DESIGN AND CONSTRUCTION OF AN INTELLIGENT DOOR CONTROLLER WITH DISPLAY INCORPORATED

BY

IKUESAN RICHARD ADEYEMI

(2003/15381EE)

A Thesis submitted to the Department of Electrical and Computer Engineering, Federal University of Technology, Minna.

NOVEMBER 2008

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A PROJECT SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE, NIGERIA.

NOVEMBER, 2008

DEDICATION

This project is dedicated to my father H.R.M. Oba Andrew k. Ikuesan and Mrs. Rose Olley. Also to Ikuesan Philip, Pastor Ikuesan Samson, and Eng'r Frank Olley.

DECLARATION

I Ikuesan Richard Adeyemi, an undergraduate student of the department of Electrical and Computer engineering, in the Federal University of Technology, Minna declare that this work was done by me and has never been done elsewhere for the award of the degree to the best of my knowledge.

I also hereby relinquish the copy right of this thesis to the Federal University of Technology, Minna.

Ikuesan R.Adeyemi	Eng'r Abolarinwa J.A
..........13/11/08......	............13/11/2008.
(Signature and Date)	(Signature and Date)
Dr. Adediran [H.O.D]	Name of External Examiner
....	....
(Signature and Date)	(Signature and Date)

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To the generation of Issachar and all members of the fellowship of Christian Students for their strength in prayer and to all my colleagues in the department and some wonderful friends, God bless you

ABSTRACT

Intelligent door controller is a form of artificial intelligent system that automatically opens a door when traffic approaches and closes after preset time duration as soon as there is no further traffic. This project was designed with duration of open operation hour within which the door opens to both entrance and exit motion but on completion of the open operation hour, it switches to a closed operation hour within which only exit motion is permitted through the door. The weight sensor is a device that incorporates the application of a floor mat voltage system in weight detection which serves as the input for control sequence technology (sensitive touch quick response technology). The control system is an embedded programmable device (a microcontroller) which decides the direction of motion of the motor, the duration of motion and the time to return. For ease of construction, this project was divided into functional sections; the input transducer module, the control module, the display module and the electromechanical module. The display module (an LCD) is controlled by the control module with display period of normal operation hour and normal close hour each with a predefined real clocking reference. The device is easy to install, can serve as an alternative to a manual notification (e.g. a bill board) for a closed and open period of operation since it can display a normal operation hour without external factor and with a real time clocking for accuracy, serve as a strict and accurate way of announcing time-out in public offices and or a place for public transaction since it allows entrance at a predefined time and also prevent entrance after the duration of the predefined time, can also serve as a measure in homes where restriction and adherence to light-out period is required. Generally, can be employed to frequently used doors such as restricted residential lodge, banks, bus stations, airport, and even offices.

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CHAPTER ONE

INTRODUCTION

Engineering is primarily concerned with the task of making life easier through application of science for the design and construction of machines and structures [2] as well as solving societal problems through technical process. In a world where ease and comfort are man's earnest desire, man's search for a method of perfection brought about what is now known as intelligent system [3]. The ability of machine to perform self oriented functions and make logical decisions there bye saving time, ensuring accuracy, efficiency in labor and hence productivity has led to the artificial intelligent [4]. With the evolution of programmable integrated circuits (example include processors, microcontroller), work done is made faster, accurate and less energy consuming. The field of control technology which now enable modern machines and equipments and self control oriented platforms to perform predefined operation with the aid of transducers, logical control units and sensors. These control techniques are being used in an ever widening variety of electronics projects like automatic electric kettle, light dimmer etc. [5]. A door is a floor length opening in a wall often equipped with a hinge or sliding pond to ensure or deny access. By design, a door may slide or rotate but here, this design is limited to a 180 degree rotation door system.

This project is about a form of intelligent system that enables one way rotating (180°) door to open when traffic approaches and close a few second after opening. It also decide which direction to open and can also alter the direction of rotation base on an emergency condition as indicated by manual push button.

1.1 AIM AND OBJECTIVE

This project deals with the design and construction of an intelligent door controller with display incorporated; which can be used to ease the manner of controlling a door. With the display it helps to improve convenience of automatic display procedures involving appropriate check system to:

- Avoid human to human interaction to its barest minimum; saving time and improve efficiency
- Reduce the risk of compromise as related to season of closure and operation
- Reduce the possible number of employee in an organization/firm, since its display (for notification) is not humanly or manually controlled.
- Accuracy of real time clocking system reliability and its availability without additional cost of a separate running computer system

Security and safety of both life and property is the major aim of this device with consciousness of the fact that the trend of technological advancement approaches artificial intelligence.

