ARDUINO BASED POWER SAVING IN INDUSTRIAL LOADS

A PROJECT REPORT

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BONAFIDE CERTIFICATE

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ARDUINO BASED POWER SAVING IN INDUSTRIAL LOADS

Abstract:

Power quality is gaining a lot of interest lately by researchers and engineers as electricity is a vital part of our daily life. The aim of this paper is to survey some of the recent existing systems, techniques and methods that are being used to monitor power quality. The survey focuses mainly on power quality monitoring systems which are composed of various tools, software, communication links etc. that work together as one coherent system. Another goal is to develop an understanding about the quality management in the area of power industry. Some of the methods and techniques that are presented discuss about power quality meter placement techniques. Finding the best locations to place the power quality monitors in the electrical grid is done by developing algorithms and approaches to find the appropriate number of monitors and the appropriate locations to place them in order to reduce the cost of the PQM system and increase its efficiency. The paper discusses the basic idea of each method or system in order to have an understanding about its importance and role. Then, a simple comparison is made between the techniques in terms of their advantages and disadvantages. After that, international industry practices and guidelines for power quality monitoring and management are discussed. Lastly, some examples for the efforts that are made in the area of power quality improvement are discussed.

CHAPTER 1

1.1 INTRODUCTION:

- The input power may get disturbed due to various factors.
- Here in our project,we monitor the voltage level,frequency and transients occur in the power system.
- The corresponding disturbance and time of occurrence are recorded in our system.
- ower Quality Monitoring (PQM) has many benefits, such as improving performance and quality. A PQM System will gather, analyze, and interpret raw electricity measurement data into useful information. A typical monitoring system measures voltage and electrical current, but ground quality may also be measured if unbalanced loads or harmonics are detected.
- There are a number of reasons to employ power quality monitoring. It allows plants to perform energy management, preventive maintenance, quality control, and saves money. Today, many end users have sensitive telecommunication or computer equipment that don't utilize PQM. This makes them vulnerable to power quality issues. Also, today's customers understand the consequences of power fluctuations and expect a higher level of service. Currently, it is estimated that power outages account for up to 40 percent of all business downtime.
- To monitor their power, modern power plants use digital fault recorders, smart relays, voltage recorders, in-plant power monitors, and special-purpose power quality equipment. A digital fault recorder activates on fault events and records the current waveforms and voltage that caused the problem. It can also capture periodic waveforms helpful in calculating

harmonic distortion levels. Smart relays check the power current and record disturbances. A variety of voltage recorders are used to monitor variations that are on the system. A voltage recorder detects a trend and gives minimum, maximum, and average voltage every two seconds. In-plant power monitors, usually at the service entrance, capture wave shape for evaluation of harmonic distortion levels or voltage sag conditions. Special-purpose power quality monitors are able to simultaneous watch voltage and current.

- In short, Power Quality Monitoring System monitors the quality of voltage and current produced by a power plant. It's employed to decrease plant and customer downtime, and optimize the quality of electricity delivered. A good system will also improve the performance, efficiency, and longevity of power generating equipment.

CHAPTER 2

2.1 LITRATURE RIVIEW

2.1.1 Review of the Power Quality Monitoring Systems in Electrical Networks

Power quality is gaining a lot of interest lately by researchers and engineers as electricity is a vital part of our daily life. The aim of this paper is to survey some of the recent existing systems, techniques and methods that are being used to monitor power quality. The survey focuses mainly on power quality monitoring systems which are composed of various tools, software, communication links etc. that work together as one coherent system. In addition, some of the methods and techniques that are presented discuss about power quality meter placement techniques. Finding the best locations to place the power quality monitors in the electrical grid is done by developing algorithms and approaches to find the appropriate number of monitors and the appropriate locations to place them in order to reduce the cost of the PQM system and increase its efficiency. The paper starts by discussing the basic idea of each method or system in order to have an understanding about its importance and role. Then, a simple comparison is made between the techniques in terms of their advantages and disadvantages. After that, international industry practices and guidelines for power quality monitoring are discussed. Lastly, some examples for the efforts that are made in the area of power quality improvement are discussed. Monitoring power quality is important because of the increasing complexity and size of electrical networks. Regulating authorities and power suppliers around the world usually monitor the amount of power that is being delivered to the end users by placing meters at different points in the power grid. These meters measure different parameters such as voltage, current, frequency, etc. Analyzing power quality is very important for the economy as the electronic

equipment are somewhat sensitive to power supply events, therefore these parameters must be maintained at acceptable levels that will not cause any damages to the electronic devices at the user's side. Monitoring devices and different electronic equipment are being used for power monitoring and control. The monitoring devices enable the engineers and the network operators to analyze the network for certain quality attributes that can have major effects on the system. Some of this quality attributes or characters include the frequency, supply voltage variation, Rapid voltage change (flicker), Supply voltage unbalance, harmonic and inter-harmonic voltage, main signaling voltage, voltage dips/ swells, interruptions on the supply voltage and transient over voltage. The most common attributes that affect the power quality are the voltage variation (flicker, dip/swell, etc.) and harmonics. Harmonics are mostly caused due to the presence of non-linear loads. Those harmonics can affect the electrical devices by generating heat which might damage those electrical devices. There are many standards and classifications for the harmonics levels in distribution systems as specified in different standards such as IEC 1000-3-2, IEEE-519 and IEC 61000-4-30 Class A [23]. The monitoring systems help the engineers and operators to detected the previously mentioned power quality attributes and identify their causes. The monitoring process could be an online monitoring process whereby the system will is monitored continuously for any interference or failure that might occur. Then there could be an alarm indicator for the system operator to take the required action. It could also be a long-term monitoring process whereby the measurements of the various quality characteristics and attributes are being stored into databases for generating periodic reports that will help in improving the overall system, make future enhancements or take prevention actions. Normally, the size of the electrical distribution grid is large, therefore it could be expensive and inefficient to place monitors in every single bus or point in the network, therefore, the system must be analyzed properly

to identify the common points that will give similar readings. This is done by developing different algorithms, techniques and software that will help in making the process easier. Placing the monitors smartly in the network also helps in reducing the cost of the power quality monitoring system. The figure below shows the overall electrical network with meters placed at various points in order to monitor the power [24]. One of the targets in quality is to achieve customer satisfaction. This is done by ensuring that the customer's needs and requirements are met. For that, it is important to understand about the type of end users (industrial, residential, etc.) in the network in order to supply power levels that match their needs. The interest in the area of power quality is driven mostly by the customers' complaints; therefore many efforts are being made to ensure that good power quality exists at all times. In the work presented by V. Becirovic et al. [20], a classification of end users was presented according to the current waveform and the type power that they use. The customers were classified into three main categories P, PQ and PQD. The P category customers use active power only while the PQ customers use both active and reactive power. The last category which is PQD is special for having high level of 5 harmonics in the current waveform along with having inductive and capacitive character. The main advantage of this classification was to make analysis on the overall system when two or more customers of the same group are having the same interference or problem. The proposed model is voltage dependent in such a way that the effect of voltage change is observed for every current waveform. The only drawback of the model proposed by Becirovic et al. is that it works only for the specified three groups of customers and any change in the classification requires re-identification [20]. Di

CHAPTER 3

3.1 Existing System:

Technology Based on Wireless Communication Wireless communication is a type of data communication that is performed and delivered wirelessly. This is a broad term that incorporates all procedures and forms of connecting and communicating between two or more devices using a wireless signal through wireless communication technologies and devices. From the previous work there are several types of technology that have been used for wireless battery monitoring system such as GSM, ZigBee, GPRS, Android, WIFI and Bluetooth communication. GSM (Global system for Mobile Communication) is a type of wireless communication that are very popular worldwide. Its frequency band is either 900MHz or 1800MHz. There are some advantages and disadvantages for the GSM module. An advantage of GSM is that it has no problem with international roaming. It is also easy to be implemented and the global subscribers create much better in network effect for GSM handset maker's carrier 506 International Journal of Engineering & Technology and users. But note that, most of the technology are patented and should have license from QUALCOMM Corp. There are various literatures on battery monitoring and management using wireless communication. Global Positioning System (GPS) utilizes GPS satellite to transmit data that provides location and the current time to a GPS receiver globally. It synchronizes the operation so that these repeating signals are transmitted at the same instant. The signals, moving at the speed of light, arrive at a GPS receiver at slightly different times because some satellites are further away than others. The distance to the GPS satellites can be determined by estimating the amount of time it takes for their signals to reach the receiver. When the receiver estimates the distance to at least

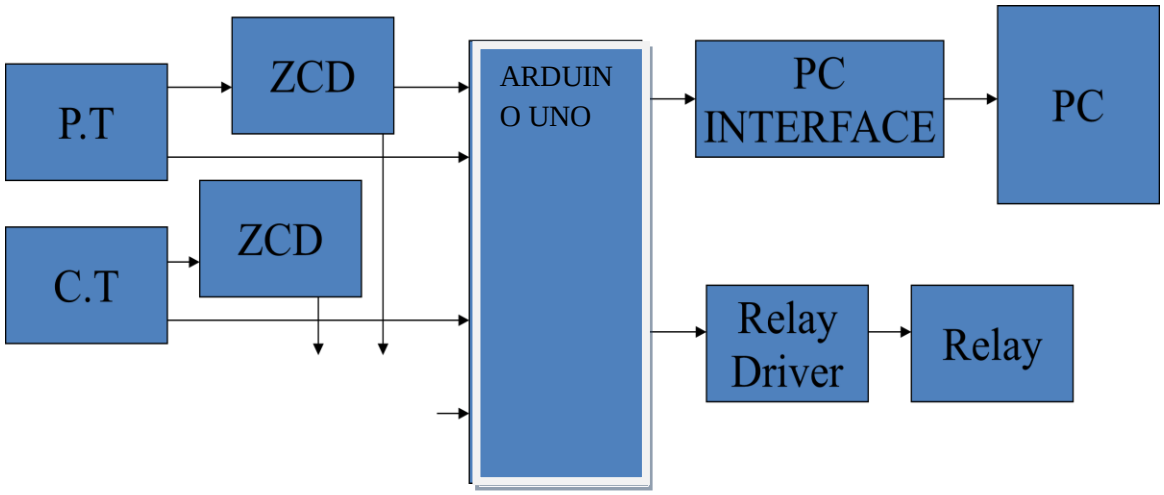
four GPS satellites, it can calculate its position in three dimensions. The accuracy of a position determined with GPS depends on the type of receiver. Most consumer GPS units have an accuracy of about +/-10m. Other types of receivers use a method called Differential GPS (DGPS) to obtain much higher accuracy [5]. A work done in [5] utilized GSM/GPS in monitoring and managing an EV battery. Android is an operating system for mobile phones, tablets and a growing range of devices encompassing everything from wearable computing to in-car entertainment. Android is a Linux-based software system, and similar to Linux, is free and open source software. It can be developed by anyone as it is Linux-based open source. The operating system is able to inform you of a new notification, SMS, Email or even the latest articles from an RSS Reader. Unfortunately, it always need an active internet connection or at least GPRS internet connection in that place so that the device is ready to go online to suit people's needs. Furthermore, the operating system has a lot of process in the background causing the wasteful of batteries.

