MINIMISING PENALITY IN INDUSTRIAL POWER CONSUMPTION BY ENGAGING APFC UNIT

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ABSTRACT

In the present technological revolution power is very precious so we need to find out the cause of power loss and improve the power system. Due to industrialization the use of inductive load increases and hence power system losses its efficiency. So we need to improve the power factor with a suitable method. Whenever we are thinking about any programmable device then the embedded technology comes into forefront.

The embedded is nowadays very much popular and most of the product are developed with microcontroller based embedded technology.

The project is designed to minimize penalty for industrial units by using automatic power factor correction unit. Power factor is defined as the ratio of real power to apparent power. This definition is often mathematically represented as kW/kVA, where the numerator is the active (real) power and the denominator is the (active + reactive) or apparent power. Reactive power is the non-working power generated by the magnetic and inductive loads, to generate magnetic flux. The increase in reactive power increases the apparent power, so the power factor also decreases. Having low power factor, the industry needs more energy to meet its demand, so the efficiency decreases.

In this proposed system the time lag between the zero voltage pulse and zero current pulse duly generated by suitable operational amplifier circuits in comparator mode are fed to two interrupt pins of the microcontroller. It displays the time lag between the current and voltage on an LCD. The program takes over to actuate appropriate number of relays from its output to bring shunt capacitors into the load circuit to get the power factor till it reaches near unity. The microcontroller used in the project belongs to 8051 family.

I-INTRODUCTION

POWER FACTOR THEORY:

In any AC system the current, and therefore the power, is made up of a number of components based on the nature of the load consuming the power. These are resistive, inductive and capacitive components. In the case of a purely resistive load, for example, electrical resistance heating, incandescent lighting, etc., the current and the voltage are in phase that is the current follows the voltage. Whereas, in the case of inductive loads, the current is out of phase with the voltage and it lags behind the voltage. Except for a few purely resistive loads and synchronous motors , most of the equipment and appliances in the present day consumer installation are inductive in nature, for example, inductive motors of all types, welding machines, electric arc and induction furnaces, choke coils and magnetic systems , transformers and regulators, etc. In the case of a capacitive load the current and voltage are again out of phase but now the current leads the voltage. The most common capacitive loads are the capacitors installed for the correction of power factor of the load.

The inductive or the capacitive loads are generally termed as the reactive loads. The significance of these different types of loads is that the **active (or true or useful) power** can only be consumed in the resistive portion of the load, where the current and the voltage are in phase.

(**Watt less or) reactive power** which is necessary for energizing the magnetic circuit of the equipment (and is thus not available for any useful work). Inductive loads require two forms of power **- Working/Active power** (measured in **kW**) to perform the actual work of creating heat, light, motion, machine output, etc., and **Reactive power** (measured in **kVAr**) to sustain the electromagnetic field. The current known as watt-less current is required to produce the magnetic field around an electric motor. If there was no watt-less current then an electric motor would not turn. The problems arise due to the fact that we can sometimes have too much watt-less current, in those cases we need to remove some of it.

The vector combination of these two power components (active and reactive) is termed as **Apparent Power** (measured in **kVA**), the value of which varies considerably for the same active power depending upon the reactive power drawn by the equipment. The ratio of the active power (kW) of the load to the apparent power (kVA) of the load is known as the **power factor** of the load.

It is a measure of how effectively the current is being converted into useful work output and more particularly is a good indicator of the effect of the load current on the efficiency of the supply system.

A load with a power factor of 1.0 result in the most efficient loading of the supply and a

Load with a power factor of 0.5 will result in much higher losses in the supply system.

Low power factor leads to large copper losses, poor voltage regulation and reduce handling capacity of the system. The increase in the load current, increase in power loss, and decrease in efficiency of the overall system Net industrial load is highly inductive causing a very poor lagging power factor. If this poor power factor is left uncorrected, the industry will require a high maximum demand from Electricity Board and also will suffer a penalty for poor power factor. Standard practice is to connect power capacitors in the power system at appropriate places to compensate the inductive nature of the load.

Disadvantage of low power factor can be easily understood by an example:

Supplied Voltage = 240 Volts Single phase.
Motor input = 10 KW
Power Factor = 0.65
Current (I1) = Power (kW)/Volts (V)*P.F
= 10000/240*0.65 = 64.1 Amp.

If the power factor of the motor is increased to 0.9 the current
Drawn by the motor shall be –
Current (I2) = Power (kW)/Volts (V)*P.F
= 10000/240*0.9 = 46.3 Amp.

Thus, as the power factor decreases the current required for the same value of active, or useful, power increases. The result is that the sizes of the equipment, like the switchgear, cables, transformers, etc., will have to be increased to cater the higher current in the circuit. All this adds to the cost.

Further, the greater current causes increased power loss or I2R losses in the circuits. Also due to higher current, the conductor temperature rises and hence the life of the insulation is reduced.

