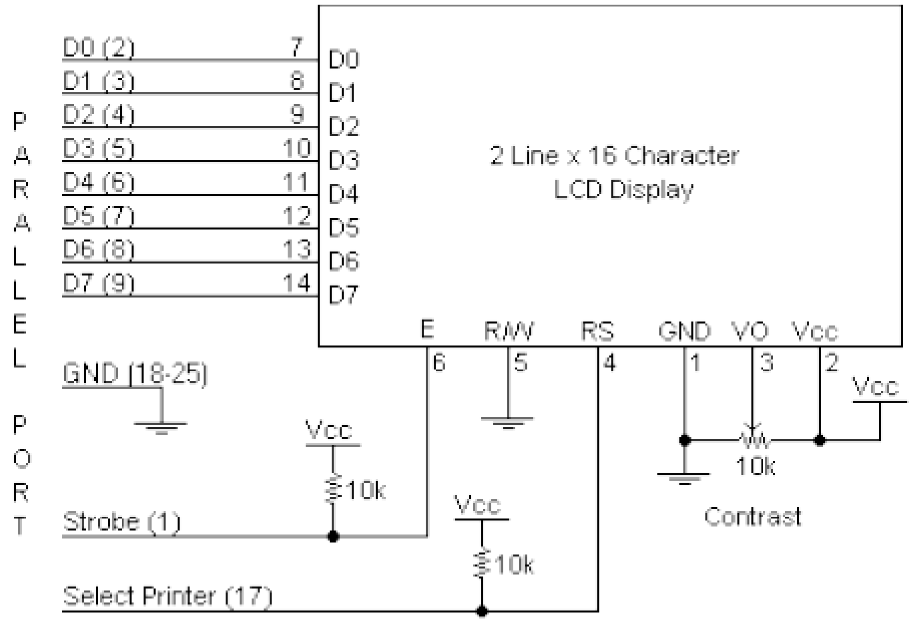

Figure: 2.7.3 schematic diagram of LCD

Circuit Description:

As shown in figure 2.7.3 the LCD panel's Enable and Register Select is connected to the Control Port. The Control Port is an open collector / open drain output. While most Parallel Ports have internal pull-up resistors, there are a few which don't. Therefore by incorporating the two 10K external pull up resistors, the circuit is more portable for a wider range of computers, some of which may have no internal pull up resistors. We make no effort to place the Data bus into reverse direction. Therefore we hard wire the R/W line of the LCD panel, into write mode. This will cause no bus conflicts on the data lines. As a result we cannot read back the LCD's internal Busy Flag which tells us if the LCD has accepted and finished processing the last instruction. This problem is overcome by inserting known delays into our program.

The 10k Potentiometer controls the contrast of the LCD panel. Nothing fancy here. As with all the examples, I've left the power supply out. You can use a bench power supply set to 5v or use a onboard +5 regulator. Remember a few de-coupling capacitors, especially if you have trouble with the circuit working properly. The 2 line x 16 character LCD modules are available from a wide range of manufacturers and should all be compatible with the HD44780. The one I used to test this circuit was a Power trip PC- 1602F and an old Philips LTN211F-10 which was extracted from a Poker Machine! The diagram to the right shows the pin numbers for these devices. When viewed from the front, the left pin is pin 14 and the right pin is pin

The LCD panel requires a few instructions to be sent, to order to turn on the display and initialize it. This is what the first for loop does. These instructions must be sent to the LCD's Instruction Register which is controlled by the Register Select (Pin 4). When pin 4 is low the instruction register is selected, thus when high the data register must be selected. We connect this to the Parallel Port's Select Printer line which happens to be hardware inverted. Therefore if we write a '1' to bit 3 of the Control Register the Select Printer line goes low. We want to first send instructions to the LCD module. Therefore the Register Select line must be low. As it is hardware inverted, we will want to set bit 3 of the Control Register to '1'. However we don't want to upset any other bits on the Control Port. We achieve this by reading the Control Port and Oaring 0x80 to it. E.g. out port (CONTROL, in port b (CONTROL) | 0x08);
this will only set bit 3. After we place a data byte on the data lines, we must then signal to the LCD module to read the data. This is done using the Enable line. Data is clocked into the LCD module on the high to low transition. The Strobe is hardware inverted, thus by setting bit 0 of the Control Register we get a high to low transition on the Strobe line. We then wait for a delay, and return the line to a high state ready for the next byte. After we initialize the LCD Module, we want to send text to it. Characters are sent to the LCD's Data Port, thus we want to clear bit 3. Once again we must only change the one bit, thus we use out port b (CONTROL, in port b(CONTROL) & 0xF7);. Then we set up another for loop to read a byte
from the string and send it to the LCD panel. This is repeated for the length of the string. The delays should be suitable for most machines. If the LCD panel is not initializing properly, you can try increasing the delays. Likewise if the panel is skipping characters, e.g. Test, 2. On the other hand, if the LCD module is repeating characters e.g. testing then you may have a faulting Enable connection. Check your Enable to Strobe connection.

