INTRODUCTION

An AC power supply typically takes the voltage from a wall outlet (mains supply) and uses a transformer to step up or step down the voltage to the desired voltage. Some filtering may take place as well. In some cases, the source voltage is the same as the output voltage; this is called an isolation transformer. Other AC power supply transformers do not provide mains isolation; these are called autotransformers; a variable output autotransformer is known as a variac. Other kinds of AC power supplies are designed to provide a nearly constant current, and output voltage may vary depending on impedance of the load. In cases when the power source is direct current, (like an automobile storage battery), an inverter and step-up transformer may be used to convert it to AC power. Portable AC power may be provided by an alternator powered by a diesel or gasoline engine. Some kinds of AC power conversion do not use a transformer. If the output voltage and input voltage are the same, and primary purpose of the device is to filter AC power, it may be called a line conditioner. If the device is designed to provide backup power, it may be called an uninterruptable power supply. A circuit may be designed with a voltage multiplier topology to directly step-up AC power.

A programmable power supply is one that allows remote control of its operation through an analog input or digital interface such as RS232or GPIB. Controlled properties may include voltage, current, and in the case of AC output power supplies, frequency. They are used in a wide variety of applications, including automated equipment testing, crystal growth monitoring, semiconductor fabrication, and x-ray generators.

An uninterruptible power supply (UPS) takes its power from two or more sources simultaneously. It is usually powered directly from the AC mains, while simultaneously charging a storage battery. Should there be a dropout or failure of the mains, the battery instantly takes over so that the load never experiences an interruption. Transmission of high speed data and communications service must have continuity/NO break of that service. Such a scheme is found in hospitals, data centers, call centers, cell sites and telephone central offices.

A high-voltage power supply is one that outputs hundreds or thousands of volts. A special output connector is used that prevents arcing, insulation breakdown and accidental human contact. High-voltage power supplies are commonly used to accelerate and manipulate electron and ion beams in equipment such as x-ray generators, electron microscopes, and focused ion beam columns, and in a variety of other applications, including electrophoresis and electrostatics.

A bipolar power supply operates in all four quadrants of the voltage/current Cartesian plane, meaning that it will generate positive and negative voltages and currents as required to maintain regulation. When its output is controlled by a low-level analog signal, it is effectively a low-bandwidth operational amplifier with high output power and seamless zero-crossings. This type of power supply is commonly used to power magnetic devices in scientific applications.

The power quality disturbances can be basically divided into six categories:

1. Transients
2. Interruptions
3. Under voltage
4. Over voltage
5. Voltage fluctuations
6. Frequency variations

1. TRANSIENTS

Transients are of two types, impulsive transients and oscillatory transients. Impulsive transients are sudden high peak events that raise the voltage and/or current levels in either a positive or a negative direction. These types of events can be categorized further by the speed at which they occur. Causes of impulsive transients include lightning, poor grounding, the switching of inductive loads, utility fault clearing, and Electrostatic Discharge (ESD). The results can range from the loss (or corruption) of data, to physical damage of equipment. Of these causes, lightning is probably the most damaging. An oscillatory transient is a sudden change in the steady-state condition of a signal's voltage, current, or both, at both the positive and negative signal limits, oscillating at the natural system frequency. In simple terms, the transient causes the power signal to alternately swell and then shrink, very rapidly. These transients occur when you turn off an inductive or capacitive load, such as a motor or capacitor bank. An oscillatory transient results because the load resists the change.

2. INTERRUPTIONS

An interruption is defined as the complete loss of supply voltage or load current. Depending on its duration, an interruption is categorized as instantaneous, momentary, temporary, or sustained. Duration range for interruption types are as follows: Instantaneous 0.5 to 30 cycles Momentary 30 cycles to 2 seconds Temporary 2 seconds to 2 minutes Sustained greater than 2 minutes The causes of interruptions can vary, but are usually the result of some type of electrical supply grid damage, such as lightning strikes, animals, trees, vehicle accidents, destructive weather (high winds, heavy snow or ice on lines, etc.), equipment failure, or a basic circuit breaker tripping.

3. UNDERVOLTAGE/SAG

A sag or under voltage is a reduction of AC voltage at a given frequency for the duration of 0.5 cycles to 1 minute's time. Sags are usually caused by system faults, and are also often the result of switching on loads with heavy startup currents.

4. OVERVOLTAGE/SWELL

A swell or over voltage is the reverse form of a sag, having an increase in AC voltage for a duration of 0.5 cycles to 1 minute's time. For swells, high-impedance neutral connections, sudden (especially large) load reductions, and a single-phase fault on a three-phase system are common sources.

5. VOLTAGE FLUCTUATION

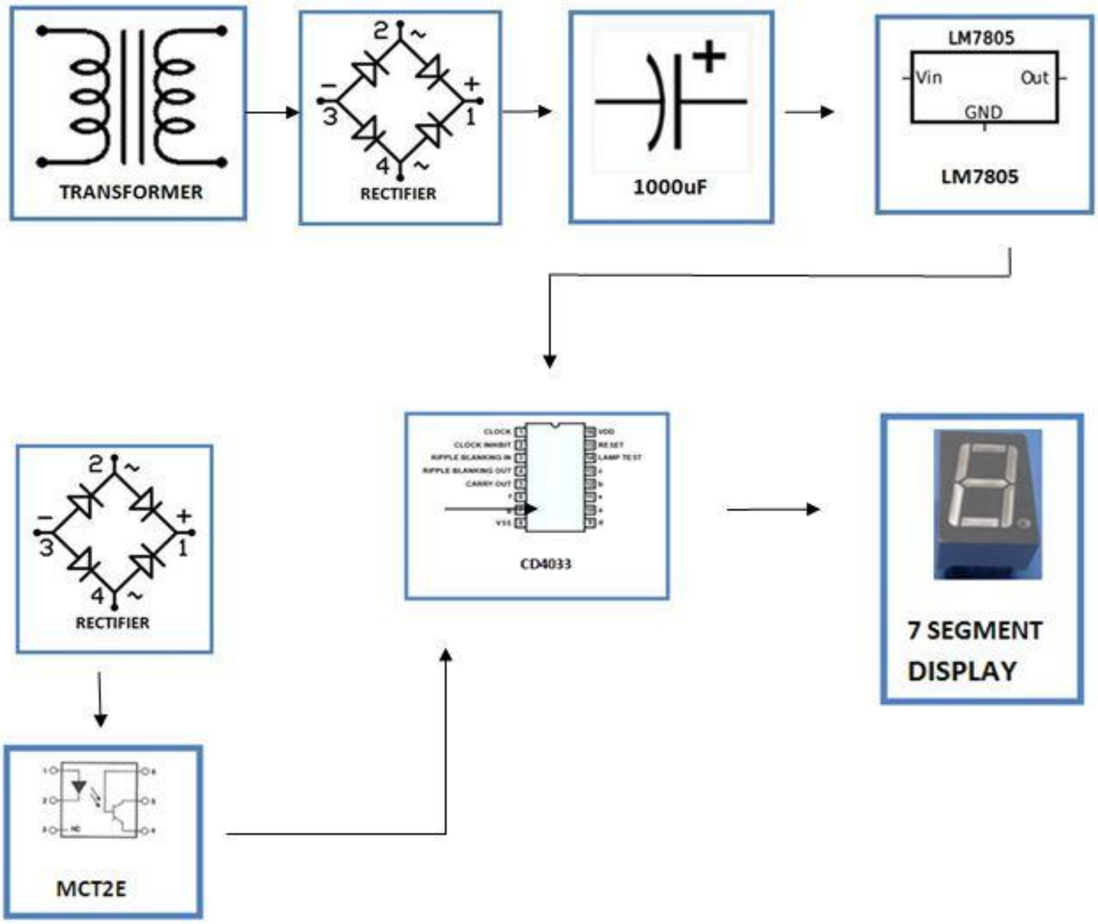
Since voltage fluctuations are fundamentally different from the rest of the waveform anomalies, they are placed in their own category. A voltage fluctuation is a systematic variation of the voltage waveform or a series of random voltage changes, of small dimensions, namely 95 to 105% of nominal at a low frequency, generally below 25 Hz. Any load exhibiting significant current variations can cause voltage fluctuations. Arc furnaces are the most common cause of voltage fluctuation on the transmission and distribution system.

6. FREQUENCY VARIATION

Frequency variation is extremely rare in stable utility power systems, especially systems interconnected via a power grid. Where sites have dedicated standby generators or poor power infrastructure, frequency variation is more common especially if the generator is heavily loaded.

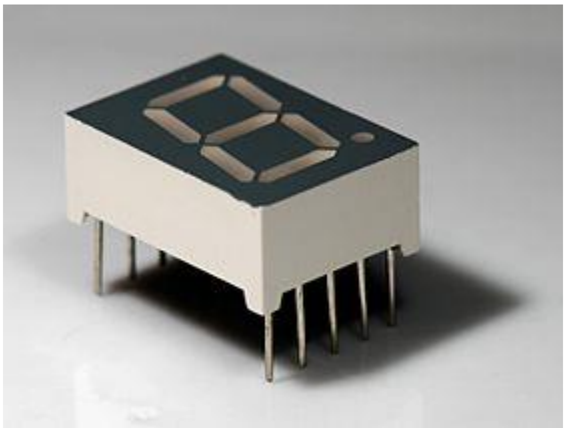
BLOCK DIAGRAM DESCRIPTION

The below shown is the block diagram of the device. The block diagram consists of a seven segment LCD display, a decade counter IC named CD4033, a step down transformer, a bridge rectifier, a voltage regulator LM 7805, an opto-isolator MCT2E and a 1000uf capacitor. The capacitor is used to store the energy which is then released into the circuit when needed.



1. SEVEN SEGMENT LCD DISPLAY

A seven-segment display (SSD), or seven-segment indicator, is a form of electronic display device for displaying decimal numerals that is an alternative to the more complex dot matrix displays.



Seven-segment displays are widely used in digital clocks, electronic meters, basic calculators and other electronic devices that display numerical information. Seven segment LCD display is interfaced with IC CD4033 which is also called a decade counter.

2. BRIDGE RECTIFIER

A diode bridge is an arrangement of four (or more) diodes in a bridge circuit configuration that provides the same polarity of output for either polarity of input. When used in its most common application, for conversion of an alternating-current (AC) input into a direct-current (DC) output, it is known as a bridge rectifier. A bridge rectifier provides full-wave rectification from a two-wire AC input, resulting in lower cost and weight as compared to a rectifier with a 3-wire input from a transformer with a center-tapped secondary winding.

The essential feature of a diode bridge is that the polarity of the output is the same regardless of the polarity at the input. Alternatives to the diode-bridge full-wave rectifiers are the center-tapped transformer and double-diode rectifier, and voltage doubler rectifier using two diodes and two capacitors in a bridge topology.

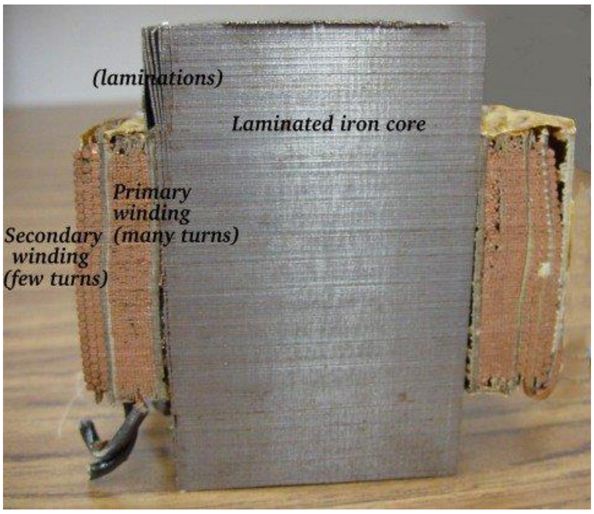
The 1N400x (or 1N4001 or 1N4000) series is a family of popular 1 A general-purpose silicon rectifier diodes commonly used in AC adapters for common household appliances. Its blocking voltage varies from 50 volts (1N4001) to 1000 volts (1N4007). This JEDEC device number series is available in the DO-41 axial package, and similar diodes are available in SMA and MELF surface mount packages (in other part number series).

The figure shows a hand-made diode bridge. The wide silver band on the diodes indicates the cathode side of the diode.