So it is evident to improve the power factor by applying certain methods and application doing so will lead to improve the system quality and will be cost effective A poor power factor due to an inductive load can be improved by the addition of power factor correction

The various conventional methods for the power factor correction are the using static capacitors, synchronous condensers, phase advancers, etc. doing so will increase the power factor

The advantages of an improved power factor:

Higher power factors result in–

a) Reduced system losses, and the losses in the cables, lines, and feeder circuits and hence lower sizes could be opted.

b) Improved system voltages, thus enable maintaining rated voltage to motors, pumps and other equipment. The voltage drop in supply conductors is a resistive loss, and wastes power heating the conductors. A 5% drop in voltage means that 5% of your power is wasted as heat before it even reaches the motor. Improving the power factor, especially at the motor terminals, can improve your efficiency by reducing the line current and the line losses.

c) Increased system capacity, by release of kVA capacity of transformers and cables for the same kW, thus permitting additional loading without immediate augmentation.

d) Reduce power cost due to reduced kVA demand charge and so also by reduced power factor charge.
Example: Let us take an example of an industry with initial load Condition of 5000 kVA at 60% power factor with a consumption of 19, 20,000 units per month, supplied at 33 KV.
Taking the Tariff as below:
1. Demand charges Rs. 144/kVA/month
2. Energy Charges Rs. 4.11 / Unit
3. PF surcharge for each 1% below 90% 1% of (Demand charges + Energy Charges)

A. Cost saving due to Power Factor improvement

(i) As we already know, by improving the power factor there will be a reduction in the kVA demand of the load. Thus, in this case the kVA MD will drop from 5000 kVA (at 60%) to 3333.33 kVA (at 90%):
Power Factor= cos φ = kW/ kVA

Cosφ1 = 0.6 = kW/kvA1 = kW/5000 =>KW=5000*0.6

Cosφ2 = 0.9 = kW/kVA2 =>KW=kVA2*0.9

For the same value of kW,

5000*0.6=kVA2*0.9

kVA2= (5000*0.6)/0.9 = 3333.33 kVA

Therefore reduction in energy bill due to reduction in maximum demand due to improved power factor from 0.6 to 0.9 shall be:
Rs. 144.00 * (5000-3333.33) = Rs. 240000.48 per month

(ii) In addition, by increasing the power factor from 60% to 90%, there shall be no power factor penalty/surcharge on account of low power factor. Thus the savings due to avoidance of the PF surcharge per month would be as below:
Rs. ((5000-3333)*144*(90-60))*1/100= Rs.72014.14

(iii) Thus the total monthly reduction in bill due to P.F improvement from 0.6 to 0.9 would be:
Rs. 240000.48 + 72014.14 = Rs. 312014.88 per month.
Net reduction per annum = 312014.88*12 = 3744178.56 ~ Rs.37, 44,179/-

B. Cost of investment for Power Factor improvement:

Size of capacitor required to improve the PF from 0.6 to 0.9
= kVA1* Sinφ1 – kVA2* Sinφ2
=5000*sin (53.1) – 3333.33*Sin (25.84) 5
=5000*0.8 – 3333.33*0.436
=4000-1453=2547 kVAr say **2550 kVAr**

If we take the cost of capacitor bank per kVAr as Rs. 200/- ,

the cost of the capacitor bank = 2550*200 = Rs. 5,10,000/-
Cost of switching and associated equipment = Rs. 3, 00,000/-
And installation, etc.
Total cost = Rs. 8, 10,000/-

Annual depreciation and interest@ 20% = Rs. 810000*0.2
= Rs. 1,62,000/-
Net Annual saving = 37,44,179 - 1,62,000 = Rs. 35,82,179/-
Net monthly saving = Rs. 2,98,515/-
Therefore payback period = 2.7 months

II-POWER FACTOR IMPROVEMENT

Unlike Director Current Circuits, where only resistance restricts the current flow, in Alternating Current Circuits, there are other circuits aspects which determines the current flow; though these are akin to resistance, they do not consume power, but loads the system with reactive currents; like D.C. circuits where the current multiplied by voltage gives watts, here the same gives only VA.

Like resistance, these are called “Reactance”. Reactance is caused by either inductance or by capacitance. The current drawn by inductance lags the voltage while the one by capacitance leads the voltage. Almost all industrial loads are inductive in nature and hence draw lagging wattles current, which unnecessarily load the system, performing no work. Since the capacitive currents is leading in nature, loading the system with capacitors wipes out them.

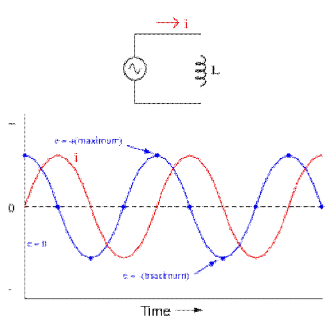


FIG2.1 : WAVEFORMS FOR INDUCTIVE LOAD

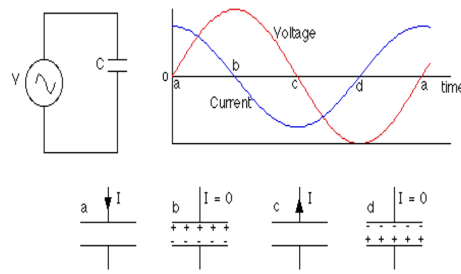


FIG 2.2 : WAVEFORMS FOR CAPACITIVE LOAD

Capacitors for power-factor improvement

Whatever the power factor is, however, the generating authority must install machines capable of delivering a particular voltage and current even though, in a particular case, not all the voltage and current products is being put to good use. The generators must be able to withstand the rated voltage and current regardless of the power delivered. For example, if an alternator is rated to deliver 1000A at 11000 volts, the machine coils must be capable of carrying rated current. The apparent power of such a machine is 11 M V A and if the load power factor is unit this 11 MVA will be delivered and used as 11 MW of active power i.e. the alternator is being used to the best of its ability. If, however, the load power factor is say, 0.8 lagging, then only 8.8 MW are taken and provide revenue, even though the generator still has to be rated at 1000A at 11 kV. The lower the power factor, the worse the situation becomes from the supply authorities’ viewpoint. Accordingly, consumers are encouraged to improve their load power factor and in many cases are penalized if they do not. Improving the power factor means reducing the angle of lag between supply voltage and supply current.