2.8 Potential Transformer:

A transformer is a static electrical device that transfers energy by inductive coupling between its winding circuits. A varying current in the primary winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic flux through the secondary winding. This varying magnetic flux induces a varying electromotive force (emf) or voltage in the secondary winding. A transformer whose output voltage is lower than it’s input voltage. A secondary winding of such a transformer has fewer turns than the primary. Such a transformer may have multiple secondary windings. It used, for instance, to decrease the voltage of electricity as it leaves the transmission system and enters the distribution system. The output voltage of a step-up transformer is higher than its input voltage. Also spelled step down transformer.

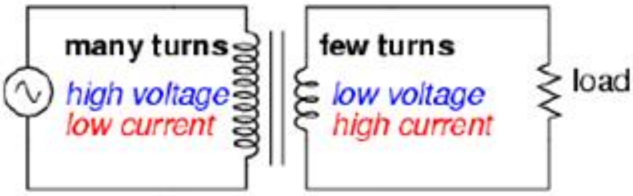

Figure.2.8.1. Potential transformer

As shown in figure 2.8.1 this is a step-down transformer, as evidenced by the high turn count of the primary winding and the low turn count of the secondary. As a step-down unit, this transformer converts high-voltage, low-current power into low-voltage, high-current power. The larger-gauge wire used in the secondary winding is necessary due to the increase in current. The primary winding, which doesn't have to conduct as much current, may be made of smaller-gauge wire.

Transformers are often constructed in such a way that it is not obvious which wires lead to the primary winding and which lead to the secondary. One convention used in the electric power industry to help alleviate confusion is the use of “H” designations for the higher-voltage winding and “X” designations for the lower-voltage winding.

Therefore, a simple power transformer will have wires labeled “H1”, “H2”, “X1”, and “X2” . There is usually significance to the numbering of the wires, which we'll explore a little later in this chapter. The fact that voltage and current get “stepped” in opposite directions (one up, the other down) makes perfect sense when you recall that power is equal to voltage times current, and realize that transformers cannot produce power, only convert it. Any device that could output more power than it took in would violate the Law of Energy Conservation in physics, namely that energy cannot be created or destroyed, only converted.

Working principle of a transformer:

- As shown in figure 2.8.2 a transformer is static (or stationary) piece of apparatus which:

1.Transfers electric power from one circuit to another.

2.It does so without a change in frequency.

3.The principle is based on mutual induction between two circuits linked by a common magnetic flux.

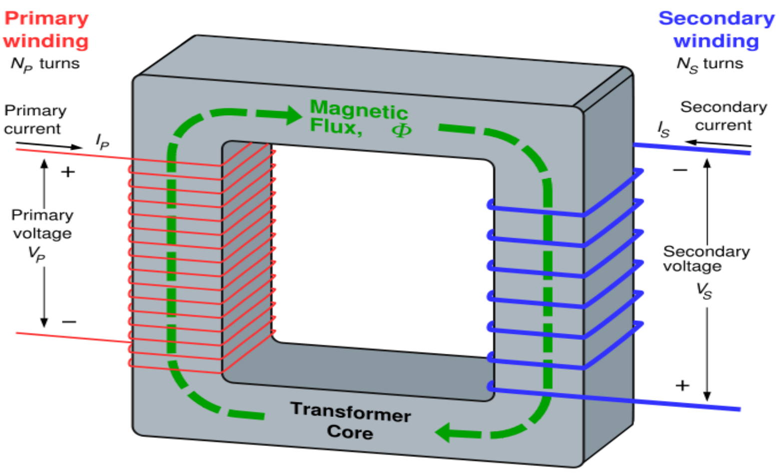

Figure 2.8.2. schematic daigram

- Basically a transformer consists o f a :

1.A primary coil or winding.

2.A secondary coil or winding.

