PROJECT REPORT ON

"NUCLEAR POWER PLANT THROUGH AUTOMATION"

Project report submitted in partial fulfillment of the degree of

BACHELOR OF ENGINEERING

BY

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SCHOOL OF ENGINEERING & TECHNOLOGY, NEW PANVEL

(Affiliated to University of Mumbai)

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REPORT OF PROJECT WORK

NUCLEAR POWER PLANT THROUGH AUTOMATION

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Among the wide panorama of people who provided us help and motivation to complete our project, we are grateful in presenting to you the rare shades of technology by documenting project "**NUCLEAR POWER PLANT THROUGH AUTOMATION**".

We wish to express our deep sense of gratitude to our **DIRECTOR DR. ABDULRAZAK HONNUTAGI** for providing us the facilities to bring this project a success.

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Last but not the least we also thank our lab technicians and all the non-teaching staff.

ABSTRACT

Nowadays the nuclear power plant system operational in domestic as well as foreign countries is generating power in terms of thousands of Kilo watts. These power plants are usually placed in a far off places away from human population so as to avoid any radiation leak casualties. This power generated is transferred to urban cities by means of overhead power lines. The existing power plants have many difficulties they are. humans are involved for operational activities on the floor they are exposed to hazardous environment. Which may cause medical problems in a long terms for them. In case of natural calamity like earthquake or storms the system cannot be shut and power generation continues so there aging a system is needed to deal with necessary changes to adapt. Also the power generated should be kept at ideal value which in all of the power plants existing is fluctuating. The idea of the project is to develop a system an automated nuclear power plant to provide the better way to existing power plants in term of efficiency , output, input, etc by controlling the plant through automation. Nuclear power is one of the ways that we can design an efficient sustainable future. Automation is the primary system used to assist operators in the task of monitoring and controlling nuclear power plants (NPP). Automation performs tasks such as assessing the status of the plant's operations as well as making real time life critical situational specific decisions. While the advantages and disadvantages of automation are well studied in variety of domains, accidents remind us that there is still vulnerability to unknown variables. This paper will look at the effects of automation within three NPP accidents and incidents and will consider why automation failed in preventing these accidents from occurring. It will also review the accidents at the Three Mile Island, Chernobyl, and Fukushima Daiichi NPP's in order to determine where better use of automation could have resulted in a more desirable outcome.

DECLARATION

I declare that this written submission represents my ideas in my own words and where others ideas or words have been included, I have adequately cited and referenced the original sources. I also declared that I have adhered to all principles of academic honesty and integrity and have not represented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission have not been taken when needed.

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Chapter 1

1. INTRODUCTION

Plant designers do not always demonstrate a systematic approach to making the necessary series of critical decisions which assign functions to men or machines, that is to establish the extent and role of automation. This view is supported by data from significant event reports, and from reviews of past and current designs. Similar sources indicate that design teams have not always adequately considered the capabilities and limitations of humans when making these haddock decisions. Although many have examined a comprehensive range of factors material to safe operation including design, training, simulation and management, there has been little formal examination by such groups of the actual role assigned to Operators. Although nuclear power plants are designed to exacting standards, using thorough quality assurance systems, they cannot be made perfect. In practice, the extent to which plant and human behavior can be analyzed and predicted is limited. This situation effectively ensures that there is a continuing role for the operator for the foreseeable future. As automation takes over the more prescriptive tasks, the role of the operator becomes that of a situation manager - an innovator to manage the unexpected.

The first step in achieving the optimum man-machine interface is, where possible, to design the plant so that natural phenomena contribute to its stability and control ability, thereby reducing the active contributions from both man and machines during operation. Much recent attention has been focused on the concept of 'inherently safe reactors', which will simplify safety system requirements and information and control system complexity. If such concepts eventually lead to commercial power reactor designs, there may well be simplifications in plant systems but overall protection, control and monitoring requirements will still require systematic assignment of functions between men and machines.

In the face of this climate, the International Atomic Energy Agency (IAEA), following a recommendation of the International Working Group on Nuclear Power Plant Control and Instrumentation, an expert group with extensive experience in nuclear power plant automation. The task of this group was to advise on the appropriate balance between the role of human actions and automation in nuclear power plants.

The need to improve performance and safety of nuclear power plants anther complex industrial processes has led to increased use of automation. In addition, the ongoing revolution in computing and information system technology is leading plant designers, through economic and performance incentives, to continually increase the extent of automation. At the same time, worldwide experience confirms that societies are demanding higher standards of designers and operators of nuclear plants. More automation, as such, is not necessarily the total solution to these problems. A major aim of this document is to promote increased safety by assisting the designer to improve the process of assigning functions to humans and to automation. Plant designers do not always demonstrate a systematic approach to making the necessary series of critical decisions which assign functions to men or machines, that is to establish the extent and role of automation. This view is supported by data from significant event reports, and from reviews of past and current designs. Similar sources indicate that design teams have not always adequately considered the capabilities and limitations of humans when making these ad hock decisions. Although post three Mile Island studies in Europe, such as that carried out by have examined a comprehensive range of factors material to safe operation including design, training, simulation and management, there has been little formal examination by such groups of the actual role assigned to operators.

Although nuclear power plants are designed to exacting standards, using thorough quality assurance systems, they cannot be made perfect. In practice, the extent to which plant and human behavior can be analyses and predicted is limited. This situation effectively ensures that there is a continuing role for the operator for the foreseeable future. As automation takes over the more prescriptive tasks, the role of the operator becomes that of a situation manager - an innovator to manage the unexpected. The first step in achieving the optimum man-machine interface is ,where possible, to design the plant so that natural phenomena contribute to its stability and control ability, thereby reducing the active contributions from both man and machines during operation.

1.1 CAPABILITIES AND LIMITATIONS OF HUMANS

A human operator possesses a number of desirable features which are not present in current levels of automation. Humans are creative, flexible, can use stored knowledge, routines and patterns to cope with novel, unexpected or beyond-design-basis situations. Such conditions could arise because combinations of or sequence of events may occur or develop to produce an unexpected situation. Human ability to recognize. consistent during adverse condition operators are overloaded with tasks or if the design of the man-machine interface is inadequate. A related skill is the ability to abstract useful information from systems which are 'noisy1 as is the human capacity to form overviews or decisions from incomplete sets of information. Whilst human actions cannot be guaranteed to be totally error-free, the human has the ability to detect his errors and correct them, when the information system provides the necessary cues and the control system and plant response allows time for corrective action to be taken. Data from human error studies confirm that the human tendency to make mistakes is a significant problem. Human errors may be mitigated by the use of procedures for certain types of task but further errors can occur in the use of a procedure if the procedure has shortcomings, an operator relies on memory, departs from the procedure or misinterprets an instruction. This approach therefore requires careful procedure design verification and validation to ensure the documentation is closely matched to the task in hand. A further problem is that some aspects of operator performance can degrade under certain stressful conditions.

1.2 CAPABILITIES AND LIMITATIONS OF AUTOMATION

Automation is used in a variety of ways in nuclear power plants. These applications can be classified by the way in which they relate to the human operator and the degree of control or influence he has over them as follows:

Information and control systems which allow operators to monitor and control processes. Computer based operator aids which process and summaries plant information in a succinct form, information analysis systems, information reduction and management systems, equipment monitoring systems, diagnostic systems, procedure support systems, etc. Automatic functions which aid or supplement the operator's control over a sequence or process, such as plant sequence control, closed. Automatic features which ensure plant safety, such as detecting variables which exceed safe limits and initiating appropriate safety actions, such as reactor scram, initiation of safeguards equipment ,etc. Also included in this category are systems which prevent unsafe conditions such as interlocks, etc. Typically there is little scope for operator intervention in such systems. In certain cases, it is not possible for the feature to be placed under the control of the operator, for example, reactor scram functions .It is often the case that the operator is given part-responsibility to ensure the correct operation of a function. An example of this is the use of operator aids to present information but still retaining the human to diagnose faults and decide on appropriate corrective actions.

1.3 Achieving system performance

Successful integration of man and machine in a system requires overall system pecan readily specify availability, reliability, speed, accuracy, etc. This includes the specification of software in the sense of machine instructions. In past and present designs of complex process systems, the same degree of excellence in the specification of detailed human tasks (or the 'software1 for human, namely operating instructions and other documentation), has not always been demonstrated. Traditionally, engineers of many disciplines have been trained to think predominantly in terms of machine capabilities rather than to consider human performance. Operational events in the nuclear industry throughout the world have, in recent years, shown the problems caused by this situation and many reviews of nuclear plant designs have shown the need to give adequate consideration to so-called 'human factors'. Although the human factors specialist (ergonomic, psychologist or engineer) is now much more in evidence in design, operation and review teams, the influence of such skills is still not sufficiently widespread or yet fully effective. The published literature on human factors contains lists of the various attributes of human sand machines.

GENERAL DISCUSSION

Achieving a balance between automation and human actions requires functions which the man-machine system must carry out to be assigned to either machines, human operatives or, more commonly, a combination of man and machine. The process is usually known in the ergonomics literature as 'allocation of functions' but for consistency with IEEE Standard. This document uses the term 'assignment'. Prior to assignment, the designer considers 'functions'. Once assigned, these can be translated into 'tasks' which are carried out by the requisite part of the system.

In practice, assignment of functions cannot be a simple and mechanistic process. Firstly, the information required to make the decisions may be incomplete or uncertain, particularly in the early stages of the project. Secondly, the criteria against which to make assignment decisions may not be absolute or may apply only conditionally. Thirdly, any individual assignment decision may interact with a previous one, necessitating re-examination and iteration of that decision leading to a revised decision. Thus the assignment of functions process is of necessity an iterative one and must be thought of as a balancing of the several factors which are involved rather than the meeting of a set of fixed design rules.

ASSIGNING FUNCTIONS

This Section outlines a methodology for assigning functions to man and machines. The methodology starts from three sources of information: global project objectives, statements of required system performance, and data on human and machine capabilities and limitations. Although stated this way for brevity, in a practical situation, these three sets will represent a considerable amount of information. Detailed data on required system performance and human and machine performance may not be available at the outset. It will therefore be necessary to employ an iterative approach, taking what is available first and then identifying what is missing. The need for certain source information may become apparent only after initial assignments have been made.

The main part of the assignment process consists of identifying four types of functions which are described. This will produce a list of functions suitable for automation and those which are better suited to humans. At this stage, the lists can only be hypothetical since the design team may not have worked with complete information and may not have considered all interactions and all limiting factors.

An iterative process must now be carried out which re-examines each of the initial assignments in the context of all others and identifies any inconsistencies. Where an assignment produces conflict with accepted human factors principles, the assignment must be reconsidered and revised. When these two categories of mis-match have been resolved it is then possible to proceed to optimize the assignment in order to achieve the best possible set of working tasks and machine specifications.