Location of power-factor improvement capacitor banks:

Any installation including the following types of machinery or equipment is likely to have low power factor which can be corrected, with a consequent saving in charges, by way of reduced demand charges, lesser low power factor penalties:

1. Induction motors of all types.
2. Power thyristor installation
3. Power transformers and voltage regulators.
4. Welding machines
5. Electric-arc and induction furnaces.
6. Choke coils and magnetic system.
7. Neon signs and fluorescent lighting.

Apart from penalties like maximum demand charges, penalty for low power factor, the factory cabling and supply equipment can be relieved of a considerable wattles or reactive load, which will enable additional machinery to be connected to the supply without enlarging these services. Additionally, the voltage drop in the system is reduced.

The method employed to achieve the improvements outlined involves introducing reactive kVA (kvar) into the system in phase opposition to the wattles or reactive current mentioned above the effectively cancels its effect in the system is achieved either with rotary machines (synchronous condensers)

III-BLOCK DIAGRAM

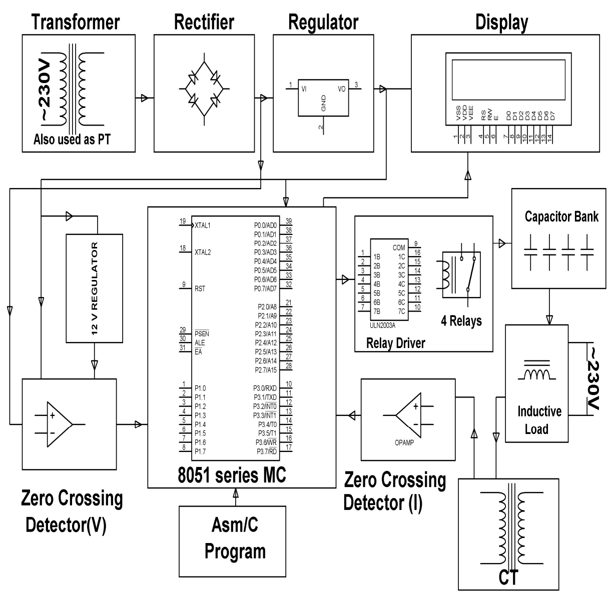


FIG3.1- BLOCK DIAGRAM

IV-DESCRIPTION

POWER SUPPLY

The circuit uses standard power supply comprising of a step-down transformer from 230Vto 12V and 4 diodes forming a bridge rectifier that delivers pulsating dc which is then filtered by an electrolytic capacitor of about 470µF to 1000µF. The filtered dc being unregulated, IC LM7805 is used to get 5V DC constant at its pin no 3 irrespective of input DC varying from 7V to 15V. The input dc shall be varying in the event of input ac at 230volts section varies from 160V to 270V in the ratio of the transformer primary voltage V1 to secondary voltage V2 governed by the formula V1/V2=N1/N2.Thus if the transformer delivers 12V at 220V input it will give 8.72V at 160V.Similarly at 270V it will give 14.72V.Thus the dc voltage at the input of the regulator changes from about 8V to 15V because of A.C voltage variation from 160V to 270V the regulator output will remain constant at 5V.

The regulated 5V DC is further filtered by a small electrolytic capacitor of 10µF for any noise so generated by the circuit. One LED is connected of this 5V point in series with a current limiting resistor of 330Ω to the ground i.e., negative voltage to indicate 5V power supply availability. The unregulated 12V point is used for other applications as and when required.

STANDARD CONNECTIONS TO 8051 SERIES MICRO CONTROLLER

ATMEL series of 8051 family of micro controllers need certain standard connections. The 4 set of I/O ports are used based on the project requirement. Every microcontroller requires a timing reference for its internal program execution therefore an oscillator needs to be functional with a desired frequency to obtain the timing reference as t =1/f.

A crystal ranging from 2 to 20 MHz is required to be used at its pin number 18 and 19 for the internal oscillator. Typically 11.0592 MHz crystal is used in general for most of the circuits using 8051 series microcontroller. Two small value ceramic capacitors of 33pF each is used as a standard connection for the crystal as shown in the circuit diagram.

RESET

Pin no 9 is provided with a reset arrangement by a combination of an electrolytic capacitor and a register forming RC time constant. At the time of switch on, the capacitor gets charged, and it behaves as a full short circuit from the positive to the pin number 9. After the capacitor gets fully charged the current stops flowing and pin number 9 goes low which is pulled down by a 10k resistor to the ground. This arrangement of reset at pin 9 going high initially and then to logic 0 i.e., low helps the program execution to start from the beginning. In absence of this the program execution could have taken place arbitrarily anywhere from the program cycle. A pushbutton switch is connected across the capacitor so that at any given time as desired it can be pressed such that it discharges the capacitor and while released the capacitor starts charging again and then pin number 9 goes to high and then back to low, to enable the program execution from the beginning. This operation of high to low of the reset pin takes place in fraction of a second as decided by the time constant R and C.

For example: A 10µF capacitor and a 10kΩ resistor would render a 100ms time to pin number 9 from logic high to low, there after the pin number 9 remains low.

External Access (EA):

Pin no 31 of 40 pin 8051 microcontroller termed as EA is required to be connected to 5V for accessing the program form the on-chip program memory. If it is connected to ground then the controller accesses the program from external memory. We are using the internal memory it is always connected to +5V.