3.A core that supports the coils or the windings

2.9 REACTOR:

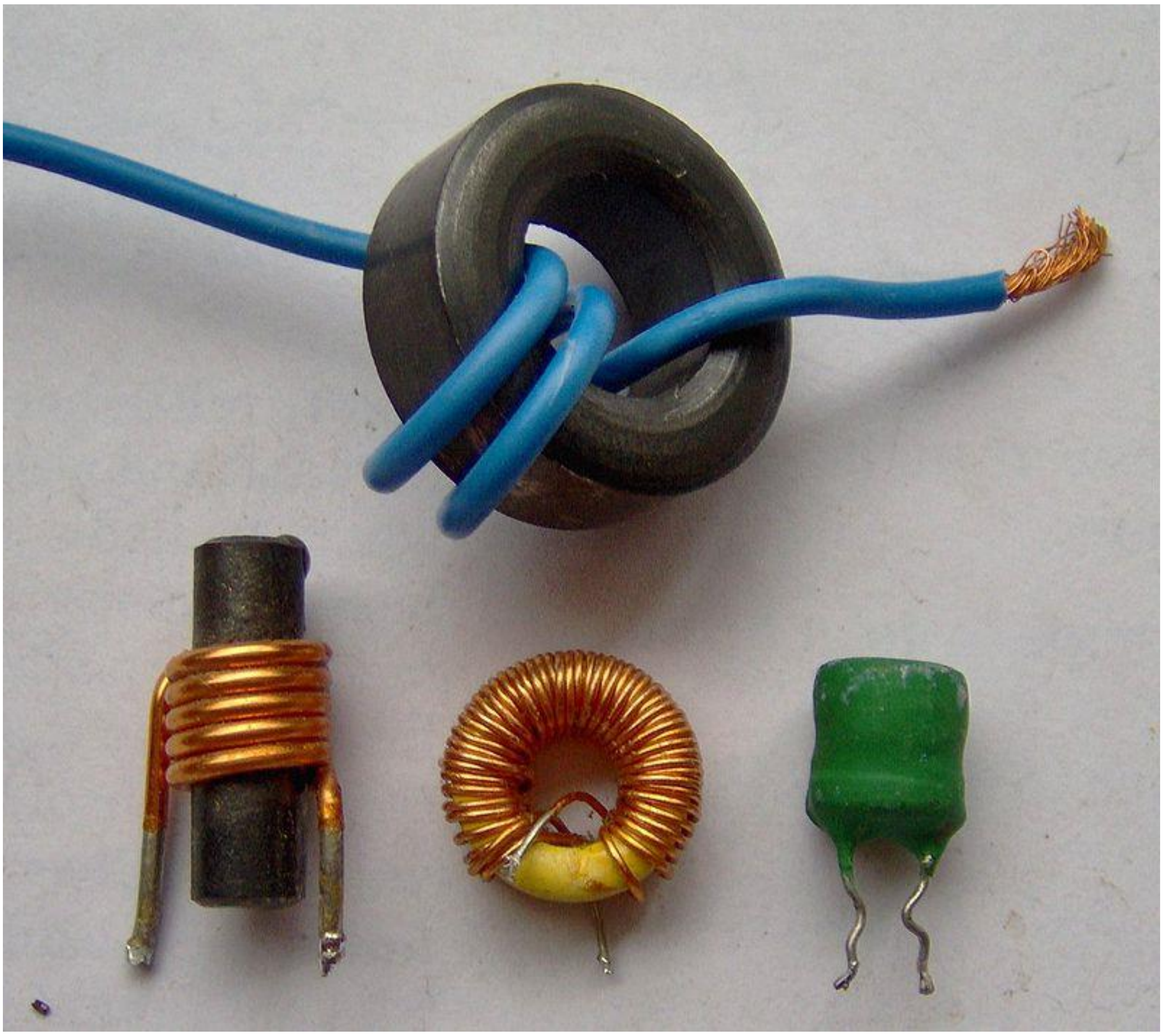

Figure 2.9.1 inductors

As shown in figure 2.9.1 an **inductor**, also called a **coil**, **choke**, or **reactor**, is a passive two-terminal electrical component that stores energy in a magnetic field when electric current flows through it.[1] An inductor typically consists of an insulated wire wound into a coil.