3.2PROPOSED SYSTEM:

In this paper we presents the design of a battery voltage sensor of an Uninterruptible power supply (UPS) by means of an Arduino board technology. The battery sensor senses the external battery voltage value and compares it with the dc charging voltage of an Uninterrupted Power Supply. An alarm is designed to notify the personnel, in the event that the two voltages do not match in terms of value compares. In most cases, UPS are equipped with sensors mainly to protect rectifier and inverter circuits without considering enough sensors to the battery circuit. These sensors make them reliable, stable as well as to alert the personnel

for any abnormality in voltage level changes. This design was fascinated with proteus software application for the simulation of the UPS battery voltage sensor and the experimental setup, Protocol and Prototype built. The performance evaluation was achieved with the battery sensor implemented into the Uninterrupted Power Supply by means of an Arduino board technology to sense the battery voltage comparing it with the Uninterrupted Power Supply charging voltage. From the experimental results, the state of the battery charge (SOC) was monitored by the designed sensor, under charge and discharge condition in percentage (%), a range of 11.6 V DC and 12V DC was achieved respectively

3.3 BLOCK DIAGRAM



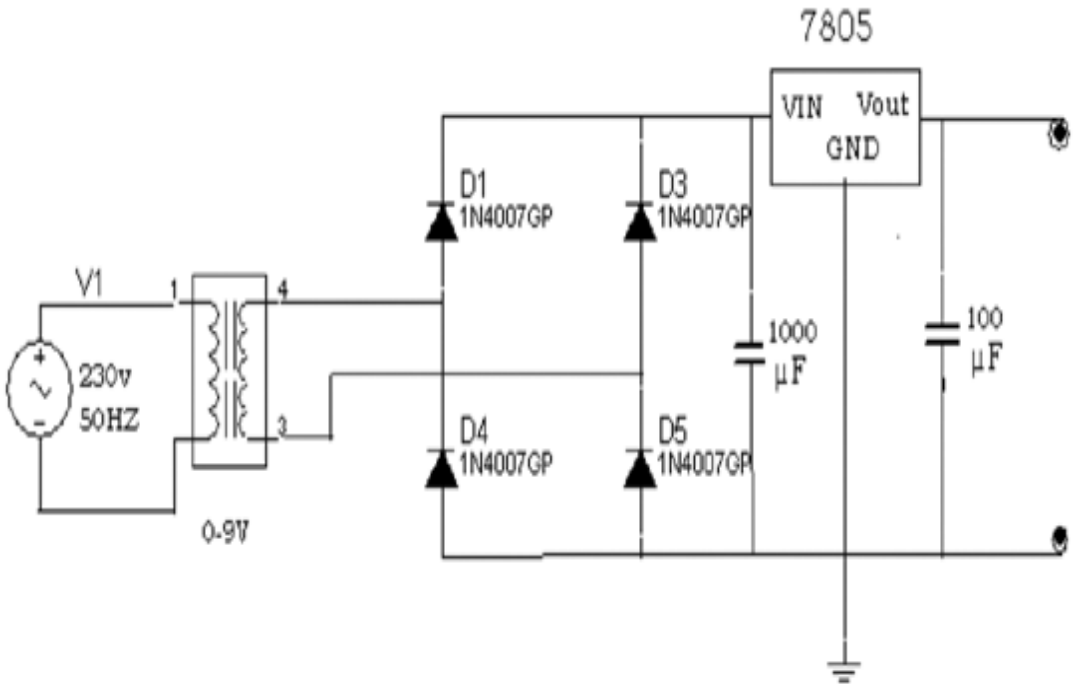
CHAPTER 4

EXPLANATION

4.1 POWER SUPPLY

4.1.1 Power Supply Design

Every circuit needs a source to give energy to that circuit. The Source wills a particular voltage and load current ratings. The following is a circuit diagram of a power supply. We need a constant low voltage regulated power supply of +5V, providing input voltages to the microcontroller RS232, LM311 and LCD display which requires 5 volts supply.



Every power supply has the following parts,

- **Transformer**
- **Rectifier**
- **Capacitor (filter)**
- **Regulator**
- **resistors**

4.1.2 TRANSFORMER

4.1.2.1 WORKING PRINCIPLE OF TRANSFORMER:

The transformer works on the principle of faradays law of electromagnetic inductions. Transformer in its simplest form.

> The core is built up of thin laminations insulated from each other in order to reduce eddy current loss in the more. The winding are unguarded from each other and also from the care. The winding connected to the load is called the secondary winding for samplings they are shown on the opposite side of core but in practice they are distributed owner both sides of the cores. The high voltage winding encloses the low voltage.

Let us say that transformer has N1 turns in its primary winding and N2 turns in its secondary winding. The primary winding is connected to a sinusoidal voltage of magnitude V1 at a frequency FH2. A working flux is set up in magnetic core. The

working flux is alternating and sinusoidal as the applied voltage is alternating and sinusoidal. When these flux link the primary and the secondary winding emf are induced in them. The emf induced in this is called the self-induced emf and that induced in the secondary is the mutually induced emf. These voltages will have sinusoidal waveform and the same frequency as that of the applied voltage. The currents, which flow in the close primary and secondary circuits, are respectively I1 and I2.

In our electrical and electronic circuit we use two important components namely.

1. **RESISTOR**
2. **CAPACITER**

4.1.2.2 RESISTOR:

A resistor is an electric component. It has a known value of resistance. It is especially designed to introduce a desired amount of resistance in a circuit. A resistor is used either to control the flow of current or to produce a voltage drop. It is the most commonly used component in electrical and electronic circuits.

TYPES OF RESISTOR

1. Carbon resistor
2. Metal oxide resistor
3. Metal film resistor
4. Wire wound resistor
5. Variable resistor-carbon resistor

4.1.2.3 CAPACITOR

Capacitor is an electrical device used for storing electrical energy. The stored electrical energy is the form of a current in to the circuits which the capacitor form a part. Capacitor is one of the important components used in Radio, TV and other electronic circuits.

Filter circuits, which is usually capacitor acting as a surge arrester always follow the rectifier unit. This capacitor is also called as a decoupling capacitor or a bypassing capacitor, is used not only to 'short' the ripple with frequency of 120Hz to ground but also to leave the frequency of the DC to appear at the output.

TYPES OF CAPACITOR:

1. Paper Capacitor
2. Mica Capacitor
3. Ceramic Capacitor
4. Electrolytic Capacitor
5. Variable Capacitor

4.1.3 VOLTAGE REGULATOR:

A voltage regulator is an electronic circuit that provides a stable DC voltage independent of the load current, temperature and AC line voltage variations. Although Voltage regulators can be designed using op-amps it is quicker and easier to use IC voltage regulator. The IC voltage regulators are inscribe and inexpensive and are available with features such as programmable, output, current voltage, boosting and floating operation for high voltage application.

4.1.4 7805 VOLTAGE REGULATOR:

78XX series are three terminal positive fixed voltage regulators. There are seven output voltage options available such as 5, 6, 8,12,15,18 and 24V in 78XX the two numbers (XX) indicate the output voltage. The connection of a 7805-voltage regulator is show infix. The AC line voltage is stepped down a cross each half of the center tapped transformers. If full wane rectifier and capacitors filter then provides an unregulated DC voltage with AC ripple of a few volts as a input to the voltage regulator. The 7805 of IC provides an output of +5 Volts D.C.

4.1.5 BRIDGE RECTIFIER

4.1.5.1 OPERATION BRIDGE RECTIFIER

During positive half cycle of input signal, anode of diode 1 becomes positive and at the sometime due anode of diode D2 becomes negative. Hence D1 conducts and D2 does not conduct. The load currier flow through D1 and the voltage drop across RL will be equal to the input voltage. During the negative half cycle of the input the anode of D1 becomes negative and the anode of D2 becomes positive. Hence D1 does not conduct and D2 conducts. The load current flow through D2 and the voltage drop across RC will be equal to the input voltage.

The maximum efficiency of a full wane rectifier is 81.2% and ripple factor is 0.48 peak inverses voltage for full ware rectifies is 2VM because the entire secondary voltage appears across the non-conducting diode.

4.3 ARDUINO UNO

Fig 4.3 shows the arduino microcontroller

The Arduino Uno is an **open-source microcontroller board** based on the **Microchip ATmega328P** microcontroller and developed by **Arduino.cc**. The board is equipped with sets of digital and analog **input/output** (I/O) pins that may be interfaced to various **expansion boards** (shields) and other circuits. The board has 14 digital I/O pins (six capable of **PWM** output), 6 analog I/O pins, and is programmable with the **Arduino IDE** (Integrated Development Environment), via a type B **USB cable**. It can be powered by the USB cable or by an external **9-volt battery**, though it accepts voltages between 7 and 20 volts. It is similar to the **Arduino Nano** and Leonardo. The hardware reference design is distributed under a **Creative Commons** Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

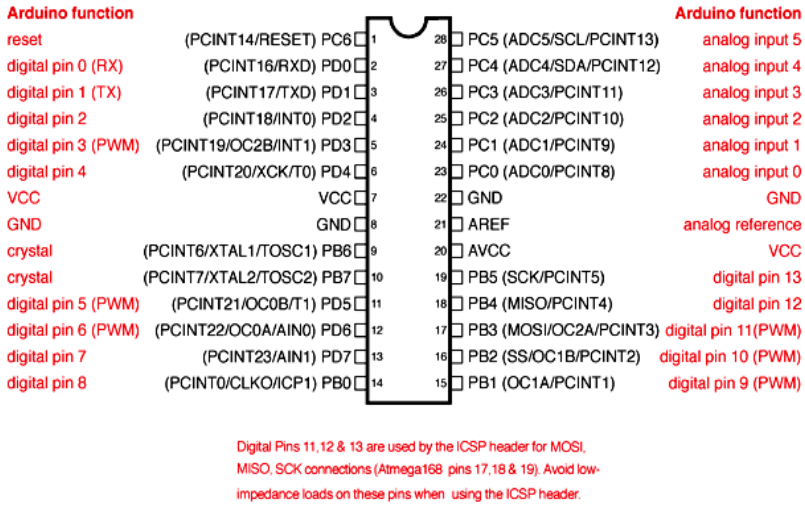
The word "**uno**" means "one" in **Italian** and was chosen to mark the initial release of **Arduino Software**. The Uno board is the first in a series of USB-based Arduino boards; it and version 1.0 of the Arduino **IDE** were the reference versions of Arduino, which have now evolved to newer releases. The ATmega328 on the board comes preprogrammed with a **bootloader** that allows uploading new code to it without the use of an external hardware programmer.