BRIEF DESCRIPTION OF WORKING OF RELAY

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and most have double throw (changeover) switch contacts. Relays allow one circuit to switch a second circuit which can be completely separate from the first. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

ULN 2003 RELAY DRIVER IC

ULN2003 is an IC which is used to interface relay with the microcontroller since the output of the micro controller is maximum 5V with too little current delivery and is not practicable to operate a relay with that voltage. ULN2003 is a relay driver IC consisting of a set of Darlington transistors. Iflogic high is given to the IC as input then its output will be logic low but not the vice versa. Here in ULN2003 pin 1 to 7 are IC inputs and 10 to 16 are IC outputs. If logic 1 is given to its pin no 1 the corresponding pin 16 goes low. If a relay coil is connected from +ve to the output pin of the uln2003,(the relay driver) then the relay contacts change their position from normally open to close the circuit as shown below for the load on (say a lamp to start glowing). If logic 0 is given at the input the relay switches off. Similarly upto seven relays can be used for seven different loads to be switched on by the normally open(NO) contact or switched off by the normally closed contact(NC)

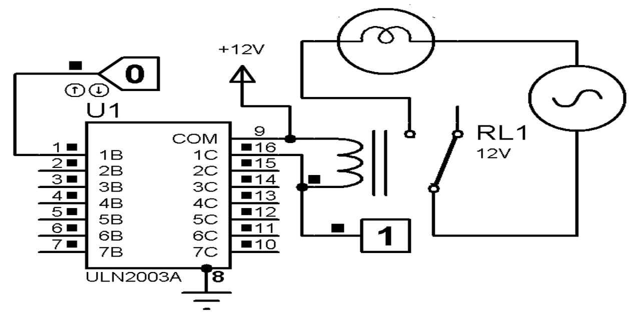


FIG4.1-LOAD OFF

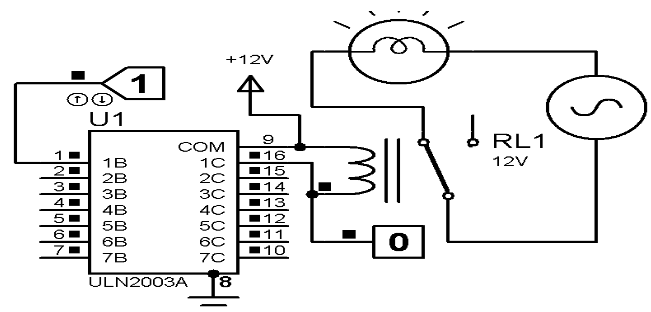


FIG4.2-LOAD ON

COMPARATOR

How an op-amp can be used as a comparator? Potential dividers are connected to the inverting and non-inverting inputs of the op-amp to give some voltage at these terminals. Supply voltage is given to +Vss and –Vss is connected to ground. The output of this comparator will be logic high (i.e., supply voltage) if the non-inverting terminal input is greater than the inverting terminal input of the comparator.

i.e., Non inverting input (+) > inverting input (-) = output is logic high

If the inverting terminal input is greater than the non-inverting terminal input then the output of the comparator will be logic low (i.e., gnd)

i.e., inverting input (-) > Non inverting input (+) = output is logic low

OPERATION EXPLANATION

CONNECTIONS

The output of power supply which is 5v is connected to the 40th pin of microcontroller and gnd to the 20th pin or pin 20 of microcontroller. Port 0.1 to 0.4 of microcontroller is connected to Pin 1to 4 of relay driver IC ULN2003. Port 0.5 to 0.7 of microcontroller is connected to Pin 4,5 and 6 of LCD display. Port 2.0 to 2.7 of microcontroller is connected to Pin 7 to 14 of data pins of LCD display. Port 3.1 of microcontroller is connected to output of the OP-Amp (A) LM339. Port 3.3 of microcontroller is connected to output of OP-Amp (B) LM339.

V-WORKING

The output of the regulator 7805 is given to the Microcontroller 40th pin. The pulsating dc is fed to R_{11} and R_{24} Resistor's. The unregulated voltage is fed to 7812. 7805 output which is 5v is fed to 40th pin of Microcontroller. The output of the 7812 regulator is 12v and is fed to op-Amp. In this circuit we have another bridge rectifier it gives an output as pulsating dc corresponding to the current flowing across the load. The LCD display is connected to corresponding pins. Relay driver drive's relay's and the contacts of relays switch ON the shunt capacitors.

Description of ZVS and ZCS:

In order to generate ZVS (Zero Voltage Sensing) pulses first we need to step down the supply voltage to 12 V and then it is converted into pulsating D.C. Then with the help of potential divider the voltage of 3 V is taken, which is given to a comparator LM339 part A. The comparator generates the zero crossing pulses by comparing this pulsating D.C with a constant D.C of 0.6 V forward voltage drop across a silicon diode.