CHAPTER-3

CHAPTER-3

CIRCUIT DESIGN & HARDWARE DESCRIPTION

3.1 CIRCUIT DESIGN:

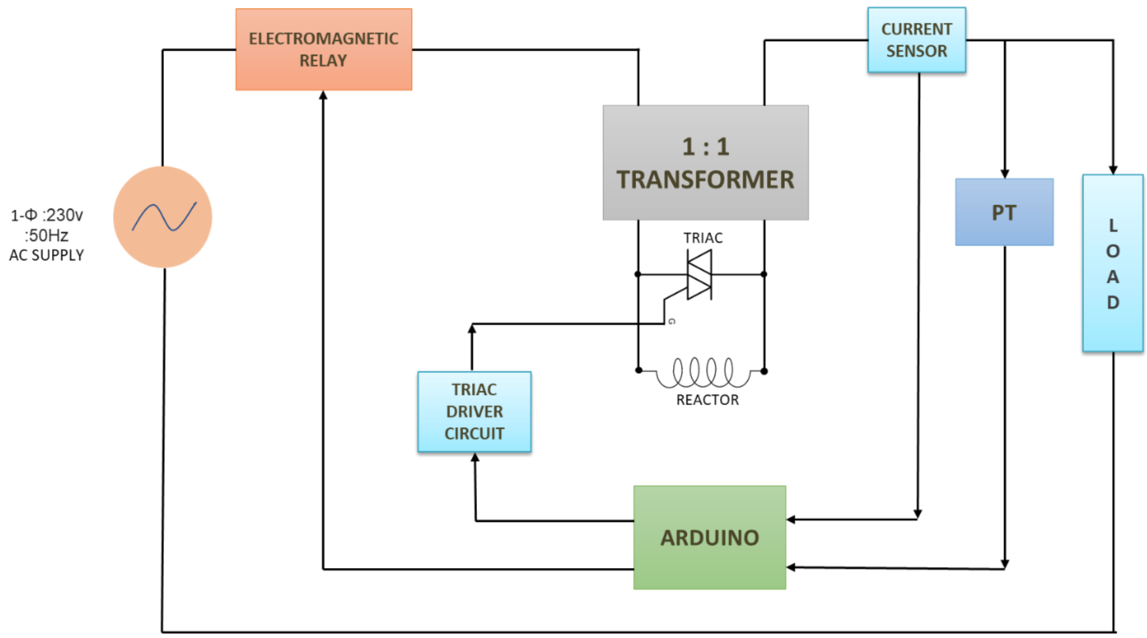

Figure 3.1.1 circuit diagram

As shown in figure 3.1.1 This paper related to fault current limitation in radial distribution of network. In order to control fault current, primary winding of an isolation transformer is connected in series with phase line and secondary winding is connected to inductive coil (reactor), which is connected in parallel with a bypass switch i.e TRIAC. This system can improve the power quality of power system. This system also gives un- interrupted power supply. The magnitude of the current is reduced due to reactor connected in secondary winding. Because of simple structure cost is very low. This system is designed for single phase 230 volts, 50Hz ac supply.