My aim and objective is to achieve precision and reliability in the design and construction of this system putting into consideration the possibility of building an artificial intelligent system.

1.2 SCOPE

This project is designed as a simple prototype of an intelligent door controller. This device could be likened to a self security analyzer, a self real time clocking system with standardized world time synchronization, which provide access control; but with the added benefit of distributed intelligence. It can be used as a totally autonomous door controller or as part of a system combining distributed intelligence with existing global capabilities. It functions for a general control; the normally open operation hour calculation, detection and response (quick detection quick response) with each season of operation indicated on a visual display unit system (an LCD). A normally closing hour calculation detection and response proceeds after a real time clocking of normal operation hour is completed, stage at which only exit movement is enabled as against the normal operation hour in which both the entrance and the exit movement are enabled. An emergency movement obstruction detection and response is incorporated to carter for emergency.

The system however reset back after the normal clocking is reached. This normally open hour and normally closed hour durations distinguishes this project from every intelligent door controller that ever existed. It however does not comprise a security check other than the open and close period.

1.3 METHODOLOGY

The techniques in this project involve the use of a voltage floor mat, an 89c52 microcontroller, a BA6209N reversible motor driver and a 16x2 LCD. For ease of construction, this project was carried out in modules; the input module (floor mat as its major component), the control module (a microcontroller as its major composition), the display module (a liquid crystal display unit as its composition) and the electromechanical module. The coordination of the door is digitally achieve through the input module by the application of a voltage floor mat (two of such floor mat are incorporated in the circuit design located at the entrance and the exit through the door). The voltage floor mat is a composition of switches/contacts connected to ground potential. The state of the floor mat defines the appropriate control for the door. A voltage logic level is sent by the floor mat to the control module. This module was designed to digitally recognize the state of the input module with the aid of its embedded program using a low level language (assembly language). This program also controls the display module; the visual display unit, which describes the time duration for the normal operation hour display and also the closing hour display with precise real time clocking.

1.4 LIMITATION

This project is designed to automatically close and open a door system and also to logically decide when to disable entrance and as such, will require different timing for different application which could be more complicating to program. Also, if incorporated to control many devices or systems, the various timing schedule or allotment for each composition may not be perfectly synchronized by the microcontroller, thereby creating a possible system real time clocking failure though it may not be humanly noticed but for higher machine computing, could generate error.

CHAPTER TWO

LITERATURE REVIEW

A door is a relatively solid surface, opaque or wholly or partly glazed, that closes an entrance to a building, vehicle, cupboard etc. The purpose of a door is to permit entry or exit, for ventilation, preventing passage of air, reducing air drifting and creating an enclosed space that can be heated or cooled more effectively. Rotating doors are especially efficient for this purpose (such as Privacy and noise reduction for aesthetics) [6, 7, and 8]. Automatic doors are powered open and close using electromechanical set-up. There are three methods by which an intelligent door is activated viz;

- A sensor detects approaching traffic and activates a corresponding circuit to open or to close door
- A switch is operated manually, perhaps after security check. This can be a push bottom switch or a swipe card
- The user pushes or pulls the door. Once the door detects the applied force, it completes the open or close cycle. These are also known as power- assisted doors.[6, 7]

2.1 HISTORICAL BACKGROUND

The oldest door in England can be found in West-Minster Abbey and dates from 1050. The earliest records of doors are those represented in the painting of the Egyptian tubs, in which they are depicted as single or double doors each in a single piece of wood. Heron of Alexandria (BC 10-70) created the first automatic door. He was a Hellenized Egyptian engineer and geometry in Alexandra, Egypt. [6, 7]

One of the applications of automatic control was James Watt's use of fly ball governor in 1987 to keep the steam engine he invented running at constant speed. An earlier example was Edmund Lee's (England 1745) use of a small pilot windmill to keep a large windmill faced into the wall [9, 10].

The first automatic doors used by people were invented in 1954 by lard Hewitt and Dee Horto and were installed in 1960. It made use of a mat actuator. The idea came to them in the mid 1950's when they saw that the existing swing door had difficulty in operating in the high wind of Corpus Christi, Texas [11, 12]. Upward sliding garage doors dates from the 1920, the first electric door openers (non automatic), were sold in 1926. The roll top desk, which has a similar form, was around in the mid eighteenth century [11]. Intelligent door system is an advanced automation system with a wide and vast application which uses embedded systems. [13]

Woodwork J. (1965) pointed out that, the kind of technology employed by an organization would determine the structure of the organization, Hickson D. (1969) viewed the intelligence of an equipment as a factor of work- flow integration, which is a determined by organizational effectiveness.