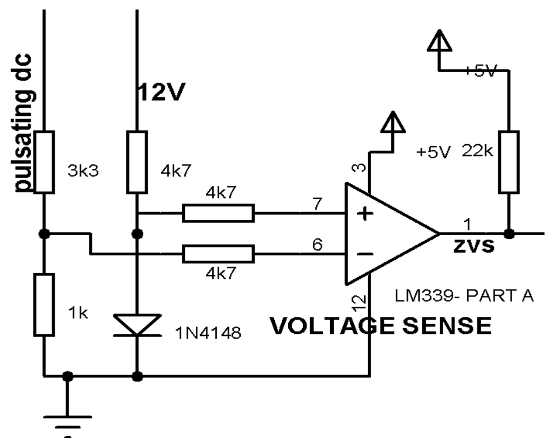


FIG5.1-VOLTAGE SENSE

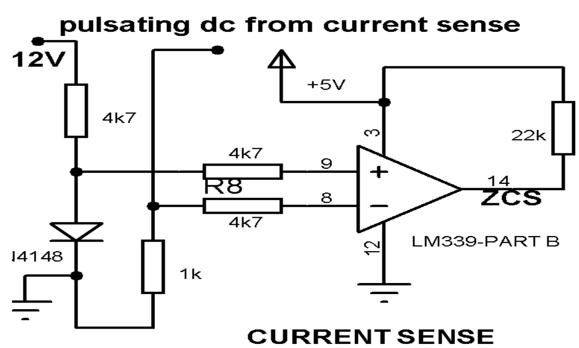


FIG5.2-CURRENT SENSE

Similarly for ZCS (Zero Current Sense) the voltage drop proportional to the load current across a resistor of 10R/10W is taken and is stepped up by a CT to feed to a bridge rectifier to generate pulsating dc for the comparator to develop ZCS as explained above like ZVS. The zero crossing pulses from a pulsating D.C both for ZVS and ZCS are shown in the figure below.

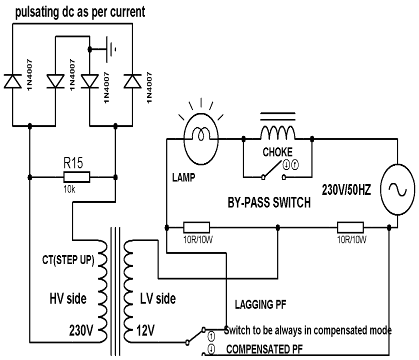


FIG5.3-CIRCUIT DIAGRAM

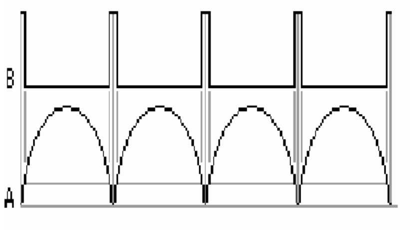


FIG5.4-ZERO CROSSING PULSES

VI-CIRCUIT EXPLAINATION:

This circuit consists of DC power supply unit, zero voltage crossing detectors, Micro-controller, LCD display, Relays and Capacitor bank and Load circuit. Let us see how it operates. The required DC power supply for Micro-controller and other peripherals is supplied by the DC power supply.

For the calculation of the power factor by the Micro-controller we need digitized voltage and current signals. The voltage signal from the mains is taken and it is converted into pulsating DC by bridge rectifier and is given to a comparator which generates the digital voltage signal. Similarly the current signal is converted into the voltage signal by taking the voltage drop of the load current across a resistor of 10 ohms. This A.C signal is again converted into the digital signal as done for the voltage signal. Then these digitized voltage and current signals are sent to the micro-controller. The micro-controller calculates the time difference between the zero crossing points of current and voltage, which is directly proportional to the power factor and it determines the range in which the power factor is. Micro-controller sends information regarding time difference between current and voltage and power factor to the LCD display to display them, Depending on the range it sends the signals to the relays through the relay driver. Then the required numbers of capacitors are connected in parallel to the load. By this the power factor will be improved.

HARDWARE COMPONENTS:

- TRANSFORMER (230 – 12 V AC)
- VOLTAGE REGULATOR
- RECTIFIER
- FILTER
- MICROCONTROLLER (AT89S52/AT89C51)
- RELAY
- RELAY DRIVER
- PUSH BUTTONS
- LCD
- LM339
- CURRENT TRANSFORMER
- INDUCTIVE LOAD
- SHUNT CAPACITOR
- LED
- 1N4007 / 1N4148
- RESISTOR

TRANSFORMER

RATING: (230-12V A.C,1A)

Transformers convert AC electricity from one voltage to another with a little loss of power. Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high voltage to a safer low voltage.

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core. Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down and current is stepped up.

The ratio of the number of turns on each coil, called the turn's ratio, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

TURNS RATIO = (Vp / Vs) = (Np / Ns)

Where,

Vp = primary (input) voltage.
Vs = secondary (output) voltage

Np = number of turns on primary coil
Ns = number of turns on secondary coil

Ip = primary (input) current Is = secondary (output) current.

VOLTAGE REGULATOR 7805

Features

• Output Current up to 1A.

• Output Voltages of 5v.

• Thermal Overload Protection.

• Short Circuit Protection.

• Output Transistor Safe Operating Area Protection.

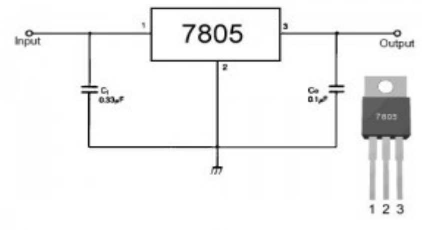


FIG6.1: VOLTAGE REGULATOR

The LM78XX/LM78XXA series of three-terminal positive regulators are available in the TO-220/D-PAK package and with several fixed output voltages, making them useful in a Wide range of applications. Each type employs internal current limiting, thermal shutdown and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output Current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

RECTIFIER

A rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), current that flows in only one direction, a process known as rectification. Rectifiers have many uses including as components of power supplies and as detectors of radio signals. Rectifiers may be made of solid statediodes, vacuum tube diodes, mercury arc valves, and other components. The output from the transformer is fed to the rectifier. It converts A.C. into pulsating D.C. The rectifier may be a half wave or a full wave rectifier. In this project, a bridge rectifier is used because of its merits like good stability and full wave rectification. In positive half cycleonly two diodes (1 set of parallel diodes) will conduct, in negative half cycle remaining two diodes will conduct and they will conduct only in forward bias only.

