'HE DESIGN AND CONSTRUCTION OF N ELECTRIC COOKER WITH FLEXIBLE TIMING

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DEDICATION

This project is dedicated to my deceased cousin Muhammed Sani Bagiwa , a final year Manchester University graduate, whose project saw the light of day.

DECLARATION

I,Gidado Mubarak, declare that this was done by me and has never been presented where for the award of a degree to the best of my knowledge. I also relinquish the copyright s project to the Federal University of Technology, Minna.

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All praises and thanks be to Allah (SWT), who has not begotten a son, who has no er in His dominion nor is He low to have a helper. And magnify Him with all the ficence. (Al-Isra-111).

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These two people have done things so remarkable, I can only wonder. Air Comd. M nan , whose kindness knows no bound and Abubakar Ojo, his extra classes were a life line academic pursuit to say the least.

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ABSTRACT

This project is the design and construction of a microcontroller based electric cooker with two seven segment displays, which enable the user to control its ·ooking time. The device contains three led's which indicate respectively whether :'s is infinity mode, minutes mode, or hour mode with a buzzer at its end to alert vhen the time elapses. The circuit is powered by a power unit which consists of a ransformer, rectifier, filter and a regulator. The functioning of all these :omponents is controlled by a programmable (89C52) microcontroller

1.0 INTRODUCTION

The relevance and role of food in the daily life of man cannot overemphasized. If constitutes one of the major necessities in the life of man in addition to clothing and housing. Well prepared food provides man with supplements with the correct nutrients required to build the body in order to carry out his daily activities, promote his health and even prolong his life span. But the means of preparing food for man's consumption plays a very important role as well. This led to the invention of cooking device which is in use with industries and domestic use.

However, heat is required to cook food, and the most important parameter that it required is strict attention in such process and temperature providing an effective means of monitoring and controlling the applied temperature is therefore necessary to properly cook the food, while the vitamins and natural nutritional values are well retained. But with advances in technology and increased demand by consumers, these devices have proved effective since they make provision for monitoring and controlling the time automatically; leading to the huge importance incurred in the food processing industry and even in homes concerned about the increasing wastage of power supply and man's negligence, especially in Industries and Domestic homes, resulting from inadequate means of monitoring and controlling the time of the cooking deivce. There has resulted loss of large amount of money, life's as well as health threats posed to man by providing him with improperly cooked and unsafe food led to the design and subsequent implementation of a better device referred to as "an electric cooker with flexible timer device"

The device as the name implies is base on a micro-controller which is being programmed to control the time when being pushed on the control unit and automatically set between defined and set limits.

1.1 AIM AND OBJECTIVES OF THE STUDY

The project is aimed at designing an electric stove that will allow the user to set any desired time (in minutes or hours) that the electric stove will cook for before it goes off automatically.

1.2 METHODOLOGY

The electric stove will be constructed by use of a metal which will carry the cooking element. The control unit of the electric stove will contain thirteen buttons. The first ten buttons will be labeled 0 to 9. The other three buttons will be labeled H (HOUR), M (MINUTES) and N (NORMAL). Three LEDs will be aligned with the hour, minutes and normal buttons. The LEDs will have different colors. On top of the 0 to 9 button arrangement shall be two LEDs.

All the thirteen buttons will be connected to the input/output ports of a microcontroller. Some of the ports of the microcontroller will be used in driving all the LEDs via PNP transistors. An electromechanical relay will also be connected to the live terminal of the electric stove's power supply cable. This relay will be controlled by a PNP transistor whose base will be connected to one of the ports of the microcontroller. Finally a buzzer will also be connected through a transistor to the microcontroller.

On powering the electric stove, one can put whatever is to be cooked on it, add all the required ingredients and when it is time to allow it cook for a while turn on the control unit. On powering the control unit It will be required that the user select the mode of operation desired. If the Normal button is pushed, the electric stove will cook continuously until its manually put off. If the Hour button is pushed, the program will recognize the time to be entered as an hour time. If on the other hand the Minutes button is pushed, it will recognize it as time in minutes. For any of these modes selected, the

corresponding LED will come on. After mode selection, the user can enter the cooking time by use of the 0 to 9 digit buttons. The stove will put itself off by use of the relay after the cooking time has elapsed and sound the buzzer to alert the user that the cooking time has elapsed.

The stove's timer is termed flexible because it allows one to enter any time in minutes or hours for the stove to cook.

1.3 STATEMENT OF THE PROBLEM

This project was influenced by some prevailing problems, modern electric cookers failed to address such problems as inaccurate means of controlling the time of the cooking device, which led to a huge wastage of food and inadequate consumption of power supplied which consequently results in loss of large amount of money and increase in PHCN Bills. Others are the health hazard associated with traditional and modern cookers.

1.4 PURPOSE OF THE STUDY

1) To provide an accurate means of timing the cooking process for enhanced food production.

2) To provide safer finished foods and confectionaries for consumption.

1.5 SIGNIFICANCE OF THE STUDY

This project work shall find wide application and significant deployment in the cooking and Manufacturing Industries with the view of achieving more on the object of study. Researchers might be interested to go further and break ne ground about this project. It shall further be applied In Industries for controlling the time of some equipment such as lecterns boilers, furnace, compressors and other timing devices.

1.6 TARGET OF THE STUDY

This project focuses on the catering industry.

CHAPTER TWO

1 BRIEF HISTORY OF ELECTRIC STOVES

On September 20,.1959 Georg B. Simpson was awarded US patent 25532 r an electro heater surface heater by an electric coil, in his words, useful to /arm rooms, boil water, cook victuals essentially an electric hot plate.

Canadian Inventor Thomas, Ahearn is often credited with inventing the ectric cooking range in 1882. Ahearn and Warren Y. Soper were owners of fawa's chaudiere electric light and power company. Ahearn first showcased e cooking range in 1892. The electric stove was showcased at the Chicago orld's fair in 1893, where an electrified model kitchen was shown. Unlike the as stove, the electrical stove was sure to catch on, partly due to the unfamiliar echnology, the need for cities and towns to be electrified, by the 1930s. The echnology had matured and the electric stove slowly began to replace the gas tove, especially in household kitchen.

In 1897, William Hadaway was granted US patent 574537 for an 'Automatically controlled Electric oven". The first technology used resistive heating coils which heated iron hot plates, on top of which the pots were placed. n the 1970's, glass ceramic cooktops started to speard. Glass – ceramic has very low thermal conductivity but lets infrared radiation pass very well. Electrical heating coils or Infrared halogen lamp are used as heating elements. Because of its physical characteristics, the cook-top heats quickly, less after heat remains, and are thus easier to clean but they only work with flat-buttoned cook ware and are markedly more expensive.

A third technology – developed first for professional kitchens, but today also entering the domestic market is the induction stoves. It heats the cookware directly through electromagnetic induction and thus requires pots and pans with

ɛrromagnetic buttons. Induction stoves are very popular today, especially in rban and suburban areas.

2 TYPES OF STOVE

ıe stoves are classified into 2 classes:

1. Unpressuriesed soild fuel stove.
2. Pressurerised liquid fuel stove.

Unpressurized solid or liquid fuel stoves

1 single burner alcohol stoves

2 Gravity-fed spirit stove.

3 solid fuel stove.