In 1789, France had her revolution and ensuring exploding of new thinking, led to the development of revolutionary new system of measurement in which all the different physical properties were linked by interrelated units; the metric system. The first weighing machine was derived from a yoke, whereby, it was discovered that two equal masses would balance if they were suspended from a beam that was supported at its center. Balances were in use in Mesopotamia as early as 4000 year BC. They consisted of straight pieces of wood suspended by a cord passing though the center.

The Greek and Romans used balances, struck from metals, usually bronze with ring-and-holes pivot. Bismar was the first recorded form of weighing device in 400BC.

Leonardo Davinci (1452-1512), designed the first recorded self weighing scale. The weight was shown on the chant by a plum bob crossing its face.

Hans Holbein's famous portrait recorded the represeniation of the knife-edge behind a wall, illustrated a prototype could have been made which was about 1500BC.

Load cells now lie in the head of every electronic weighing machine which is a composition of a strain gauge, thin metal foil electrical resistor and a power supply. [14, 15]

A liquid crystal display (LCD) is an electro-optical amplitude modulator realized as a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power. [16]

1888: Friedrich Reinitzer (1858-1927) discovers the liquid crystalline nature of cholesterol extracted from carrots (that is, two melting points and generation of colors) and published his findings at a meeting of the Vienna Chemical Society on May 3, 1888 (F. Reinitzer: *Beiträge zur Kenntniss des Cholesterins, Monatshefte für Chemie (Wien) 9, 421-441 (1888)*). [17]

1911: Charles Mauguin first experiments of liquids crystals confined between plates in thin layers.

1922: George Friedel describes the structure and properties of liquid crystals and classified them in 3 types (nematics, smectics and cholesterics).

1936: The Marconi Wireless Telegraph company patents the first practical application of the technology, *"The Liquid Crystal Light Valve"*.

1962: The first major English language publication on the subject *"Molecular Structure and Properties of Liquid Crystals"*, by Dr. George W. Gray. [18]

1962: Richard Williams of RCA found that liquid crystals had some interesting electro-optic characteristics and he realized an electro-optical effect by generating stripe-patterns in a thin layer of liquid crystal material by the application of a voltage. This effect is based on an electro-hydrodynamic instability forming what is now called "Williams domains" inside the liquid crystal. [19]

1964: In the fall of 1964 George H. Heilmeier, then working in the RCA laboratories on the effect discovered by Williams realized the switching of colors by field-induced realignment of dichroic dyes in a homeotropically oriented liquid crystal. Practical problems with this new electro-optical effect made Heilmeier to continue work on scattering effects in liquid crystals and finally the realization of the first operational liquid crystal display based on what he called the *dynamic scattering mode* (DSM). Application of a voltage to a DSM display switches the initially clear transparent liquid crystal layer into a milky turbid state. DSM displays could be operated in transmissive and in reflective mode but they required a considerable current to flow for their operation. [20, 21, 22]

1960s: Pioneering work on liquid crystals was undertaken in the late 1960s by the UK's Royal Radar Establishment at Malvern. The team at RRE supported ongoing work by George Gray and his team at the University of Hull who ultimately discovered the cyanobiphenyl liquid crystals (which had correct stability and temperature properties for application in LCDs).

1970: On December 4, 1970, the twisted nematic field effect in liquid crystals was filed for patent by Hoffmann-LaRoche in Switzerland, (Swiss patent No. 532 261) with Wolfgang Helfrich and Martin Schadt (then working for the Central Research Laboratories) listed as inventors [20]. Hoffmann-La Roche then licensed the invention to the Swiss manufacturer Brown, Boveri & Cie who produced displays for wrist watches during the 1970s and also to Japanese electronics industry which soon produced the first digital quartz wrist watches with TN-LCDs and numerous other products. James Fergason at the Westinghouse Research Laboratories in Pittsburgh while working with Sardari Arora and Alfred Saupe at Kent State University Liquid Crystal Institute filed an identical patent in the USA on April 22, 1971. [23]

In 1971 the company of Fergason ILIXCO (now LXD Incorporated) produced the first LCDs based on the TN-effect, which soon superseded the poor-quality DSM types due to improvements of lower operating voltages and lower power consumption.