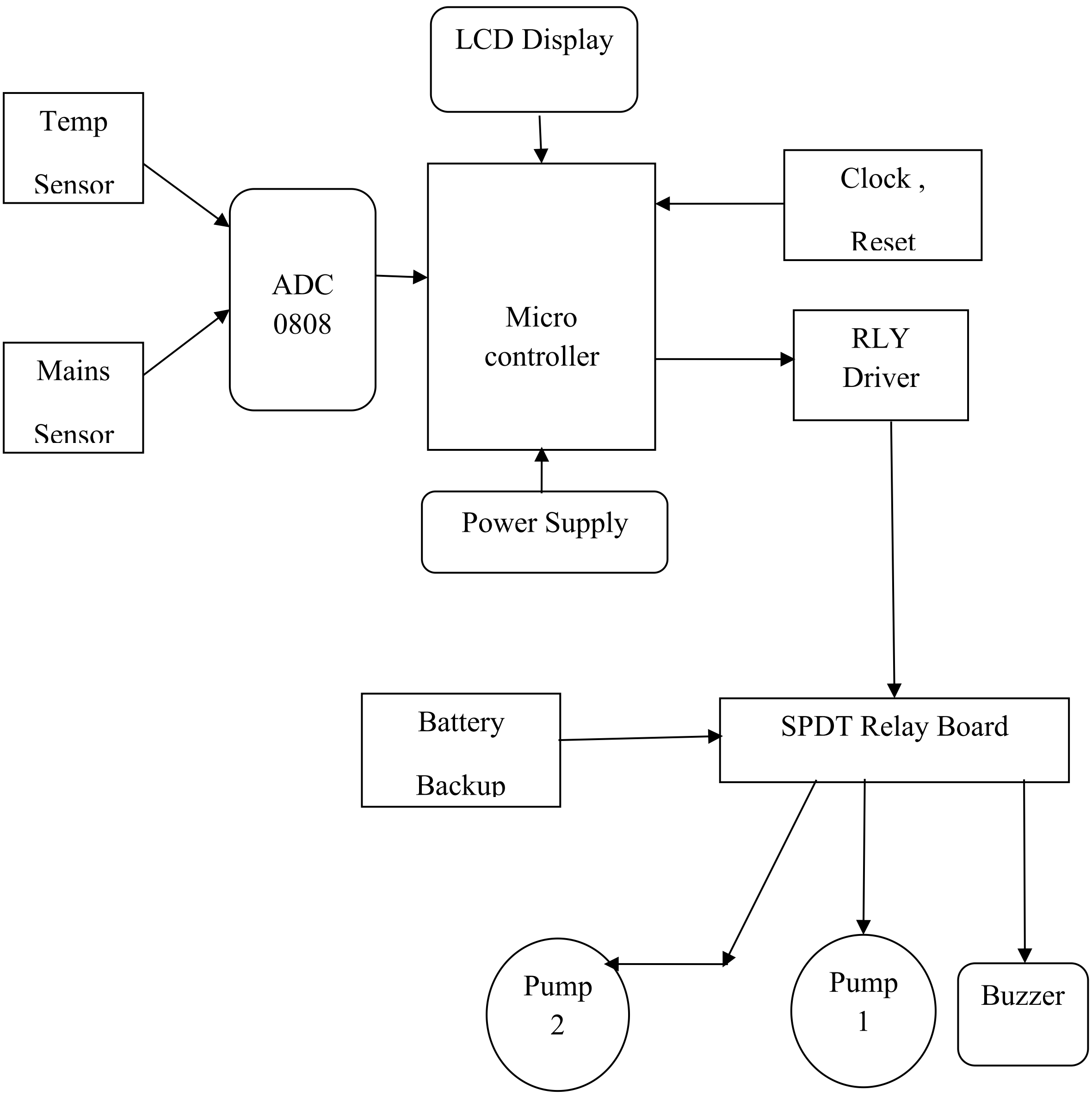
1.4 INTERFACING WITH RELATED DESIGN ACTIVITIES

One of the outputs from the methodology described will be statements of tasks to be carried out by operating staff. These will include functions which are shared between men and machines. For practical reasons, to allow operating staff requirements and role to be identified and developed, this information must now be expressed in terms of task descriptions, job descriptions and staff requirements specifications. For practical application to control and monitoring of the plant at the detailed level, operating staff tasks will usually be expressed in the form of operating procedures, operating rules, technical schedules, etc. Notwithstanding this, a definition of the role of each member of the operating staff should be produced, which clearly defines the operator's role and responsibilities in both the maintenance of safety and in achieving production goals. At this stage, a check should be made that there is no conflict between the various safety and production goals which have been defined and that the goal definitions which exist are complete and consistent. Where any potential conflict is identified this must be fully analyst and task specifications revised accordingly. If it is not possible to eradicate such potential conflicts, the operating staff must be provided with adequate guidance to resolve these during operation of the plant.

Operating staff task specifications will also provide a basis on which to confirm information and control interface needs. Examination of the detailed task statements will also enable information display content and form to be confirmed as well as types of input, selection and control devices. From this information and a consideration of the context in which a task or tasks are performed, it may be possible to identify where additional operator support systems or job aids are required. This information will need to be fed into the design process for the man-machine interface and supporting facilities.

Chapter 2

2.1 BLOCK DIAGRAM



2.2 Description

Above is the block diagram of nuclear power through automation. The functions of various blocks associated with it .The microcontroller used here is 89S51e power plant it.

Temperature sensor:

The heat dissipated through the process of bombarding of nuclear fuel mostly uranium in the reactor is used for the purpose of the power generation .This heat is measured by the temperature sensor .

Mains sensor:

The electrical output generated by the plant are measured . The voltage associated with the power production is measured by the sensor called as main sensor.

ADC 0808:

The parameters measured by the sensors are fed to the ADC block. The readings measured by the sensors are in terms of analog input, but for the operation of the power plant digital inputs are required. Hence the ADC block used here converts the analog inputs to digital before feeding it to the microcontroller for the further operation. The ADC used here is generally ADC 0808.

Microcontroller :

The AT89S51 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Phillips's high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Phillips AT89C51 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

Buzzer:

The cooling water is passed through the pipes for the purpose of cooling the heating chamber in which nuclear reaction takes place

Pumps:

The pump 1 is AC pump which works when mains voltage is applied and the pump 2 to DC pump when main voltage is not there its gets ON.

SPDT RELAY:

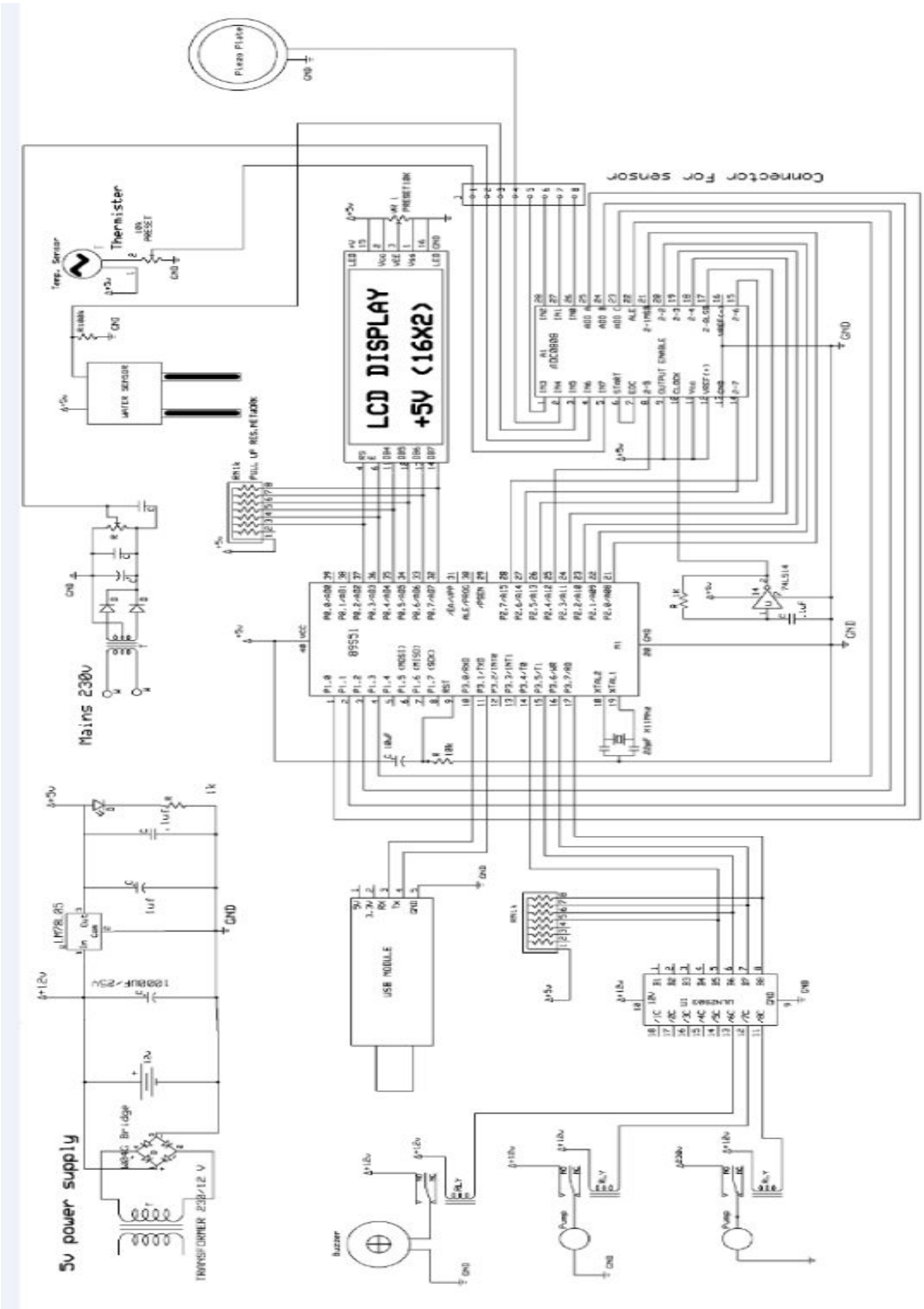
When an electric current is passed through the coil, the resulting magnetic field attracts the armature, and the consequent movement of the movable contact or contacts either makes or breaks a connection with a fixed contact. If the set of contacts was closed when the relay was de-energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open. When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position. Most relays are manufactured to operate quickly. In a low voltage application, this is to reduce noise. In a high voltage or high current application, this is to reduce arcing.