3. STEP DOWN TRANSFORMER

Transformer is a very useful device. With it, we can easily multiply or divide voltage and current in AC circuits. Indeed, the transformer has made long-distance transmission of electric power a practical reality, as AC voltage can be “stepped up” and current “stepped down” for reduced wire resistance power losses along power lines connecting generating stations with loads. At either end (both the generator and at the loads), voltage levels are reduced by transformers for safer operation and less expensive equipment. A transformer that increases voltage from primary to secondary (more secondary winding turns than primary winding turns) is called a step-up transformer. Conversely, a transformer designed to do just the opposite is called a step-down transformer.

The below figure shows the cross section of the transformer showing both the primary and secondary winding. 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.



Transformer cross-section showing primary and secondary windings is a few inches tall (approximately 10 cm).

4. CAPACITOR-1000uf

A capacitor is a passive two-terminal electronic component that stores electrical energy in an electric field. The effect of a capacitor is known as capacitance. While some capacitance exists between any two electrical conductors in proximity in a circuit, a capacitor is a component designed to add capacitance to a circuit. The capacitor was originally known as a condenser or condensator. Capacitors are widely used in electronic circuits for blocking direct current while allowing alternating current to pass. In analog filter networks, they smooth the output of power supplies. In resonant circuits they tune radios to particular frequencies. In electric power transmission systems, they stabilize voltage and power flow. The applications of the capacitors include energy storage, digital memory, pulsed power and weapons, power conditioning, suppression and cooling, signal processing and sensing.

5. DECADE COUNTER- IC CD4033

In this proposed mini project we use Johnson 5-stage decade counter. IC CD4033 (IC2) is a decade counter/7-segment decoder. Its pin 3 is held high so that the display initially shows '0.' Clock pulses are applied to clock input pin 1 and clock-enable pin 2 is held low to enable the counter.

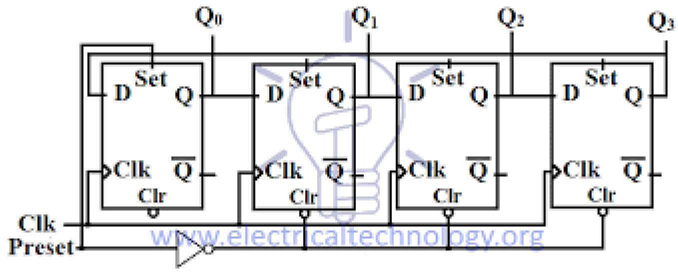


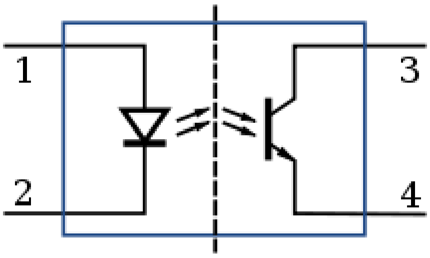
Fig: A schematic Johnson counter

A counter is a device which stores (and sometimes displays) the number of times a particular event or process has occurred, often in relationship to a clock signal. A counter circuit is usually constructed of a number of flip-flops connected in cascade. Counters are a very widely used component in digital circuits, and are manufactured as separate integrated circuits and also incorporated as parts of larger integrated circuits.

A decade counter is one that counts in decimal digits, rather than binary. A decade counter may have each (that is, it may count in binary-coded decimal, as the 7490 integrated circuit did) or other binary encodings. "A decade counter is a binary counter that is designed to count to 1010 (decimal 10).A decade counter is one that counts in decimal digits, rather than binary. It counts from 0 to 9 and then resets to zero. The counter output can be set to zero by pulsing the reset line low. The count then increments on each clock pulse until it reaches 1001 (decimal 9).

6. OPTOISOLATOR-MCT2E

An opto-isolator (also called an optocoupler, photo coupler, or optical isolator) is an electronic component that transfers electrical signals between two isolated circuits by using light. Opto-isolators prevent high voltages from affecting the system receiving the signal. Commercially available opto-isolators withstand input-to-output voltages up to 10 kV and voltage transients with speeds up to 25 kV/µs.



Schematic diagram of an opto-isolator showing source of light (LED) on the left, dielectric barrier in the center, and sensor (phototransistor) on the right

A common type of opto-isolator consists of an LED and a phototransistor in the same opaque package. Other types of source-sensor combinations include LED-photodiode, LED-LASCR, and lamp-photo resistor pairs. Usually opto-isolators transfer digital (on-off) signals, but some techniques allow them to be used with analog signals.

The operation of the optocoupler is very simple. An opto-isolator contains a source (emitter) of light, almost always a near infrared light-emitting diode (LED), that converts electrical input signal into light, a closed optical channel (also called dielectrically channel), and a photo sensor, which detects incoming light and either generates electric energy directly, or modulates electric current flowing from an external power supply. The sensor can be a photo resistor, a photodiode, a phototransistor, a silicon-controlled rectifier (SCR) or a triac. Because LEDs can sense light in addition to emitting it, construction of symmetrical, bidirectional opto-isolators is possible. An optocoupled solid-state relay contains a photodiode opto-isolator which drives a power switch, usually a complementary pair of MOSFETs. A slotted optical switch contains a source of light and a sensor, but its optical channel is open, allowing modulation of light by external objects obstructing the path of light or reflecting light into the sensor.

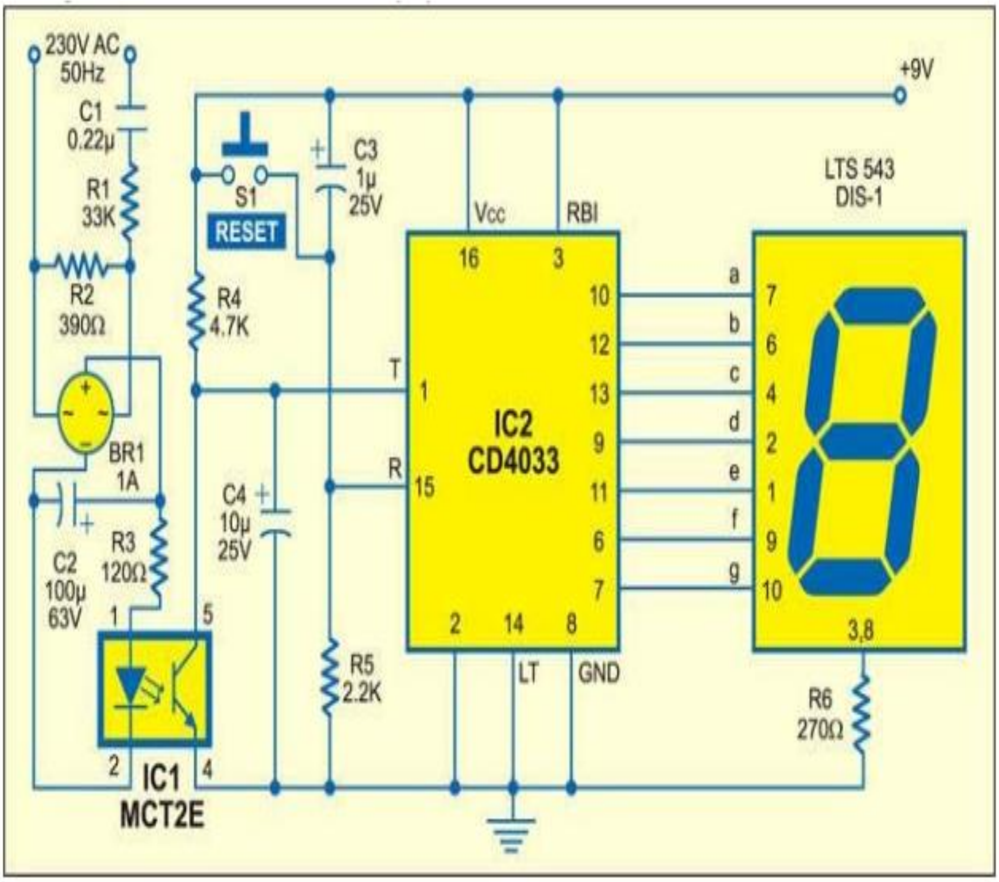
7. VOLTAGE REGULATOR-LM 7805

A voltage regulator is a system designed to automatically maintain a constant voltage level. A voltage regulator may use a simple feed-forward design or may include negative feedback. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. In automobile alternators and central power station generator plants, voltage regulators control the output of the plant. In an electric power distribution system, voltage regulators may be installed at a substation or along distribution lines so that all customers receive steady voltage independent of how much power is drawn from the line. Such devices are popular because they require few or no external components and provide the functions of pass element, voltage reference, and protection from overcurrent in one package. Here in this block we use LM 7805 as the voltage regulator.

An IC voltage regulator in a TO-220 style package

CIRCUIT DIAGRAM DESCRIPTION



This circuit counts mains supply interruptions (up to 9) and shows the number on a 7-segment display. It is highly useful for automobile battery chargers. Based on the number of mains interruptions, the user can extend the charging time for lead-acid batteries.

IC CD4033 is a decade counter 7-segment decoder. Its pin 3 is held high so that the display initially shows '0.' Clock pulses are applied to clock input pin 1 and clock-enable pin 2 is held low to enable the counter. Seven-segment, common-cathode display indicates the mains interruption count. Capacitor provides a small turn-on delay for the display. This circuit contains three stage, first one is AC power input stage, second stage is optocoupler & Johnson decade counter then final third stage is number display.

Figure above shows the circuit of the interruption counter with indicator. A 9V (PP3 or 6F22) battery powers the entire circuit. Figure below shows the block diagram of the mains interruption counter circuit along with the battery charger and lead-acid battery as used in automobile battery charger shops.

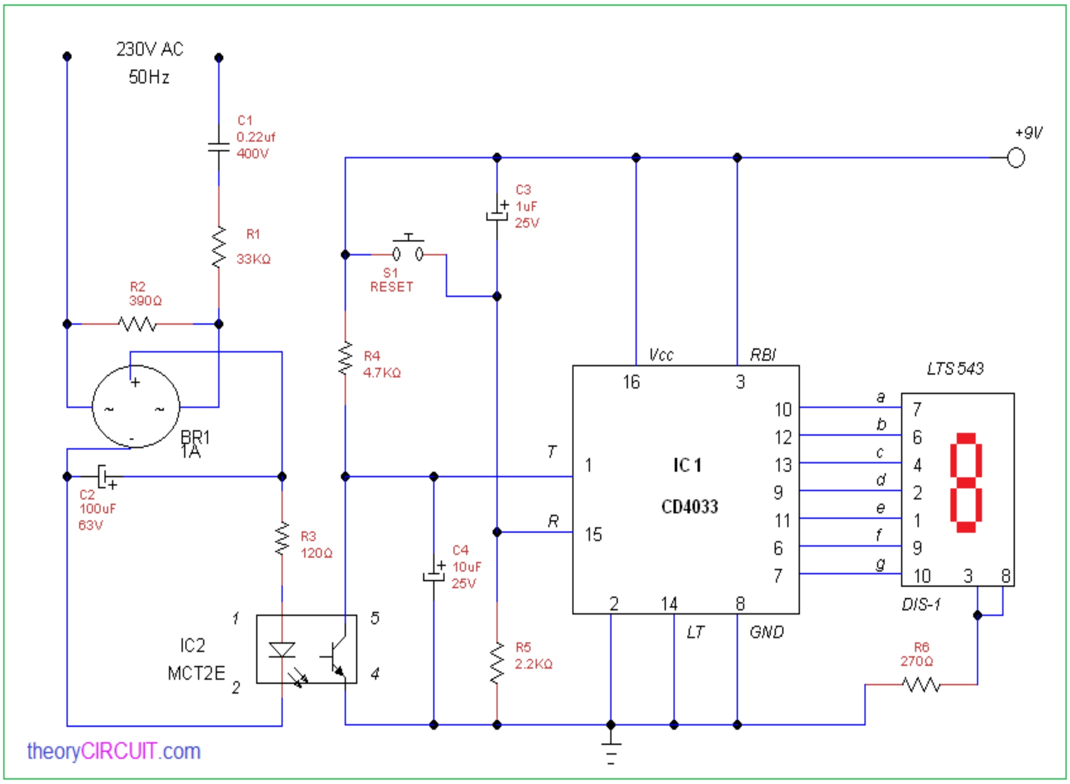
When 9V is applied to the circuit, IC2 is reset by the power-on-reset signal provided by capacitor C3 and resistor R5 and the 7-segment display (DIS1) shows ‘0.’ The 230V AC mains is fed to mains-voltage detection optocoupler IC MCT2E (IC1) via capacitor C1 and resistors R1 and R2 followed by bridge rectifier BR1, smoothing capacitor C2 and current-limiting resistor R2. Illumination of the LED inside optocoupler IC1 activates its internal phototransistor and clock input pin 1 of IC2 is pulled down to low level.