.2.1. SINGLE BURNER ALCOHOL STOVES

The simplest type of stove is an unpressurized single burner design, in which he burner contains the fuel and which once lit burns until it is either extinguished or the fuel is exhausted. There are both liquid- and solid-fuel stoves of this variety. Because they are extremely small and lightweight, this type of stove tends to be favored by ultralight backpackers as well as those seeking to minimize weight and bulk, particularly for extended backpacking trips. Solid-fuel stoves are also commonly used in emergency kits both because they are compact and the fuel is very stable over time.[9]

The Trangia stove is a popular commercial alcohol stove, which is available in many different models, from a single bare burner to an integrated expedition cooking system. Some of these come with a sealing cover, allowing the burner to be packed while still containing fuel, although putting the lid on while the stove is hot can damage it. An even simpler system is the Sterno heater, in which the can that contains a jellied fuel also serves as the burner. Homemade

beverage can stoves (or "Pepsi can stoves") are similar. These are made from discarded aluminum beverage cans, and come in a wide variety of different designs

2.2.2. GRAVITY-FED SPIRIT STOVES

The traditional "spirit stove" (alcohol or methylated spirits) consists of a small reservoir or fuel tank raised above and to the side of the burner. The fuel tank supplies the methylated spirits under gravity to the burner, where it is vaporized and burned. The gravity-fed spirit stove is still found in many pleasure boats, although it has largely replaced by compressed gas stoves.[10]

Lighting a gravity-fed spirit stove is similar to lighting a traditional Primus stove. Around each burner is a priming pan used to preheat the burner. To light the stove, the burner is first turned on to allow a small amount of fuel to pass through the burner and collect as a liquid in the priming pan. The burner is then turned off, and the fuel ignited to preheat the burner. When the fuel in the pan is almost all gone, the burner is turned on again, and fuel passes into the burner where it is vaporized and passes through the jets.

These stoves look and even sound a bit like pressurized burner stoves, but the fuel tank is under no pressure. They remain popular for small boats owing to the minimal fire risk they pose in a confined space.

2.2.3. SOLID FUEL STOVES

A solid-fuel stove may consist of no more than a metal plate to hold the fuel, a set of legs to keep it out of contact with the ground, and some supports for the billycan or cooking vessel. This design is scalable, and may be used for

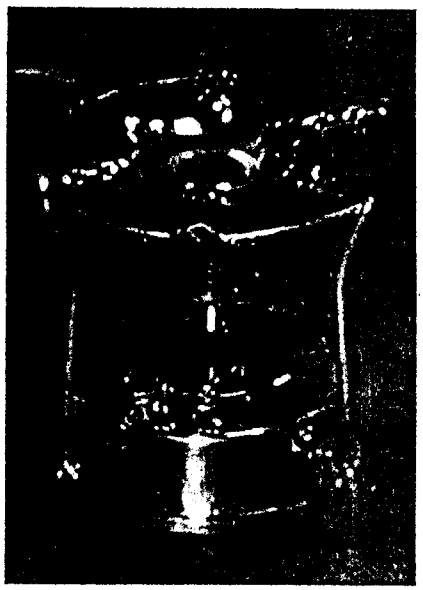
While simple, solid fuel stoves have several disadvantages. In most cases, the burn rate may be controlled only by varying the amount of fuel placed on the fire, while fluid fuels may be controlled precisely with valves. In addition, no solid fuel burns completely. It produces considerable amounts of ash and soot, which soils both the stove and the cooking vessels. In addition, because some of the chemical energy of the fuel remains locked up in the ash and soot, solid fuel releases less heat, gram for gram.

Another type of a solid fuel stove that has becoming more common is what is called the rocket stove. It is found more commonly in the third world countries where wood fuel sources are more scarce but it has been introduced to developed countries in recent years. There are a couple of different designs that are used but smaller ones are portable and are made of steel and other materials with insulation inside a double-walled design with a chamber for partial biomass gasification and additional mixing to increase BTUs and provide a cleaner, more complete burn. The advantage of these rocket stoves is very little fuel they need, such as wood and dry weeds, to be able to cook a whole meal with it, keeping the air more clean with less hydrocarbons

Under Pressurized liquid fuel stoves:

2.2.4Primus stoves

Main article: Primus stove



Primus kerosene pressure stove

The introduction of the first pressurized burner portable stove is generally credited to Frans Wilhelm Lindqvist, in 1892. Lindqvist's stove was based on the pressurized blowtorch but fitted with an upturned burner assembly of his own design. Together with partner J.V. Svensson, Lindqvist established the Primus brand of stove, which quickly developed into a worldwide market leader.

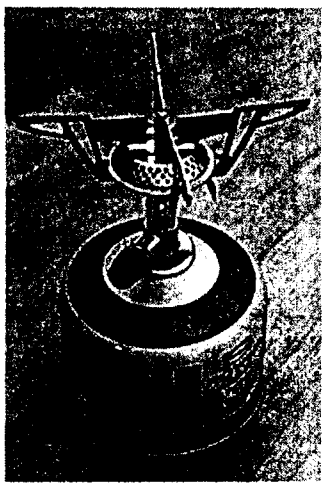
The kerosene burning Primus stoves and their imitators were made of brass and were a significant advance over previous designs, which had used a wick to supply liquid fuel to the burner by capillary action. The Primus burner vaporized the fuel in a loop of pipe which rose up from the fuel tank at the stove's base, and which was pre-heated with alcohol (or "methylated spirits")

efore being combusted in the burner. Initial pressure is provided by a small, hand operated pump integrated into the stove's fuel tank. The flame on a Primus stove is adjusted by using the pump to increase the pressure in the tank to make the flame larger, or by venting the tank to reduce the pressure and make the flame smaller. Later models used a separate valve to adjust the flame. Primus-style stoves were made in a variety of sizes and styles, and many were designed to be disassembled for storage and transportation in a separate case.[1]

2.2.5Coiled burner stoves

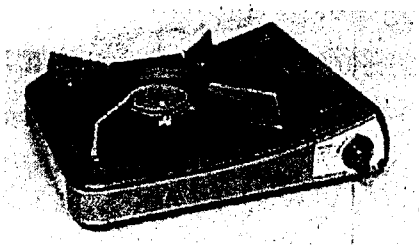
The "coiled burner" stove is a variant on the pressurized burner design, in which the burner assembly consists of a coiled loop with a small hole in the lower part, through which the vaporized fuel exits and combusts. Generally small, lightweight and cheaply made, these were sold under the brand name "Stesco", "Tay-Kit", "Handy Camper" and others. A more substantial version of the coiled burner stove is the Swiss made Borde stove.

2.2.6. GAS CARTRIDGE STOVES



Gas cartridge camping stove

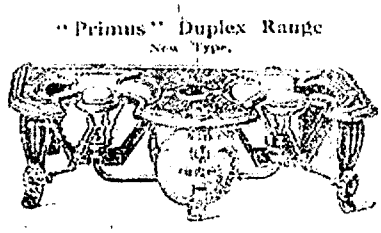
The design of most portable gas cartridge stoves is similar to that of many pressurized burner stoves, except the fuel tank or cartridge contains a liquefied gas – typically butane, propane or a mixture of hydrocarbons – that is held under pressure. While the gas in the cartridge is in a liquid state when stored under pressure, it vaporizes immediately as it leaves the storage bottle (i.e., without priming), arriving at the burner as a gas. The principal advantage of gas cartridge stoves is convenience: no priming is required, they are generally maintenance-free and capable of immediate high heat output, the flame is easily adjusted and they are generally considered simpler to operate.[20] There are two basic designs for most gas cartridge stoves used for camping: the burner assembly is fitted into the top of the gas cartridge, which serves as the stove's base, or the stove is free-standing and the cartridge is separated from the burner and connected by means of a small hose or pipe.[21] Single burner propane stoves commonly used in food service have the gas container integrated into the body of the stove.