While the Uno communicates using the original STK500 protocol, it differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a **USB-to-serial converter**.[7]

4.3.1 Specifications

- Microcontroller: Microchip ATmega328P[7]
- Operating Voltage: 5 Volts
- Input Voltage: 7 to 20 Volts
- Digital I/O Pins: 14 (of which 6 can provide PWM output)
- PWM Pins: 6 (Pin # 3, 5, 6, 9, 10 and 11)[9]
- UART: 1
- I2C: 1
- SPI: 1
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Length: 68.6 mm
- Width: 53.4 mm
- Weight: 25 g
- ICSP Header: Yes
- Power Sources: DC Power Jack & USB Port

4.3.2 PIN DIAGRAM



4.3.3 General pin functions

- **LED**: There is a built-in LED driven by digital pin 13. When the pin is high value, the LED is on, when the pin is low, it is off.
- **VIN**: The input voltage to the Arduino/Genuino board when it is using an external power source (as opposed to 5 volts from the USB connection or

other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

- **5V**: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
- **3V3**: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND**: Ground pins.
- **IOREF**: This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source, or enable voltage translators on the outputs to work with the 5V or 3.3V.

  Reset: Typically used to add a reset button to shields that block the one on the board.[7]

4.3.4 Special pin functions

Each of the 14 digital pins and 6 analog pins on the Uno can be used as an input or output, under software control (using pinMode(), digitalWrite(), and digitalRead() functions). They operate at 5 volts. Each pin can provide or receive 20 mA as the recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50K ohm. A maximum of 40mA must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller. The Uno has 6 analog inputs, labeled A0 through A5; each provides 10 bits of

resolution (i.e. 1024 different values). By default, they measure from ground to 5 volts, though it is possible to change the upper end of the range using the AREF pin and the analogReference() function.[7]

In addition, some pins have specialized functions:

- **Serial** / UART: pins 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL serial chip.
- **External interrupts**: pins 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- PWM (pulse-width modulation): pins 3, 5, 6, 9, 10, and 11. Can provide 8-bit PWM output with the analogWrite() function.
- SPI (Serial Peripheral Interface): pins 10 (SS), 11 (MOSI), 12 (MISO), and 13 (SCK). These pins support SPI communication using the SPI library.
- **TWI** (two-wire interface) / I²C: pin SDA (A4) and pin SCL (A5). Support TWI communication using the Wire library.
- **AREF** (analog reference): Reference voltage for the analog inputs.[7]

4.3.5 Automatic (software) reset[edit]

Rather than requiring a physical press of the reset button before an upload, the Arduino/Genuino Uno board is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip.[7]

This setup has other implications. When the Uno is connected to a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened.[7]

4.3.6 Key Applications

- Low cost PC/tablet/laptop
- IoT applications
- Media centre
- Robotics
- Industrial/Home automation
- Print server
- Security monitoring
- Wireless access point
- Environmental sensing/monitoring (e.g. weather station)

4.4 LIQUID CRYSTAL DISPLAY

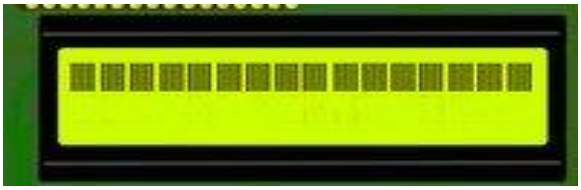


Fig 4.5 shows lcd diagram

LCD (liquid crystal display) is the technology used for displays in notebook and other smaller computers. Like light-emitting diode (LED) and gas-plasma technologies, LCDs allow displays to be much thinner than cathode ray tube (CRT) technology. LCDs consume much less power than LED and gas-display displays because they work on the principle of blocking light rather than emitting it.

An LCD is made with either a passive matrix or an active matrix display display grid. The active matrix LCD is also known as a thin film transistor (TFT) display. The passive matrix LCD has a grid of conductors with pixels located at each intersection in the grid. A current is sent across two conductors on the grid to control the light for any pixel. An active matrix has a transistor located at each pixel intersection, requiring less current to control the luminance of a pixel. For this reason, the current in an active matrix display can be switched on and off more frequently, improving the screen refresh time (your mouse will appear to move more smoothly across the screen, for example).

Some passive matrix LCD's have dual scanning, meaning that they scan the grid twice with current in the same time that it took for one scan in the original technology. However, active matrix is still a superior technology.

An LCD is a small low cost display. It is easy to interface with a micro-controller because of an embedded controller(the black blob on the back of the board).This controller is standard across many displays which means many micro-controllers have libraries that make displaying messages as easy as a single line of code. LCDs with a small number of segments, such as those used in digital watches and pocket calculators, have individual electrical contacts for each segment. An external dedicated circuit supplies an electric charge to control each segment. This display structure is unwieldy for more than a few display elements.

Small monochrome displays such as those found in personal organizers, or older laptop screens have a passive-matrix structure employing super-twisted

pneumatic (STN) or double-layer STN (DSTN) technology—the latter of which addresses a color-shifting problem with the former—and color-STN (CSTN)—wherein color is added by using an internal filter. Each row or column of the display has a single electrical circuit. The pixels are addressed one at a time by row and column addresses. This type of display is called passive-matrix addressed because the pixel must retain its state between refreshes without the benefit of a steady electrical charge. As the number of pixels (and, correspondingly, columns and rows) increases, this type of display becomes less feasible. Very slow response times and poor contrast are typical of passive-matrix addressed LCDs.

High-resolution color displays such as modern LCD computer monitors and televisions use an active matrix structure. A matrix of thin-film transistors (TFTs) is added to the polarizing and color filters. Each pixel has its own dedicated transistor, allowing each column line to access one pixel. When a row line is activated, all of the column lines are connected to a row of pixels and the correct voltage is driven onto all of the column lines.

4.4.1 Features:

- Built-in controller (KS 0066 or Equivalent)
- + 5V power supply (Also available for + 3V)
- 1/16 duty cycle
- B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K (LED) ,Optional for + 3V power supply
- Intelligent, with built-in Hitachi HD44780 compatible LCD controller and RAM providing simple interfacing
- 6.61 x 15.8 mm viewing area
- 7.5 x 7 dot matrix format for 2.96 x 5.56 mm characters, plus cursor line

- 8. Can display 224 different symbols
- 9. Low power consumption (1 mA typical)
- 10. Powerful command set and user-produced characters
- 11. TTL and CMOS compatible
- 12. Connector for standard 0.1-pitch pin headers

4.4.2 Mechanical Specifications

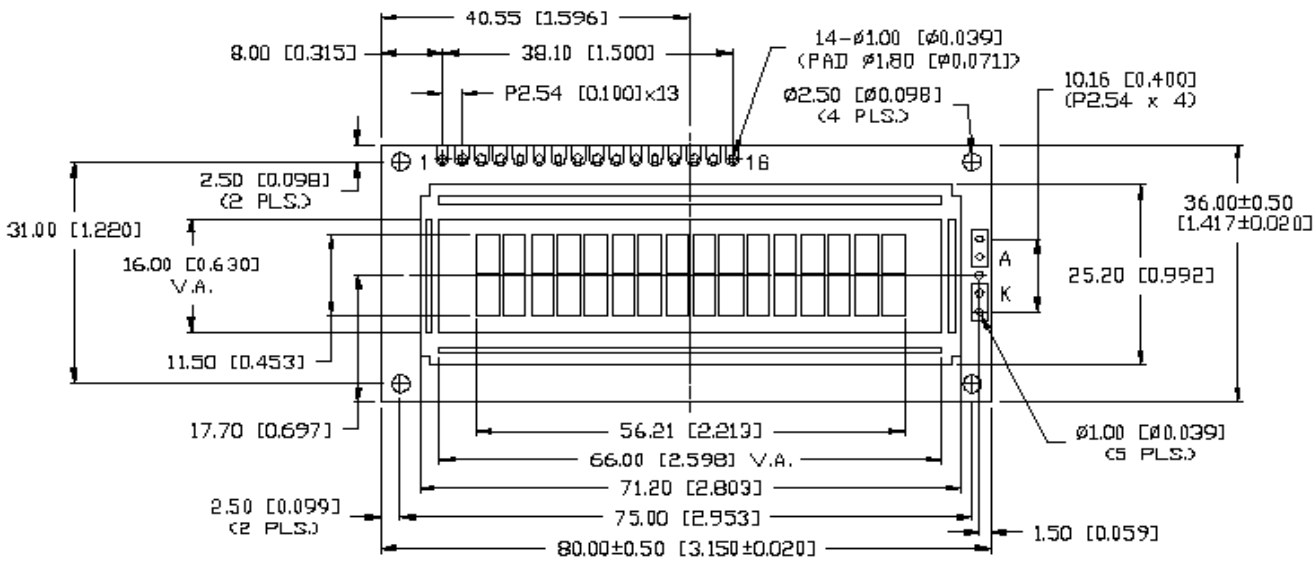


Fig 4.6 shows the lcd circuit diagram

4.4.3 Pin Configurations:

Pin No	Symbol	Details
1	GND	Ground
2	Vcc	Supply Voltage +5V
3	Vo	Contrast adjustment
4	RS	0->Control input, 1-> Data input
5	R/W	Read/ Write
6	E	Enable
7 to 14	D0 to D7	Data
15	VB1	Backlight +5V
16	VB0	Backlight ground