CONSTRUCTION AND WORKING

First stage of this circuit is getting AC power that need to be counted on interruption, by using polyester capacitor C1 and Bridge Rectifier high voltage AC supply is bring down to low Voltage DC then IC2 (opto coupler detector) MCT2E detects the interruption to the AC supply, this event clock is counted by the IC CD4033 (5 stage Johnson decade counter) and drives the seven segment display LTS543.A Reset switch is connected at the pin 15 of IC1, this circuit needs separate DC power source at 9V.

CIRCUIT OPERATION

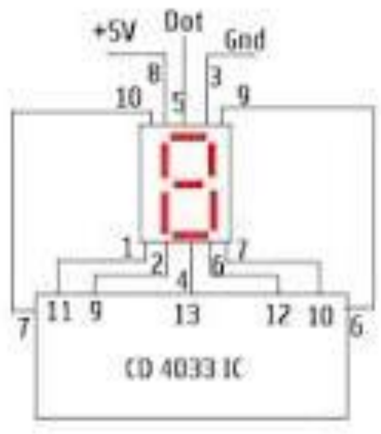
When mains fails for the first time, clock input pin 1 of IC2 again goes high and display DIS1 shows ‘1.’ When mains resumes, pin 1 of IC2 goes low and DIS1 continues to show ‘1.’ When mains fails for the second time, clock input pin 1 of IC2 goes high and display DIS1 shows ‘2.’ When mains resumes, pin 1 of IC2 again goes low and DIS1 continues to show ‘2.’ This way, the counter keeps incrementing by ‘1’ on every mains interruption. Note that this circuit can count up to nine mains interruptions only.



1. INTERFACING CD4033 WITH LEDS

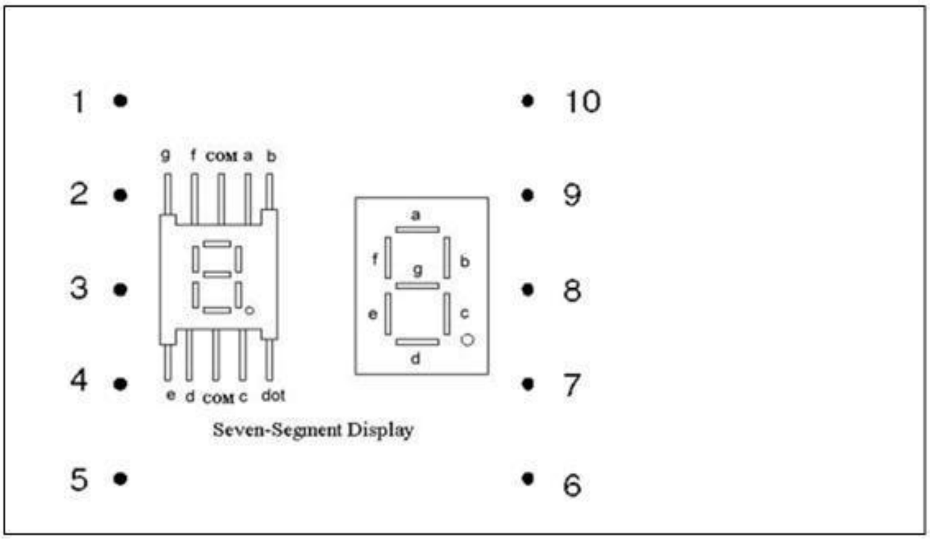
Below circuit can be used to detect the electromagnetic radiation or emf present around it. The radiation may from TV, computer etc.

Working of circuit is simple whenever it detects radiation it receive clock at pin put 1 and its counter starts and LED's connected at output stars glowing. And the cycle repeats till the reset pin receives high at its input.



2. INTERFACING CD4033 WITH SEVEN SEGMENT DISPLAY

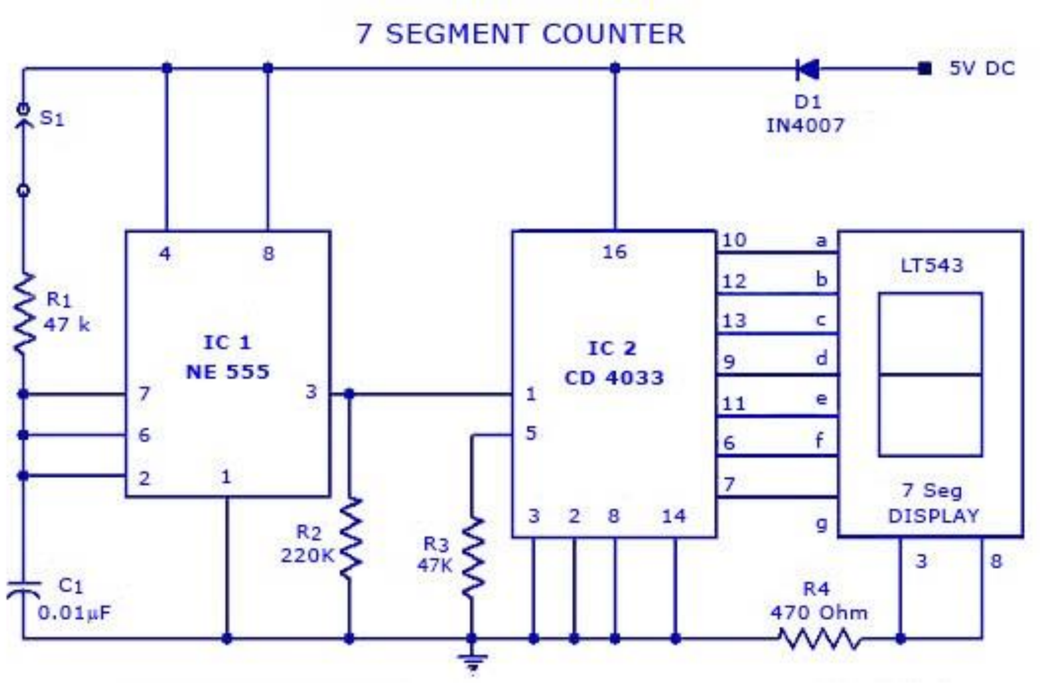
The circuit describes below count numbers from 0 to 9 and display the same on 7 segment display. Whenever you press the switch, clock input receives the signals and its counter advances one by one. And it will count up to 9 and again start counting from 0 on each successive pressing of switch. Pin configuration of 7 segment display can be obtained from the figure shown below.



3. INTERFACING CD4033 WITH THE TIMER IC

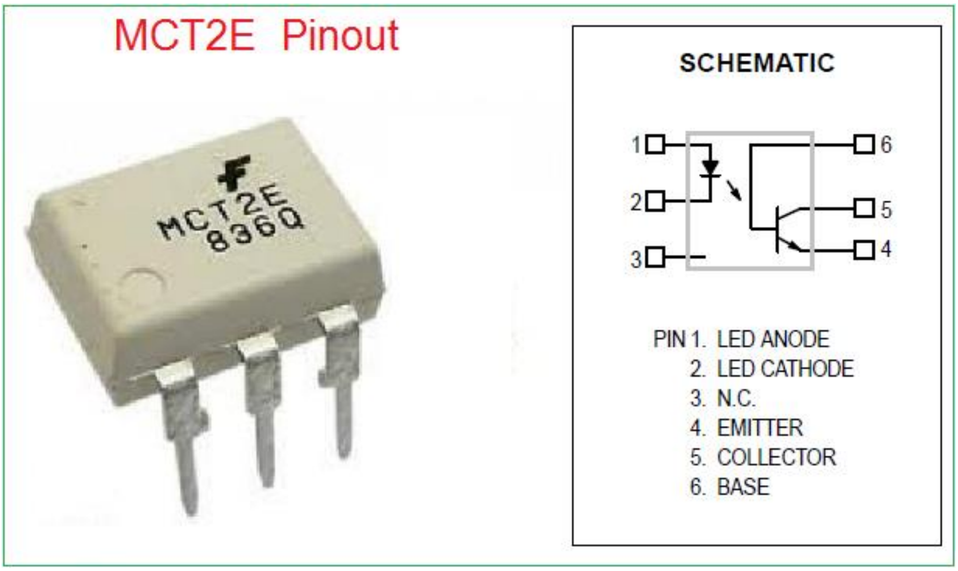
In the following circuit we have used a 555 timer in astable oscillator mode to provide clock signal to input of IC CD4033 to start its counting which can be display on 7 segment display. Here reset switch is used to reset the counting any time needed by the user.

You can also interface two CD4033 IC if you want to increase the counting beyond 9. This can be done by cascading 2 CD4033 IC, connect the carry out of first IC to the clock input of second IC. Now when first IC completes its counting than second IC will start the counting. Connect reset pin of both the IC together and ground it with the help of resistor. And make rest connection like done in following circuit. Similarly you can cascade more IC's. Now you can perform different experiments and play around this IC like you can add LDR so that it will start its counter when shadow falls on it or you can cascade two or more CD4033 to make timer circuits etc.



HARDWARE DESCRIPTION

1. MCT2E-OPTOISOLATOR



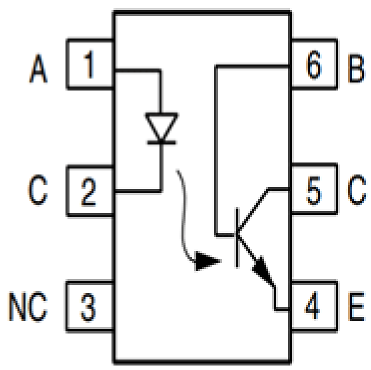
1	Anode (A)	Anode pin of the IR LED. Connected to logic input
2	Cathode (C)	Cathode pin of the IR LED
3	NC	Cannot be used
4	Emitter (E)	Emitter pin of the Transistor. Connected to isolated ground.
5	Collector (C)	Collector pin of the Transistor. This is the logic output pin
6	Base (B)	Base pin of the Transistor. It is normally not used for transistor mode, but will be used in diode mode

DESCRIPTION

- ❖ Standard single channel phototransistors couplers. The MCT2/MCTE family is an industry standard single channel phototransistor
- ❖ Each optocoupler consists of gallium arsenide infrared LED and a silicon NPN phototransistor.
- ❖ These couplers are Underwriters Laboratories (UL) listed to comply with a 5300V_{RMS} isolation test voltage.
- ❖ This isolation is accomplished through Vishay double molding isolation manufacturing process.
- ❖ These isolation processes and the Vishay ISO9001 quality program results in the highest isolation process available for a commercial plastic phototransistor optocoupler.
- ❖ The devices are available in lead formed configuration suitable for surface mounting and are available either on tape and reel, or in standard tube shipping containers.

WHERE TO USE MCT2E PHOTOTRANSISTOR OPTOCOUPLER

MCT2E is a phototransistor optocoupler, as the name “phototransistor” suggests it has a transistor which is controlled based on light (photon). So this IC basically has an IR (infrared) LED and a photo-transistor inside it. When the IR led is powered the light from it falls on the transistor and it conducts. The arrangement and pin-outs of the IR LED and the photo-transistor is shown below.



This IC is used to provide electrical isolation between two circuits, one part of the circuit is connected to the IR LED and the other to Photo-transistor. The digital signal given to the IR LED will be reflected on the transistor but there will be no hard electrical connection between the two. This comes in very handy when you are trying to isolate a noisy signal from your digital electronics, so if you are looking for an IC to provide optical isolation in your circuit design then this IC might be the right choice for you.