LCD display:

2x16 Serial LCD Display is connected to the 89S51 microcontroller port to display the value of temperature , mains voltage , vibration and moisture.

CHAPTER 3

3.1 CIRCUIT DIAGRAM



3.2 WORKING OF CIRCUIT

The 230V power supply is the primary requirement for working and with the help of stepdown transformer it is stepdown to 12v and 1ampere Ac current. With the help of rectifier it is converted from AC to DC and it gets filter which is of 1microfarad.But circuit require 5V hence the voltage is regulated with 7805 voltage regulator. Spike suppressor is used to remove the spike.The microcontroller is 89S51 which had been given clock with the help of Crystal Oscillator and connected to a Capacitor, Reset. 89S51 hsas four port 0,1,2 and 3 and each one had 8pins , LCD display and reset is connected at port 0. The port1 send address to ADC 0808 to select the sensor which has to be addressed and the clock is given by 7414 IC to the ADC0808 and ADC converts the analog to digital and is returned at the port 2 of microcontroller.

The data received at port2 is binary which is converted into decimal and displayed on 16*2 LCD display. The Rx pin of port 3 send data to serial to USB converter to PC and the data can be seen on PC. The lower 4bits output of port 3 is connected to the 4 transistor which amplify the signal and SPDT relay which is of 12V get magnetized, whenever there is an occurrence of any fault .When the temperature arises or goes down relay1 gets ON and if it rises high AC pump is ON and pump lower the rising temperature in the nuclear power plant by cooling.But when the Mains supply goes less than 180V, the efficiency of AC pump is less. Than Relay2 is ON and starts the DC pump which had been given backup supply. When there is leakage or moisture which lower the cooling efficieny the Relay 3 gets ON and gives an alarm with the help of buzzer. Relay 4 gets ON when there is a vibration like Earthquake or tsunami and it cuts the supply to the reacter and

Power plant is shutdown for a time interval . We required sensor for sensing temperature , humidity, vibration and main voltage.So for temperature sensing Thermistor of 10KOhm is used as temperature changes resistance changes but what is required is voltage, so voltage potential divider is there and the junction output is given to ADC .As temperature changes there is a change at junction voltage.

For mains voltage sensing Potential Transformer is there and for moisture, when the liquid is between two electrode the current flows and ADC get voltage and detect the moisture. With the help of piezo plate vibration is sense and OP-AMP is there which amplify the signal and this signal is sent to ADC.

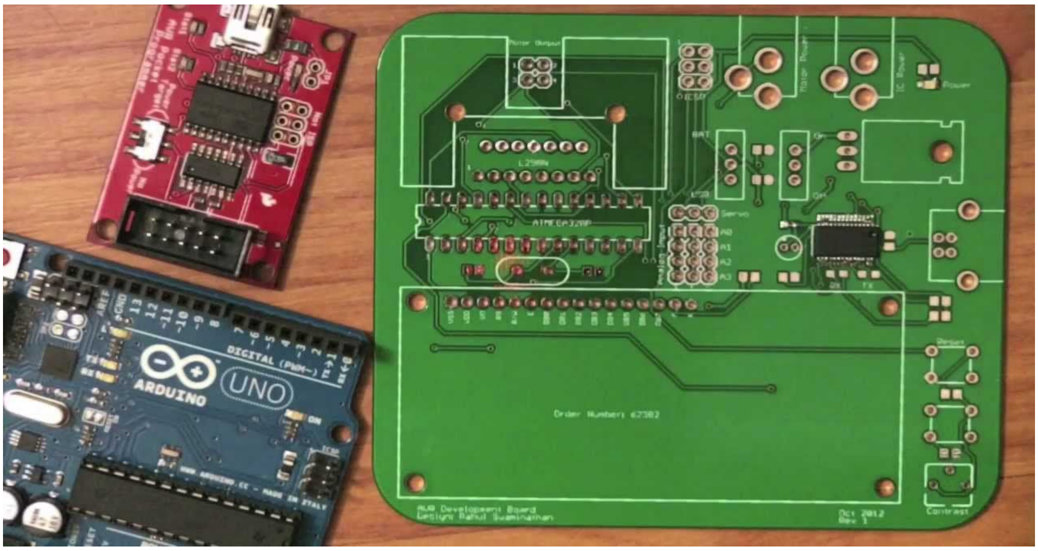
In parallel with mains voltage with rectifier and filter, a 12v battery is connected when mains is there battery is charged and whenever a more current is required it acts as buffer and supply and if mains voltage is OFF then the battery will acts as an UPS and supplies the power.Both the AC pump and DC pump will acts as a chilling tower for Nuclear power plant and it helps in lowering the temperature of the reactor of power plant.

Chapter 4

4.1PCB FABRICATION

4.1.1P.C.B. MAKING

- P.C.B. is printed circuit board which is of insulating base with layer of thin copper-foil.
- The circuit diagram is then drawn on the P. C. B. with permanent marker and then it is dipped in the solution of ferric chloride so that unwanted copper is removed from the P.C.B., thus leaving components interconnection on the board.
- The specification of the base material is not important to know in most of the application, but it is important to know something about copper foil which is drawn through a thin slip.
- The resistance of copper foil will have an affect on the circuit operation.

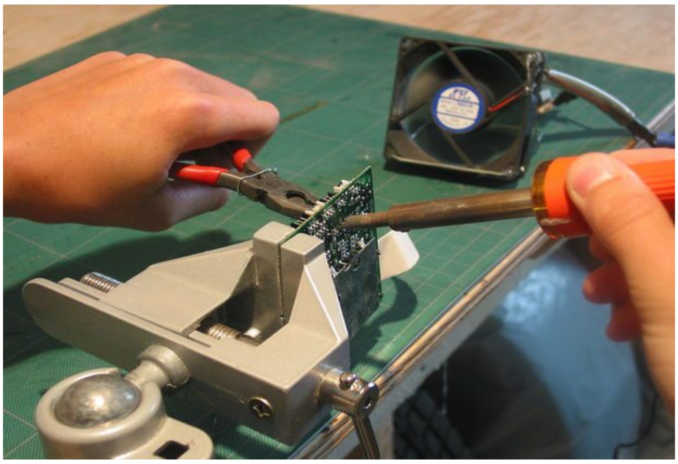


- Base material is made of lamination layer of suitable insulating material such as treated paper, fabric; or glass fibers and binding them with resin. Most commonly used base materials are formed paper bonded with epoxy resin.
- It is possible to obtain a range of thickness between 0.5 mm to 3 mm.

- Thickness is the important factor in determining mechanical strength particularly when the commonly used base material is "**Formea**" from paper assembly.
- Physical properties should be self supporting these are surface resistivity, heat dissipation, dielectric, constant, dielectric strength.
- Another important factor is the ability to wishstand high temperature.

4.1.2 DESIGNING THE LAYOUT :

- While designing a layout, it must be noted that size of the board should be as small as possible.
- Before starting, all components should be placed properly so that an accurate measurement of space can be made.
- The component should not be mounted very close to each other or far away from one another and neither one should ignore the fact that some component reed ventilation, which considerely the dimension of the relay and transformer in view of arrangement, the bolting arrangement is also considered.
- The layout is first drawn on paper then traced on copper plate which is finalized with the pen or permanent marker which is efficient and clean with etching.
- The resistivity also depends on the purity of copper, which is highest for low purity of copper. The high resistance path are always undesired for soldered connections.
- The most difficult part of making an original printed circuit is the conversion from, theretical circuit diagram into wiring layout. without introducing cross over and undesirable effect.
- Although it is difficult operation, it provides greater amount of satisfaction because it is carried out with more care and skill.
- The board used for project has copper foil thickness in the range of 25 40 75 microns.
- The soldering quality requires 99.99% efficiency.



- It is necessary to design copper path extra large. There are two main reasons for this,
  - i. The copper may be required to carry an extra large overall current:-
  - ii. It acts like a kind of screen or ground plane to minimize the effect of interaction.
- The first function is to connect the components together in their right sequence with minimum need for interlinking i.e. the jumpers with wire connections.
- It must be noted, that when layout is done, on the next day it should be dipped in the solution and board is move continuously right and left after etching perfectly the board is cleaned with water and is drilled.
- After that holes are drilled with 1 mm or 0.8 mm drill. Now the marker on the P. C. B. is removed.
- The Printed Circuit Board is now ready for mounting the components on it.

4.2 SOLDERING :

1. For soldering of any joints first the terminal to be soldered are cleaned to remove oxide film or dirt on it. If required flux is applied on the points to be soldered.
2. Now the joint to be soldered is heated with the help of soldering iron. Heat applied should be such that when solder wire is touched to joint, it must melt quickly.

3. When joint is completely covered with molten solder, the soldering iron is removed.
4. The joint is allowed to cool, without any movement.
5. The bright shining solder indicates good soldering.
6. In case of dry solder joint, a air gap remains in between the solder matal and the joint. It means that soldering is improper. This is removed and again soldering is done.
7. Thus is this way all the components are soldered on P. C. B.

Chapter 5

5.1 ADVANTAGES

1. Reduction in response time:

Due to the automation of the system ,there is an increase in the action/reaction time of the respected system in the traditional system ,all the decisions are taken by the humans/employees so there is possibility that the authorized person may delay the necessary action .this may speed up the aging of the system. When the system is automated ,it boost the response time of the respected system since there is no thinking involved by the machine.

2. Increase in accuracy and repeatability:

When an automated system is employed to perform a task , the accuracy of the system increases .also when it is performing a particular task over and over again ,it gives the accurate results as compared to when employee is performing the specified task .if an employee is performing the specified task ,chances of errors are increased due to repeatability.

3. Lower running cost:

Owing to the automation of the system ,various costs are diminished such as payrol, sick days, benefits, etc. of the employees when the system is operated by them. due to the automation, less employees are needed to get the job done. This causes reduction in running cost.

4. Increased safety:

Due to the automation of the system ,dangerous tasks and prone to injury can be performed at ease These task could be hazardous to the employee if they are in full control of the system.

5. Reduction in errrors:

No one is perfect in this world and if the authorization of the sytem is under employees sleeves chances of errors are high which contributes to the aging of the system .if the system is automated ,the chances of errors are significantly reduced.if the machine is empoyeed to perform repeated tasks ,it is less likely to make a mistake than employee

5.2 DISADVANTAGES

1. Less versatility:

With the use of automation technique by having a machine that can perform a certain task limits to the flexibility and variety of tasks that an employee could do.

2. More pollution:

In the automation technique ,different types of machines operate using motor which may require gases or chemicals in order to operate contributing to pollution leading to impure environment in workplace.

3. Large capital cost:

Machines associated to the automation are very costly. With automated machines running anywhere the costs may range between thousands and millions of rupees depending on the level of automation.