3.2 HAEDWARE DESCRIPTION:

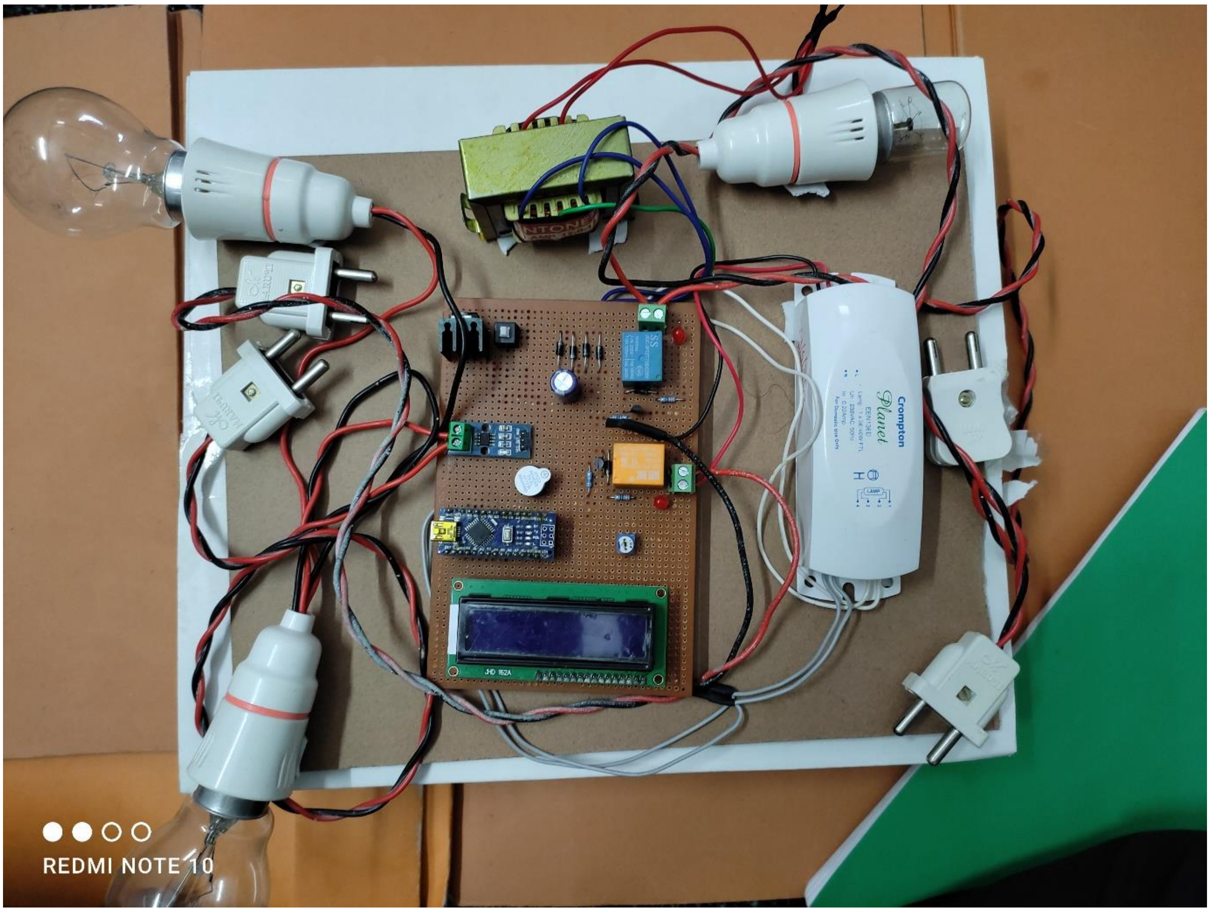

Figure 3.2.1 operating circuit

As shown in figure 3.2.1 operating circuit of fault current limitation by using series transformer .This is related to fault current limitation in radial distribution of network. In order to control fault current, primary winding of an isolation transformer is connected in series with phase line and secondary winding is connected to inductive coil (reactor), which is connected in parallel with a bypass switch i.e TRIAC. This system can improve the power quality of power system. This system also gives un- interrupted power supply. The magnitude of the current is reduced due to reactor connected in secondary winding. Because of simple structure cost is very low. This system is designed for single phase 230 volts, 50Hz ac supply.

In Normal Mode: - The line or load current flows through primary winding and secondary winding is shirt circuited. The primary winding is continuously in operation. In normal mode safe current range is 1 Amp.

In Abnormal Mode: - The primary winding can carry line or load current but secondary winding is connected to Reactor with opening TRIAC switch to limit magnitude of fault current to greater level.

When current greater than 1 Amp system goes to faulty mode. Transformer Secondary side reactor added to circuit & fault current chopped. If fault current greater than 60 Seconds then gives signal through relay by glowing lamp.

In order to control the fault current, primary winding of an isolating transformer is connected in series with the line and the secondary side is connected to a reactor, paralleled with a bypass switch which is made of anti-parallel TRIAC. By controlling the magnitude of ac reactor current, the fault current is reduced and voltage of the terminal point is kept at a reference level (230 volts). Also, by this switching overvoltage is reduced significantly.

It can improve the power quality and also, due to its simple construction, the cost is very low. This system limits the fault current without negligible delay, smooth the fault current waveform, and improve the power quality.

CHAPTER-4

CHAPTER-4

APPLICATIONS AND ADVANTAGES

4.1 ADVANTAGES:

The Fault current limitation by using series transformer is useful for the consumers who are suffering from the continuous interruption of power supply. Chopping of large fault current

Avoid continuous interruption of supply

Safe and reliable operation

Improve power quality

Lower in cost

4.2 APPLICATIONS:

It is used in radial distribution network
It is used in distribution networks
It is used in medium voltage power distribution network
It is used for realiable opration.
It is used for nearer the power generating stations.
It is used in power transmission lines.

CHAPTER-5

CHAPTER-5

FUTURE SCOPE, RESULT AND CONCLUSION

5.1 RESULT:

The practical implementation of fault current limitation by using series transformer as shown in figure 5.1.The hardware is designed and the operation has been done based upon the program written in the Arduino for fault current limitation by using series transformer.

Condition	Normal	Abnormal
Initial current value	<1 Amp	>1.0 Amp
Current value after reactor chopping	------	0.9 Amp