Gas cartridge stove

As camping stoves, gas cartridges tend to be costly, and usually are not refillable. Single use cartridges are considered objectionable by some on environmental grounds, and they do not operate well in cold weather.[22] In addition, there is little compatibility between different makers and systems, and cartridges for older cartridge stoves are often unobtainable. Outside of camping,

ngle burner stoves using cans of compressed gas are popular for catering and other food service applications.[23]



2 burner liquid fuel pressure stove, circa 1920

Refillable gas bottles are heavier and tend to be used on larger stoves intended for car camping or expedition base camps, or residential use (as for barbecues).

2.2.7 MULTIPLE BURNER STOVES

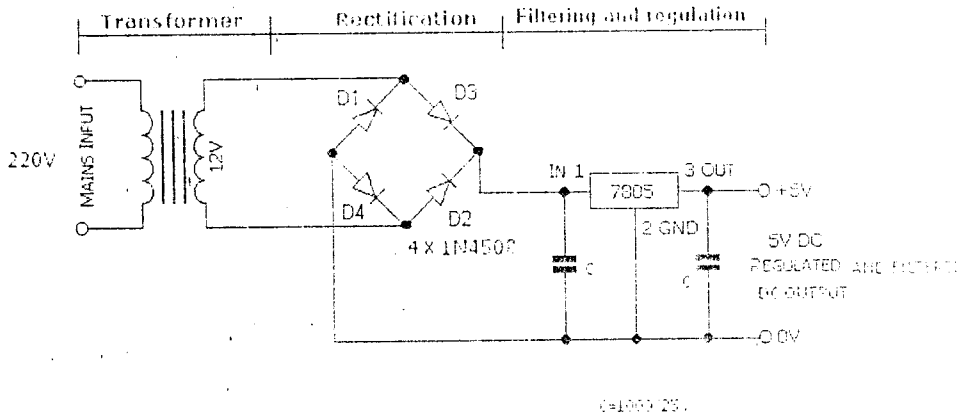
Stoves with two or more burners that may be operated together or separately are common for use in base camp, car camping and other situations involving cooking for larger groups. The folding "suitcase" style by Coleman is the best known of this design, and is intended to be used on a flat, stable surface such as a tabletop. This type of stove may have a separate fuel tank for each burner, or a single tank shared by both burners. Multiple burner stoves generally use alcohol, naphtha or compressed gas.

.2COMPONENTS USED FOR THE PROJECT

2.2.1 POWER SUPPLY UNIT

The power supply unit consists of the following

Transformer, Rectifier, Regulator and Filter unit. The circuit below shows the circuit diagram of a typical power supply unit.



Power supply unit

2.2.1 TRANSFORMER

A transformer is a static electronic device by means of which electronic power in one circuit is transformed into electronic power of the same frequency in another circuit. It can raise or lower the voltage in a circuit but with corresponding decrease or increase in current. The physical basis of a transformer is mutual induction between two circuit linked by a common magnetic flux (D).

The two coils posses high mutual inductance. If one of the coils is connected to a source of alternating voltage, an alternating flux is set up in the laminated core, most of which is linked with the other coil in which is produced mutually induced e.m.f. If the second coil circuit is closed, a current flows in it and so electric energy is transferred from the first coil to the second coil. The

st coil, in which electric energy is fed from the AC supply mains is called PRIMARY winding and the other from which energy is drawn out is called SECONDARY winding.[1,3]

There are two types of transformer:

i. Step up transformer

ii. Step down transformer

The type of transformer used in this project is STEP-DOWN transformer. A step down transformer is a transformer that changes the voltage from high level to low level, the number of turns in the primary winding is less than that of the secondary winding. The transformer rating used is 240/12v[6,3,2].

2.2.3 RECTIFIER

A rectifier is an electronic circuit which converts an A.C voltage into pulsating D.C voltage. It can be achieved by the use of semiconductor diodes. Rectification is classified into:

i. Half wave rectification

ii. Full wave rectification

iii. Full wave (Bridge) rectification

However, full wave Bridge rectification would be discussed as it is the type of rectification that is employed in this project (3).

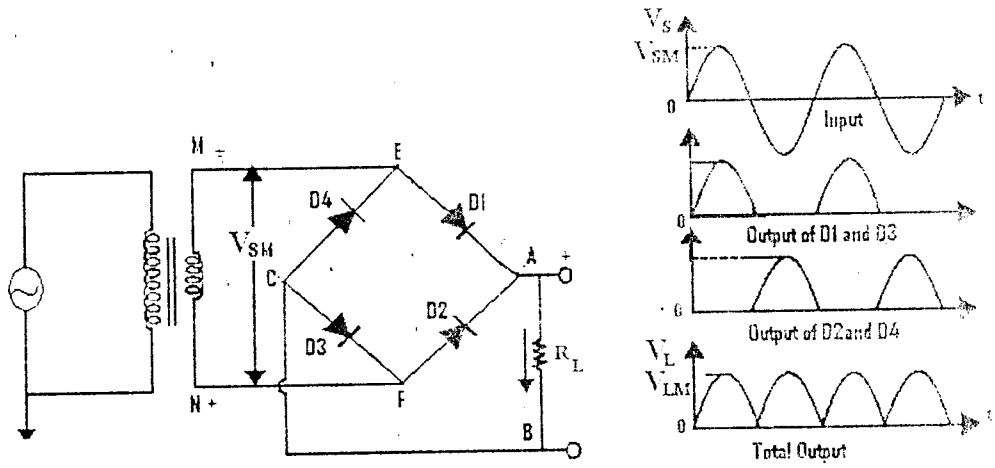


FIG 3: 2.2.2 Shows the wave form of a bridge rectifier [1]

In full rectification, both half cycles of the input are utilized with two out of four diodes' working alternatively. In this case, use of a transformer is essential.

When the A.C input supply is switched on, the M and N of the transformer secondary became +ve and –ve respectively. During the +ve input half-cycle, terminal M of the secondary is positive as N is – ve Diodes D1 and D3 became forward – biased (ON) where as D2 and D4 are reversed – biased (OFF). Hence the current flows along MEABCFN producing a drop across R_L.

During the – ve half – cycle, secondary terminal N becomes +ve and M – ve. Now D2 and D4 are forward – biased. Circuit current flows along NFABCEM.[1]

2.2.4 RIPPLE FILTERING

By the analysis of fourier series, we know that a rectified sine wave consist of a Dc component and harmonics of the supply frequency. These harmonics are responsible for the ripples and this is undesirable for smooth operation of our electronic circuits (the computer controlled witch). The process of removing these ripples is known as filtering. A ripple filter is basically a low pass filter that passes the DC component but the A.C component as show below

The five main types of filter circuit are:

i. Capacitor filter
ii. Resistance capacitance (RC) filter
iii. Inductance or choke – capacitance filter (LC)
iv. R-L-C filters

v. Series induction filter.

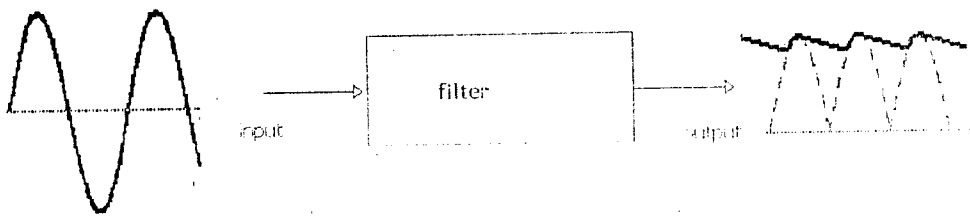


Figure 2.2.3 shows filtered DC output[3,i,2]

2.2.5 RESISTOR

A resistor is a component offering a certain definite electrical resistance. Resistors are commonly used in electronics to control the amount of current that flows in a particular part of a circuit and to serve as circuit elements that limit the current to some desired value. The value of a resistor is known by the combination of colors printed on them, larger resistors have these specifications printed on them.