4.4.4 Circuit Connections

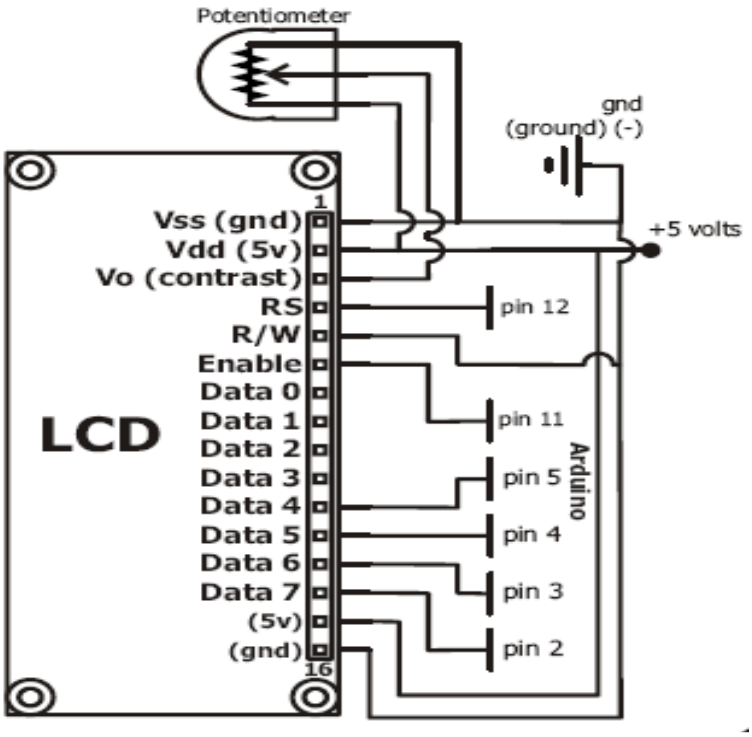


Fig 4.7 shows the lcd circuit connections

4.4.5 Programming:

Algorithm to send data to LCD:

1.Make R/W low

2.Make RS=0; if data byte is command .RS=1; if data byte is data (ASCII value)

3.Place data byte on data register

4.Pulse E (HIGH to LOW)

5.Repeat the steps to send another data byte

3.4.6 LCD Initialization:

This is the pit fall for beginners. Proper working of LCD depend on the how the LCD is initialized. We have to send few command bytes to initialize the LCD. Simple steps to initialize the LCD

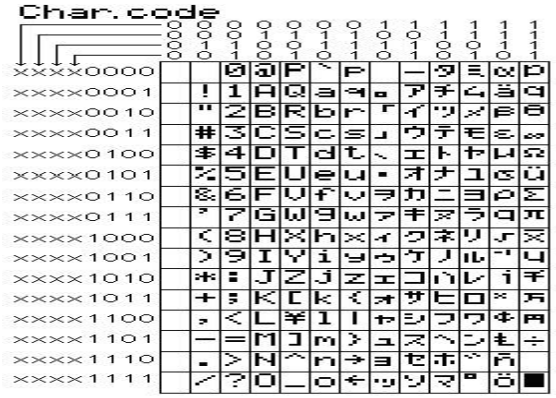
1.Specify function set: Send **38H** for 8-bit,double line and 5x7 dot character format.

2.Display On-Off control: Send **0FH** for display and blink cursor on.

3.Entry mode set: Send **06H** for cursor in increment position and shift is invisible.

4. Clear display: Send **01H** to clear display and return cursor to home position.

LCD commands and codes:



4.4.7 LCD COMMANDS AND CODES:

1	Clear display screen
2	Return Home
4	Decrement cursor (shift cursor to left)
5	Increment cursor (shift cursor to right)
6	shift display right
7	shift display left
8	Display off, cursor off
A	Display off, cursor on
C	Display on, cursor off
E	Display on, cursor blinking
F	Display on, cursor blinking
10	Shift cursor position to left
14	Shift cursor position to right
18	Shift the entire display to the left
1C	Shift the entire display to the right
80	Force cursor to the beginning of 1st line
C0	Force cursor to the beginning of 2nd line
38	2 lines and 5 x 7 matrix.

4.4.8 Interfacing LCD with the Microcontroller

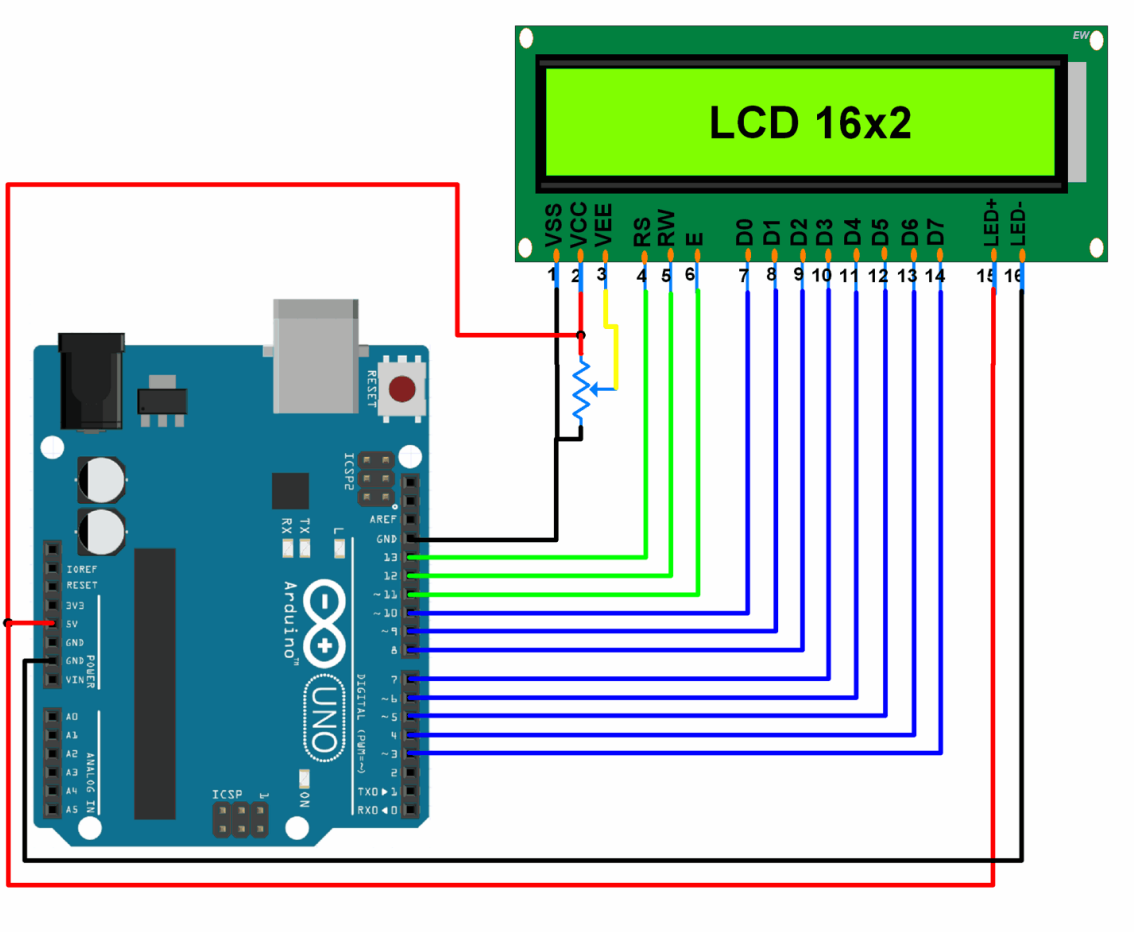


Fig 4.8 shows the Interfacing LCD with the Microcontroller

4.4.9 Circuit Explanation

The LCD we have used in this project is HD1234. This is an alphanumeric type of LCD with 16 pins. Of which Pins 7 to 14 are used as data pins, through which an 8-bit data can be input to the LCD. These Pins are connected to the Port 0 of Micro controller. There are 3 control pins RS (Pin-4), RW (Pin-5) and EN (Pin-6). The RS pin is connected to the 28^{th} Pin of micro controller. The RW pin is usually grounded. The Enable pin is connected to 27^{th} Pin. The LCD has two Rows and 16 Columns. The LCD is powered up with 5V supply connected to Pins 1(Gnd) and 2(Vcc). The Pin 3 is connected to Vcc through a Potentiometer. The potentiometer is used to adjust the contrast level.

4.5 CURRENT SENSOR:

The invention of electricity has led to a revolutionary change in the life of humans. We invented many innovative applications of electricity to make our daily life easier. Today almost all of our equipment runs on electricity. The flow of charge is known as Current. Different devices need a different amount of current based on their functional requirements. Some devices are so sensitive that they get damaged when a high amount of current is delivered to them. So, to save such a situation and monitor the amount of current required or being used in an application, measurement of current necessary. This is where the Current Sensor comes into play. One such sensor is the ACS712 Current Sensor.

Current flowing through a conductor causes a voltage drop. The relation between current and voltage is given by Ohm’s law. In electronic devices, an increase in the amount of current above its requirement leads to overload and can damage the device.

Measurement of current is necessary for the proper working of devices. Measurement of voltage is Passive task and it can be done without affecting the system. Whereas measurement of current is an Intrusive task which cannot be detected directly as voltage.