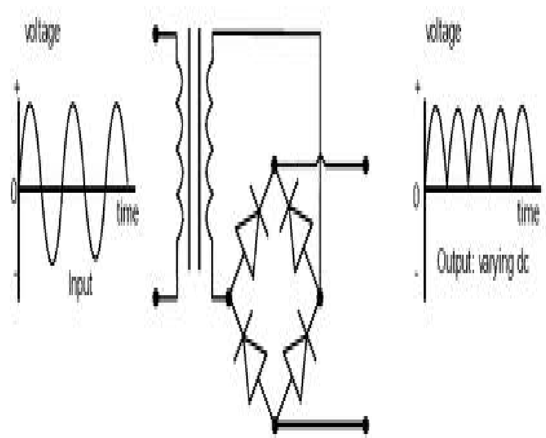


FIG6.2: BRIDGE RECTIFIER

FILTER

Capacitive filter is used in this project. It removes the ripples from the output of rectifier and smoothens the D.C. Output received from this filter is constant until the mains voltage and load is maintained constant. However, if either of the two is varied, D.C. voltage received at this point changes. Therefore a regulator is applied at the output stage.

The simple capacitor filter is the most basic type of power supply filter. The use of this filter is very limited. It is sometimes used on extremely high-voltage, low-current power supplies for cathode-ray and similar electron tubes that require very little load current from the supply. This filter is also used in circuits where the power-supply ripple frequency is not critical and can be relatively high. Below figure can show how the capacitor charges and discharges.

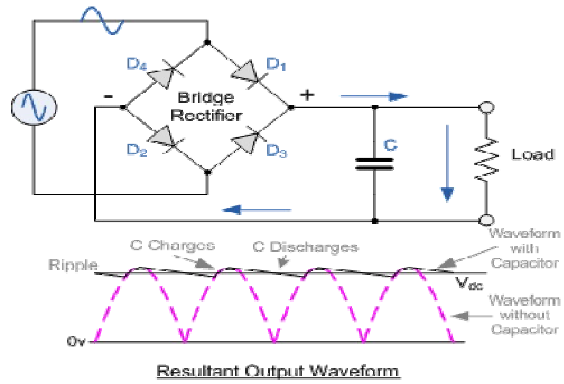


FIG6.3-RESULTANT OUTPUT WAVEFORM

MICROCONTROLLER AT89S52

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density non-volatile memory technology and is compatible with the industry standard 80C51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional non-volatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications. The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

Features:

- 8K Bytes of In-System Programmable (ISP) Flash Memory
- Endurance: 10,000 Write/Erase Cycles
- 4.0V to 5.5V Operating Range
- Fully Static Operation: 0 Hz to 33 MHz
- Three-level Program Memory Lock
- 256 x 8-bit Internal RAM
- 32 Programmable I/O Lines
- Three 16-bit Timer/Counters
- Eight Interrupt Sources
- Low-power Idle and Power-down Modes
- Interrupt Recovery from Power-down Mode
- Fast Programming Time
- Flexible ISP Programming (Byte and Page Mode)

Pin Configurations of AT89S52-

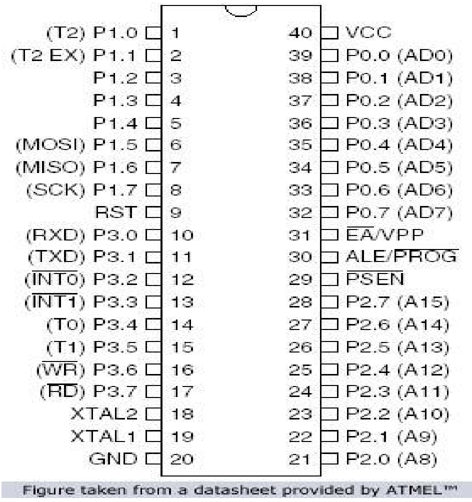


FIG-6.4: PIN DIAGRAM OF AT89S52

Pin Description:

VCC: Supply voltage.

GND: Ground.

Port 0: Port 0 is an 8-bit open drain bidirectional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as high-impedance inputs. Port 0 can also be configured to be the multiplexed low-order address/data bus during accesses to external program and data memory. In this mode, P0 has internal pull-ups. Port 0 also receives the code bytes during Flash programming and outputs the code bytes during program verification. External pull-ups are required during program verification.

Port 1: Port 1 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups. In addition, P1.0 and P1.1 can be configured to be the timer/counter 2 external count input (P1.0/T2) and the timer/counter 2 trigger input (P1.1/T2EX).

Port 2: Port 2 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 2 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups. Port 2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that uses 16-bit addresses (MOVX @ DPTR). In this application, Port 2 uses strong internal pull-ups when emitting 1s. During accesses to external data memory that uses 8-bit addresses (MOVX @ RI), Port 2 emits the contents of the P2 Special Function Register.

Port 3: Port 3 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pull-ups.

RST: Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device. This pin drives high for 98 oscillator periods after the Watchdog times out. The DISRTO bit in SFR AUXR (address 8EH) can be used to disable this feature. In the default state of bit DISRTO, the RESET HIGH out feature is enabled.

ALE/PROG: Address Latch Enable (ALE) is an output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during Flash programming.

PSEN: Program Store Enable (PSEN) is the read strobe to external program memory. When the AT89S52 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

EA/VPP: External Access Enable. EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH. Note, however, that if lock bit 1 is programmed, EA will be internally latched on reset. EA should be strapped to VCC for internal program executions. This pin also receives the 12-volt programming enable voltage (VPP) during Flash programming.