HOW TO USE MCT2E

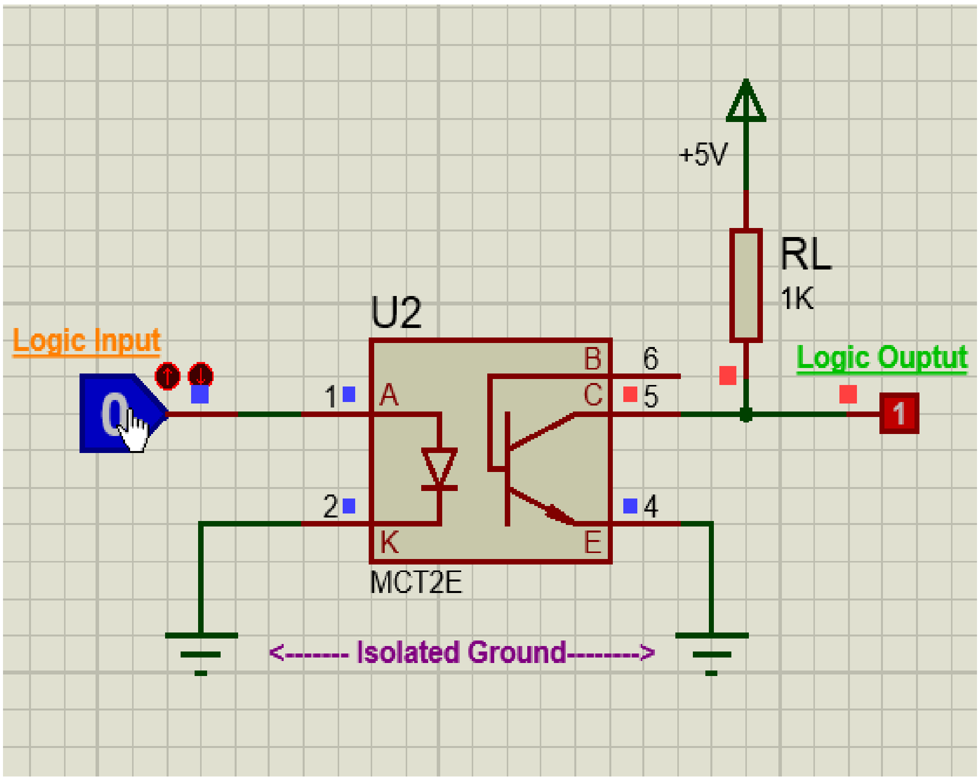
The MCT2E can be used in two modes, the Phototransistor mode and the photodiode mode. Out of which the Phototransistor mode is mostly used, so let us look at that mode first.

In the Photo-transistor mode we will not be using the base pin (pin 6) of the transistor; we just have to connect the anode pin of the IR LED (pin 1) to the logic input which has to be isolated and the cathode (pin 2) of the IR led to the ground. Then Pull high the collector pin of the transistor using a resistor (here I have used 1K) and connect the collector pin to the output of your desired logic circuit. The Emitter (pin 4) is grounded.

Now, when the Logic input is low the IR LED will not conduct and hence the transistor will also be in off state. Hence the Logic output will remain high, this high voltage can be set anywhere up-to 30V (Collector-Emitter Voltage) here I have used +5V. There pull-up resistor 1K acts as a load resistor.

But when the Logic input is made high, this high voltage should be a minimum of 1.25V (Diode Forward voltage) the IR LED conducts and so the photo-transistor is also turned on. This will short the collector and emitter and hence the Logic Output voltage will become zero. This way the logic input will be reflected at the logic output and still provides and isolation between the two. The complete working can also be understood form the GIF file above.

Another important parameter to consider while using an Optocoupler, is the rise time (tr) and fall time (tf). The output will not get high as soon as the input logic is made low and vice versa. The below waveform shows the time taken for the output to transit from one state to another. For MCT2E the rise time (TPDHL) and fall time (TPDLH) is 5us.



FEATURES

- Interfaces with common logic families.
- Input-output coupling capacitances<0.5pF
- Industry standard dual in-line 6-pin package
- 5300V_{RMS} isolation test voltage

MCT2E SPECIFICATIONS

- Input Diode Forward Voltage: 1.25V
- Collector-Emitter Voltage: 30V
- On-State Collector Current: 5mA
- Transistor HFE: 300
- Rise Time: 5us
- Fall Time: 5us
- Available as 6-pin PDIP with and without M-suffix

MCT2E EQUIVALENTS

4N35 Optocoupler IC

ALTERNATIVE OPTOCOUPLERS

MOC3021 (Zero Cross TRIAC), MOC3041 (Non-Zero Cross TRIAC), FOD3180 (High-Speed MOSFET),

ADVANTAGES

- Control circuits are well protected due to electrical isolation.
- Wideband signal transmission is possible.
- Due to unidirectional signal transfer, noise from the output side does not get coupled to the input side.
- Interfacing with logic circuits is easily possible.
- It is small size & light weight device.

DISADVANTAGES

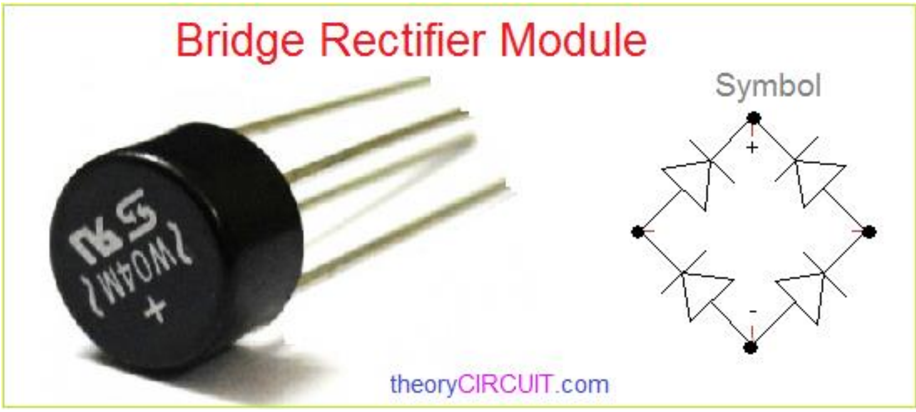
- Slow speed.
- Possibility of signal coupling for high power signals.

APPLICATIONS

- AC mains detection
- Reed relay driving
- Switch mode power supply feedback
- Telephone ring detection
- Logic ground isolation
- Logic coupling with high frequency noise rejection

2. BRIDGE RECTIFIER

A rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction. The process is known as rectification, since it "straightens" the direction of current.

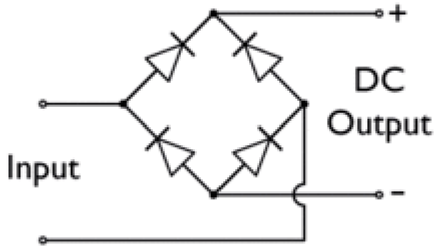


Rectifiers have many uses, but are often found serving as components of DC power supplies and high-voltage direct current power transmission systems. Rectification may serve in roles other than to generate direct current for use as a source of power. As noted, detectors of radio signals serve as rectifiers. In gas heating systems flame rectification is used to detect presence of a flame. Rectifier circuits may be single-phase or multi-phase (three phase being the most common number of phases).

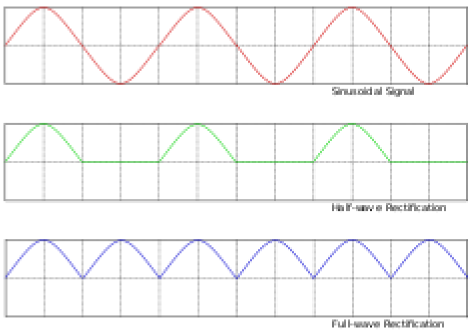
A diode is a two-terminal electronic component that conducts current primarily in one direction (asymmetric conductance); it has low (ideally zero) resistance in one direction, and high (ideally infinite) resistance in the other. A semiconductor diode, the most common type today, is a crystalline piece of semiconductor material with a p–n junction connected to two electrical terminals. The most common function of a diode is to allow an electric current to pass in one direction (called the diode's forward direction), while blocking it in the opposite direction (the reverse direction). This unidirectional behavior is called rectification, and is used to convert alternating current (ac) to direct current (dc).

There are two types of rectifications possible: half-wave rectification and full- wave rectifications. Therefore there are two types of rectifiers available: half wave rectifier and full wave rectifier. A full-wave rectifier converts the whole of the input waveform to one of constant polarity (positive or negative) at its output. Mathematically, this corresponds to the absolute value function. In half-wave rectification of a single-phase supply, either the positive or negative half of the AC wave is passed, while the other half is blocked. Mathematically, it is a step function (for positive pass, negative block): passing positive corresponds to the ramp function being the identity on positive inputs, blocking negative corresponds to being zero on negative inputs.

A diode bridge is an arrangement of four (or more) diodes in a bridge circuit configuration that provides the same polarity of output for either polarity of input. When used in its most common application, for conversion of an alternating-current (AC) input into a direct-current (DC) output, it is known as a bridge rectifier. A bridge rectifier provides full-wave rectification from a two-wire AC input, resulting in lower cost and weight as compared to a rectifier with a 3-wire input from a transformer with a center-tapped secondary winding



Alternatives to the diode-bridge full-wave rectifiers are the center-tapped transformer and double-diode rectifier, and voltage doubler rectifier using two diodes and two capacitors in a bridge topology.



AC, half-wave and full-wave rectified signals

FEATURES

- ✓ Diffused junction
- ✓ Low forward voltage drop
- ✓ High current capability
- ✓ Low reverse leakage current
- ✓ Lead free finish

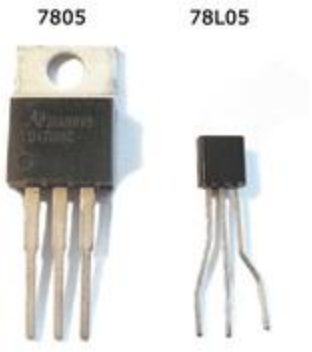
APPLICATIONS

- Radio demodulation
- Form logic gates
- Power conversion
- Over voltage protection
- Temperature measurements
- Current steering
- Waveform clipper and clamper

3. VOLTAGE REGULATOR

The voltage regulator we use in this proposed project is three terminal 1A positive voltage regulator. The UTC LM78XX family is monolithic fixed voltage regulator integrated circuit. They are suitable for applications that required supply current up to 1A.

78xx (sometimes L78xx, LM78xx, MC78xx...) is a family of self-contained fixed linear voltage regulator integrated circuits. The 78xx family is commonly used in electronic circuits requiring a regulated power supply due to their ease-of-use and low cost. For ICs within the 78xx family, the *xx* is replaced with two digits, indicating the output voltage (for example, the 7805 has a 5-volt output, while the 7812 produces 12 volts).

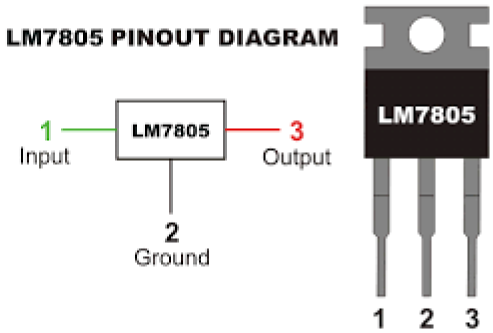


7805 in TO-220 and TO-92 packages

The 78xx line are positive voltage regulators: they produce a voltage that is positive relative to a common ground. There is a related line of 79xx devices which are complementary negative voltage regulators. 78xx and 79xx ICs can be used in combination to provide positive and negative supply voltages in the same circuit.78xx ICs have three terminals and are commonly found in the TO-220 form factor, although they are available in surface-mount, TO-92, and TO-3 packages. These devices support an input voltage anywhere from around 2.5 volts over the intended output voltage up to a maximum of 35 to 40 volts depending on the model, and typically provide 1 or 1.5 amperes of current (though smaller or larger packages may have a lower or higher current rating).

There are common configurations for 78xx ICs, including 7805 (5 V), 7806 (6 V), 7808 (8 V), 7809 (9 V), 7810 (10 V), 7812 (12 V), 7815 (15 V), 7818 (18 V), and 7824 (24 V) versions. The 7805 is the most common, as its regulated 5-volt supply provides a convenient power source for most TTL components. Less common are lower-power versions such as the LM78Mxx series (500 mA) and LM78Lxx series (100 mA) from National Semiconductor. Some devices provide slightly different voltages than usual, such as the LM78L62 (6.2 volts) and LM78L82 (8.2 volts) as well as the STMicroelectronics L78L33ACZ (3.3 volts). The 7805 has been used in some ATX power supply designs for the +5VSB (+5V stand by) output.

PINOUT OF LM 78XX



FEATURES

- Output current up to 1A.
- Fixed output voltage of 3.3V,4.7V,5V,6V,7V,8V,9V,10V,12V,,15V,18V AND 24V available.
- Thermal overload shutdown protection.
- Short circuit current limiting.
- Output transistor SOA protection.