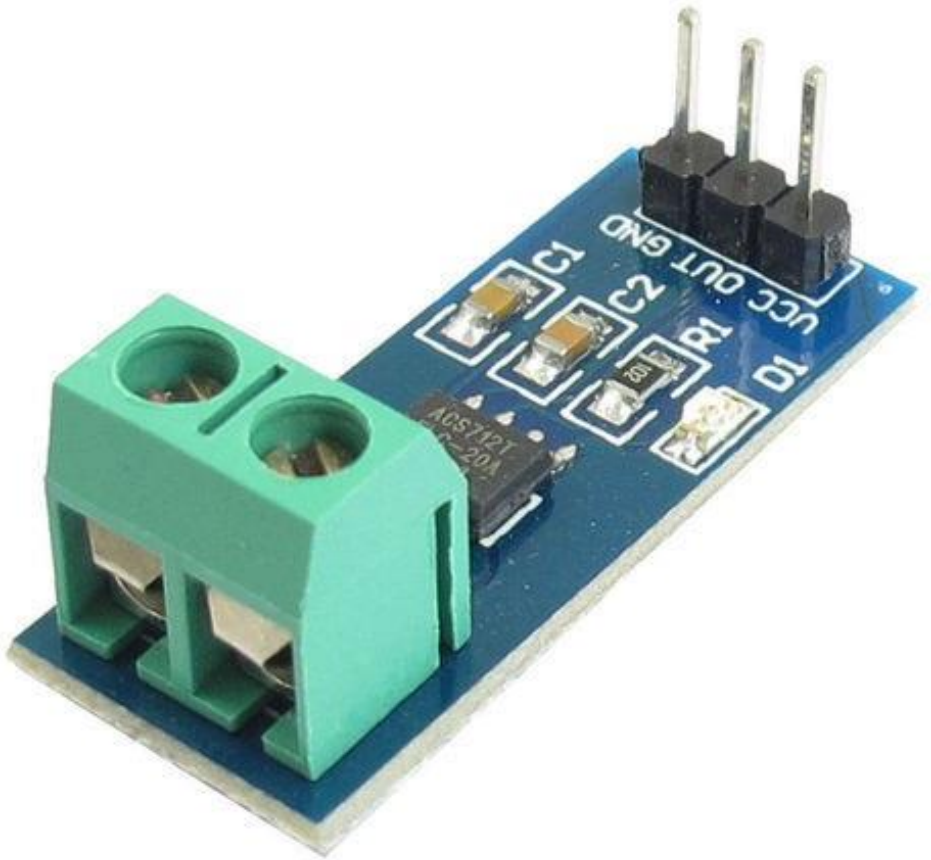


Fig 4.9 ACS712

For measuring current in a circuit, a sensor is required. ACS712 Current Sensor is the sensor that can be used to measure and calculate the amount of current applied to the conductor without affecting the performance of the system.

ACS712 Current Sensor is a fully integrated, Hall-effect based linear sensor IC. This IC has a 2.1kV RMS voltage isolation along with a low resistance current conductor.

4.5.1Working Principle

Current Sensor detects the current in a wire or conductor and generates a signal proportional to the detected current either in the form of analog voltage or digital output.

Current Sensing is done in two ways – Direct sensing and Indirect Sensing. In Direct sensing, to detect current, Ohm's law is used to measure the voltage drop occurred in a wire when current flows through it.
A current-carrying conductor also gives rise to a magnetic field in its surrounding. In Indirect Sensing, the current is measured by calculating this magnetic field by applying either Faraday's law or Ampere law. Here either a Transformer or Hall effect sensor or fiberoptic current sensor are used to sense the magnetic field.
ACS712 Current Sensor uses Indirect Sensing method to calculate the current. To sense current a liner, low-offset Hall sensor circuit is used in this IC. This sensor is located at the surface of the IC on a copper conduction path. When current flows through this copper conduction path it generates a magnetic field which is sensed by the Hall effect sensor. A voltage proportional to the sensed magnetic field is generated by the Hall sensor, which is used to measure current.

The proximity of the magnetic signal to the Hall sensor decides the accuracy of the device. Nearer the magnetic signal higher the accuracy. ACS712 Current Sensor is available as a small, surface mount SOIC8 package. In this IC current flows from

Pin-1 and Pin-2 to Pin-3 and Pin-4. This forms the conduction path where the current is sensed. Implementation of this IC is very easy.

ACS712 can be used in applications requiring electrical isolation as the terminals of the conduction path are electrically isolated from the IC leads. Thus, this IC doesn't require any other isolation techniques. This IC requires a supply voltage of 5V. Its output voltage is proportional to AC or DC current. ACS712 has a nearly zero magnetic hysteresis.

Where Pin-1 to Pin-4 forms the conduction path, Pin-5 is the signal ground pin. Pin-6 is the FILTER pin that is used by an external capacitor to set the bandwidth. Pin-7 is the analog output pin. Pin-8 is the power supply pin.

Applications of ACS712 Current Sensor

This IC can detect both AC and DC current so, it has a wide range of applications. ACS712 is used in Peak detection circuits, circuits to increase gain, rectification application for AtoD converters, Overcurrent fault latch, etc…The filter pin provided by this IC is used to eliminate the attenuation effect in resistor divider circuits.

ACS712 is used in many industrial, commercial and communication applications. This IC is applicable for Automobile applications. Some of the typical applications of this IC can be found in motor control circuits, for load detection and management, SMPS, overcurrent fault protection circuit.

4.6 VOLTAGE SENSOR:

A voltage sensor is a sensor used to calculate and monitor the amount of voltage in an object. Voltage sensors can determine the AC voltage or DC voltage level. The input of this sensor is the voltage, whereas the output is the switches, analog voltage signal, a current signal, or an audible signal.

Sensors are devices that can sense or identify and react to certain types of electrical or optical signals. The implementation of a **voltage sensor** and current sensor techniques have become an excellent choice for the conventional current and voltage measurement methods.

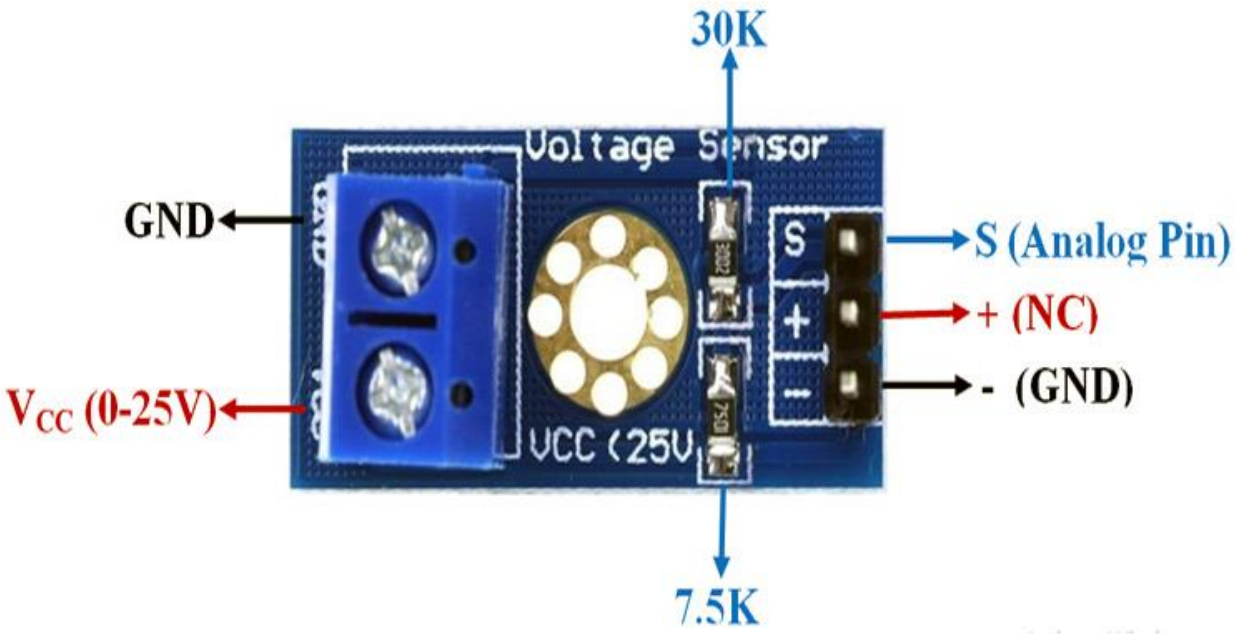


Fig 4.10 voltage sensor

Types of Voltage Sensors:

In this article, we can discuss a voltage sensor in detail. A voltage sensor can determine, monitor, and measure the supply of voltage. It can measure the AC level and/or DC voltage level. The input to the voltage sensor is the voltage itself, and the output can be analog voltage signals, switches, audible signals, analog current levels, frequency, or even frequency-modulated outputs.

That is, some **voltage sensors** can provide sine or pulse trains as output, and others can produce amplitude modulation, pulse width modulation, or frequency modulation outputs.

In voltage sensors, the measurement is based on a voltage divider. Two main types of voltage sensors are available: **capacitive type voltage sensor** and **resistive type voltage sensor**.

Advantages of Voltage Sensors Over Conventional Measuring Techniques

The advantage of voltage sensors include:

- Small in weight and size
- Personnel safety is high

CHAPTER 5

Software Specifications

- Arduino Compiler
- MC Programming Language: C

SOFTWARE:

5.1 Arduino IDE

The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as **Windows, Mac OS X, and Linux**. It supports the programming languages C and C++. Here, IDE stands for **Integrated Development Environment**.

The program or code written in the Arduino IDE is often called as sketching. We need to connect the Genuino and Arduino board with the IDE to upload the sketch written in the Arduino IDE software. The sketch is saved with the extension '.ino.'