RELAY

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

Applications of relays

- Control a high-voltage circuit with a low-voltage signal, as in some types of modems or audio amplifiers.
- Control a high-current circuit with a low-current signal, as in the starter solenoid of an automobile.

ULN2003

RELAY DRIVER:

ULN2003 is a high voltage and high current Darlington transistor array.

DESCRIPTION:

The ULN2003 is a monolithic high voltage and high current Darlington transistor arrays. It consists of seven NPN Darlington pairs that feature high-voltage outputs with common-cathode Clamp diode for switching inductive loads. The collector-current rating of a single Darlington pair is 500mA. The Darlington pairs may be paralleled for higher current capability. Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED gas discharge), line drivers, and logic buffers.

The ULN2003 has a 2.7kW series base resistor for each Darlington pair for operation directly with TTL or 5V CMOS devices.

Features

- Temperature, Operating Range:-20°C to +85°C
- Transistor Polarity: NPN
- Temp, Op. Min:-20°C
- Temp, Op. Max:85°C
- Current, Output Max:500mA
- Input Type: TTL, CMOS 5V
- Output Type: Open Collector
- Transistor Type: Power Darlington Voltage, Input Max:5V

Voltage, Output Max:50V

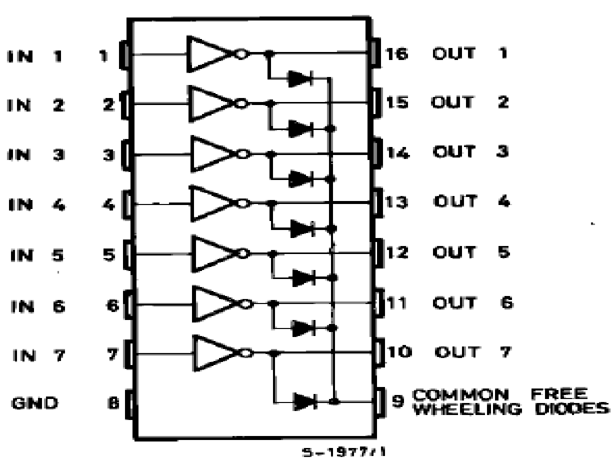


FIG6.5–PIN DIAGRAM

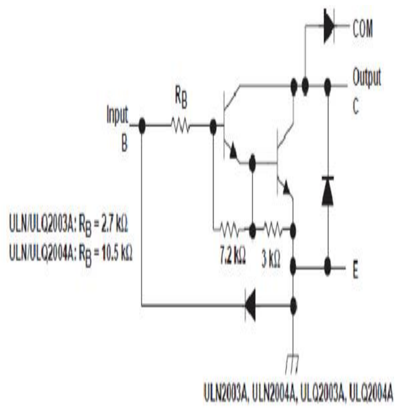


FIG6.6 –CIRCUIT DIAGRAM

PUSH BUTTONS

A push-button is a simple switch mechanism for controlling some aspect of a machine or a process. Buttons are typically made out of hard material, usually plastic or metal. The surface is usually flat or shaped to accommodate the human finger or hand, so as to be easily depressed or pushed. Buttons are most often biased switches, though even many un-biased buttons (due to their physical nature) require a spring to return to their un-pushed state.

Uses:

In industrial and commercial applications push buttons can be linked together by a mechanical linkage so that the act of pushing one button causes the other button to be released. In this way, a stop button can "force" a start button to be released. This method of linkage is used in simple manual operations in which the machine or process have no electrical circuits for control.

Pushbuttons are often color-coded to associate them with their function so that the operator will not push the wrong button in error. Commonly used colors are red for stopping the machine or process and green for starting the machine or process.

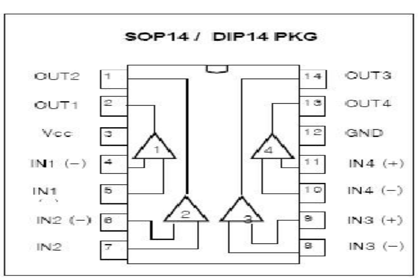
. The source of the energy to illuminate the light is not directly tied to the contacts on the back of the pushbutton but to the action the pushbutton controls. In this way a start button when pushed will cause the process or machine operation to be started and a secondary contact designed into the operation or process will close to turn on the pilot light and signify the action of pushing the button caused the resultant process or action to start.

LIQUID CRYSTAL DISPLAY

LCD Background:

Frequently, an 8051 program must interact with the outside world using input and output devices that communicate directly with a human being. One of the most common devices attached to an 8051 is an LCD display. Some of the most common LCDs connected to the 8051 are 16x2 and 20x2 displays. This means 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.

QUAD VOLTAGE COMPARATOR LM339



ORDERING INFORMATION

Device	Package
LM339D	SOP 14
LM339N	DIP 14

FIG6.7- PIN CONFIGUARATION

The LM339 consists of four independent precision voltage comparators, with an offset voltage specification as low as 20㎷ max for each comparator, which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

Features

- Wide single supply voltage range 2.0VDC TO 36VDC or dural supplies ±1.0VDC to ±18VDC
- Very low supply current drain (0.8㎃) independent Of supply voltage (1.0㎽/comparator at 5.0VDC)
- Low input biasing current 25㎁
- Low input offset current ±5㎁ and offset voltage
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Low output 250㎷ at 4㎃ saturation voltage
- Output voltage compatible with TTL, DTL, ECL, MOS and CMOS logic system
- Moisture Sensitivity Level 3

APPLICATION

- A/D Converters
- Wide range VOC
- MOS clock generator
- High voltage logic gate
- Multivibrators

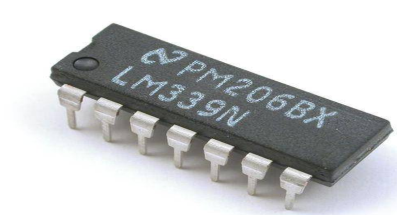


FIG 6.8- QUAD VOLTAGE COMPARATOR LM339

INDUCTIVE LOAD

A load that is predominantly inductive, so that the alternating load current lags behind the alternating voltage of the load. Also known as lagging load. Any devices that have coils of wire in there manufacture can be classed as inductive loads.