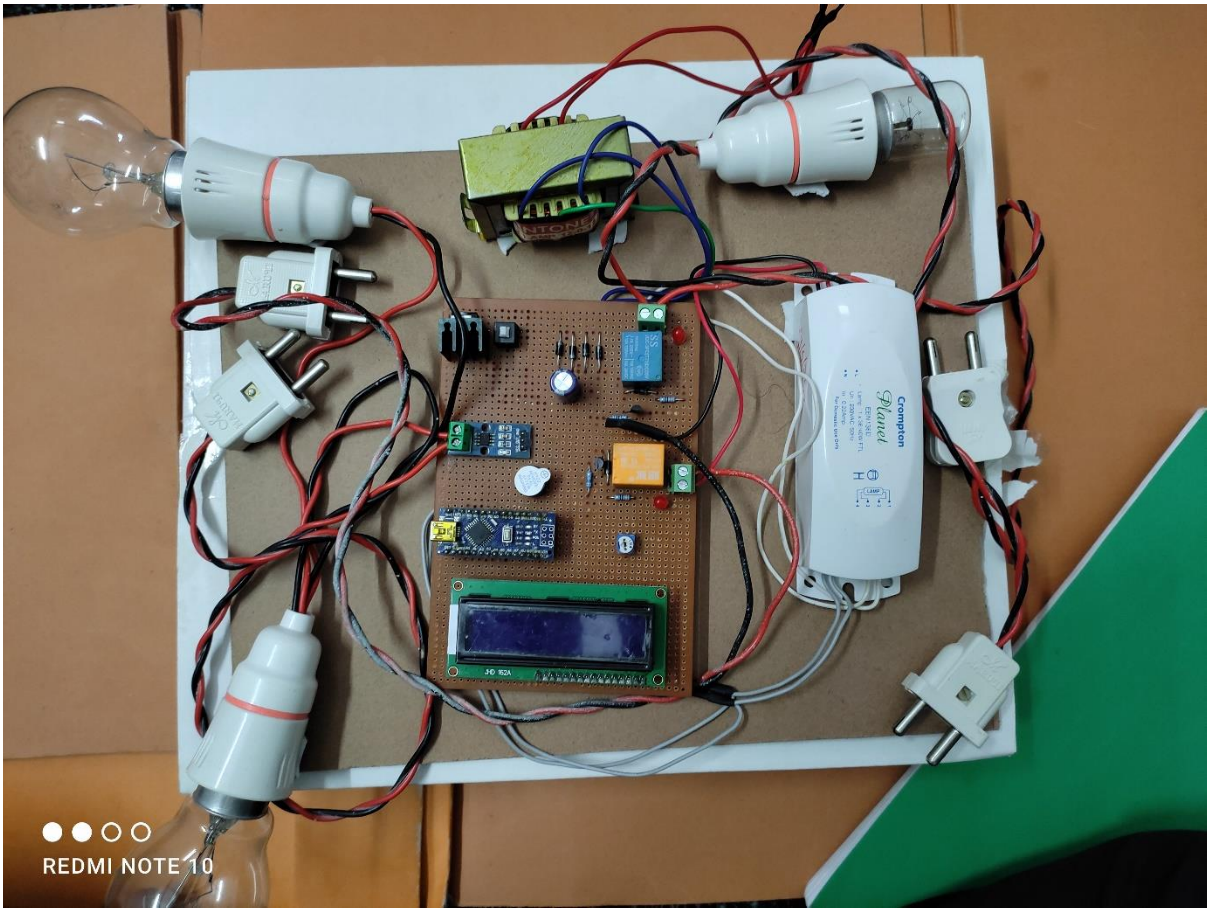

Figure 5.1.1 operating circuit

As figure shown 5.1.1 operating circuit of hardware circuit

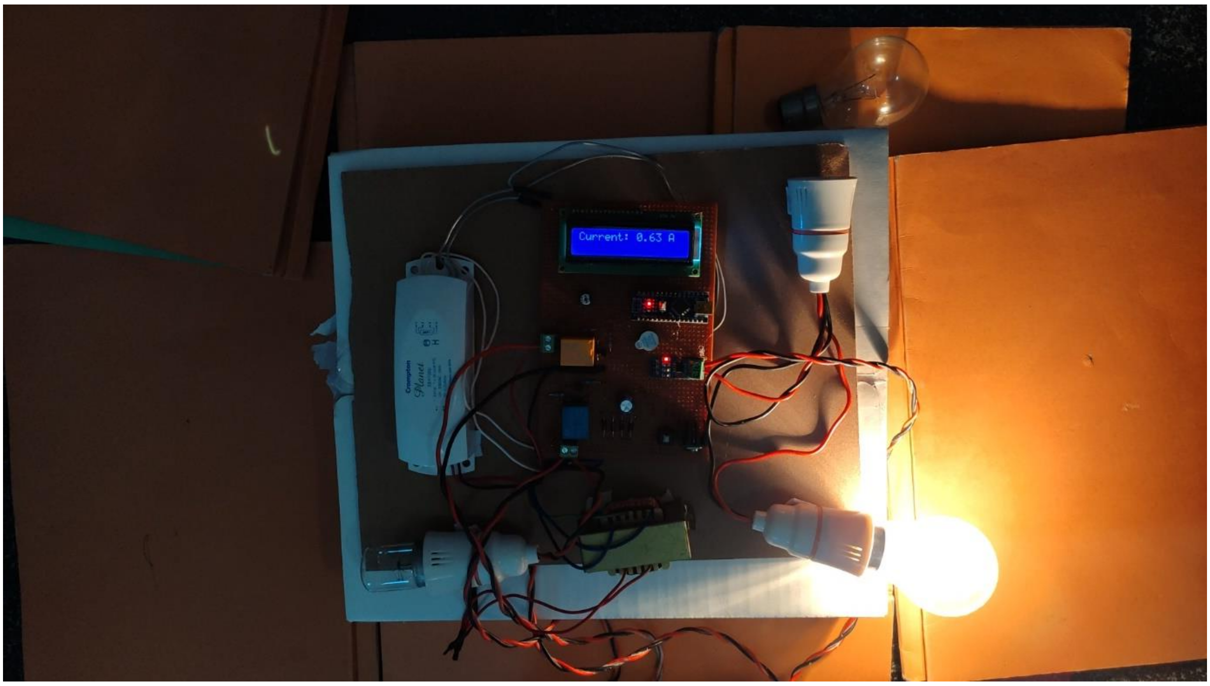

Figure 5.1.2 operating circuit under normal condition

As shown in figure 5.1.2 operating circuit under normal condition

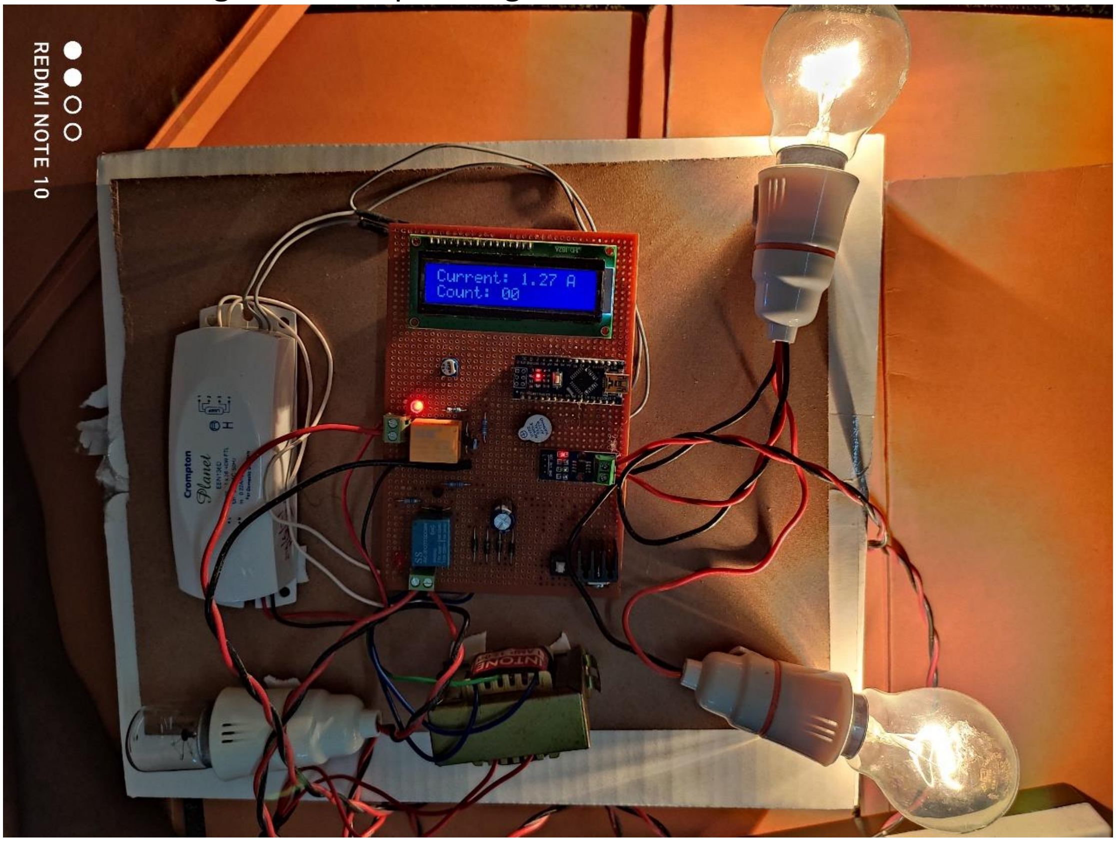

Figure 5.1.3 operating circuit under abnormal condition

As shown in figure 5.1.3 operating circuit under abnormal condition

5.2 CONCLUSION:

The main advantages of the proposed Fault Current Limitation by using series transformer is chopping of larger fault current magnitude, mitigate voltage sag. This system is useful in radial distribution network application.

Due to expansion of power system networks complexity in the system is increased. So temporary faults in the system are increasing nowadays. Consumers are suffering from continuous interruption of supply. Transient faults having larger magnitude that may damage protective equipments which are costlier .Fault current limitation by using series transformer has lower losses than series reactor based technology. This system can reduces voltage sag in supply voltage, also improve power quality. This system can remove fault current without interrupting supply lines. A 1:1 ratio isolation transformer has primary winding is continuously connected in series with phase line. The secondary winding is connected to reactor in parallel with TRIAC. The system is designed for single phase

5.3 FUTURE SCOPE:

Fault current limiter can quickly limit the short circuit current and ensure the safety and operation stability of the system. This is a potential short-circuit current limited technique. There are various classes of Fault Current Limiter(FCL), this paper presents the research mainly based on high-voltage current-limiting fuses and Fault current limiter for rapid isolating. Because the simulation model of the fuse is not provided in the current mainstream power system simulation software, a new fuse modeling method based on the software of PSCAD-EMTDC and ANSYS is proposed after much documents having been referenced, then fault current limiter model is established according to this method. This model is applied to the nonlinear circuit simulation system which is used for the simulation analysis of on-off overvoltage about FCL. The simulation results are similar with the actual experimental results, it sufficiently shows the accuracy of this method for on-off process by simulated fault current limiter.