Any electrical wire has resistance, depending on its material, diameter and length. Wires that must conduct very heavy currents (ground wires on lightning rods, for example) have large diameters to reduce resistance.

The power dissipated by a resistive circuit carrying electric current is in the form of heat. Circuits dissipating excessive energy will literally burn up. Practical circuits must take power capacity into account

Circuit resistance can be calculated from the current flow and the voltage by application of ohms law



Fig.2.2.4 Symbols of resistor (a) fixed (b) variable resistor

2.6 CAPACITORS

A Capacitor is a passive electronic component consisting of a pair of conductors separated by a dielectric. When a potential difference exists across the conductors, an electric field is established in the dielectric. This field stores energy and produces a mechanical force between the plates.

The effect is greatest between wide, flat, parallel, and narrowly separated conductors.

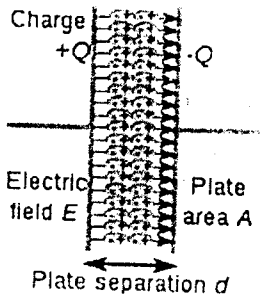


Fig. 2.2.6 The Schematic of a Capacitor

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. In practice, the dielectric between the plates passes a small amount of leakage current. The conductors and leads introduce an equivalent series resistance and the dielectric has an electric field strength limit resulting in a breakdown voltage.

Capacitors are widely used in electronic circuits to block the flow of direct current while allowing alternating current to pass, to filter out interference, to smooth the output of power supplies, and for many other purposes. They are used in resonant circuits in radio frequency equipment to select particular frequencies from a signal with many frequencies.

However, the selection of capacitors solely depends on the consideration of the following;

i. Capacitance value

ii. Tolerance

iii. Voltage rating

iv. Frequency

v. Power dissipation

vi. Temperature and

vii. Stability.

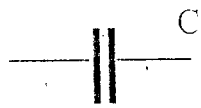


Fig. 2.2.5 Conventional Symbol of a Capacitor

2.3 TRANSISTORS

There are two types of standard transistors, **NPN** and **PNP**, with different circuit symbols. The letters refer to the layers of semiconductor material used to make the transistor. Most transistors used today are NPN because this is the easiest type to make from silicon.

The three legs are of a transistor labeled **base** (B), **collector** (C) and **emitter** (E).

A Darlington pair is two transistors connected together to give a very high current gain.

2.3.1 TRANSISTOR CURRENTS

There are two current paths through a transistor.

The small **base current** controls the larger **collector current**.

When the switch is closed a small current flows into the base (B) of the transistor. It is just enough to make LED B glow dimly. The transistor amplifies this small current to allow a larger current to flow from its collector (C) to its emitter (E). This collector current is large enough to make LED C light brightly.

When the switch is open no base current flows, so the transistor switches off the collector current. Both LEDs are off.

A transistor amplifies current and can be used as a switch.

This arrangement where the emitter (E) is in the controlling circuit (base current) and in the controlled circuit (collector current) is called **common emitter mode**. It is the most widely used arrangement for transistors.

2.3.2 FUNCTIONAL MODEL OF AN NPN TRANSISTOR

The operation of a transistor is difficult to explain and understand in terms of its internal structure. It is more helpful to use this functional model:

- The base-emitter junction behaves like a diode.
- A base current I_B flows only when the voltage V_{BE} across the base-emitter junction is 0.7V or more.
- The small base current I_B controls the large collector current Ic.
- $Ic = h_{FE} \times I_B$ (unless the transistor is full on and saturated) where h_{FE} is the (DC current gain). a typical value for h_{FE} is 100 (it has no units because it is a ratio)
- The collector-emitter resistance R_{CE} is controlled by the base current I_B:
    - $I_B = 0$ R_{CE} = infinity transistor off
    - I_B small R_{CE} reduced transistor partly on
    - I_B increased $R_{CE} = 0$ transistor full on ('saturated')

2.3.3 Darlington pair

This is two transistors connected together so that the current amplified by the first is amplified further by the second transistor. The overall current gain is equal to the two individual gains multiplied together:

Darlington pair current gain, $h_{FE} = h_{FE1} \times h_{FE2}$

(h_{FE1} and h_{FE2} are the gains of the individual transistors)

This gives the Darlington pair a very high current gain, such as 10000, so that only a tiny base current is required to make the pair switch on.

A Darlington pair behaves like a single transistor with a very high current gain. It has three leads (**B**, **C** and **E**) which are equivalent to the leads of a standard individual transistor. To turn on there must be 0.7V across both base-emitter junctions which are connected in series inside the Darlington pair, therefore it requires 1.4V to turn on.

Darlington pairs are available as complete packages but you can make up your own from two transistors; TR1 can be a low power type, but normally TR2 will need to be high power. The maximum collector current Ic(max) for the pair is the same as Ic(max) for TR2.

A Darlington pair is sufficiently sensitive to respond to the small current passed by your skin and it can be used to make a **touch-switch**. For this circuit which just lights an LED the two transistors can be any general purpose low power transistors. The 100k resistor protects the transistors if the contacts are linked with a piece of wire.

2.3.4 Using a transistor as a switch

When a transistor is used as a switch it must be either **OFF** or **fully ON**. In the fully ON state the voltage V_{CE} across the transistor is almost zero and the transistor is said to be **saturated** because it cannot pass any more collector

current Ic. The output device switched by the transistor is usually called the 'load'.

The power developed in a switching transistor is very small:

- In the **OFF** state: power = Ic × V_{CE}, but Ic = 0, so the power is zero.
- In the **full ON** state: power = Ic × V_{CE}, but V_{CE} = 0 (almost), so the power is very small.

This means that the transistor should not become hot in use and you do not need to consider its maximum power rating. The important ratings in switching circuits are the **maximum collector current Ic(max)** and the **minimum current gain h_{FE}(min)**. The transistor's voltage ratings may be ignored unless you are using a supply voltage of more than about 15V.

2.3.5 Protection Diode

If the load is a **motor**, relay or **solenoid** (or any other device with a coil) a diode must be connected across the load to protect the transistor from the brief high voltage produced when the load is switched off. It is known that the protection diode is connected 'backwards' across the load, in this case a relay coil.

Current flowing through a coil creates a magnetic field which collapses suddenly when the current is switched off. The sudden collapse of the magnetic field induces a brief high voltage across the coil which is very likely to damage transistors and ICs. The protection diode allows the induced voltage to drive a brief current through the coil (and diode) so the magnetic field dies away quickly rather than instantly. This prevents the induced voltage becoming high enough to cause damage to transistors and ICs.

.4 RELAYS

Transistors cannot switch AC or high voltages (such as mains electricity) and they are not usually a good choice for switching large currents (> 5A). In these cases a relay will be needed, but note that a low power transistor may still be needed to switch the current for the relay's coil.

2.4.1 Advantages of relays:

- Relays can switch **AC and DC**, transistors can only switch DC.
- Relays can switch **high voltages**, transistors cannot.
- Relays are a better choice for switching **large currents** (> 5A).
- Relays can switch **many contacts** at once.

2.4.2 Disadvantages of relays:

- Relays are **bulkier** than transistors for switching small currents.
- Relays **cannot switch rapidly**, transistors can switch many times per second.
- Relays **use more power** due to the current flowing through their coil.
- Relays **require more current than many ICs can provide**, so a low power transistor may be needed to switch the current for the relay's coil.