4. Increase in unemployment:

If the amount of automation is increased ,it will lead to the reduction of working employee causing high unemployment rates.

5. Unpredictable costs:

It may be possible that certain costs that is unpredictable costs may exceed the actual cost set by the automation during the initial stage .Research and development costs of automating a process ,their maintenance costs ,cost of training the employee contributes to the unpredictable costs.

5.3 APPLICATION

1.Medicine & Scientific Research:

In nuclear medicine, medical professionals inject a tiny amount of a radioisotope—a chemical element that produces radiation—into a patient's body. A specific organ picks up the radioisotope, enabling a special camera to take a detailed picture of how that organ is functioning. For example:

Myocardial per-fusion imaging maps the blood flow to the heart, allowing doctors to see whether a patient has heart disease and determine the most effective course of treatment.

Bone scans can detect the spread of cancer six to 18 months earl kidney scans are much more sensitive than X-rays or ultrasounds in fully evaluating kidney function.

Imaging with radioactive technetium-99 can help diagnose bone infections at the earliest possible stage.

These kinds of diagnostic procedures involve very small amounts of radioisotopes. In higher doses, radioisotopes also help treat disease. For example, radioactive iodine's widespread use in therapy for thyroid cancer results in a lower recurrence rate than drug therapy. It also avoids potentially fatal side effects, such as the destruction of bone marrow.

Sealed sources of radiation placed inside the body, or radiation directed from external sources, are effective in treating various cancers. Nearly half of all cancer patients in the United States receive radiation treatment at some point in their therapy.

Hospitals also use radiation to sterilize materials, thus helping to prevent the spread of diseases. Exposing these materials to radiation does not make them radioactive.

2.Water Desalination:

Readily available drinking water is out of reach for as much as a fifth of the world's population, a bar to human development. One solution is water desalination, which extracts salt from seawater to produce drinkable fresh water. Nuclear energy is being used for some desalination efforts, but the potential in this arena is enormous and has multiple benefits over the more common fossil-fuel based desalination.

3.Small Nuclear Reactors and Desalination: Perfect Together

More recently, Argentina, China and South Korea have developed small nuclear reactor designs specifically to generate both electricity and fresh water. These run from 5 to 330 megawatts thermal. Russia has designed a barge-like floating nuclear facility, operating at 80 megawatts thermal. Small reactor technology may be key to expanding clean, nuclear energy-based desalination.

Though nuclear energy has not displaced fossil fuels in water desalination projects, it has emerged from the background in the last several years, especially as climate change has become an important concern and small reactor technology has matured.

Chapter 6

6.1 COMPONENT LIST

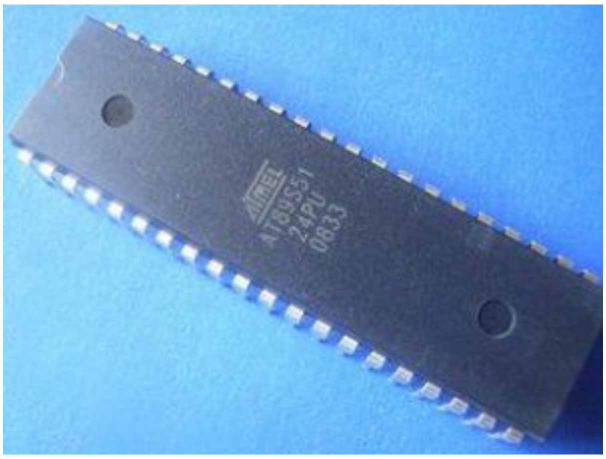
SR.No	Description	Qty.	Price
1	Transformer 12-0-12V,750Ma	1	35
2	Diode 1N4007	4	4
3	Capacitor1000uF,25V	1	5
4	Voltage regulator IC 7805	1	10
5	Capacitor 1uF	1	1
6	LED	1	1
7	Resistors	15	5
8	Disc capacitors	5	5
9	IC Base	5	10
10	PCB	1	250
11	Wires	2	25
12	Solder wire	1	25
13	Cabinet	1	150
14	Mains cord	1	10
15	Transistor BC548	5	15

6.2 DATASHEET

6.2.1 Microcontroller 89S51

Definition:

An embedded microcontroller is a chip which has a computer processor with all its support functions (clock & reset), memory (both program and data), and I/O (including bus interface) built into the device. These built in functions minimize the need for external circuits and devices to be designed in the final application.



- **Embedded Microcontroller**

When all the hardware required to run the application is provided on the chip, it is refer to as an Embedded Microcontroller. All that is typically required to operate the device is power, reset, and a clock. Digital I/O pins are provided to allow interfacing with external.

The 89S51 microcontroller

The AT89S51 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Phillips's high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Phillips AT89S51 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

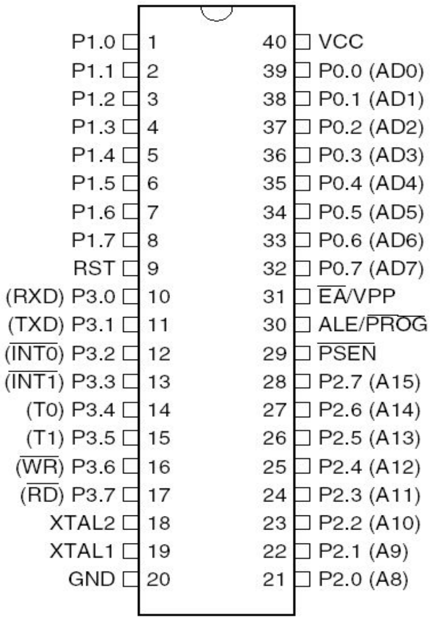
The AT89S51 is designed with static logic for operation down to zero frequency and supports two Software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning. The Power-down Mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next Hardware reset.

a) Features of 89S51

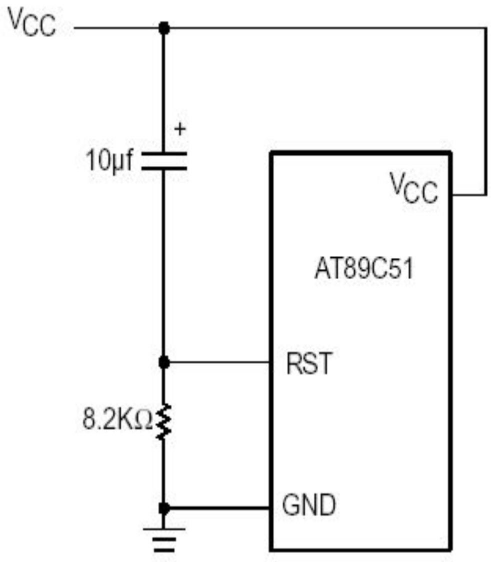
Following is the features of 89S51 microcontroller as per the datasheet given by Phillips-

- Compatible with MCS-51™ Products
- 4K Bytes of In-System Reprogrammable Flash Memory Endurance: 1,000 Write/Erase Cycles
- Fully Static Operation: 0 Hz to 24 MHz
- Three-level Program Memory Lock
- 128 x 8-bit Internal RAM
- 32 Programmable I/O Lines
- Two 16-bit Timer/Counters
- Six Interrupt Sources
- Programmable Serial Channel
- Low-power Idle and Power-down Modes

b) Pin Diagram of 89C51:



c) BLOCK DIAGRAM:



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Phillips AT89C51 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

Pin Description

- **VCC**

  Supply voltage.

- **GND**

  Ground.

- **Port 0**

  Port 0 is an 8-bit open-drain bi-directional 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 may 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 bi-directional 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. Port 1 also receives the low-order address bytes during Flash programming and verification.

- **Port 2**

  Port 2 is an 8-bit bi-directional 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, it 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.

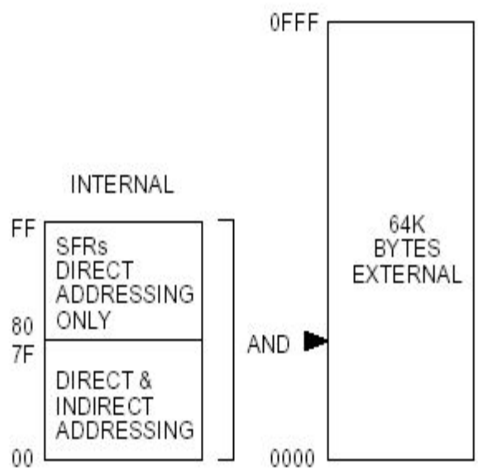
Port 2 also receives the high-order address bits and some control signals during Flash programming and verification.

- **Port 3**

Port 3 is an 8-bit bi-directional 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. Port 3 also serves the functions of various special features of the AT89C51 as listed below:

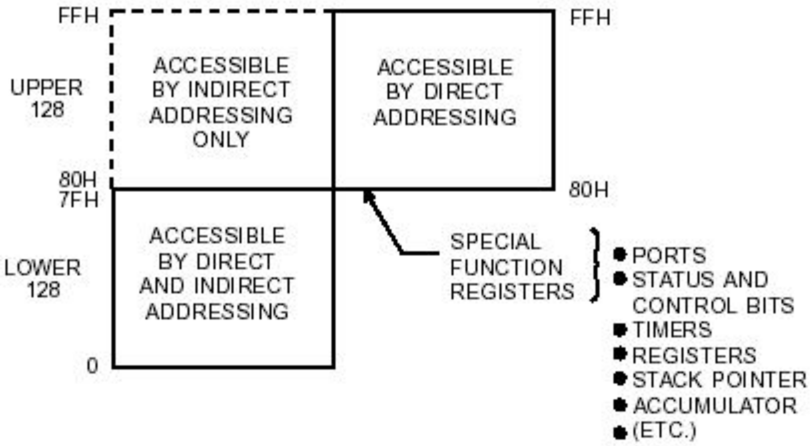
Data Memory

The C51 Microcontroller Family can address up to 64 K bytes of Data Memory to the chip. The "MOVX" instruction is used to access the external data memory (refer to the C51 instruction set, in this chapter, for detailed description of instructions). The 80C51 has 128 bytes of on-chip-RAM (256 bytes in the 80C52, 83C154 and 83C154D) plus a number of Special Function Registers (SFR). The lower 128 bytes of RAM can be accessed either by direct addressing (MOV data addr). or by indirect addressing (MOV @Ri).



Internal Data Memory Organization

Internal data memory is shown in Figure. The memory space is divided into three blocks, which are generally referred to as the Lower 128, the Upper 128, and SFR space.