The Arduino IDE will appear as:

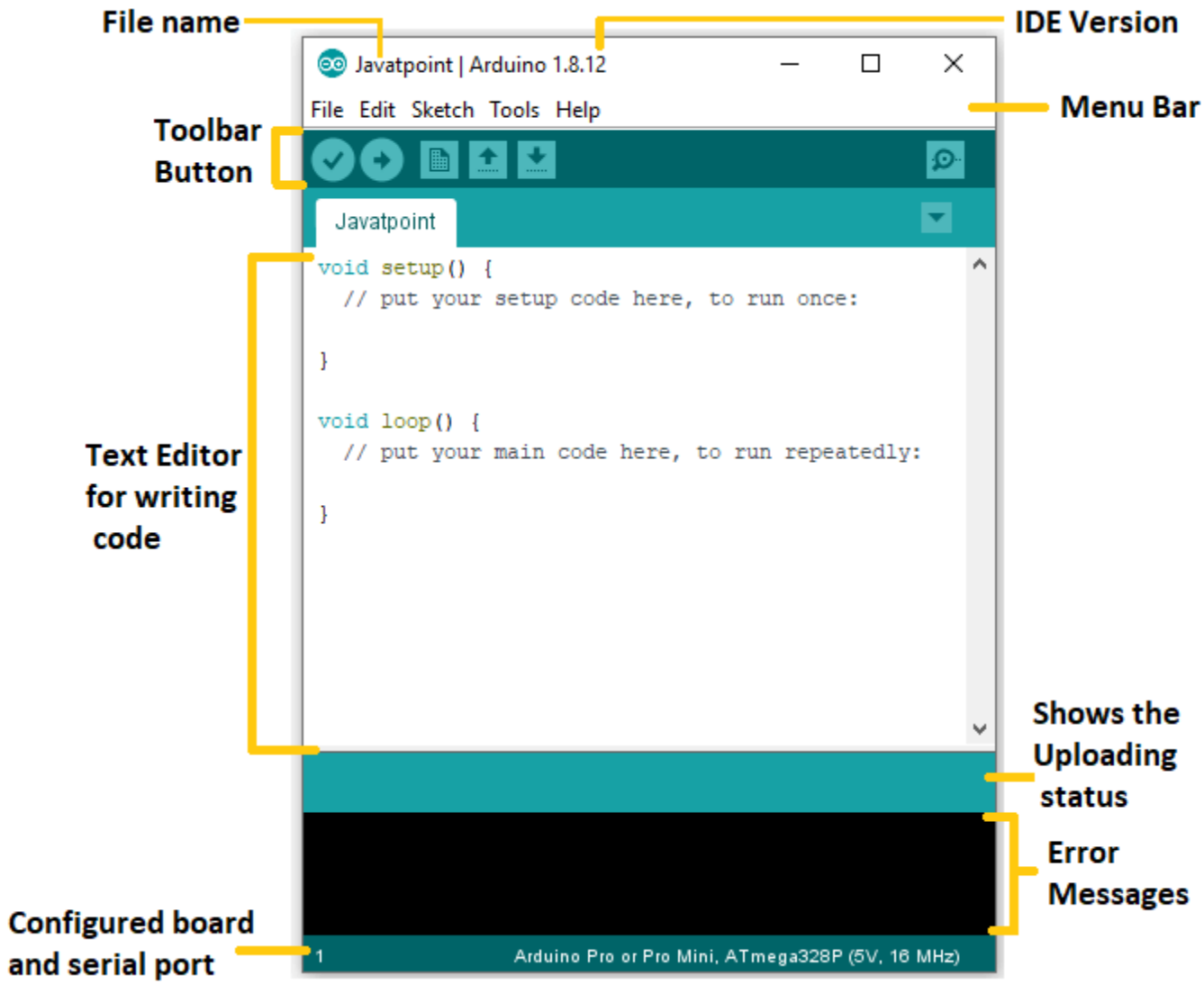


Fig 5.1 arduino ide

Let's discuss each section of the Arduino IDE display in detail.

46M

1K

Features of Java - Javatpoint

Toolbar Button

The icons displayed on the toolbar are **New, Open, Save, Upload,** and **Verify**.

It is shown below:

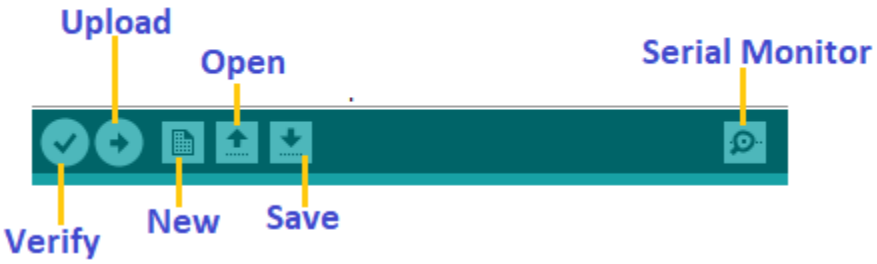


Fig 5.2 upload

Upload

The Upload button compiles and runs our code written on the screen. It further uploads the code to the connected board. Before uploading the sketch, we need to make sure that the correct board and ports are selected.

We also need a USB connection to connect the board and the computer. Once all the above measures are done, click on the Upload button present on the toolbar.

The latest Arduino boards can be reset automatically before beginning with Upload. In the older boards, we need to press the Reset button present on it. As soon as the uploading is done successfully, we can notice the blink of the Tx and Rx LED.

If the uploading is failed, it will display the message in the error window.

We do not require any additional hardware to upload our sketch using the Arduino Bootloader. A **Bootloader** is defined as a small program, which is loaded in the microcontroller present on the board. The LED will blink on PIN 13.

Open

The Open button is used to open the already created file. The selected file will be opened in the current window.

Save

The save button is used to save the current sketch or code.

New

It is used to create a new sketch or opens a new window.

Verify

The Verify button is used to check the compilation error of the sketch or the written code.

Serial Monitor

The serial monitor button is present on the right corner of the toolbar. It opens the serial monitor.

It is shown below:

When we connect the serial monitor, the board will reset on the operating system Windows, Linux, and Mac OS X. If we want to process the control characters in our sketch, we need to use an external terminal program. The terminal program should be connected to the COM port, which will be assigned when we connect the board to the computer.

Menu Bar

- **File**

When we click on the File button on the Menu bar, a drop-down list will appear. It is shown below:

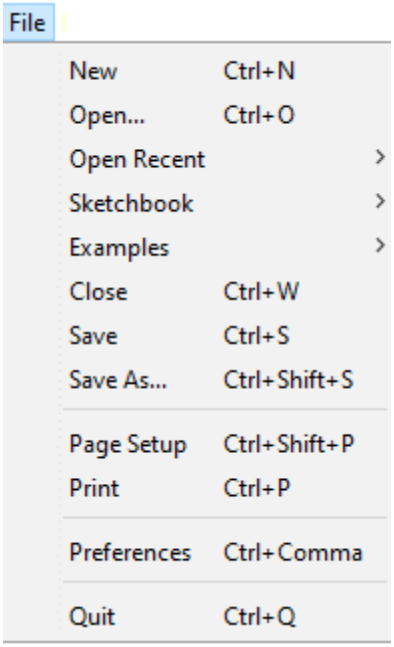


Fig 5.3 menu bar

Let's discuss each option in detail.

New

The New button opens the new window. It does not remove the sketch which is already present.

Open

It allows opening the sketch, which can be browsed from the folders and computer drivers.

Open Recent

The Open Recent button contains the list of the recent sketches.

Sketchbook

It stores the current sketches created in the Arduino IDE software. It opens the selected sketch or code in a new editor at an instance.

Examples

It shows the different examples of small projects for a better understanding of the IDE and the board. The IDE provides examples of self-practice.

Close

The Close button closes the window from which the button is clicked.

Save

The save button is used to save the current sketch. It also saves the changes made to the current sketch. If we have not specified the name of the file, it will open the '**Save As...**' window.

Save As...

We can save the sketch with a different name using the '**Save As...**' button. We can also change the name accordingly.

Page Setup

It allows setting the page margins, orientation, and size for printing. The '**Page Setup**' window will appear as:

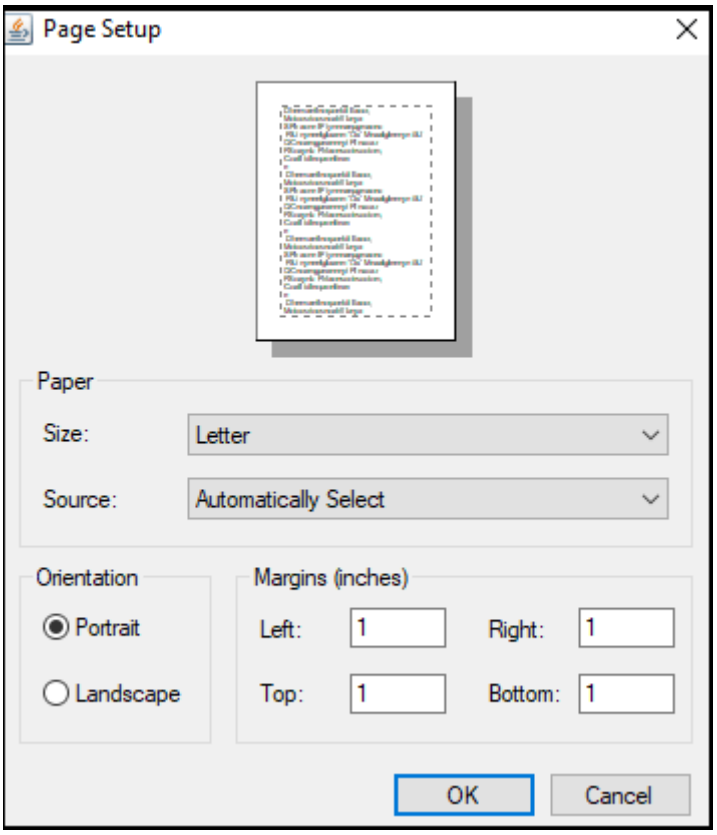


Fig 5.4 page setup

Print

According to the settings specified in the 'Page Setup', it prepares the current sketch for printing.

Preferences

It allows the customization settings of the Arduino IDE.

Quit

The Quit button is used to close all the IDE windows. The same closed sketch will be reopened when we will open the Arduino IDE.

- **Edit**

When we click on the Edit button on the Menu bar, a drop-down list appears. It is shown below:

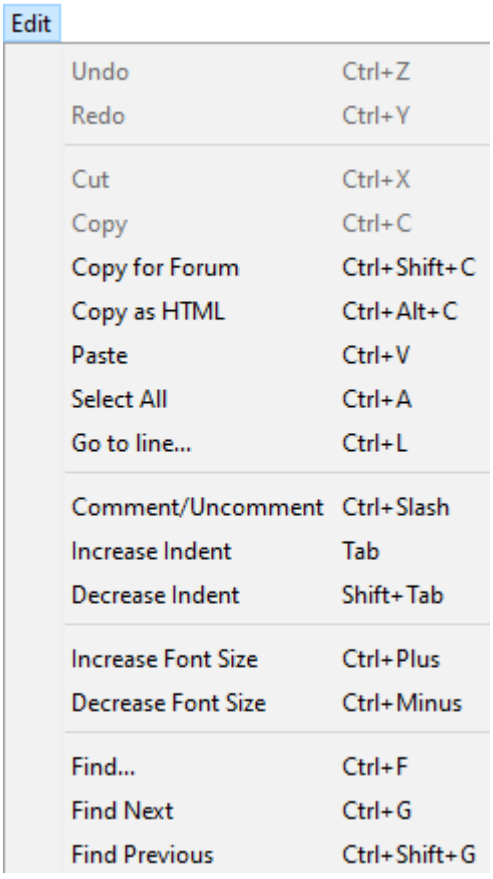


Fig 5.5 edit

Let's discuss each option in detail.