CURRENT TRANSFORMER

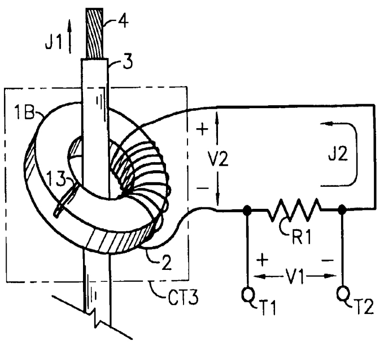


FIG 6.9- CURRENT TRANSFORMER

In electrical engineering, a current transformer (CT) is used for measurement of electric currents. Current transformers, together with voltage transformers (VT) (potential transformers (PT)), are known as instrument transformers. When current in a circuit is too high to directly apply to measuring instruments, a current transformer produces a reduced current accurately proportional to the current in the circuit, which can be conveniently connected to measuring and recording instruments. A current transformer also isolates the measuring instruments from what may be very high voltage in the monitored circuit. Current transformers are commonly used in metering and protective relays in the electrical power industry.

SHUNT CAPACITORS

FIG6.10 - SHUNT CAPACITORS

Shunt capacitor banks are used to improve the quality of the electrical supply and the efficient operation of the power system. Studies show that a flat voltage profile on the system can significantly reduce line losses. Shunt capacitor banks are relatively inexpensive and can be easily installed anywhere on the network.

LED

LEDs are semiconductor devices. Like transistors, and other diodes, LEDs are made out of silicon. What makes an LED give off light are the small amounts of chemical impurities that are added to the silicon, such as gallium, arsenide, indium, and nitride.

When current passes through the LED, it emits photons as a byproduct. Normal light bulbs produce light by heating a metal filament until it is white hot. LEDs produce photons directly and not via heat, they are far more efficient than incandescent bulbs.

Not long ago LEDs were only bright enough to be used as indicators on dashboards or electronic equipment. But recent advances have made LEDs bright enough to rival traditional lighting technologies. Modern LEDs can replace incandescent bulbs in almost any application.

1N4007

Diodes are used to convert AC into DC these are used as half wave rectifier or full wave rectifier. Three points must he kept in mind while using any type of diode.

1. Maximum forward current capacity
2. Maximum reverse voltage capacity
3. Maximum forward voltage capacity

RESISTORS

A resistor is a two-terminal electronic component designed to oppose an electric current by producing a voltage drop between its terminals in proportion to the current, that is, in accordance with Ohm's law:

$$V = IR$$

Resistors are used as part of electrical networks and electronic circuits. They are extremely commonplace in most electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel/chrome).

The primary characteristics of resistors are their resistance and the power they can dissipate. Resistors are also implemented within integrated circuits, particularly analog devices, and can also be integrated into hybrid and printed circuits.

CAPACITORS

A capacitor or condenser is a passive electronic component consisting of a pair of conductors separated by a dielectric. When a voltage potential difference exists between the conductors, an electric field is present in the dielectric. This field stores energy and produces a mechanical force between the plates. The effect is greatest between wide, flat, parallel, narrowly separated conductors.

An ideal capacitor is characterized by a single constant value, capacitance, which is measured in farads. This is the ratio of the electric charge on each conductor to the potential difference between them.

A capacitor is a device for storing electric charge. The forms of practical capacitors vary widely, but all contain at least two conductors separated by a non-conductor. Capacitors used as parts of electrical systems, for example, consist of metal foils separated by a layer of insulating film. Capacitors are widely used in electronic circuits for blocking direct current while allowing alternating current to pass, in filter networks, for smoothing the output of power supplies, in the resonant circuits that tune radios to particular frequencies and for many other purposes.

ADVANTAGE OF IMPROVED POWER FACTOR

- Reactive power decreases
- Avoid poor voltage regulation
- Over loading is avoided
- Copper losses decrease
- Transmission loss decrease
- Improved voltage regulation
- Efficiency of supply system and apparatus increases

VII-CONCLUSION

This project has proposed the advanced method of the power factor correction by using the microcontroller which has the many advantages over the various conventional methods of the power factor compensation. The switching of capacitors is done automatically by using the relay and thus the power factor correction is more accurate. Thus we have presented the possible advanced method for the correction of the power factor.Installation capacitor bank for power factor correction will obtain profitable both sides consumer and electric flow. Installation of capacitor bank can reduce reactive current consumption further minimize a losses. By observing all aspects of the power factor it is clear that power factor is the most significant part for the utility company as well as for the consumer. Utility companies get rid from the power losses while the consumers are free from low power factor penalty charges. The automotive power factor correction using capacitive load banks is very efficient as it reduces the cost by decreasing the power drawn from the supply. As it operates automatically, manpower are not ,required and this Automated Power factor Correction using capacitive load banks can be used for the industries purpose in the future.

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