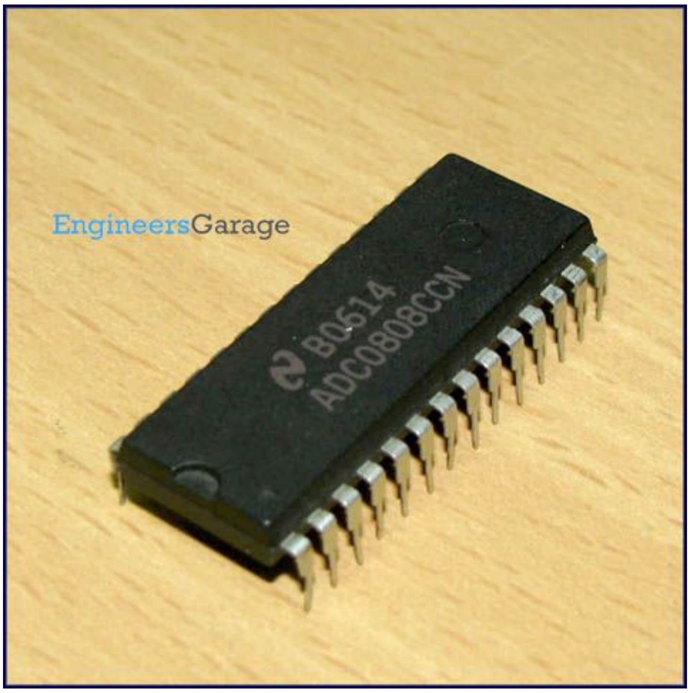
Internal data memory addresses are always 1 byte wide, which implies an address space of only 256 bytes. However, the addressing modes for internal RAM can in fact accommodate 384 bytes. Direct addresses higher than 7FH access one memory space, and indirect addresses higher than 7FH access a different memory space. Thus, Figure 7 shows the Upper 128 and SFR space occupying the same block of addresses, 80H through FFH, although they are physically separate entities.

The 128 Byte Memory

The next 16 bytes above the register banks form a block of bit-addressable memory space. The microcontroller instruction set includes a wide selection of single-bit instructions, and these instructions can directly address the 128 bits in this area. These bit addresses are 00H through 7FH. All of the bytes in the Lower 128 can be accessed by either direct or indirect addressing. The Upper 128 (Figure 9) can only be accessed by indirect addressing. The Upper 128 bytes of RAM are only in the devices with 256 bytes of RAM.

6.2.2ADC0808 General Description:

ADC0809 of National Semiconductor (8-Bit µP Compatible A/D Converters with 8-Channel Multiplexer)



The ADC0808, ADC0809 data acquisition component is a monolithic CMOS device with an 8-bit analog-to-digital converter, 8-channel multiplexer and microprocessor compatible control logic. The 8-bit A/D converter uses successive approximation as the conversion technique. The converter features a high impedance chopper stabilized comparator, a 256R voltage divider with analog switch tree and a successive approximation register. The 8-channel multiplexer can directly access any of 8-single-ended analog signals. The device eliminates the need for external zero and full-scale adjustments. Easy interfacing to microprocessors is provided by the latched and decoded multiplexer address inputs and latched TTL TRI-STATE® outputs.

The design of the ADC0808, ADC0809 has been optimized by incorporating the most desirable aspects of several A/D conversion techniques. The ADC0808, ADC0809 offers high speed, high accuracy, minimal temperature dependence, excellent long-term accuracy and repeatability, and consumes minimal power. These features make this device ideally suited to applications from process and machine control to consumer and automotive applications. For 16-channel multiplexer with common output (sample/hold port) see ADC0816 data sheet. (See AN-247 for more information.)

Features

1. Easy interface to all microprocessors operates ratio metrically or with 5 VDC or analog span adjusted voltage reference;
2. No zero or full-scale adjust required;
3. 8-channel multiplexer with address logic;
4. 0V to 5V input range with single 5V power supply;
5. Outputs meet TTL voltage level specifications;
6. Standard hermetic or molded 28-pin DIP package;
7. 28-pin molded chip carrier package;
8. ADC0808 equivalent to MM74C949;
9. ADC0809 equivalent to MM74C949-1.

Key Specifications

1. Resolution 8 Bits
2. Total Unadjusted Error ±1/2 LSB and ±1 LSB
3. Single Supply 5 VDC
4. Low Power 15 mW
5. Conversion Time 100 µs

DISPLAY

Various display device such as seven segment display. LCD display, etc can be interfaced with microcontroller to read the output directly. In our project we use a two line LCD display with 16 characters each.

LCD_

Liquid crystal Display (LCD) displays temperature of the measured element, which is calculated by the microcontroller. CMOS technology makes the device ideal for application in hand held, portable and other battery instruction with low power consumption.

Net Media 2x16 Serial LCD Display Module

GENERAL SPECIFICATION:

- Drive method: 1/16 duty cycle
- Display size: 16 character * 2 lines
- Character structure: 5*8 dots.
- Display data RAM: 80 characters (80*8 bits)
- Character generate ROM: 192 characters
- Character generate RAM: 8 characters (64*8 bits)
- Both display data and character generator RAMs can be read from MPU.
- Internal automatic reset circuit at power ON.
- Built in oscillator circuit.

PIN Configuration

JP1/JP14 Pins 1 – 8	Description	JP1/JP14 Pins 9 -16	Description
Pin1	Ground	Pin9	D2 (Not Used)
Pin2	VCC (+5)	Pin10	D3 (Not Used)
Pin3	Contrast	Pin11	D4
Pin4	Data/Command (R/S)	Pin12	D5
Pin5	Read/Write (W)	Pin13	D6
Pin6	Enable (E1)	Pin14	D7
Pin7	D0 (Not Used)	Pin15	VCC (LEDSV+)
Pin8	D1 (Not Used)	Pin16	Ground

LCD Control Codes

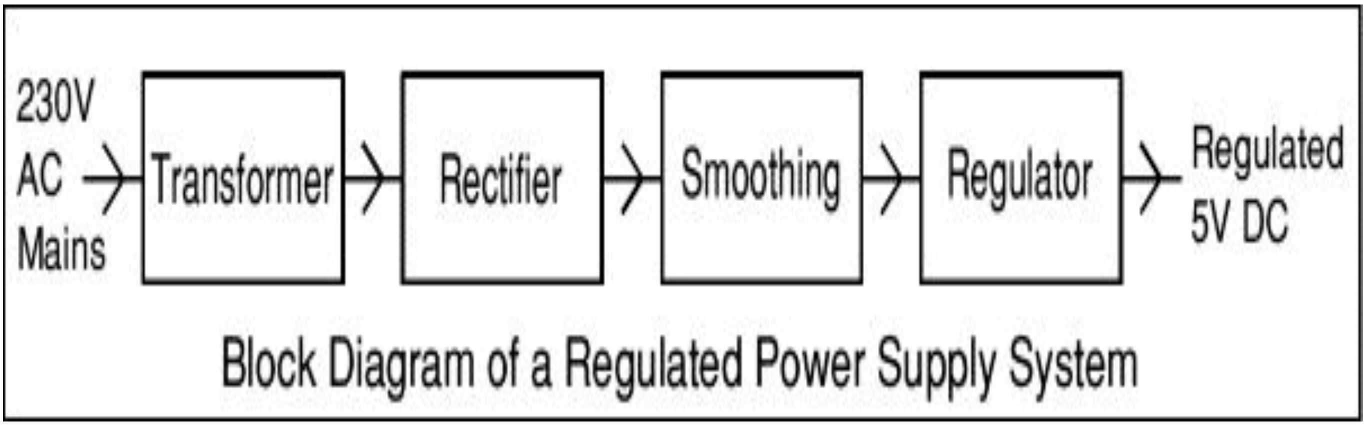
Description	Keyboard Code	ASCII or Decimal value
Display custom character 0-7	Ctrl-@ -Through- Ctrl-G	0 - 7
BackSpace	Ctrl-H	8
Horizontal Tab	Ctrl-I	9
New Line	Ctrl-J	10
Vertical Tab	Ctrl-K	11
Form Feed (Clear Screen)	Ctrl-L	12

Carriage Return	Ctrl-M	13
Reset Controller	Ctrl-N	14
Set Geometry	Ctrl-O	15
Set Tab Size	Ctrl-P	16
Set Cursor Position	Ctrl-Q	17
*Not Used	*****	**
Set Contrast	Ctrl-S	19
Set Backlight	Ctrl-T	20
Command Escape	Ctrl-U	21
Data Escape	Ctrl-V	22
Raw Data Escape	Ctrl-W	23
*Not Used	*****	**
Display an ASCII Character	None	22 – 255

6.2.3 POWER SUPPLY

There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function.

For example a 5V regulated supply:



Each of the blocks is described in more detail below:

- Transformer - steps down high voltage AC mains to low voltage AC.
- Rectifier - converts AC to DC, but the DC output is varying.
- Smoothing - smoothes the DC from varying greatly to a small ripple.
- Regulator - eliminates ripple by setting DC output to a fixed voltage.

Power supplies made from these blocks are described below with a circuit diagram and a graph of their output:

- Transformer only
- Transformer + Rectifier
- Transformer + Rectifier + Smoothing
- Transformer + Rectifier + Smoothing + Regulator

SPDT RELAY BOARD

The basic relay carrier modules allow simple control of a single-pole, double-throw (SPDT) switch from low-voltage, low-current control signals. This item includes the basic carrier PCB with a soldered-in 12 V relay, 5.0 mm terminal blocks for the switch connections, and straight 0.1" male header for the control connections. The included power relay is rated for up to 10 A under most conditions.

PPM (Parts per Million):

This is like a percent error (1000 PPM = .1% error), and is convenient for calculating error with crystals. 5ppm on a 4MHz crystal = 5*4 = 20Hz possible error. Most microcontroller applications don't require too much accuracy, 100ppm is fine. If the parallel capacitors don't match the crystal's capacitive load exactly, they will pull the frequency, but not much. This offers more info about pullability and crystals in general. It seems to indicate that on a 20pF CL crystal, you may get 16ppm/pF error between the anticipated load.

Diodes

Diodes are components that allow current to flow in only one direction. They have a positive side (leg) and a negative side. When the voltage on the positive leg is higher than on the negative leg then current flows through the diode (the resistance is very low). When the voltage is lower on the positive leg than on the negative leg then the current does not flow (the resistance is very high). The negative leg of a diode is the one with the line closest to it. It is called the cathode. The postive end is called the anode.

Resistors

Resistors are components that have a predetermined resistance. Resistance determines how much current will flow through a component. Resistors are used to control voltages and currents. A very high resistance allows very little current to flow. Air has very high resistance. Current almost never flows through air. (Sparks and lightning are brief displays of current flow through air. The light is created as the current burns parts of the air.) A low resistance allows a large amount of current to flow. Metals have very low resistance. That is why wires are made of metal. They allow current to flow from one point to another point without any resistance. Wires are usually covered with rubber or plastic. This keeps the wires from coming in contact with other wires and creating short circuits. High voltage power lines are covered with thick layers of plastic to make them safe, but they become very dangerous when the line breaks and the wire is exposed and is no longer separated from other things by insulation.