ADVANTAGES

- While external capacitors are typically required, 78xx series ICs do not require additional components to set their output voltage. 78xx designs are simple in comparison to switch-mode power supply designs.
- 78xx series ICs have built-in protection against a circuit drawing too much current. They have protection against overheating and short-circuits, making them robust in most applications.

DISADVANTAGES

- The input voltage must always be higher than the output voltage by some minimum amount (typically 2.5 volts). This can make these devices unsuitable for powering some devices from certain types of power sources
- As they are based on a linear regulator design, the input current required is always the same as the output current.
- When using them in 'LM317 mode', with an R1/R2 voltage divider, note that the bias/adjust current drawn is several orders of magnitude higher (5 mA vs 50 µA), so this extra current makes the simple R1/R2 voltage division calculation less accurate for higher values of R.

APPLICATIONS

- AV devices
- Small –power supply units
- Measurement devices
- Medical equipment
- RF, radio communication devices.

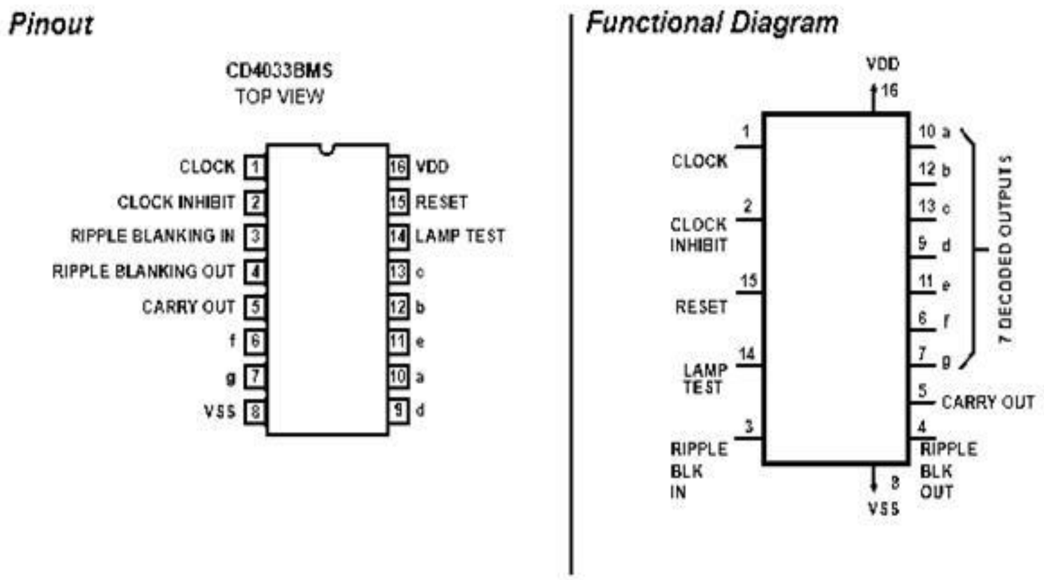
4. DECADE COUNTER

The IC 4033 is a Johnson decade counter/decoder IC specifically designed for working with 7 segment displays. Basically it's a clock or pulse counter IC which responds to positive pulses at its clock input and decodes it serially to produce a directly readable display of the count number through the connected 7 segment display module.CD 4033 commonly used in digital display. It has a 5 stage Johnson decade counter with decoder which convert the Johnson code to a 7 segment decoded output. Means it will convert the input into numeric display which can be seen on 7 segment display or with the help of LED's. CD4026B AND CD4033B each consists of a 5-stage Johnson decade counter and an output decoder which converts Johnson code to a 7-segment decoded output for driving one stage in a numerical display. These devices are particularly advantageous in display applications where power dissipation low and/or low package count are important.

Inputs common to both types are CLOCK RESET and CLOCK INHIBIT; common outputs are CARRY OUT and the seven decoded outputs (a,b,c,d,e,f,g).Additional inputs and outputs for the CD4026B include DISPLAY ENABLE input and DISPLAY ENABLE and UNGATED “C-SEGMENT” outputs. Signals peculiar to the CD4033B are RIPPLE-BLANKING INPUT AND LAMP TEST INPUT and a RIPPLE-BLANKING OUTPUT.

A high RESET signal clears the decade counter to its zero count. The counter is advanced one count at the positive clock signal transition if the CLOCK INHIBIT signal is LOW. Counter advancement via the clock line is inhibited when the CLOCK INHIBIT signal is high. The CLOCK INHIBIT signal can be used as a negative-edge clock if the clock line is held high. Antilock gating is provided on the JOHNSON counter, thus assuring proper counting sequence. The CARRY-OUT (C_{OUT}) signal completes one cycle every ten CLOCK INPUT cycles and is used to clock the succeeding decade directly in a multi-decade counting chain. The seven decoded outputs (a,b,c,d,e,f,g) illuminate the proper segments in a seven segment display device used for representing the decimal numbers 0 to 9.The 7-segment outputs go high on selection in the CD 4033B;in the CD4026B these outputs go high only when DISPLAY ENABLE IN is high.

Advantage of this IC is it can be operated at high voltage of 20V. But is highly sensitive, can detect emf present in the atmosphere and is sensitive to static charge also. When you touch your finger at its input terminal its counter get started therefore care should be taken while using it. It can be used in various application like in 7 segment decimal display circuit, in clocks, timer etc. To understand its working first have a look on its pin diagram.



1. **Pin 1 known as Clock in** - It receives clock signals, and at every positive clock counter advances one by one. You can provide clock with the switch, 555 timer or with the help of logic gates.

2. **Pin 2 known as Clock inhibit** - CD4033 counter advances one by one by receiving positive pulse at this time clock inhibit pin should be grounded. If it is connected to supply than counter advancement will be inhibited means there will be no meaning of clock pulse.

3. **Pin 3 and pin 4 known as Ripple blanking in and Ripple blanking** - It is used to display only one zero blanking the other zero. For this IC have ripple blanking in and ripple blanking out. For example you want to display 345 and you are using five 7 segment display then it will display 00345 if blanking input and out is off. But if it is on than you will receive 345. It improves the readability of the circuit.

4. **Pin 5 known as carry out** - It is used to complete one cycle for every 10 clock input cycle and it also used to cascade more IC's.

5. **Pin 6, pin7 and Pin9 to pin 13** - These are 7 decoded output from a to g used to illuminates the corresponding segment of 7 segment display to display the digit from 0 to 9.

6. **Pin 14 known as Lamp test -** It is used to check that all segments of 7 segment is working properly or not. For testing momentarily make the pin low.

7. **Pin 15 known as Reset -** It is used to reset the counter. When it receives high it clears the counter and counting again starts from zero. One important thing reset pin should again made low to start the counter once again.

8. **Pin 8 known as ground** pin and **Pin 16 known as V_{dd} -**It should be connected to power supply.

FEATURES

- Counter and seven segment decoding in one package.
- Easily interfaced with 7-segment display types.
- Ideal for low power displays.
- Schmitt –triggered clock inputs.
- Ripple Blanking and Lamp Test.
- Standardized, symmetrical output characteristics.
- Fully static counter operation: DC to 6Mhz at V_{DD}=10V
- 100% tested for quiescent current at 20V
- 5V, 10V and 15V parametric ratings.

APPLICATIONS

- Decade counting 7-segment decimal display.
- Clock, watches, timers.
- Frequency division 7-segment decimal displays.
- Counter/display driver for meter applications.

5. STEP-DOWN TRANSFORMER

A transformer is an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. Electromagnetic induction produces an electromotive force within a conductor which is exposed to time varying magnetic fields. Transformers are used to increase or decrease the alternating voltages in electric power applications. It is a step down transformer in which the secondary winding is more than primary winding. Due to this windings it can able to step down the voltage. A Transformer changes electricity from high to low voltage or low to high voltage using two properties of electricity. A Step down Transformer is a device which converts high primary voltage to a low secondary voltage. Transformer work on the principle of "Faraday's law of electromagnetic induction". Mutual induction between the windings is responsible for transmission action in a transformer. Faraday's law states that "when the magnetic flux linking a circuit changes, an electromotive force is induced in the circuit proportional to the rate of change of the flux linkage". The emf (Electro Motive Force) induced between the two windings is determined by the number of turns in primary and secondary winding respectively. This ratio is called as Turns Ratio. The voltage reduction capability of step down transformers depends on the turn ratio of the primary and secondary coil. The Transformer act as step down transformer reducing AC - 240V to AC - 12V.

FEATURES

- Output current: 1A
- Supply voltage: 220-230VAC
- Output voltage: 12VAC
- Soft Iron Core
- 1Amp Current Drain

APPLICATIONS

- DIY projects Requiring In-Application High current drain.
- On chassis AC/AC converter.
- Designing a battery Charger.
- Electronic applications.
- Step down applications (Power transmission).
- In main adapters and chargers for cell phones, stereos and CD players
- To step down the voltage level in transmission line
- In welding machines by reducing voltage and increasing current.
- In televisions, voltage stabilizers, inverters, etc.

Step down Transformers can be classified into three categories based on tapings in secondary coil. They are:

- Single Phase Step Down Transformer
- Center Tapped Step Down Transformer
- Multi Tapped Step Down Transformer

ADVANTAGES

- Useful in stepping down the voltage, thereby making transmission power easier and cheaper
- More than 99% of efficiency
- Provides varied voltage requirements
- Low Cost
- High Reliability
- High Durability

DISADVANTAGES

- ✓ Requires a lot of maintenance failing which can damage the transformer
- ✓ Volatility in feedstock costs
- ✓ Fault rectification takes more time

6.7 SEGMENT LCD DISPLAY

A seven-segment display (SSD), or seven-segment indicator, is a form of electronic display device for displaying decimal numerals that is an alternative to the more complex dot matrix displays. Seven-segment displays are widely used in digital clocks, electronic meters, basic calculators, and other electronic devices that display numerical information.

CONCEPT

The seven elements of the display can be lit in different combinations to represent the Arabic numerals. Often the seven segments are arranged in an oblique (slanted) arrangement, which aids readability. In most applications, the seven segments are of nearly uniform shape and size (usually elongated hexagons, though trapezoids and rectangles can also be used), though in the case of adding machines, the vertical segments are longer and more oddly shaped at the ends in an effort to further enhance readability. The numerals 6 and 9 may be represented by two different glyphs on seven-segment displays, with or without a 'tail'. The numeral 7 also has two versions, with or without segment F. The seven segments are arranged as a rectangle of two vertical segments on each side with one horizontal segment on the top, middle, and bottom. Additionally, the seventh segment bisects the rectangle horizontally. There are also fourteen-segment displays and sixteen-segment displays (for full alpha numeric); however, these have mostly been replaced by dot matrix displays. Twenty-two segment displays capable of displaying the full ASCII character set were briefly available in the early 1980s, but did not prove popular. The segments of a 7-segment display are referred to by the letters A to G, where the optional decimal point (an "eighth segment", referred to as DP) is used for the display of non-integer numbers.

IMPLEMENTATIONS

Seven-segment displays may use a liquid crystal display (LCD), a light-emitting diode (LED) for each segment, an electro chromic display, or other light-generating or controlling techniques such as cold cathode gas discharge, vacuum fluorescent, incandescent filaments, and others.

A multiplexed 4-digit, seven-segment display with only 12 pins

Multiple-digit LED displays as used in pocket calculators and similar devices used multiplexed displays to reduce the number of I/O pins required to control the display.

LIQUID CRYSTAL DISPLAY

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and seven-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements. LCDs can either be normally on (positive) or off (negative), depending on the polarizer arrangement. For example, a character positive LCD with a backlight will have black lettering on a background that is the color of the backlight, and a character negative LCD will have a black background with the letters being of the same color as the backlight. Optical filters are added to white on blue LCDs to give them their characteristic appearance.

LCDs are slowly being replaced by OLEDs, which can be easily made into different shapes, and have a lower response time, wider color gamut, virtually infinite color contrast and viewing angles, lower weight for a given display size and a slimmer profile and potentially lower power consumption. OLEDs, however, are more expensive for a given display size due to the very expensive electroluminescent materials or phosphors that they use. Also due to the use of phosphors, OLEDs suffer from screen burn-in and there is currently no way to recycle OLED displays, whereas LCD panels can be recycled, although the technology required to recycle LCDs is not yet widespread. Attempts to increase the lifespan of LCDs are quantum dot displays, which offer similar performance as an OLED display, but the Quantum dot sheet that gives these displays their characteristics cannot yet be recycled.