2.5 8051 MICROCONTROLLER

The 8051 Intel microcontroller is a 40 pin, 8-bit programmable component. The original 8051 core ran at 12 clock cycles per machine cycle. Some important features and applications of the microcontroller are:

i. It provides many functions (CPU, RAM, ROM, I/O, Interrupt, logic timer etc) in one package.

ii. 8-bit ALU, Accumulator and 8-bit register, hence making it an 8-bit microcontroller.
iii. 8-bit data bus
iv. 16-bit address bus.
v. On-chip RAM 128 bytes of data memory.
vi. On-chip ROM- 4 bytes of program data.
vii. 4 byte bi-directional I/O port.
viii. UART (serial port).
ix. Two 16-bit counter/timer.
x. Two level interrupt priority.

The 8051 has four distinct types of memory namely; Internal RAM, Special Function Register, Program Memory and External Data Memory.

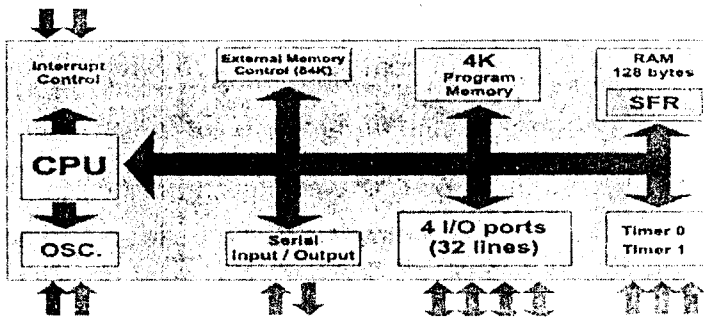


Fig. 2.5 Internal Architecture of the 8051 Microcontroller

There are many high level Programming language compilers for the 8051 controller, such as C,C++, Pascal/ Object Pascal, Modula 2, but the most widely used are C and assembly. The 8051 instruction set offers many addressing modes, including;

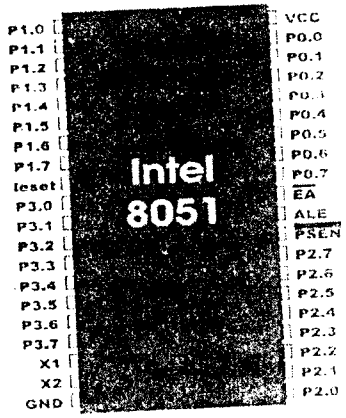
i. Direct Register, using ACC (Accumulator) and R0-R7.
ii. Direct Memory, which accesses the internal RAM or the SFR depending on the address

iii. Indirect Memory, the instruction used may vary to access internal RAM, external RAM or Program memory.

iv. Individual bits of range of IRAM and some of the SFRs.



Fig. 2.5.1 8051 microcontroller



2.5.2 Pin Schematics of the 8051 Microcontroller

The frequency of the full wave signal is double the input frequency. This makes sense. A full wave output has twice as many cycles as the sine wave input has, but the full wave get double the number of positive half cycles. The effect is to double the frequency.

Therefore, the output frequency of the full wave rectifier is.

$$F_{out} = 2fm$$

This implies that,

$$dt = \frac{1}{2f_m} = \frac{1}{(2x50)} = 0.01\sec$$

Avoiding damages, as the capacitor begins discharging up in less than half a cycle.

The maximum current that can be drawn by the mains circuit is determined by the voltage regulator following the filtering capacitor, the 7805.

The standard 7800 series can produce output current in excess of 1A when used with adequate heat sink. Therefore can supply a maximum of 1A. Thus I_{load} = 1A (maximum).

The value of C can be calculated from $C\frac{Idt}{dv}$

dv, which in the ripple voltage, is chosen to be 30% of Vp, where Vp is the peak Voltage.

Therefore, $V_p = Vrms\sqrt{2}$

Where Vrms = 24v, since the transformer of 220v/24v was used

$V_p = 24.x\sqrt{2} = 33.94V$

For bridge rectifier $Vp_{(out)} = Vp_{(in)} - 1.4v$, since 0.7v dropped across a diode whenever it conducts. And it is only for two diodes that will conduct at a time.

Therefore, $Vp_{(out)} = 24\sqrt{2} - 1.4 = 32.54V$

$$dv = \frac{30}{100} \times 32.54 = 9.76V$$

Therefore, $C = \frac{1 \times 6.01}{9.76} = 0.001024F$

$C = 1024\mu f$

So the commercial value of 100μF,35v was used in order to reduce

To the minimum. the expected ripple voltage. Using this value of capacitor

$dv = \frac{1 \times 0.01}{1000 \times 10^{-6}} = 10.0V$

So the output wave form goes from a peak value of 32.54 to (32.54 - 10) = 22.54v.

It may be noted that the input voltage to the IC regulator must be at least 2v above the output voltage. This is required in order to maintain regulation

Therefore since the output voltage is 5v. The ripple is neglected and the peak value of 15.57v to 11.02v is accepted by the 7805 to a negligible value.

The average voltage going to 7805 in calculated by

$V_p - 0.5dv = 32.54 - (0.5 \times 10)$

$= 32.54 - 5$

$= 27.54v$

The output from the 7805 is 5v at maximum current output of 1A. The output will remain constant in spite of input voltage variation.

.1.2 DESIGN OF RELAY UNIT

A 6v, 10A electromechanical relay was used to effectively power ON and OFF of electric stove at will. The fig below shows how the relay was [illegible] transistor.

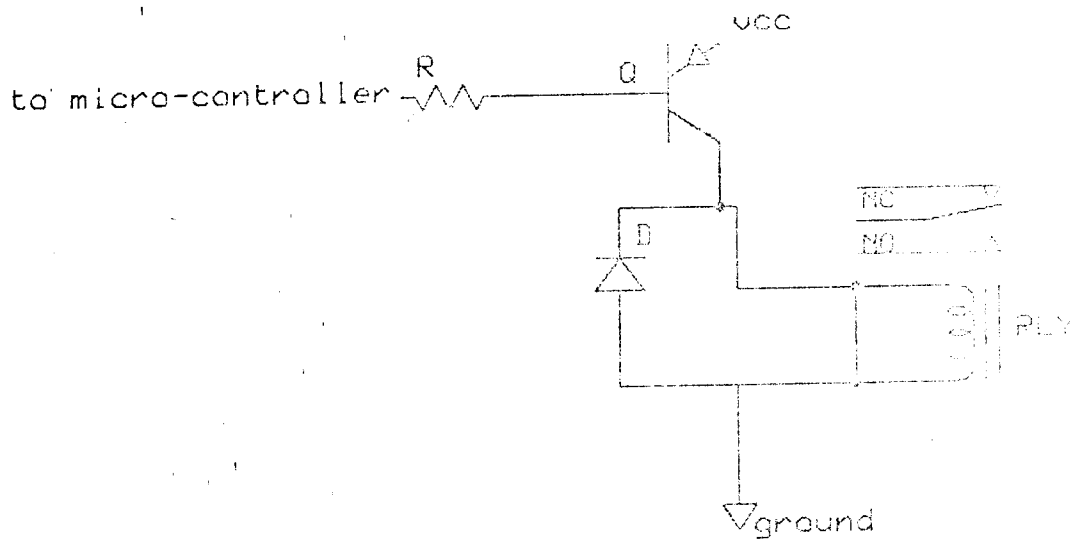


Fig 3.1.2: Circuit Diagram of Relay driver unit

The Relay has an internal resistance of 100Ω

Thus max collector current, $I_c = \frac{V_{cc} - 0.7}{R_c} = \frac{5 - 0.7}{100} = \frac{4.3}{100} = 43mA$