Resistance is given in units of ohms. (Ohms are named after Mho Ohms who played with electricity as a young boy in Germany.) Common resistor values are from 100 ohms to 100,000 ohms. Each resistor is marked with colored stripes to indicate it's resistance. To learn how to calculate the value of a resistor by looking at the stripes on the resistor, go to Resistor Values which includes more information about resistors.

Variable Resistors

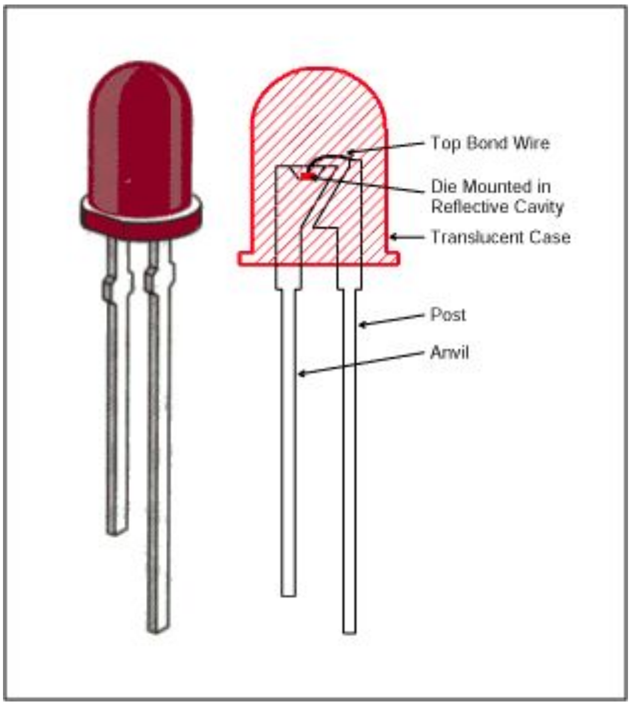
Variable resistors are also common components. They have a dial or a knob that allows you to change the resistance. This is very useful for many situations. Volume controls are variable resistors. When you change the volume you are changing the resistance which changes the current. Making the resistance higher will let less current flow so the volume goes down. Making the resistance lower will let more current flow so the volume goes up. The value of a variable resistor is given as it's highest resistance value. For example, a 500 ohm variable resistor can have a resistance of anywhere between 0 ohms and 500 ohms. A variable resistor may also be called a potentiometer (pot for short).

Switches

Switches are devices that create a short circuit or an open circuit depending on the position of the switch. For a light switch, ON means short circuit (current flows through the switch, lights light up and people dance.) When the switch is OFF, that means there is an open circuit (no current flows, lights go out and people settle down. This effect on people is used by some teachers to gain control of loud classes.)

When the switch is ON it looks and acts like a wire. When the switch is OFF there is no connection.

6.2.4 LED



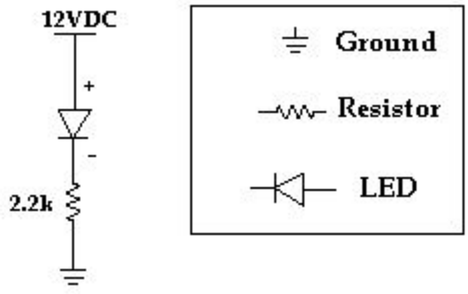
An LED is the device shown above. Besides red, they can also be yellow, green and blue. The letters LED stand for Light Emitting Diode. Light Emitting Diodes are great for projects because they provide visual entertainment. LEDs use a special material which emits light when current flows through it. Unlike light bulbs, LEDs never burn out unless their current limit is passed. A current of 0.02 Amps (20 mA) to 0.04 Amps (40 mA) is a good range for LEDs. They have a positive leg and a negative leg just like regular diodes. To find the positive side of an LED, look for a line in the metal inside the LED. It may be difficult to see the line. This line is closest to the positive side of the LED. Another way of finding the positive side is to find a flat spot on the edge of the LED. This flat spot is on the negative side.

When current is flowing through an LED the voltage on the positive leg is about 1.4 volts higher than the voltage on the negative side. Remember that there is no resistance to limit the current so a resistor must be used in series with the LED to avoid destroying it.

If you are unfamiliar with diodes, take a moment to review the components in Basic Components, Section 1.2. The important thing to remember about diodes (including LEDs) is that current can only flow in one direction.

To make an LED work, you need a voltage supply and a resistor. If you try to use an LED without a resistor, you will probably burn out the LED. The LED has very little resistance so large amounts of current will try to flow through it unless you limit the current with a resistor. If you try to use an LED without a power supply, you will be highly disappointed.

So first of all we will make our LED light up by setting up the circuit below.



Step 1.) First you have to find the positive leg of the LED. The easiest way to do this is to look for the leg that is longer.

Step 2.) Once you know which side is positive, put the LED on your breadboard so the positive leg is in one row and the negative leg is in another row. (In the picture below the rows are vertical.)

Step 3.) Place one leg of a 2.2k ohm resistor (does not matter which leg) in the same row as the negative leg of the LED. Then place the other leg of the resistor in an empty row.

Step 4.) Unplug the power supply adapter from the power supply. Next, put the ground (black wire) end of the power supply adapter in the sideways row with the blue stripe beside it. Then put the positive (red wire) end of the power supply adapter in the sideways row with the red stripe beside it.

Step 5.) Use a short jumper wire (use red since it will be connected to the positive voltage) to go from the positive power row (the one with the red stripe beside it) to the positive leg of the LED (not in the same hole, but in the same row). Use another short jumper wire (use black) to go from the ground row to the resistor (the leg that is not connected to the LED). Refer to the picture below if necessary.

The breadboard should look like the picture shown below.

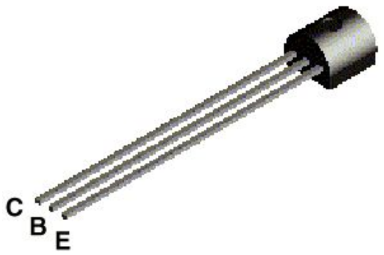
Now plug the power supply into the wall and then plug the other end into the power supply adapter and the LED should light up. Current is flowing from the positive leg of the LED through the LED to the negative leg. Try turning the LED around. It should not light up. No current can flow from the negative leg of the LED to the positive leg.

People often think that the resistor must come first in the path from positive to negative, to limit the amount of current flowing through the LED. But, the current is limited by the resistor no matter where the resistor is. Even when you first turn on the power, the current will be limited to a certain amount, and can be found using ohm's law.

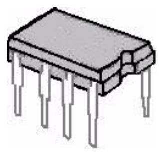
6.2.5 Transistor

Transistors are basic components in all of today's electronics. They are just simple switches that we can use to turn things on and off. Even though they are simple, they are the most important electrical component. For example, transistors are almost the only components used to build a Pentium processor. A single Pentium chip has about 3.5 million transistors. The ones in the Pentium are smaller than the ones we will use but they work the same way.

Transistors that we will use in projects look like this:



The transistor has three legs, the Collector (C), Base (B), and Emitter (E). Sometimes they are labeled on the flat side of the transistor. Transistors always have one round side and one flat side. If the round side is facing you, the Collector leg is on the left, the Base leg is in the middle, and the Emitter leg is on the right.

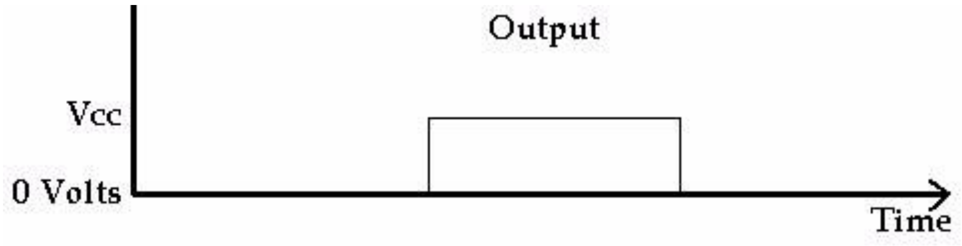


Introduction

As electronic designs get bigger, it becomes difficult to build the complete circuit. So we will use prebuilt circuits that come in packages like the one shown above. This prebuilt circuit is called an IC. IC stands for Integrated Circuit. An IC has many transistors inside it that are connected together to form a circuit. Metal pins are connected to the circuit and the circuit is stuck into a piece of plastic or ceramic so that the metal pins are sticking out of the side. These pins allow you to connect other devices to the circuit inside. We can buy simple ICs that have several inverter circuits like the one we built in the LED and Transistor section or we can buy complex ICs like a Pentium Processor.

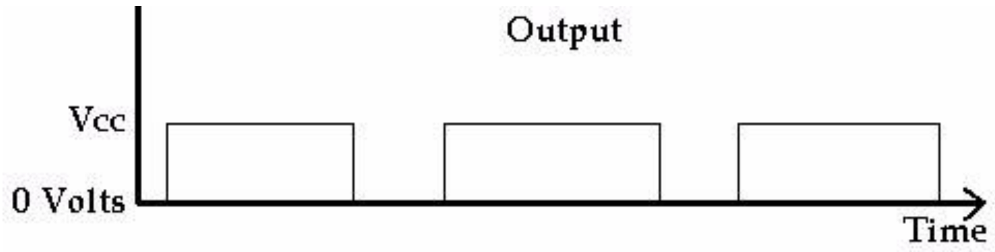
The Pulse - More than just an on/off switch

So far the circuits we have built have been stable, meaning that the output voltage stays the same. If you change the input voltage, the output voltage changes and once it changes it will stay at the same voltage level. The 555 integrated circuit (IC) is designed so that when the input changes, the output goes from 0 volts to Vcc (where Vcc is the voltage of the power supply). Then the output stays at Vcc for a certain length of time and then it goes back to 0 volts. This is a pulse. A graph of the output voltage is shown below.

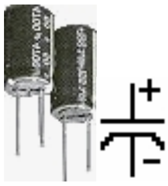


The Oscillator (A Clock) - More than just a Pulse

The pulse is nice but it only happens one time. If you want something that does something interesting forever rather than just once, you need an oscillator. An oscillator puts out an endless series of pulses. The output constantly goes from 0 volts to Vcc and back to 0 volts again. Almost all digital circuits have some type of oscillator. This stream of output pulses is often called a clock. You can count the number of pulses to tell how much time has gone by. We will see how the 555 timer can be used to generate this clock. A graph of a clock signal is shown below.