SPECIFICATIONS

- **Resolution** The resolution of an LCD is expressed by the number of columns and rows of pixels (e.g., 1024×768). Each pixel is usually composed 3 sub-pixels, a red, a green, and a blue one.

- **Spatial performance:** For a computer monitor or some other display that is being viewed from a very close distance, resolution is often expressed in terms of dot pitch or pixels per inch, which is consistent with the printing industry.
- **Temporal performance:** the temporal resolution of an LCD is how well it can display changing images, or the accuracy and the number of times per second the display draws the data it is being given.
- **Color performance**: There are multiple terms to describe different aspects of color performance of a display. Color gamut is the range of colors that can be displayed, and color depth, which is the fineness with which the color range is divided.
- **Brightness and contrast ratio:** Contrast ratio is the ratio of the brightness of a full-on pixel to a full-off pixel. Brightness is usually stated as the maximum light output of the LCD, which can vary greatly based on the transparency of the LCD and the brightness of the backlight.

ADVANTAGES

- Very compact, thin and light, especially in comparison with bulky, heavy CRT displays.
- Low power consumption.
- Little heat emitted during operation, due to low power consumption.
- No geometric distortion.
- The possible ability to have little or no flicker depending on backlight technology.
- Sharp image with no bleeding or smearing when operated at native resolution.
- Emits almost no undesirable electromagnetic radiation (in the extremely low frequency range), unlike a CRT monitor.
- Can be made in almost any size or shape.
- No theoretical resolution limit.
- Can be made in large sizes of over 80-inch (2 m) diagonal.
- Unaffected by magnetic fields, including the Earth's.

DISADVANTAGES

- Limited viewing angle in some older or cheaper monitors, causing color, saturation, contrast and brightness to vary with user position, even within the intended viewing angle.
- Only one native resolution.

- Input lag, because the LCD's A/D converter waits for each frame to be completely been output before drawing it to the LCD panel.
- Loss of brightness and much slower response times in low temperature environments.
- Loss of contrast in high temperature environments.

APPLICATIONS

- ❖ LCD televisions, computer monitors, instrument panels, aircraft cockpit displays, and indoor and outdoor signage.
- ❖ Small LCD screens are common in portable consumer devices such as digital cameras, watches, calculators, and mobile telephones, including smartphones.
- ❖ LCD screens are also used on consumer electronics products such as DVD players, video game devices and clocks.
- ❖ LCD screens are available in a wider range of screen sizes than CRT and plasma displays, with LCD screens available in sizes ranging from tiny digital watches to very large television receivers.

7. CAPACITOR

A capacitor is a passive two-terminal electronic component that stores electrical energy in an electric field. The effect of a capacitor is known as capacitance. The capacitor was originally known as a condenser or condensator. The physical form and construction of practical capacitors vary widely and many capacitor types are in common use. Most capacitors contain at least two electrical conductors often in the form of metallic plates or surfaces separated by a dielectric medium. A conductor may be a foil, thin film, sintered bead of metal, or an electrolyte. The non-conducting dielectric acts to increase the capacitor's charge capacity. Materials commonly used as dielectrics include glass, ceramic, plastic film, paper, mica, and oxide layers. Capacitors are widely used as parts of electrical circuits in many common electrical devices. Unlike a resistor, an ideal capacitor does not dissipate energy.

The forms of practical capacitors vary widely, but all contain at least two electrical conductors separated by a dielectric (insulator); for example, one common construction consists of metal foils separated by a thin layer of insulating film. When there is a potential difference (voltage) across the conductors, a static electric field develops across the dielectric, causing positive charge to collect on one plate and negative charge on the other plate. Energy is stored in the electrostatic field. An ideal capacitor is characterized by a single constant value, capacitance, measured in farads. This is the ratio of the electric charge on each conductor to the potential difference between them.

The capacitance is greatest when there is a narrow separation between large areas of conductor, hence capacitor conductors are often called plates, referring to an early means of construction. In practice, the dielectric between the plates passes a small amount of leakage current and also has an electric field strength limit, resulting in a breakdown voltage, while the conductors and leads introduce an undesired inductance and resistance. The capacitance of a capacitor is proportional to the surface area of the plates (conductors) and inversely related to the gap between them. In practice, the dielectric between the plates passes a small amount of leakage current. It has an electric field strength limit, known as the breakdown voltage. The conductors and leads introduce an undesired inductance and resistance.

Capacitance is defined as the ratio of the electric charge on each conductor to the potential difference between them. The unit of capacitance is the farad (F), defined as one coulomb per volt (1 C/V). Capacitance values of typical capacitors for use in general electronics range from about 1 Pico farad (pF) (10^{-12} F) to about 1 mili farad (mF) (10^{-3} F). Capacitors are widely used in electronic circuits for blocking direct current while allowing alternating current to pass. In analog filter networks, they smooth the output of power supplies. In resonant circuits they tune radios to particular frequencies. In electric power transmission systems, they stabilize voltage and power flow.

8. AC adapter

An adapter or adaptor is a device that converts attributes of one device or system to those of an otherwise incompatible device or system. Some modify power or signal attributes, while others merely adapt the physical form of one connector to another. There are different types of adapters we use mainly. They are:

Switch-mode mobile phone charger

1. TRAVEL ADAPTER

Difficulty arises when moving an electrical device between countries that use different sockets. A passive electric power adapter, sometimes called a travel plug or travel adapter, allows using a plug from one region with a foreign socket. As other countries supply 120-volt, 60 Hz AC, using a travel adapter in a country with a different supply poses a safety hazard if the connected device does not support both input voltages.

2. AC TO DC ADAPTERS

We use this kind of adapter in our proposed mini project. An AC-to-DC power supply adapts electricity from household mains voltage (either 120 or 230 volts AC) to low-voltage DC suitable for powering consumer electronics. Small, detached power supplies for consumer electronics are called AC adapters, or variously power bricks, wall warts, or chargers.

3. COMPUTER ADAPTERS

A host controller connects a computer to a peripheral device, such as a storage device, network, or human interface device. As a host controller can also be viewed as bridging the protocols used on the buses between peripheral and computer, and internally to the computer, it is also called a host bus adapter. Likewise, specific types may be called adapters: a network interface controller may be called a network adapter, and a graphics card a display adapter.

Adapters for external ports

Adapters (sometimes called dongles) allow connecting a peripheral device with one plug to a different jack on the computer. They are often used to connect modern devices to a legacy port on an old system, or legacy devices to a modern port. Such adapters may be entirely passive, or contain active circuitry. A common type is a USB adapter. One kind of serial port adapter enables connections between 25-contact and nine-contact connectors, but does not affect electrical power- and signaling -related attributes.

4. HIGH PRESSURE ADAPTER

High pressure gases are often connected from a storage container to the device using the gas via a pressure hose that has standard connectors. To allow different standards to inter-operate, adapters are commonly used.

MODES OF OPERATION

Originally, most AC/DC adapters were linear power supplies, containing a transformer to convert the mains electricity voltage to a lower voltage, a rectifier to convert it to pulsating DC, and a filter to smooth the pulsating waveform to DC, with residual ripple variations small enough to leave the powered device unaffected.

A linear circuit must be designed for a specific, narrow range of input voltages (e.g., 220–240 VAC) and must use a transformer appropriate for the frequency (usually 50 or 60 Hz), but a switched-mode supply can work efficiently over a very wide range of voltages and frequencies; a single 100–240 VAC unit will handle almost any mains supply in the world.

However, unless very carefully designed and using suitable components, switching adapters are more likely to fail than the older type, due in part to complex circuitry and the use of semiconductors. Unless designed well, these adapters may be easily damaged by overloads, even transient ones, which can come from lightning, brief mains overvoltage (sometimes caused by an incandescent light on the same power circuit failing), component degradation, etc. A very common mode of failure is due to the use of electrolytic capacitors whose equivalent series resistance (ESR) increases with age; switching regulators are very sensitive to high ESR (the older linear circuit also used electrolytic capacitors, but the effect of degradation is much less dramatic). Well-designed circuits pay attention to the ESR, ripple current rating, pulse operation, and temperature rating of capacitors.

Adapters with AC outputs may consist only of a passive transformer, or they may employ switch-mode circuitry. AC adapters consume power (and produce electric and magnetic fields) even when not connected to a load; for this reason they are sometimes known as "electricity vampires", and may be plugged into power strips to allow them to be conveniently turned on and off.AC adapters are used with electrical devices that require power but do not contain internal components to derive the required voltage and power from mains power. The internal circuitry of an external power supply is very similar to the design that would be used for a built-in or internal supply.

ADVANTAGES

- Safety
- Heat reduction
- Electrical noise reduction
- Weight and size reduction
- Ease of replacement

AC adapter supporting four different AC plug systems

- Configuration versatility
- Simplified product inventory, distribution, and certification.
- Constant voltage is produced by a specific type of adapter (eliminators) used for computers and laptops.

DISADVANTAGES

- ✓ High cost.
- ✓ Wastefulness of the profusion of power adapters used by electronic devices.
- ✓ Inconvenience.

APPLICATIONS

- The USB connector is a de facto standard in low-power AC adapters for many portable devices.
- Numerous accessory gadgets ("USB decorations") were designed to connect to USB only for DC power and not for data interchange.
- Electric fans, lamps, alarms, coffee warmers, battery chargers, and even toys have been designed to tap power from a USB connector.
- Plug-in adapters equipped with USB receptacles are widely available to convert 120 VAC or 240 VAC power to 5 VDC USB power.
- Micro-USB and mini-USB connectors, which are electrically compatible in function to the original USB connector but physically smaller are widely used these days.

PCB DESIGNING AND LAYOUT

PCB FABRICATION

Printed Circuit Boards (PCB) is a mechanical assembly of layers of fiber glass sheet laminated with etched copper patterns. It is used to mount electronic parts in a rigid manner suitable for packaging.

This type of integrated circuit components used in the fabrication process has an important role in the design of PCB. The conductor width, spacing between the signal conductors etc., are calculated to get optimum wave independence of the conductor's lines. Optimum wave independence gives minimum delay or rising or trailing edge of the pulse in digital circuit.

ART WORK GENERATION

The generation of PCB artwork should be considered as the first step of the PCB manufacturing process. The artwork is generated at 1:1:1 or 4:2 scale according to the accuracy needed. Ink drawing on a transparent drawing paper or cut up and strip method are the methods used for the artwork generation.

ROUTING

Presently artwork generation is not used for the PCB fabrication. Instead there are many types of software available for the routing of PCBs. Mainly used software's are CAD SOFTWARE EAGLE, PORTAL, ISIS ORCAD, TRAXMARKER, EASY PCB etc. Here we make use of CAD SOFTWARE EAGLE.

1. MANUAL: Traces are placed manually as done in the traditional method where you change the path of the trace every time you click on the mouse.
2. FOLLOW ME: This highly interactive method combines the power of an auto router with the control and flexibility of manual routing.
3. AUTO ROUTER: This fully automated method will auto route an entire trace by clicking on a ratsnet line.

Then using a laser printer solution prints the routed diagrams. Laser printer is very affordable, fast and good quality. The printer used must have at least

600 dpi resolution for all but simplest PCB will require only 300 dpi resolution. It is very important that the printer produces good solid black with no toner pinhole.

When using tracing paper or drafting film, always use manual paper feed, and set the straightest possible paper output path, to keep the artwork as flat as possible and minimize jamming. The printed diagram is then converted into film by using vertically mounted cameras.

SCREEN PRINTING

Screen printing is arguably the most versatile of all the printing process. It can be used to print a wide variety of substrates, including paper, paper board, plastic glass, plastics, glass metals, posters, labels, deals, signage and all types of electronic circuit board. The advantage of screen writing over other processes is that the press can print on substrates of any shape, thickness and size.

A significant characteristics of screen-printing is that a greater thickness of the ink can be applied to the substrates that is possible with other printing techniques. This allows for some very interesting effects that are not possible using other printing methods. Because of the simplicity of the application process, a wider range of inks and dyes are available for use in screen printing than for any other printing process.

ETCHING

In all subtractive PCB process, etching is one of the most important steps. The final copper pattern is formed by selective removal of all unwanted copper, which is not protected by the etch resist. There are two basic ways that you can remove unwanted copper from copper-clad substrate to form electronic circuits: mechanical etching and chemical milling (etching).

1. MECHANICAL ETCHING

It involves the use of a precise numerically controlled multi-axis machine tool and a special milling cutter to remove a narrow strip of copper from the boundary of each pad and trace. The removal of this copper electrically isolates the circuit element from the rest of the foil.