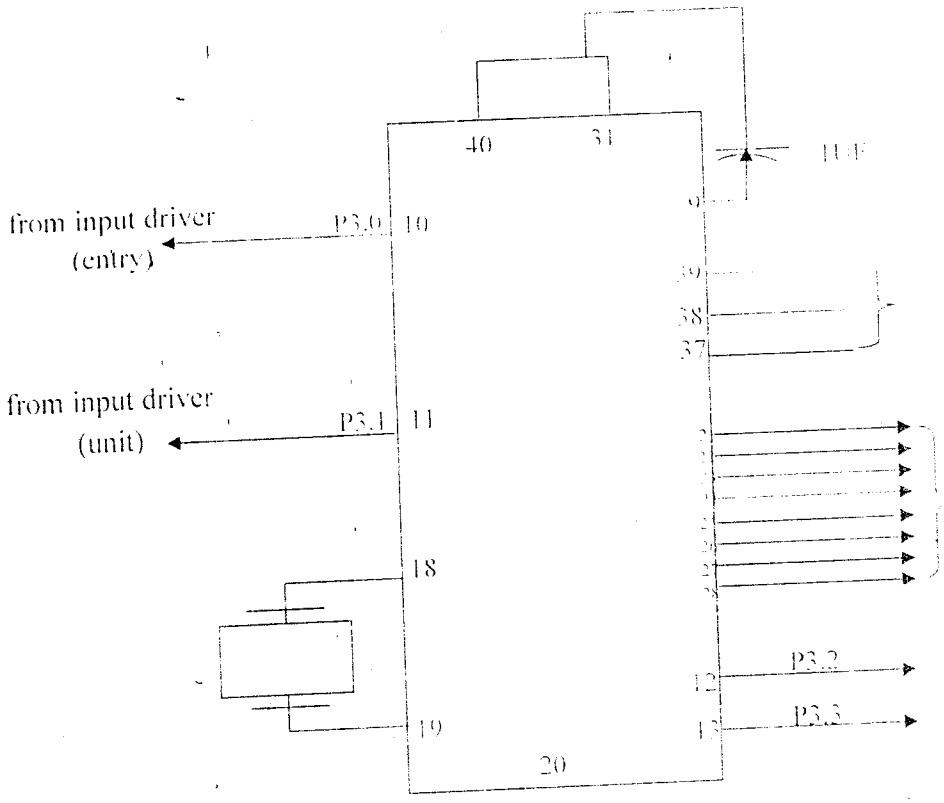


Fig 3.6 circuit diagram of microcontroller unit

3.1.3 FEATURES OF AT89C52

The following are the features of AT89C52 used in this design:

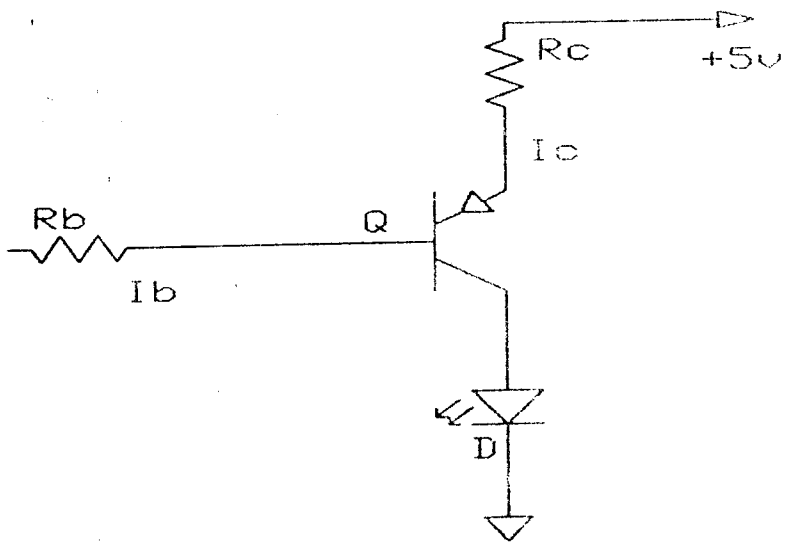
- Compatible with MCS – 51 products
- 8kBytes of In-system Reprogrammable Flash Memory.
- bEndurance: 1,000 write/erase cycles.
- Fully static operation: 0Hz to 24MHz
- Three-level program memory lock.
- 256 x 8 – bit Internal RAM. 32 programmable I/0 lines.
- Three 16-bit Timer/counters.
- Eight interrupt sources.
- Programmable serial channel.

The AT89C52 addresses both of these needs by having 32 I/O. bit manipulation and bit checking.

The input from input drivers units to the micro-controller. automatically caused microcontroller to carry out the specific functions as programmed within the microcontroller chip. The output of this goes to the display drivers, relay driver and the Buzzer units. Port 12 and port 13 show the unit circuit diagram. 1uf connected from Vcc to the reset pin of microcontroller in order to automatically reset it as it is powered.

3.1.4 DESIGN OF INDICATOR UNIT

All L.E.D's used as indicators were driven using BC638. PNP transistor. The fig below shows how the convection for each indicator was carried out.



The L.E.D requires a minimum of 4mA for proper brightness and maximum of 10mA for current of 4 mA . Resistance

$$R_c = \frac{V_{cc} - 0.7}{I} = \frac{5 - 0.7}{4mA} = \frac{4.3}{4} = 1.07k\Omega$$

3.1.6 DESIGN OF INPUT SWITCH

A total of fourteen switches were used as input drivers. They are all configured in the same manner, thus the figure below show the connection of just one of the switches.