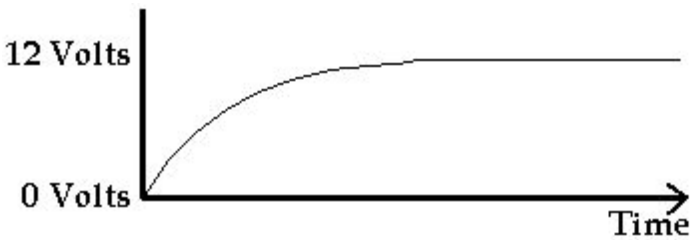


6.2.6 Capacitor



The picture above on the left shows two typical capacitors. Capacitors usually have two legs. One leg is the positive leg and the other is the negative leg. The positive leg is the one that is longer. The picture on the right is the symbol used for capacitors in circuit drawings (schematics). When you put one in a circuit, you must make sure the positive leg and the negative leg go in the right place. Capacitors do not always have a positive leg and a negative leg. The smallest capacitors in this kit do not. It does not matter which way you put them in a circuit.

A capacitor is similar to a rechargable battery in the way it works. The difference is that a capacitor can only hold a small fraction of the energy that a battery can. (Except for really big capacitors like the ones found in old TVs. These can hold a lot of charge. Even if a TV has been disconnected from the wall for a long time, these capacitors can still make lots of sparks and hurt people.) As with a rechargable battery, it takes a while for the capacitor to charge. So if we have a 12 volt supply and start charging the capacitor, it will start with 0 volts and go from 0 volts to 12 volts. Below is a graph of the voltage in the capacitor while it is charging.



The same idea is true when the capacitor is discharging. If the capacitor has been charged to 12 volts and then we connect both legs to ground, the capacitor will start discharging but it will take some time for the voltage to go to 0 volts. Below is a graph of what the voltage is in the capacitor while it is discharging.

We can control the speed of the capacitor's charging and discharging using resistors.

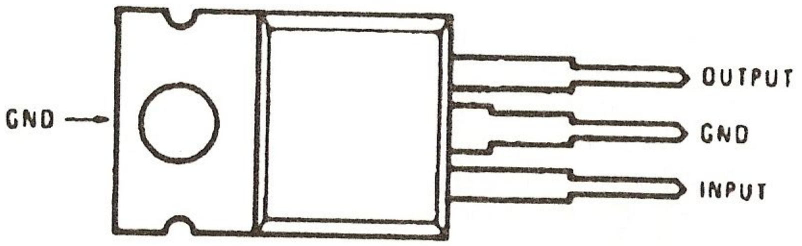
Capacitors are given values based on how much electricity they can store. Larger capacitors can store more energy and take more time to charge and discharge. The values are given in Farads but a Farad is a really large unit of measure for common capacitors. In this kit we have 2 33pf capacitors, 2 10uf capacitors and 2 220uF capacitors. Pf means picofarad and uf means microfarad. A picofarad is 0.000000000001 Farads. So the 33pf capacitor has a value of 33 picofarads or 0.000000000033 Farads. A microfarad is 0.000001 Farads. So the 10uf capacitor is 0.00001 Farads and the 220uF capacitor is 0.000220 Farads. If you do any calculations using the value of the capacitor you have to use the Farad value rather than the picofarad or microfarad value.

Capacitors are also rated by the maximum voltage they can take. This value is always written on the larger can shaped capacitors. For example, the 220uF capacitors in this kit have a maximum voltage rating of 25 volts. If you apply more than 25 volts to them they will die. We don't have to worry about that with this kit because our power supply can only put out 12 volts.

6.2.7 VOLTAGE REGULATOR:

A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. It may use an electromechanical mechanism, or passive or active electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages. With the exception of shunt regulators, all voltage regulators operate by comparing the actual output voltage to some internal fixed reference voltage. Any difference is amplified and used to control the regulation element. This forms a negative feedback servo control loop. If the output voltage is too low, the regulation element is commanded to produce a higher voltage. If the output voltage is too high, the regulation element is commanded to produce a

Plastic Package
TO-220 (T)



Top View

Order Number LM7805CT,
LM7812CT or LM7815CT
See NS Package Number T03B

lower voltage. In this way, the output voltage is held roughly constant.

General Description

The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid-state electronic equipment. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and currents. The LM78XX series is available in an aluminumTO-3 package, which will allow over 1.0A load current if adequate heat sinking is provided. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating. Considerable effort was expanded to make the LM78XX series of regulators easy to use and minimize the number of external components. It is not necessary to bypass the output, although this does improve transient response. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply. For output voltage other than 5V, 12V and 15V the LM117series provides an output voltage range from 1.2V to 57V.

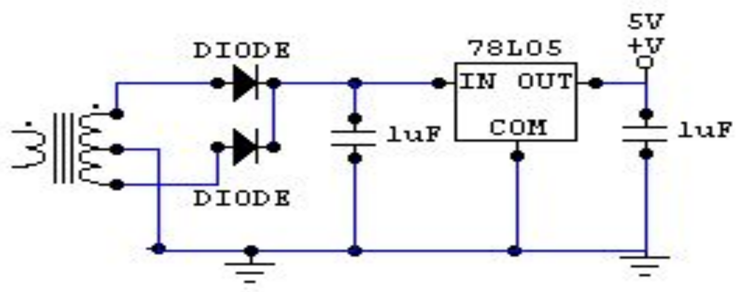
FEATURES

- Output current in excess of 1A
- Internal thermal overload protection
- No external components required
- Output transistor safe area protection
- Internal short circuit current limit
- Available in the aluminum TO-3 package

Voltage Range

- LM7805C 5V
- LM7812C 12V
- LM7815C 15V
-

Typical Application Circuit



In our project we require power supply of 5V. From the mains supply we get 230V, 50 Hz. So to convert that configuration into the required configuration we need to use following circuits with signal conditioners:

6.2.8 STEP DOWN TRANSFORMER

- STEP DOWN TRANSFORMER
- FULL WAVE BRIDGE RECTIFIER
- FILTER CONDENSER
- D.C. REGULATED 3 PIN I .C.

Transformer here used is the **CENTER TAPPED STEP DOWN TRANSFORMER**. The primary winding turns are greater than that of the secondary. Input supply to primary is 230V, 50 Hz that produces the 0-24V at the secondary. Secondary of the transformer is connected to the **FULL WAVE BRIDGE RECTIFIER**. It gives unipolar waveform of the transformer output. It converts the a.c. supply into d.c. Voltage.

But output obtained from the rectifier is not complete ripple free and contains the ac nature. Thus it needs to be smoothened using **FILTER CONDENSER**. Here the capacitor assembly allows only its rated voltage through it for one cycle. Property of capacitor to be insensitive to the high frequency at the input side helps to have smooth output.

Sometimes, due to mains power supply fluctuation and the ageing of the circuit components the output fails to remain at constant level. Thus we need to add the **VOLTAGE REGULATORS**.

Due to the high voltage operating temperatures there may be heat generation, which leads to the sparks or may even catch fire and damage the whole circuitry. Thus we use heat sink. All the output is then connected to the connector to provide the supply for remaining circuit.

Power supply design:-

Power supply is the first and the most important part of our project. For our project we require +5V regulated power supply with maximum current rating 500Ma.

Step down Transformer:-

Step down transformer is the first part of regulated power supply. To step down the mains 230V A.C. we require step down transformer. Following are the main characteristic of electronic transformer.

1) Power transformers are usually designed to operate from source of low impedance at a single freq.
2) It is required to construct with sufficient insulation of necessary dielectric strength.
3) Transformer ratings are expressed in volt–amp. The volt-amp of each secondary winding or windings are added for the total secondary VA. To this are added the load losses.
4) Temperature rise of a transformer is decided on two well-known factors i.e. losses on transformer and heat dissipating or cooling facility provided unit.

Rectifier Unit:-

Rectifier unit is a ckt. which converts A.C. into pulsating D.C. Generally semi-conducting diode is used as rectifying element due to its property of conducting current in one direction only. Generally there are two types of rectifier.

1) Half wave rectifier
2) Full wave rectifier.

In half wave rectifier only half cycle of mains A.C. is rectified so its efficiency is very poor. So we use full wave bridge type rectifier, in which four diodes are used. In each half cycle, two diodes conduct at a time and we get maximum efficiency at o/p.

Following are the main advantages and disadvantages of a full-wave bridge type rectifier ckt.

Advantages:

1) The need of center tapped transformer is eliminated.
2) The o/p is twice that of center tap circuit for the same secondary voltage.
3) The PIV rating of diode is half of the center tap circuit.

Disadvantages:

1) It requires four diodes.
2) As during each half cycle of A.C. input, two diodes are conducting therefore voltage drop in internal resistance of rectifying unit will be twice as compared to center tap circuit.

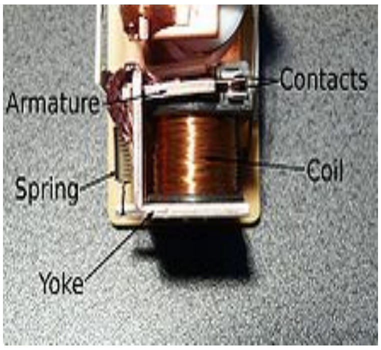
Filter Circuit :-

Generally a rectifier is required to produce pure D.C. supply for using at various places in the electronic circuit. However, the o/p of rectifier has pulsating character i.e. if such a D.C. is applied to electronic circuit it will produce a hum i.e. it will contain A.C. and D.C. components. The A.C. components are undesirable and must be kept away from the load. To do so a filter circuit is used which removes (or filters out) the A.C. components reaching the load. Obviously a filter circuit is installed between rectifier and voltage regulator. In our project we use capacitor filter because of its low cost, small size and little weight and good characteristic. Capacitors are connected in parallel to the rectifier o/p because it passes A.C. but does not pass D.C. at all.

6.2.9 RELAY

A **relay** is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism, but other operating principles are also used. Relays find applications where it is necessary to control a circuit by a low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. Relays found extensive use in telephone exchanges and early computers to perform logical operations. A type of relay that can handle the high power required to directly drive an electric motor is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protection relays

Basic design and operation



A simple electromagnetic relay consists of a coil of wire surrounding a soft iron core, an iron yoke, which provides a low reluctance path for magnetic flux, a movable iron armature, and a set, or sets, of contacts; two in the relay pictured. The armature is hinged to the yoke and mechanically linked to a moving contact or contacts. It is held in place by a spring so that when the relay is de-energized there is an air gap in the magnetic circuit. In this condition, one of the two sets of contacts in the relay pictured is closed, and the other set is open. Other relays may have more or fewer sets of contacts depending on their function. The relay in the picture also has a wire connecting the armature to the yoke. This ensures continuity of the circuit between the moving contacts on the armature, and the circuit track on the printed circuit board (PCB) via the yoke, which is soldered to the PCB.