2. CHEMICAL ETCHING

It relies on the action of any one of a family of corrosive liquids to dissolve away unwanted copper in order to define the desired circuit pattern. But in practice, factors like under etching and overhang completes the etching process.

3. UNDER ETCHING

During etching process etching must progress vertically. But in practice etching takes place in the sideways which attacks the pattern below the etch resist. Under etching can be minimized by keeping the etching time as short as possible and by pressurized perpendicular discharge of the etched towards the surface to be etched.

DESIGNING PCB USING EAGLE CAD

EAGLE is a scriptable electronic design automation (EDA) application with schematic capture, printed circuit board (PCB) layout, auto-router and computer-aided manufacturing (CAM) features. EAGLE stands for Easily Applicable Graphical Layout Editor and is developed by Cad Soft Computer.

FEATURES

EAGLE contains a schematic editor, for designing circuit diagrams. Schematics are stored in files with .SCH extension, parts are defined in device libraries with .LBR extension. Parts can be placed on many sheets and connected together through ports. The PCB layout editor stores board file with extension .BRD .It allows back-annotation to the schematic and auto-routing to automatically connect traces based on the connections defined in the schematic. EAGLE provides a multi-window graphical user interface and menu system for editing, project management and to customize the interface and design parameters. The system can be controlled via mouse, keyboard hotkeys or by entering specific commands at an embedded command line. Multiple repeating commands can be combined into script files (with file extension .SCR) .It is possible to explore design files utilizing an EAGLE-specific object-oriented programming language.

- Download and install eagle cad

- Click on File and select New Project. Rename the Project to an appropriate name. Right click on the project and create new schematic
- A new schematic window will open with a blank work space. This is called the Schematic Editor, where you can draw schematics of your design. Save the schematic file with extension .sch
- Now, we have to add components to our schematic. For this, select Add Option from the side tool bar. A new window opens with a list of all components available in the libraries
- After selecting the component, click on OK and then you can place the component on the schematic sheet. Click on the sheet once to place the components and if you want to rotate the component, right click. After placing the component on the schematic, press Esc to return to the component selection window.
- After placing all the components, rename the components to something understandable
- Next step is to connect these components. You have to use the net option from the side tool bar and start making the connections
- After making all the connections, Save the schematic file
- After completing the schematic, we have to proceed with the design of the PCB layout. Select the switch to board option from the top tool bar. You can create the board file from the schematic
- A new window opens which is the PCB layout editor. The black space is the board area and all the components are at the outside bottom left of the board area. Now, we need to place the components in to the editor
- Now, using the group option from the side tool bar, select all the components and using move option move all the components and populate the board area
- Using the move option, place the components on the board as per the position you want the component to be on the board. You can see thin yellow wires running between the components. These wires are called air wires and are representation of connections between components. When we route the path between components, these air wires will disappear as an indication of successful connection
- Now, it is time to make the connections or traces for the PCB. For this, we are going to use the Route tool from the side tool bar. Also set the width of the trace to be

routed as your requirement. Here, I have set the trace width to approximately 1mm. Then, select the signal layer that is bottom layer, as our PCB is a single sided board

- Start routing the traces from pin to pin. As you progress with routing, the air wires will start disappearing
- Complete all the connections and make sure that one trace do not interact with other (as this is considered as a short circuit)
- Adjust the size of the board as per the required dimensions and save the file. The board file will be save with .brd extension
- Select the polygon option from the side tool bar and start drawing the polygon along the edges of the board. Make sure that the signal layer is bottom. The starting and ending points of the polygons must meet
- You will get a dotted line along the edges of the board. Select Name option and rename the polygon to GND. Hit ratsnet option from the side tool bar to see the ground pour and the layout for the PCB is ready

SOLDERING THE COMPONENTS

SOLDERING TOOLS

The basic tools that are used for this purpose are

- Soldering Iron
- Solder Wire
- Flux
- PCB and the components that are to be soldered

The soldering iron is the heat source tool for the process. It should be of high quality. Of course the price may increase with the quality, but the soldering will be perfect. Usually a 25 Watt soldering iron is adequate for the process. A higher Watt device may bring too much heat to the PCB and will surely damage the sensitive components. A lesser Watt device may not have adequate heat and thus is prone to be extensively used. This may also cause extensive heat damage.

The solder wire is used to fix the components like resistors, capacitors and so on to the PCB in the given fields. The leads of the devices are connected to the track of the PCB by melting the soldering wire to the junction. When the heat from the soldering iron touches the soldering wire it starts melting and this melted wire when introduced to the junction, joins the components to the track firmly.

The soldering wire is actually an alloy of tin and lead in the ratio 60:40. This is the best ratio that is considered for soldering in PCB's. There are other proportions of this alloy and they are considered low quality as tin content with respect to lead will be lower.

A high quality solder wire will have a melting point of about 250 degree Celsius and will have a very high conductivity along with a shiny appearance. When a high quality solder wire is used to connect the components to the PCB, there is to be no fear of corrosion in future.

Flux is another important component that is used in soldering purposes. It is scaled to the core of the solder wire before soldering. The flux is used to reduce the surface tension of the solder wire in its melting point. Thus, it acts as a wetting agent and wets the parts that are to be joined to the PCB. This also helps in the proper heat transfer from the solder iron to the solder wire.

Another main use of the flux is to prevent oxidation of both the solder wire and the components that are added to the PCB. The Tin-Lead alloy that is used as solder wire may have no problem when attached to copper. But they do not attach so well, when in contact with the oxides of the copper. The oxides of copper mostly form when the temperature is increased for soldering. The flux can prevent the formation of metal oxide as they are nearly inert at room temperature and become strongly reduced when the temperature increases. The use of flux causes the rise of smoke when the soldering process continues. During this time the flux acts as a catalyst and helps in removing the oxidants and thus cause a better solder joint.

SOLDERING TECHNIQUE

- First of all keep the solder iron plugged in for about a minute and a half before starting to use it. By that time the solder iron may get heated to the optimum temperature (250 degree Celsius)
- Bend the leads of the different devices that are to be connected to the PCB. For a clean bend, the approximate distance of bend is about 2mm from its body ends
- If you are connecting a resistor to the PCB, find its spot and place it into the hole of the PCB

- After placing the resistor flip the PCB in such a way that the inserted leads looks towards you
- Take the soldering iron in the right hand and the solder wire in the left hand. The solder wire must be placed on your fingertips with about 3 inches extending from your fingertip
- Bring both the solder iron tip and the solder wire tip close to the base of the lead of the resistor and copper track of the PCB. Make them come in contact at the same instant at the junction
- You will notice that the solder wire starts to melt as soon as the contact is made
- When the wire starts melting keep pushing it till the joint has been filled up with the molten alloy
- Move away the solder wire and the solder iron simultaneously and allow the molten wire to solidify. Thus one lead of the resistor has been connected to the PCB. Do the same step for the other lead and also for all other components

PCB LAYOUT

THEORY

A PCB can be made by many methods like UV etching, Toner transfer method, using a CNC mill etc. We'll be doing it with the toner transfer method as it's the only method which doesn't require access to expensive equipment/materials. To make a PCB need two things, an etchant and an etch resist. The etch resist is a material put on the PCB where want the copper to stay intact. In the toner transfer method, the toner of the laser printer acts as the resist. The toner is a kind of a polymer mixed with carbon that sticks to the paper when heated. The toner should be heated until it becomes sticky enough to hold on to the paper but it's not enough if it's just heated, a lot of pressure has to be applied to fuse it with the paper. This is what the laser printer does when it prints a paper. What we need is to transfer the toner from the paper to the copper board to act as the resist. To do this, we need to put the paper on the board and heat it using the iron box and apply a lot of pressure. There are people who have modified laser printers to directly print on a copper board but that is a very complicated method. The kind of paper use to print the layout can make a huge difference. After a lot of experimentation I found that glossy photo paper work really well, the higher the DPI (dots per inches) the better. Can get a pack of 20-25 papers for around Rs.150 depending on the quality of the paper. After the paper is pressed on to the board and heated, it is removed by soaking it in water and rubbing it off. Only the black toner remains on the board after this. Then the etchant comes into picture, the etchant I use is Ferric chloride but can try a solution of HCL(about 20%) and Hydrogen peroxide(the stuff get in medical stores) if can get a hold it. When the board is immersed in the etching solution, the etchant removes the copper wherever there is no resist and the copper remains intact wherever there is resist (that's why it is called a resist) can. Then clean the board, drill holes and solder the components.

Taking the print out of the layout

 first take the print out of the layout on a normal paper.

 next cut a piece of photo paper slightly larger than the layout and stick it to the paper using insulation tape

 the tape should be near the top of the layout such that it goes into the printer first. Then put the paper in the printer and take the print out.

1. PREPARING THE PCB

Before transfer the layout, must cut and clean the PCB. Use a paper cutter to make deep markings on the PCB and snap it to the required size, leave some room for error.

2. CLEANING THE PCB

Do not use a metallic brush to clean it as it might scratch the surface of the board. I've found that scotch brite does the job excellently (The green stuff which is used to clean utensils). Put some kind of dishwashing liquid if it's necessary and scrub it with the scotch brite until see our face on the copper. Then dry the PCB using a piece of cloth. Next take a light colored cloth and put some nail polish remover on it and start rubbing the board, should see some black stuff on the cloth. Move to a clean area in the cloth and put some more nail polish remover and rub it again. Keep doing this until there's no more black stuff. From Then on nothing should touch the PCB except the paper.

3. IRONING THE LAYOUT

Before take the printout, switch on iron box and turn it up all the way to the maximum setting. Then take the printout on the photo paper and cut it to the exact dimension, do not leave extra space around the edges as it'll affect the outcome of the PCB when remove the paper.

Place the layout facing down on the copper side and gently slide the iron box until it covers the whole lat. Then put a lot of pressure and hold it for at least a minute but make sure don't move the paper and also that the paper is flat. After this the paper will get stuck to the board and cannot move it even if want to. Then slide the iron box all over the layout and cover every inch of it for a few times. Then incline the iron box so that only a part of the tip touches the board and rub it all over the board putting pressure. The incline should be really small so that the tip doesn't accidentally cut the paper. This step will ensure that all the toner gets transferred correctly. If do this with a magazine paper or any other thin paper, the transfer gets smudged and becomes useless. Then iron it again for a few times with the iron flat.

4. TAKING OUT THE PAPER

After ironed the layout, let it cool until can touch it with r bare hands. Then put the board in a soap solution and let it just sit there for at least half an hour. The soap helps soften the paper so that it can be easily removed. Leave it for at least 30 minutes. The longer leave the board in the soap solution, the better, but who is got the patience. Then slowly try to remove the paper, do not force it if it does not come out, and try to remove it layer by layer by rubbing in circular motion. There is still a layer of paper left. This is toughest part to remove. Try to remove as much as possible by rubbing it with r fingers. Mine came out easily since I'd left it for a few hours. If the final layer doesn't come out easily, take a tooth brush and gently rub it in circular motion. Then dry it with a cloth. If there is any paper left, it will become white and can easily see it. There is a piece of paper stuck between two wires, remove it carefully using a safety pin. Any paper stuck on the board will act as an etch resist, so be sure to remove them. Can also see that all the holes are covered with paper, it is a good idea to remove them too as it will help guides the drill bit easily when drilling. If there is a place that the toner is missing or is light, take a permanent marker and fill in the missing parts.

5. ETCHING

Fill the plastic lid with water, and slowly add the ferric chloride powder. The amount of ferric chloride add depends on the amount of water taken. On the container, it says that to make 1 liter of solution need 500gm of ferric chloride, that ratio seems about right. Then slowly put the board inside the solution and immerse it completely. Then start rocking the container back and forth to speed up the etching process. After about 10 minutes, take out the board using the forceps and put it under running water. See how much of the etching is complete and put it back. This will give an estimate for how much longer will have to etch. Etching it for longer than necessary is also not a good idea as even the copper under the resist gets removed. So stop it as soon as it is done. The area inside the red portion hasn't completely been etched. After a couple of minutes take it out again and see how much is complete, if its fully complete move on to the next step, else put it back and rock it till its complete.