Undo

The Undo button is used to reverse the last modification done to the sketch while editing.

Redo

The Redo button is used to repeat the last modification done to the sketch while editing.

Cut

It allows us to remove the selected text from the written code. The text is further placed to the clipboard. We can also paste that text anywhere in our sketch.

Copy

It creates a duplicate copy of the selected text. The text is further placed on the clipboard.

Copy for Forum

The 'Copy for Forum' button is used to copy the selected text to the clipboard, which is also suitable for posting to the forum.

Copy as HTML

The 'Copy for Forum' button is used to copy the selected text as HTML to the clipboard. It is desirable for embedding in web pages.

Paste

The Paste button is used to paste the selected text of the clipboard to the specified position of the cursor.

Select All

It selects all the text of the sketch.

Go to line...

It moves the cursor to the specified line number.

The window will appear as:

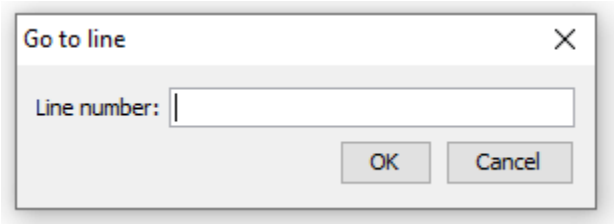


Fig 5.6 go to line

Comment/Decomment

The Comment/ Decomment button is used to put or remove the comment mark (//) at the beginning of the specified line.

Increase Indent

It is used to add the space at the starting of the specified line. The spacing moves the text towards the right.

Decrease Indent

It is used to subtract or remove the space at the starting of the specified line. The spacing moves the text towards the left.

Increase Font Size

It increases the font size of the written text.

Decrease Font Size

It decreases the font size of the written text.

Find...

It is used to find the specified text. We can also replace the text. It highlights the text in the sketch.

The window will appear as:

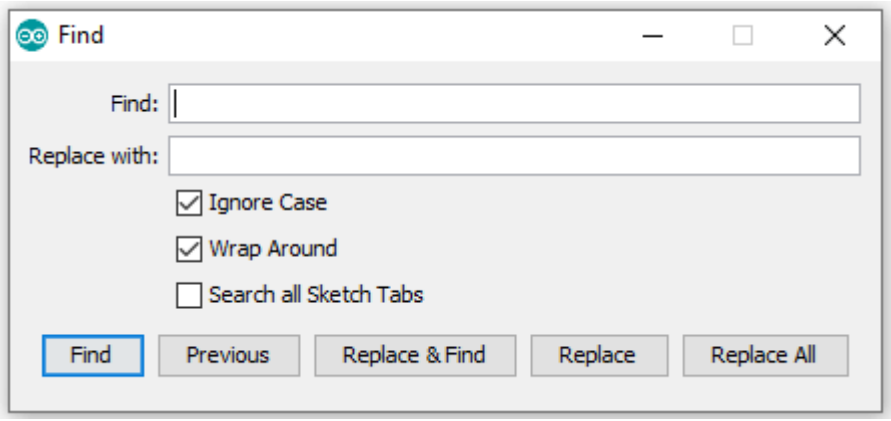


Fig 5.7 windows text

Find Next

It highlights the next word, which has specified in the '**Find...**' window. If there is no such word, it will not show any highlighted text.

Find Previous

It highlights the previous word, which has specified in the '**Find...**' window. If there is no such word, it will not show any highlighted text.

- **Sketch**

When we click on the Sketch button on the Menu bar, a drop-down list appears. It is shown below:

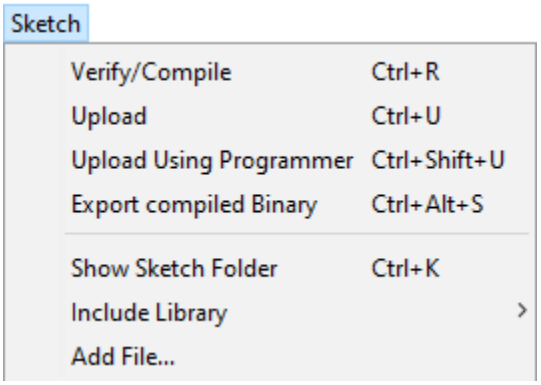


Fig 5.8 sketch bar

Let's discuss each option in detail.

Verify/Compile

It will check for the errors in the code while compiling. The memory in the console area is also reported by the IDE.

Upload

The Upload button is used to configure the code to the specified board through the port.

Upload Using Programmer

It is used to override the Bootloader that is present on the board. We can utilize the full capacity of the Flash memory using the '**Upload Using Programmer**' option. To implement this, we need to restore the Bootloader using the **Tools**-> **Burn Bootloader** option to upload it to the USB serial port.

Export compiled Binary

It allows saving a .**hex** file and can be kept archived. Using other tools, .hex file can also be sent to the board.

Show Sketch Folder

It opens the folder of the current code written or sketch.

Include Library

Include Library includes various Arduino libraries. The libraries are inserted into our code at the beginning of the code starting with the #. We can also import the libraries from .zip file.

Add File...

The Add File... button is used to add the created file in a new tab on the existing file.

For example, let's add '**Blink**' file to the '**Javatpoint**' file. The tab will now appear as:

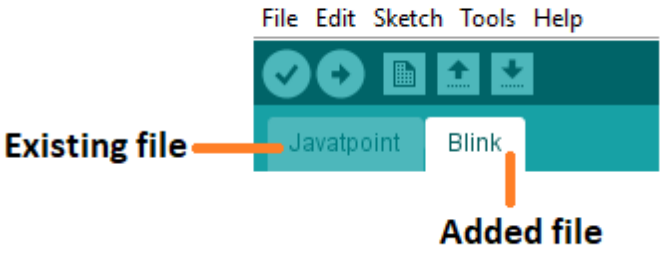


Fig 5.9 blink

We can also delete the corresponding file from the tab by clicking on the **small triangle** -> **Delete** option.

Tools

When we click on the Tools button on the Menu bar, a drop-down list appears. It is shown below:

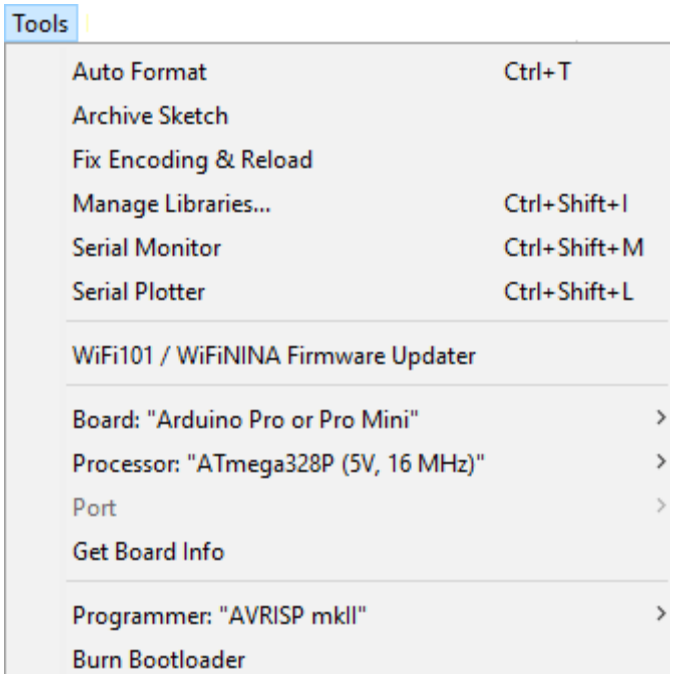


Fig 5.10 menu bar

Let's discuss each option in detail.

Auto Format

The Auto Format button is used to format the written code. For example, lining the open and closed curly brackets in the code.

Archive Sketch

The copy of the current sketch or code is archived in the .zip format. The directory of the archived is same as the sketch.

Fix Encoding and Reload

This button is used to fix the inconsistency between the operating system char maps and editor char map encoding.

Manage Libraries...

It shows the updated list of all the installed libraries. We can also use this option to install a new library into the Arduino IDE.

Serial Monitor

It allows the exchange of data with the connected board on the port.

Serial Plotter

The Serial Plotter button is used to display the serial data in a plot. It comes preinstalled in the Arduino IDE.

WiFi101/WiFiNINA Firmware Updater

It is used to check and update the Wi-Fi Firmware of the connected board.

Board

We are required to select the board from the list of boards. The selected board must be similar to the board connected to the computer.

Processor

It displays the processor according to the selected board. It refreshes every time during the selection of the board.

Port

It consists of the virtual and real serial devices present on our machine.

Get Board Info

It gives the information about the selected board. We need to select the appropriate port before getting information about the board.

Programmer

We need to select the hardware programmer while programming the board. It is required when we are not using the onboard USB serial connection. It is also required during the burning of the Bootloader.

Burn Bootloader

The Bootloader is present on the board onto the microcontroller. The option is useful when we have purchased the microcontroller without the bootloader. Before burning the bootloader, we need to make sure about the correct selected board and port.

Help

When we click on the Help button on the Menu bar, a drop-down list will appear. It is shown below:

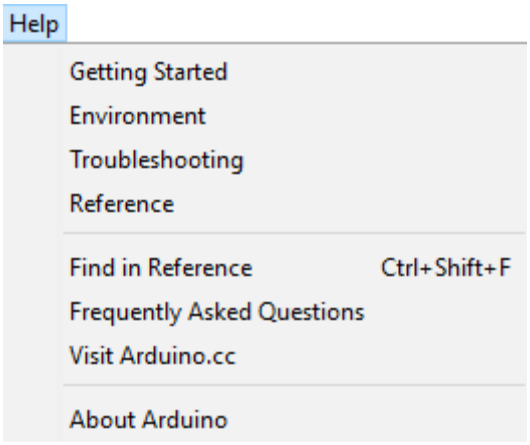


Fig 5.11 help

The Help section includes several documents that are easy to access, which comes along with the Arduino IDE. It consists of the number of options such as Getting Started, Environment, Troubleshooting, Reference, etc. We can also consider the image shown above, which includes all the options under the Help section.