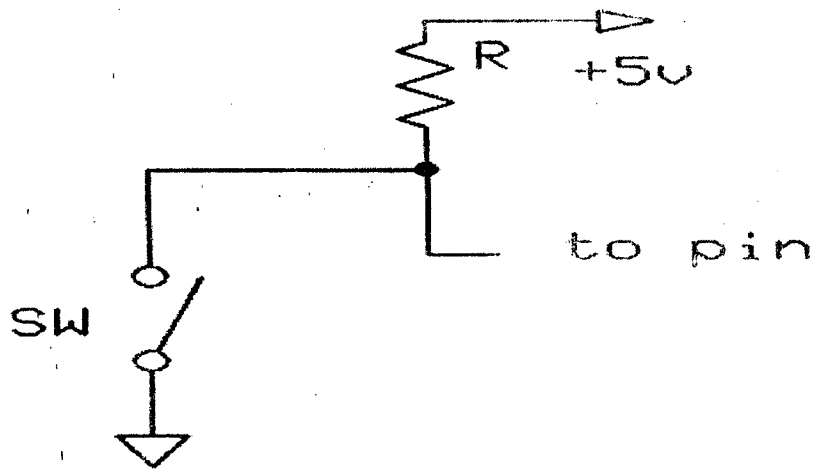
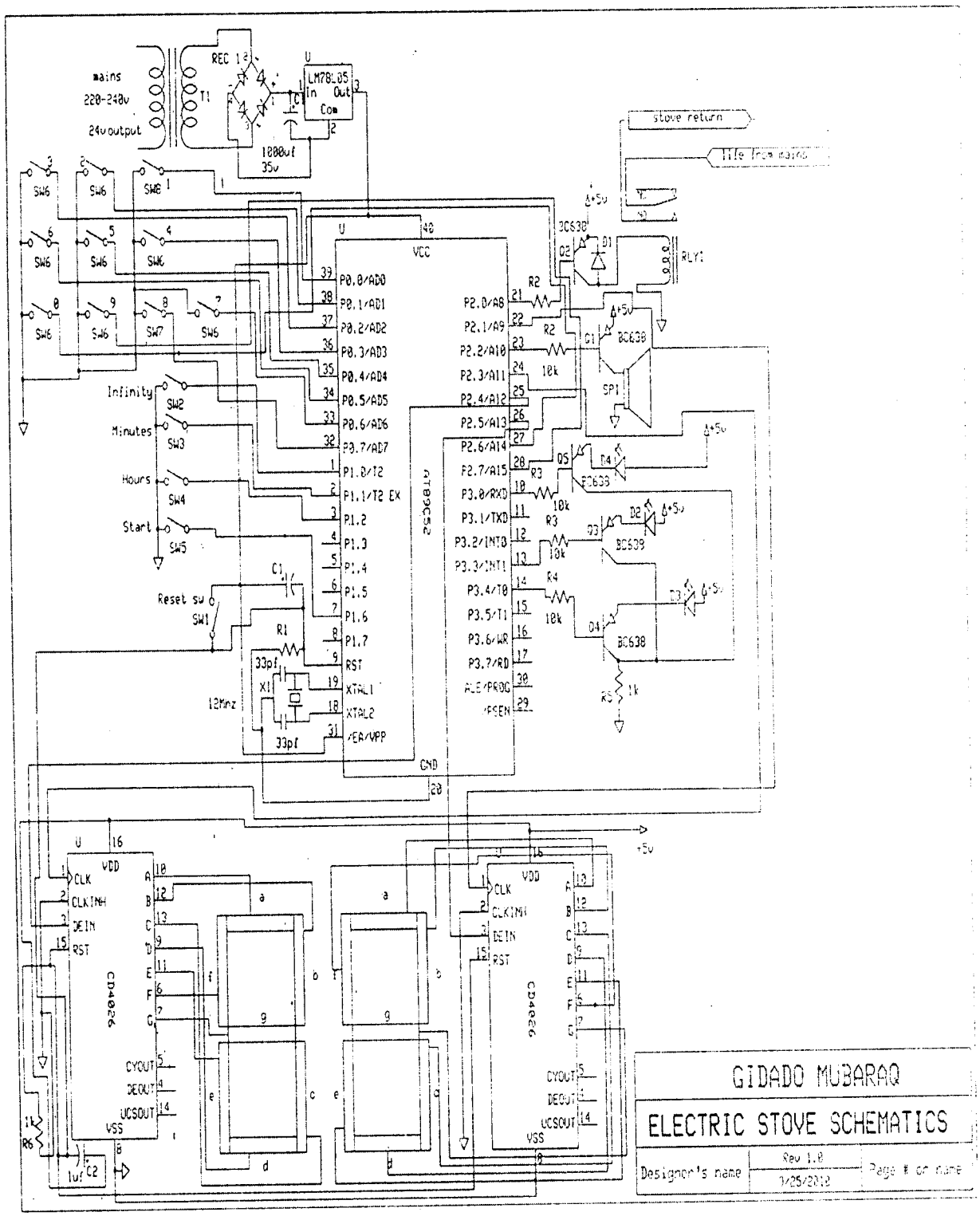


Figure 3.1.6 input switch

Each pin is pulled to +5V by the micro controller with the help of an internal pull-in resistor, typical value 100KΩ.initiatwarelly,the pin is pulled to +5V vai software but is trigged by taking pin to ground externally.


mains
220-240v
24v output
T1
REC 1
LM78L05
In Out
Com
1000uf
35v
stove return
life from mains
RLY1
BC638
SP1
Infinity
Minutes
Hours
Start
Reset sw
SW1
SW2
SW3
SW4
SW5
SW6
SW7
SW8
VCC
GND
AT89C52
P0.0/AD0
P0.1/AD1
P0.2/AD2
P0.3/AD3
P0.4/AD4
P0.5/AD5
P0.6/AD6
P0.7/AD7
P1.0/T2
P1.1/T2 EX
P1.2
P1.3
P1.4
P1.5
P1.6
P1.7
RST
XTAL1
XTAL2
/EA/VPP
P2.0/A8
P2.1/A9
P2.2/A10
P2.3/A11
P2.4/A12
P2.5/A13
P2.6/A14
P2.7/A15
P3.0/RXD
P3.1/TXD
P3.2/INT0
P3.3/INT1
P3.4/T0
P3.5/T1
P3.6/WR
P3.7/RD
ALE/PROG
/PSEN
R1
R2
R3
R4
R5
R6
10k
1k
33pf
12Mhz
X1
C1
C2
1uf
+5v
CD4026
VDD
VSS
CLK
CLKINH
DEIN
RST
CYOUT
DEOUT
UCSOUT
GIDADO MUBARAQ
ELECTRIC STOVE SCHEMATICS
Designer's name
Rev 1.0
Page # or name

CHAPTER FOUR

TEST, RESULTS AND DISCUSSION

The design completed, its workability needs to be tested. This is confirmed or done by subjecting the design to a series of test procedures. This procedures help in the test of each of the unit and the results tabulated. This chapter gives the various test procedures and their corresponding results.

4.1 Testing Procedures

Individual blocks are tested in order to aid debugging the system. This is done before the various modules are put together.

4.1.1 Voltage Regulator

Testing the functionality of the voltage regulator is an important step. This will help to avoid damage the full voltage that is expected by the regulator, including voltage spikes. We will measure the output voltage with a multi-meter to ensure that it will be accurate and stable when the voltage regulator is plugged into our detection system. We will also measure the current of the voltage regulator.

4.1.2 Microcontroller

For the microcontroller block, it will be connected to the serial port of a computer through a logic level converter. This is so that command signals can be sent form the computer to the microcontroller. A multi-mater is used to measure the various output pins, which would be connected to the switches, and checked to see if the required outputs correspond to the input command sent from the computer.

4.1.3 Electronic Switches

Both the solid switches and electromechanical relay arrangements are tested to ascertain their behavior when a control signal is sent from the microcontroller. Their input signal (control signal) will be a 5v dc connected to the individual driver components and an ac voltage source will be connected to the power switching devices. When the required control signal is passed to the circuit drivers to close the switches, the outputs are measured to see if the input voltage and current are passed through the closed switched. This is repeated for a control signal o open the switch.

4.1.4 Software

To properly test the software module. An oscilloscope is connected to pin 3 of the serial port of the microcontroller, to check that the output pulses are equivalent to the command signals expected by the microcontroller circuit.

4.2 Results

The output voltage regulator (7805 IC) was measured and found to be 5v.

Table 4.1 Test Results for Voltage Regulator

Input Voltage	Output Voltage	Input Current	Output Current
11v	5v	237Ma	470mA

The AT89C52 microcontroller responded as expected when certain bytes where written from the serial port. Below is the tabulated result of the test.

Table 4.2 Results of Microcontroller Test

Serial input(hex)	P3.2	P3.3	P3.4	P3.5	Meaning
0x04	1	1	0	1	System Power on
0x07	0	0	0	1	System power and load land 2on

The relay switch responded well at passing of the appropriate control signal, closing and opening the circuit as required.

CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

It can be concluded from the results obtained that the device can cook for as long as the user wants and that the microcontroller can be used to time accurately and to also attain flexibility in timing.

It can also be concluded that through effective design other kitchen and household activities can be automated making life more comfortable for man and preventing any disaster due to user error.

5.2 Recommendations for Further Work

It is recommended that future design provides a temperature sensor that will measure and display cooking temperature. It is also recommended that future design contain an oven for roasting. The use of an LCD will be recommended as it will make the devise more users friendly i.e. make the devise easy to use.