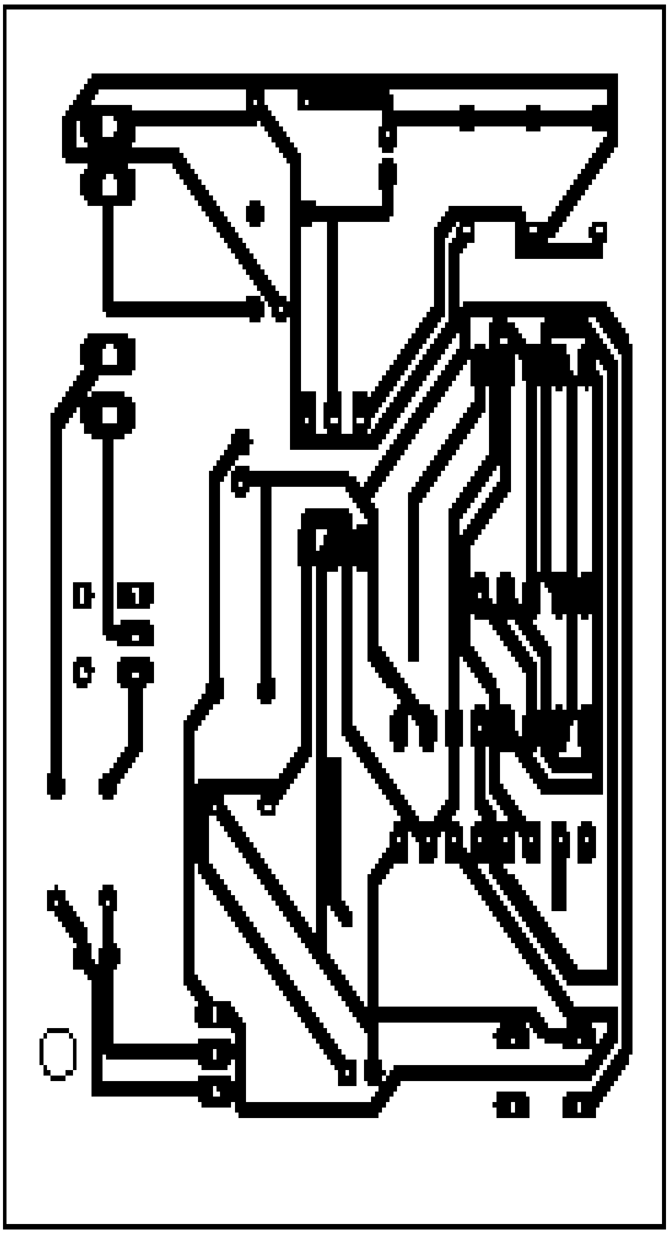
6. DRILLING THE HOLES

After etched the PCB, clean it and dry it. Then to drill the holes need a drilling machine which can hold really small drill bits. If are in Bangalore, can get this in SP road, it is called a PCB drilling machine, it is really cheap but it is a hand drill and it takes quite some time to drill. If want to drill faster, can invest in a portable drilling machine which will be useful for many other things too. Also need to get 0.8mm and 1mm drill bits which cost about Rs.10 per bit. Get some extra of each as breaking a few on first try.

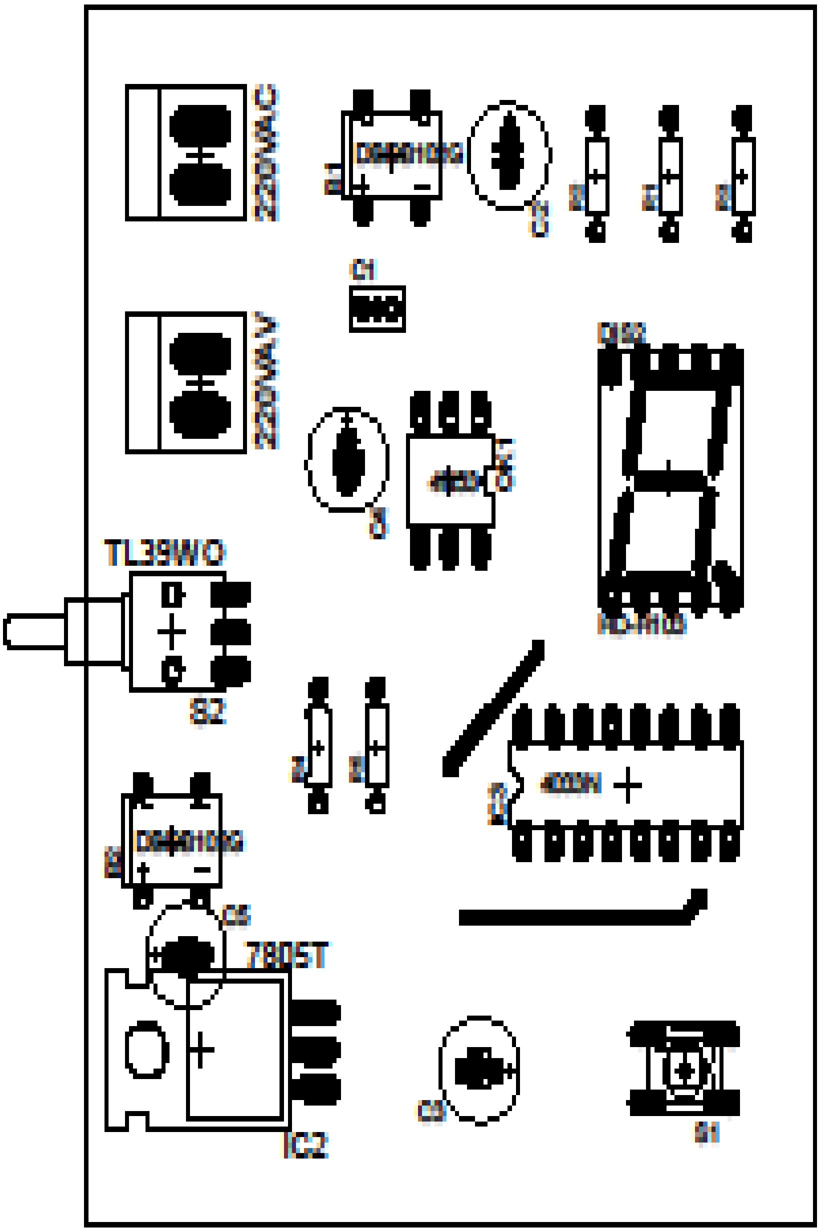
7. SOLDERING THE COMPONENTS

Before start soldering, have to remove the toner. Just scrub it with the scotch brite till see the copper. Then clean it with the nail polish remover to remove all the dirt. It's a good idea to solder it right after have done this, if leave the board for a long time then the copper will oxidize and make it harder to solder, in which case have to scrub it again.

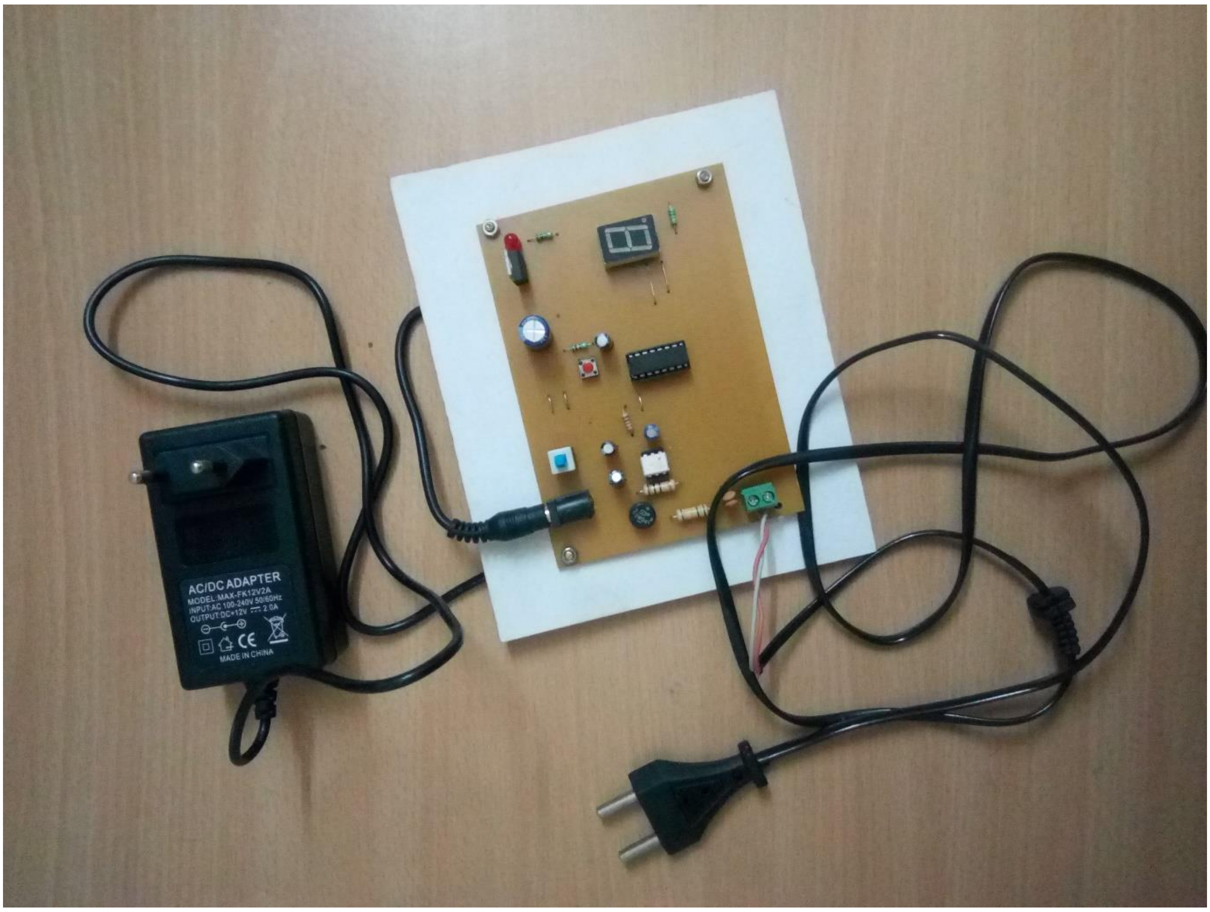
PCB LAYOUT



COMPONENT LAYOUT



FINAL PRODUCT PICTURE



ADVANTAGES

1. Reduced noise.
2. High device performance offered.
3. Simple and easy designed circuit.
4. Protect the components used in the device.
5. Long time operation allowed.

DISADVANTAGES

1. Performance affected by environment.
2. Needs expert installation.
3. Time consuming.

APPLICATIONS

- Used where it is necessary to know whether the main supply is continuous or not.
- Useful for monitoring main supplies to recording equipment, especially in the recording of computer software tapes, where the slightest interruption in the main supply will cause an error in the data being recorded.
- Used with digital clocks working with mains.
- An interruption in the main supply will case in LED to flash as a warning that the mains supply was interrupted.
- Highly useful in automobile battery chargers.

FUTURE SCOPE

The proposed mini project device is AC main power supply interruption with indicator. This circuit will help us to count the AC power interruption using seven segment display from 0 to 9 (you can design two digit counter by adding another counter stage) and also we can reset the count when needed. We can alternatively design or improve the circuit by adding another counter stage so we design two digit counter. This helps us to display the two digit interruptions counter.

CONCLUSION

An AC power supply typically takes the voltage from a wall outlet (mains supply) and uses a transformer to step up or step down the voltage to the desired voltage. Some filtering may take place as well. There are different types of interruptions which occur in the main power supply at times. Some of such situations are power outage, electrical fault such as short circuit etc. Voltage dips can be caused by any of a number of events including the starting current of large motors, inrush currents occurring on the connection of certain reactive loads and system faults.

In this mini project, we are designing a circuit of main supply interruption counter with indicator. This circuit counts the number of times the power supply interruption has occurred and shows the number of interruptions on the seven segment LCD display. Based on how many times the interruption has occurred in main supply, the user can extend the charging time of the lead-acid batteries. This circuit contains three stage, first one is AC power input stage, second stage is optocoupler & Johnson decade counter then final third stage is number display. It is a simple and easily designed circuit which has various applications in the field of digital clocks and as a warning LED flash display.

In this proposed device, long time charging of the user’s device (for eg, automobile) is possible. There is low noise reduction, high performance and there will be no mechanical or electrical harm to the components used in this device. This device mainly focuses on the counting of the main supply interruption which will occur during its operation. We can reset the counter afterwards. The early mentioned interruption can be in the form of the voltage fluctuation, power outage, short circuit etc.

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