When an electric current is passed through the coil, the resulting magnetic field attracts the armature, and the consequent movement of the movable contact or contacts either makes or breaks a connection with a fixed contact. If the set of contacts was closed when the relay was de-energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open. When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position. Usually this force is provided by a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low voltage application, this is to reduce noise. In a high voltage or high current application, this is to reduce arcing.

When the coil is energized with direct current, a diode is often placed across the coil to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a voltage spike dangerous to circuit components. Some automotive relays already include a diode inside the relay case. Alternatively a contact protection network, consisting of a capacitor and resistor in series, may absorb the surge. If the coil is designed to be energized with alternating current (AC), a small copper ring can be crimped to the end of the solenoid. This "shading ring" creates a small out-of-phase current, which increases the minimum pull on the armature during the AC cycle.[1]

By analogy with functions of the original electromagnetic device, a solid-state relay is made with a thyristor or other solid-state switching device. To achieve electrical isolation an optocoupler can be used which is a light-emitting diode (LED) coupled with a photo transistor.

Applications

Relays are used to and for:

- 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,
- Detect and isolate faults on transmission and distribution lines by opening and closing circuit breakers (protection relays),

A DPDT AC coil relay with "ice cube" packaging

- Isolate the controlling circuit from the controlled circuit when the two are at different potentials, for example when controlling a mains-powered device from a low-voltage switch. The latter is often applied to control office lighting as the low voltage wires are easily installed in partitions, which may be often moved as needs change. They may also be controlled by room occupancy detectors in an effort to conserve energy,
- Logic functions. For example, the boolean AND function is realised by connecting normally open relay contacts in series, the OR function by connecting normally open contacts in parallel. The change-over or Form C contacts perform the XOR (exclusive or) function. Similar functions for NAND and NOR are accomplished using normally closed contacts. The Ladder programming language is often used for designing relay logic networks.
    - Early computing. Before vacuum tubes and transistors, relays were used as logical elements in digital computers. See ARRA (computer), Harvard Mark II, Zuse Z2, and Zuse Z3.
    - Safety-critical logic. Because relays are much more resistant than semiconductors to nuclear radiation, they are widely used in safety-critical logic, such as the control panels of radioactive waste-handling machinery.
- Time delay functions. Relays can be modified to delay opening or delay closing a set of contacts. A very short (a fraction of a second) delay would use a copper disk between the armature and moving blade assembly. Current flowing in the disk maintains magnetic field for a short time, lengthening release time. For a slightly longer (up to a minute) delay, a dashpot is used. A dashpot is a piston filled with fluid that is allowed to escape slowly. The time period can be varied by increasing or decreasing the flow rate. For longer time periods, a mechanical clockwork timer is installed.

Temperature Sensor Input

The default choice for this sensor is the LM35 type. The performance is adequate for this application, and it is possible to connect it direct to the ADC input. In this case, the LM35C is used which allows negative temperatures to be measured.

To provide these as a positive voltage with single supply, the sensor negative supply is connected to ground via a diode to lift the zero degrees output to around 0.7 V. This allows the actual output voltage to go below the zero level while remaining positive with respect to supply 0 V (**Figure 10.5 below**).

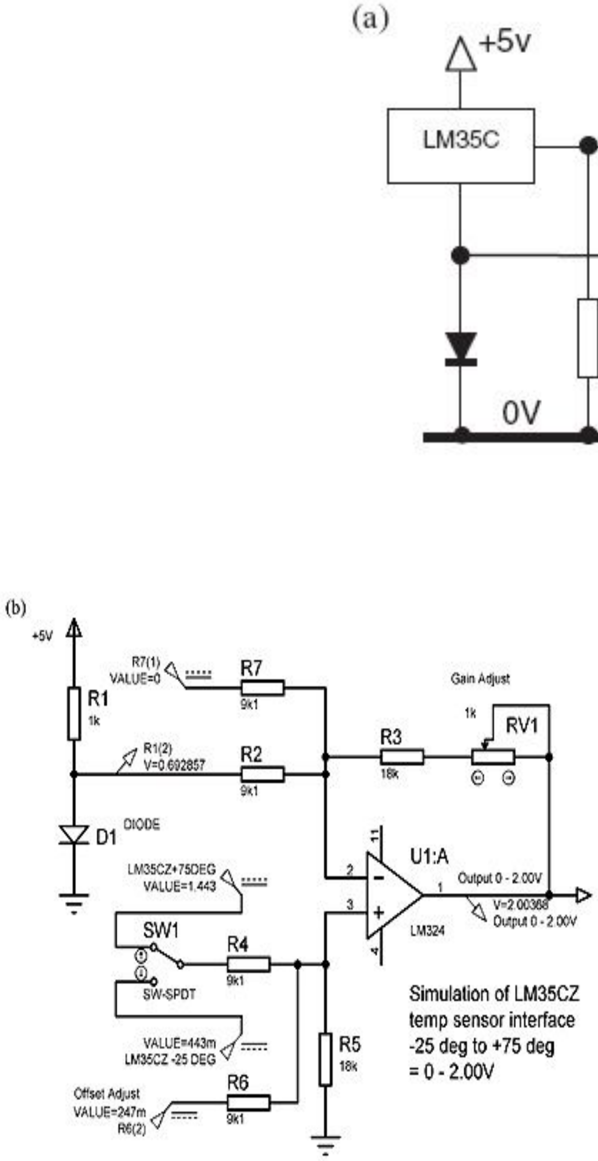


Figure 10.5. Temperature sensor interface: (a) sensor connections; (b) interface simulation.

The interface uses a differential amplifier with two positive and two negative inputs, based on the universal amplifier described previously. The number of positive and negative inputs must always be equal to conform to this model. A reference diode provides a negative input to balance the positive offset on the sensor input.

The input from the sensor is simulated by a switch which provides the maximum and minimum voltage which would be seen at the input. A further positive input provides the offset at the amplifier output to give 0.00"2.00V corresponding to the input range of 100°C. The overall sensitivity is 20 mV/°C. A further negative input of 0 V is needed to match the offset input. The preset feedback resistance is adjusted for a gain of 2.00.

The circuit provides the following arithmetic sums at each end of the range (-25 and +75 degrees Centigrade).

The 6 mV at the output (3 mV at the input) is the offset of the amplifier, which is allowed for in the external offset adjust (250"3 = 247 mV). Notice that in the simulation there is a residual offset at 2.000 V output, but this is less than 5 mV, which is acceptable (<0.5% at full scale).

The reference diode current may need to be adjusted in the real hardware by changing its 1k current feed resistor to a value that gives the same current as that provided by the sensor to its offset diode.

When converted with a 2.56 V reference, the temperature range will be represented by binary numbers equivalent to 0"200, with 50 representing 0 degrees Centigrade. This scaling offset can be corrected in software, prior to display.

Remember that the single supply amplifier output will not go all the way to zero, so the actual range starts at about -23 degrees Centigrade. In normal circumstances, this is acceptable, as this temperature is rarely experienced in temperate climates.

Humidity Sensor Interface

The humidity sensor selected has integrated signal conditioning so that an output between 0.8 and 3.9 V is produced, representing a change in relative humidity of 0"100%. A simple buffered attenuator is used to shift the signal range for input to the ADC. The output of 0 V from the single supply amplifier cannot be obtained, so the output is shifted up to the range 0.5"2.50 V, giving 20 mV/%. This offset must be removed in software, by subtracting 5010 from the 8-bit binary input.

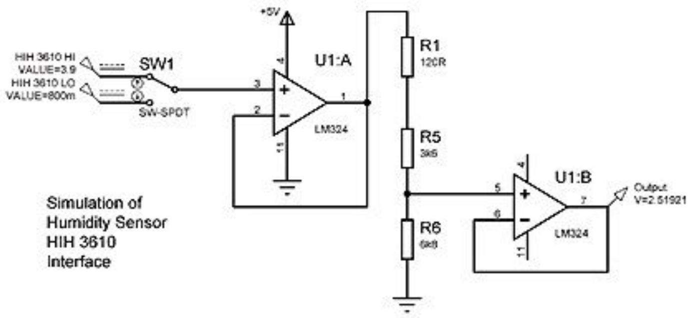


Figure 10.8. Humidity sensor interface

The small residual offset is easier to eliminate in software, by adjusting the offset correction factor, and subtracting 52 instead of 50. This allows preferred values to be used in the attenuator, reducing component cost. **Figure 10.8 above** shows the simulated interface operating at 100% humidity.

The input and output buffering of the attenuator network simply reduces any error due to loading effects. However, the sensor is only specified about 4% accurate normally, so this may not be absolutely necessary.The sensor can be supplied with individual calibration data if a more accurate output is needed.

Pin Functions

Abbreviation	Full Name	Function
TD	Transmit Data	Serial Data Output (TXD)
RD	Receive Data	Serial Data Input (RXD)
CTS	Clear to Send	This line indicates that the Modem is ready to exchange data.
DCD	Data Carrier Detect	When the modem detects a "Carrier" from the modem at the other end of the phone line, this Line becomes active.
DSR	Data Set Ready	This tells the UART that the modem is ready to establish a link.
DTR	Data Terminal Ready	This is the opposite to DSR. This tells the Modem that the UART is ready to link.
RTS	Request To Send	This line informs the Modem that the UART is ready to exchange data.
RI	Ring Indicator	Goes active when modem detects a ringing signal from the PSTN.

CONCLUSION

In nuclear power plants, automation of information acquisition, processing and display is an established feature. Similarly, automatic control of plant functions is a key feature of operation. Automation of safety and protective actions has long been necessary in order to achieve system reliability targets. Disastrous industrial accidents have focused world attention on operator errors and have stimulated proposals for increased automation to reduce operator errors. Furthermore, as digital technology becomes increasingly available and economical, there is a trend by designers to produce more integrated systems which encompass many of the plant monitoring and control aspect. Additional operator support functions are being incorporated, particular support fault identification and analysis and to extend critical function monitoring and present procedures on graphical CRT displays. These developments are taking place in many design agencies and utilities throughout the world and reflect a desire on the part of all operating staff and managements to provide improved monitoring of plant operations and added assurances regarding safety., the design of nuclear power plant systems and equipment, designers are adopting a more system-based approach. For the designers, the additional technological features provide further challenges in terms of justifying their style, form and integration into the overall plant control and monitoring systems. Integrated systems provide greater potential for presenting high level information to operators and improving their B comprehension of complex events. The additional levels of automation will tend to insulate the user from the raw system and exacerbate any problems caused by machine failure and malfunction. This concern is partially solved by systematic and rigorous verification and validation of automated systems performed by the users. The designer should ensure there is a net gain in overall functionality when new technologies are incorporated into an existing system

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