The interaction between wind turbines and grid results in increasing short-circuit level and fault ride-through (FRT) capability problem during fault condition. In this paper, the bridge-type fault current limiter (FCL) with discharging resistor is used for solving these problems. For this FCL, a control scheme is proposed, which uses the dc reactor current as control variable, to adjust the terminal voltage of induction generator (IG) without measuring any parameters of system. In this paper, the wind energy conversion system (WECS) is a fixed-speed system equipped with a squirrel-cage IG. The drivetrain is represented by a two-mass model. The analytical and simulation studies of the bridge-type FCL and proposed control scheme for limiting the fault current and improving FRT capability are presented and compared with the impact of the application of the series dynamic braking resistor (SDBR).

High demand for sustainable electric energy makes the use of Distributed Generators (DGs) inevitable for future systems. However, introducing DGs into distribution networks increases fault current levels with potential for causing serious damage to power system apparatus. Increasingly, power quality during fault and recovery periods is also adversely affected. To alleviate these problems, a Static Fault Current Limiter (SFCL) is investigated in this work as a potential solution. The studied SFCL comprises a bridge rectifier with semiconductor switch IGBT bypassed by limiting inductor and ZnO Varistor. A case study of a 15-kV radial distribution system with SFCL located at the source end is simulated using EMTP-RV software. Simulation results following system faults show that the use of FCL in distribution networks can efficiently suppress fault current magnitudes and enhance the power quality in terms of voltage sag.

CHAPTER-6

CHAPTER-6

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CHAPTER-7

CHAPTER-7

APPENDIX

Program is developed on embedded c language.The program is written below

PROGRAM:

```
include the library code:
#include <LiquidCrystal.h> //library for LCD
// initialize the library with the numbers of the interface pins
const int rs = 2, en = 3, d4 = 4, d5 = 5, d6 = 6, d7 = 7;
//Measuring Current Using ACS712
const int VIN = A0; // define the Arduino pin A0
#include <Robojax_AllegroACS_Current_Sensor.h>

Robojax_AllegroACS_Current_Sensor robojax(MODEL, VIN);

int count = 60;
const int buzzer = 8;

#define inductorRelay 11
#define faultRelay 10

void setup() {
 //baud rate
 Serial.begin(9600);//baud rate at which arduino communicates with Laptop/PC
 // set up the LCD's number of columns and rows:

 pinMode(inductorRelay, OUTPUT);
```

```
  pinMode(faultRelay, OUTPUT);
  digitalWrite(faultRelay, LOW);

  // Print a message to the LCD.
  lcd.setCursor(0, 0);
  lcd.print("FAULT CURRENT");
  lcd.setCursor(0, 1);
  lcd.print("DETECTION SYSTEM");
  delay(2000);//delay for 2 sec
}

void loop() //method to run the source code repeatedly
{
  float currValue = robojax.getCurrentAverage(300);

  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Current: ");
  lcd.setCursor(9, 0);
  lcd.print(currValue);
  lcd.setCursor(14, 0);
  lcd.print("A");
  delay(1000);

    currValue = currValue + 0.5;
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Current: ");
```

```
lcd.setCursor(9, 0);
lcd.print(currValue);
lcd.setCursor(14, 0);
lcd.print("A");
digitalWrite(faultRelay, LOW);
digitalWrite(inductorRelay, LOW);
digitalWrite(buzzer, LOW);
delay(1000);



currValue = currValue + 1;
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Current: ");
lcd.setCursor(9, 0);
lcd.print(currValue);
lcd.setCursor(14, 0);
lcd.print("A");
digitalWrite(inductorRelay, HIGH);
for (count = 60; count <= 60; )
{
  lcd.setCursor(0, 1);
  lcd.print("Count: ");
  lcd.setCursor(7, 1);
  lcd.print(count);
  delay(1000);
}
```

```
digitalWrite(faultRelay, HIGH);
digitalWrite(buzzer, HIGH);
lcd.clear();
lcd.setCursor(2, 0);
lcd.print("Fault Current");


delay(3000);
digitalWrite(faultRelay, LOW);
digitalWrite(buzzer, LOW);
}
```