Some documents like Getting started, Reference, etc., can be accessed without the internet connection as well. It will directly link us to the official website of Arduino

5.2 PROTEUS

The Proteus Design Suite is an Electronic Design Automation (EDA) tool including schematic capture, simulation and PCB Layout modules. It is developed in Yorkshire, England by Labcenter Electronics Ltd with offices in North America and several overseas sales channels. The software runs on the Windows operating system and is available in English, French, Spanish and Chinese languages.

5.2.1 Product modules

The Proteus Design Suite is a Windows application for schematic capture, simulation, and PCB layout design. It can be purchased in many configurations, depending on the size of designs being produced and the requirements for microcontroller simulation. All PCB Design products include an auto router and basic mixed mode SPICE simulation capabilities.

Schematic Capture

Schematic capture in the Proteus Design Suite is used for both the simulation of designs and as the design phase of a PCB layout project. It is therefore a core component and is included with all product configurations.

Microcontroller Simulation

The micro-controller simulation in Proteus works by applying either a hex file or a debug file to the microcontroller part on the schematic. It is then co-simulated along with any analog and digital electronics connected to it. This enables it's used in a broad spectrum of project prototyping in areas such as motor control, temperature control and user interface design. It also finds use in the general hobbyist community and, since no hardware is required, is convenient to use as a training or teaching tool. Support is available for co-simulation of:

- Microchip Technologies PIC10, PIC12, PIC16,PIC18,PIC24,dsPIC33 Microcontrollers.
- Atmel AVR (and Arduino), 8051 and ARM Cortex-M3 Microcontroller
- NXP 8051, ARM7, ARM Cortex-M0 and ARM Cortex-M3 Microcontrollers.

- Texas Instruments MSP430, PICCOLO DSP and ARM Cortex-M3 Microcontrollers.
- Parallax Basic Stamp, Free scale HC11, 8086 Micro controller

PCB design

The PCB Layout module is automatically given connectivity information in the form of a netlist from the schematic capture module. It applies this information, together with the user specified design rules and various design automation tools, to assist with error free board design. Design Rule Checking does not include high speed design constraints.[12]PCB's of up to 16 copper layers can be produced with design size limited by product configuration.

3D verification

The 3D Viewer module allows the board under development to be viewed in 3D together with a semi-transparent height plane that represents the boards enclosure. STEP output can then be used to transfer to mechanical CAD software such as Solidworks or Autodesk for accurate mounting and positioning of the board.

1 Electronic design automation (EDA)

Electronic design automation (EDA), also referred to as electronic computer-aided design (ECAD), is a category of software tools for designing electronic systems such as integrated circuits and printed circuit boards. The tools work

together in a design flow that chip designers use to design and analyze entire semiconductor chips. Since a modern semiconductor chip can have billions of components, EDA tools are essential for their design. This article describes EDA specifically with respect to integrated circuits.

a) Current status

Current digital flows are extremely modular (see Integrated circuit design, Design closure, and Design flow (EDA)). The front ends produce standardized design descriptions that compile into invocations of "cells,", without regard to the cell technology. Cells implement logic or other electronic functions using a particular integrated circuit technology. Fabricators generally provide libraries of components for their production processes, with simulation models that fit standard simulation tools. Analog EDA tools are far less modular, since many more functions are required, they interact more strongly, and the components are (in general) less ideal. EDA for electronics has rapidly increased in importance with the continuous scaling of semiconductor technology.[2] Some users are foundry operators, who operate the semiconductor fabrication facilities, or "fabs", and design-service companies who use EDA software to evaluate an incoming design for manufacturing readiness. EDA tools are also used for programming design functionality into FPGAs.

Design

- High-level synthesis (or behavioural synthesis, algorithmic synthesis) – high-level design description (e.g. in C/C++) is converted into RTL.

- Logic synthesis – translation of RTL design description (e.g. written in Verilog or VHDL) into a discrete netlist of logic gates.
- Schematic capture – For standard cell digital, analog, RF-like Capture CIS in Orcad by Cadence and ISIS in Proteus
- Layout – usually schematic-driven layout, like Layout in Orcad by Cadence, ARES in Proteus

Simulation

- Transistor simulation – low-level transistor-simulation of a schematic/layout's behavior, accurate at device-level.
- Logic simulation – digital-simulation of an RTL or gate-netlist's digital (boolean 0/1) behavior, accurate at boolean-level.
- **Behavioral Simulation** – high-level simulation of a design's architectural operation, accurate at cycle-level or interface-level.
- Hardware emulation – Use of special purpose hardware to emulate the logic of a proposed design. Can sometimes be plugged into a system in place of a yet-to-be-built chip; this is called in-circuit emulation.
- Technology CAD simulate and analyze the underlying process technology. Electrical properties of devices are derived directly from device physics.
- Electromagnetic field solvers, or just field solvers, solve Maxwell's equations directly for cases of interest in IC and PCB design. They are known for being slower but more accurate than the layout extraction above.

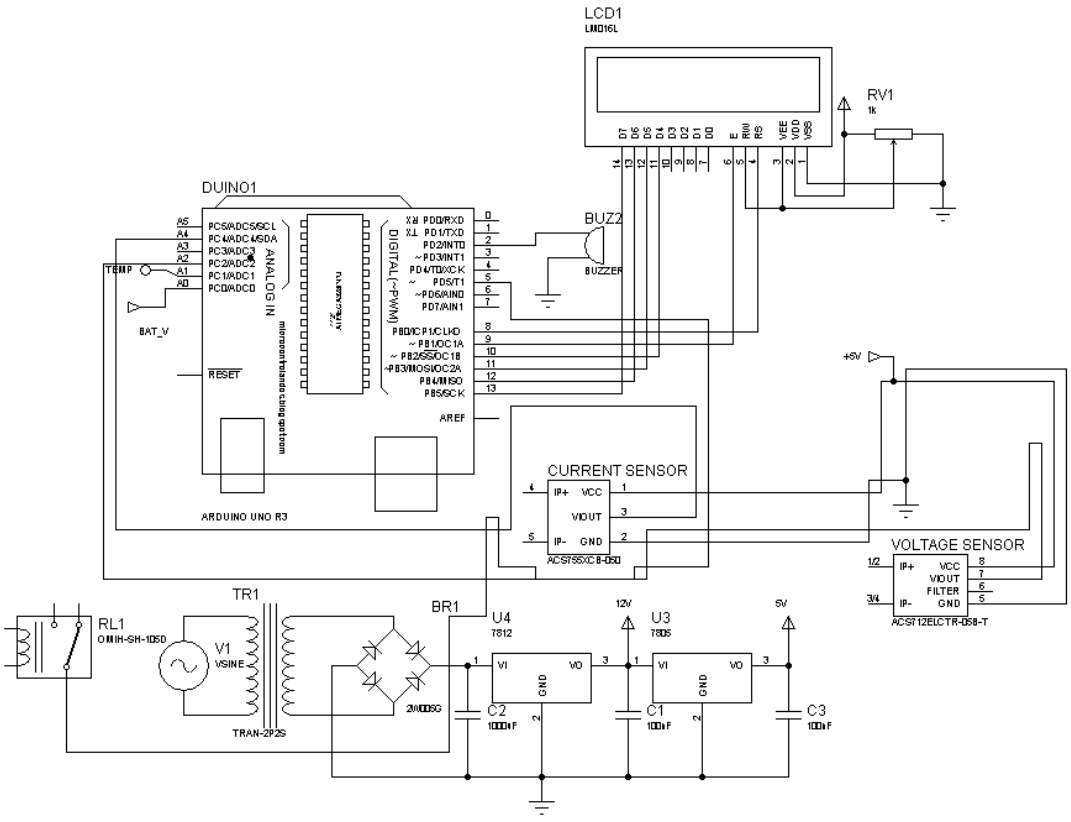
5.2.2 Analysis and verification

- Functional verification

- Clock Domain Crossing Verification (CDC check): Similar to linting, but these checks/tools specialize in detecting and reporting potential issues like data loss, meta-stability due to use of multiple clock domains in the design.
- Formal verification, also model checking: Attempts to prove, by mathematical methods, that the system has certain desired properties, and that certain undesired effects (such as deadlock) cannot occur.
- Equivalence checking: algorithmic comparison between a chip's RTL-description and synthesized gate-netlist, to ensure functional equivalence at the logical level.
- Static timing analysis: Analysis of the timing of a circuit in an input-independent manner, hence finding a worst case over all possible inputs.
- Physical verification, PV: checking if a design is physically manufacturable, and that the resulting chips will not have any function-preventing physical defects, and will meet original specifications.

CHAPTER 6

6.1 CIRCUIT DIAGRAM



6.2 CIRCUIT EXPLANATION

power quality monitoring systems which are composed of various tools, software, communication links etc. that work together as one coherent system. Another goal is to develop an understanding about the quality management in the area of power industry. Some of the methods and techniques that are presented discuss about power quality meter placement techniques. Finding the best locations to place the power quality monitors in the electrical grid is done by developing algorithms and

approaches to find the appropriate number of monitors and the appropriate locations to place them in order to reduce the cost of the PQM system and increase its efficiency. The paper discusses the basic idea of each method or system in order to have an understanding about its importance and role. Then, a simple comparison is made between the techniques in terms of their advantages and disadvantages. After that, international industry practices and guidelines for power quality monitoring and management are discussed. Lastly, some examples for the efforts that are made in the area of power quality improvement are discussed

Conclusion:

The project has been completed successfully and the output results are verified. The results are in line with the expected output. The project has been checked with both software and hardware testing tools. In this work "LCD, arduino,Relay and Relay Driver" are chosen are proved to be more appropriate for the intended application. The project is having enough avenues for future enhancement. The project is a prototype model that fulfills all the logical requirements. The project with minimal improvements can be directly applicable for real time applications. Thus the project contributes a significant step forward in the field of **"automations",** and further paves a road path towards faster development s in the same field. The project is further adaptive towards continuous performance and peripheral up gradations. This work can be applied to variety of industrial and commercial applications.

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