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APPENDIX

```
ORG 0000H
   CLR A
       MOV R0,#00H
    MOV R2,#00H
      MOV R1,#00H
      MOV R3,#00H
    MOV R4,#00H
    MOV R5,#00H
    MOV R6,#00H
    MOV R7,#00H
CLR P3.7
CALL OJAY
SETB P3.7
CLR P2.0
CLR P2.5
CLR P2.4
CLR P2.2
LCALL OJAY
LCALL OJAY
LCALL OJAY
SETB P2.2

LJMP SHAGGY
OJAY:LCALL OJ
     INC R3
      CJNE R3,#14H, OJAY
      MOV R3,#00H
      RET
OJ:MOV TMOD,#01
   MOV TL0,#0H
   MOV TH0,#3CH
   SETB TR0
   JNB TF0,$
   CLR TF0
   CLR TR0
   RET
SALIS:CLR P3.7
       LCALL OJAY
       SETB P3.7
       CLR P2.4
       CLR P2.5
      CJNE R0,#0,E40261
      SJMP E40262
E40261:CLR P2.1
        LCALL OJ
        SETB P2.1
        LCALL OJ
        LCALL OJ
        LCALL OJ
        DEC R0
        CJNE R0,#0,E40261
        MOV R0,#00
E40262:CJNE R6,#0,E40261
        SJMP RAMIY
```

```
4027:CLR P2.4
     LCALL OJ
     SETB P2.5
     LCALL OJ
     LCALL OJ
     LCALL OJ
     DEC R6
     CJNE R6,#0,E4027
     MOV R6,#00
AMIY:SETB P2.4
     SETB P2.5
     RET
PMINETE:LCALL OJAT
        INC R1
        CJNE R1,#60,PMINETE
        MOV R1,#00
        RET
PHOUR:LCALL EPMINETE
        INC R7
        CJNE R7,#60,EPHOUR
        MOV R7,#00
        RET
MAR:JNB P0.0,ONEOJ
    JNB P0.1,TWOOJ
    JNB P0.2,THROJ
    JNB P0.3,FOUOJ
    JNB P0.4,FIVOJ
    JNB P0.5,SIXOJ
    JNB P0.6,SEVOJ
    JNB P0.7,EIGOJ
    JNB P2.7,NINOJ
    JNB P2.6,TENOJ
    SJMP UMAR
NEOJ:JNB P0.0,$
     LCALL OJ
     SJMP ONE
WOOJ:JNB P0.1,$
     LCALL OJ
     SJMP TWO
HROJ:JNB P0.2,$
     LCALL OJ
     SJMP THR
OUOJ:JNB P0.3,$
     LCALL OJ
     SJMP FOU
IVOJ:JNB P0.4,$
     LCALL OJ
     SJMP FIV
IXOJ:JNB P0.5,$
     LCALL OJ
     SJMP SIX
EVOJ:JNB P0.6,$
     LCALL OJ
     SJMP SEV
IGOJ:JNB P0.7,$
     LCALL OJ
     SJMP EIG
```

```
027:CLR P2.3
    LCALL OJ
    SETB P2.3
    LCALL OJ
    LCALL OJ
    LCALL OJ
    DEC R6
    CJNE R6,#0,B6027
    MOV R6,#00
IY:SETB P2.4
    SETB P2.5
    RET
INETE:LCALL OJAY
      INC R1
      CJNE R1,#60,EPMINETE
      MOV R1,#00
      RET
HOUR:LCALL EPMINETE
      INC R7
      CJNE R7,#60,EPHOUR
      MOV R7,#00
      RET
AR:JNB P0.0,ONEOJ
   JNB P0.1,TWOOJ
   JNB P0.2,THROJ
   JNB P0.3,FOUOJ
   JNB P0.4,FIVOJ
   JNB P0.5,SIXOJ
   JNB P0.6,SEVOJ
   JNB P0.7,EIGOJ
   JNB P2.7,NINOJ
   JNB P2.6,TENOJ
   SJMP UMAR
EOJ:JNB P0.0,$
    LCALL OJ
    SJMP ONE
OOJ:JNB P0.1,$
    LCALL OJ
    SJMP TWO
OOJ:JNB P0.2,$
    LCALL OJ
    SJMP THR
OOJ:JNB P0.3,$
    LCALL OJ
    SJMP FOU
'OJ:JNB P0.4,$
    LCALL OJ
    SJMP FIV
.OJ:JNB P0.5,$
    LCALL OJ
    SJMP SIX
 OJ:JNB P0.6,$
    LCALL OJ
    SJMP SEV
OJ:JNB P0.7,$
    LCALL OJ
    SJMP EIG
```

```
NINOJ:JNB P2.7,$
      LCALL OJ
      SJMP NIN
'ENOJ:JNB P2.6,$
      LCALL OJ
      SJMP TEN
ONE:MOV A,#1
SJMP ESS
TWO:MOV A,#2
SJMP ESS
THR:MOV A,#3
SJMP ESS
FOU:MOV A,#4
SJMP ESS
FIV:MOV A,#5
SJMP ESS
SIX:MOV A,#6
SJMP ESS
SEV:MOV A,#7
SJMP ESS
EIG:MOV A,#8
SJMP ESS
NIN:MOV A,#9
SJMP ESS
ZEN:MOV A,#0
ESS:LCALL OJ
LCALL OJ
LCALL OJ
LCALL OJ
LCALL OJ
RET
SHAGGY:JNB P1.0,INFINITY
       JNB P1.1,MINUTE
       JNB P1.2,HOUR
       SJMP SHAGGY
INFINITY:CLR P3.0
         LCALL OJ
         LCALL OJ
         SETB P2.0
         LCALL OJAY
         LCALL OJAY
         LJMP CT
MINUTE:MOV R2,#1
       CLR P3.1
       LCALL OJ
       LCALL OJ
       LCALL OJ
       LCALL OJ

ENSE: LCALL UMAR
      MOV R4,A
      MOV R0,A
      CLR A
      CLR P3.3
      LCALL OJ
      LCALL UMAR
      MOV R5,A
```

```
      MOV R5,A
      CLR A
      CLR P3.4
      LCALL OJAY
      SJMP ACTIVE
JR:CLR P3.2
   LCALL OJ
   LCALL OJ
   LCALL OJ
   LCALL OJ
   SJMP SENSE
:IVE:MOV A,R4
      MOV B,#10
      MUL AB
      ADD A,R5
:T: JNB P1.4,COOK
    SJMP TEST
 K:CALL SALIS
    CJNE R2,#4,LONG
    SETB P2.0
 E:MOV R2,A
 RE:LCALL EPMINETH
   DEC R2
   MOV A,R2
   MOV B,#10
   DIV AB
   MOV R0,A
   MOV R6,B
   LCALL SALIS
   CJNE R2,#00,UHERE
   SJMP CTE
 G:SETB P2.0
 RE:MOV R2,A
   LCALL EPHOUR
   DEC R2
   MOV A,R2
   MOV B,#10
   DIV AB
   MOV R0,A
   MOV R6,B
   LCALL SALIS
   CJNE R2,#00,UTHERE
   CLR P2.0
   CLR P2.2
   LCALL OJAY
   LCALL OJAY
   LCALL OJAY
   LCALL OJAY
   LCALL OJAY
   LCALL OJAY
   LCALL OJAY
   LCALL OJAY
   LCALL OJAY
   LCALL OJAY
   SETB P2.2
   ?
```

```
/ A,#200
J:LCALL EPHOUR
: A
NE A,#0,NYU
)
```