1972: The first active-matrix liquid crystal display panel was produced in the United States by T. Peter Brody. [24]

2007: In the 4th Quarter of 2007 for the first time LCD surpassed CRT in worldwide sales. [25]

2008: LCD TVs are the main stream with 50% market share of the 200 million TVs forecast to ship globally in 2008 according to Display Bank. [26]

A detailed description of the origins and the complex history of liquid crystal displays from the perspective of an insider during the early days has been published by Joseph A. Castellano in "Liquid Gold, The Story of Liquid Crystal Displays and the Creation of an Industry" [27]. Another report on the origins and history of LCD from a different perspective has been published by Hiroshi Kawamoto, available at the IEEE History Center. [28]

CHAPTER THREE

DESIGN ANALYSIS AND CONSTRUCTION

3.1 DESIGN ANALYSIS

The circuit design of an intelligent door controller incorporating a display was carried out in modules as represented below:

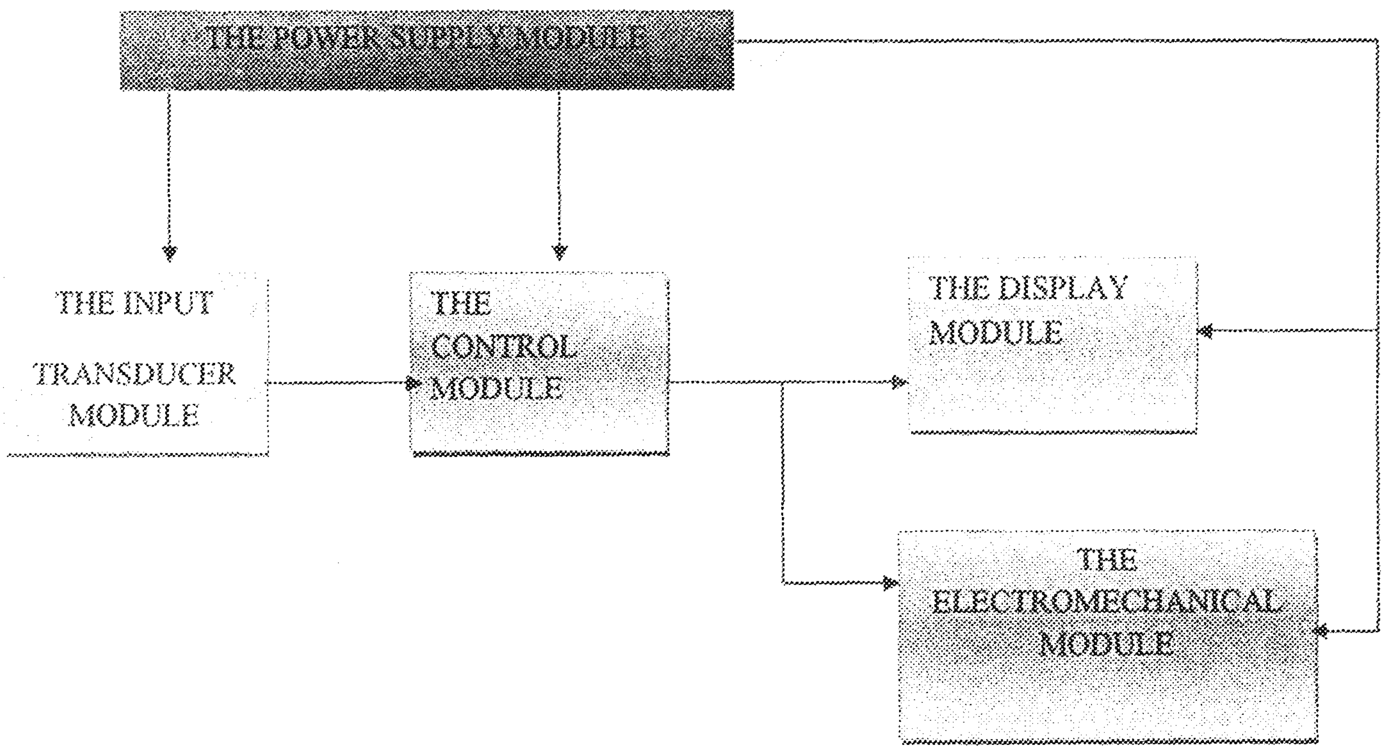


Fig 3.0 block diagram of an intelligent door controller incorporating display

As shown above, the system consists of;

1. The power supply module

2. The input transducer module

3. The control module

4. The display module

5. The electromechanical module

3.2 THE POWER MODULE

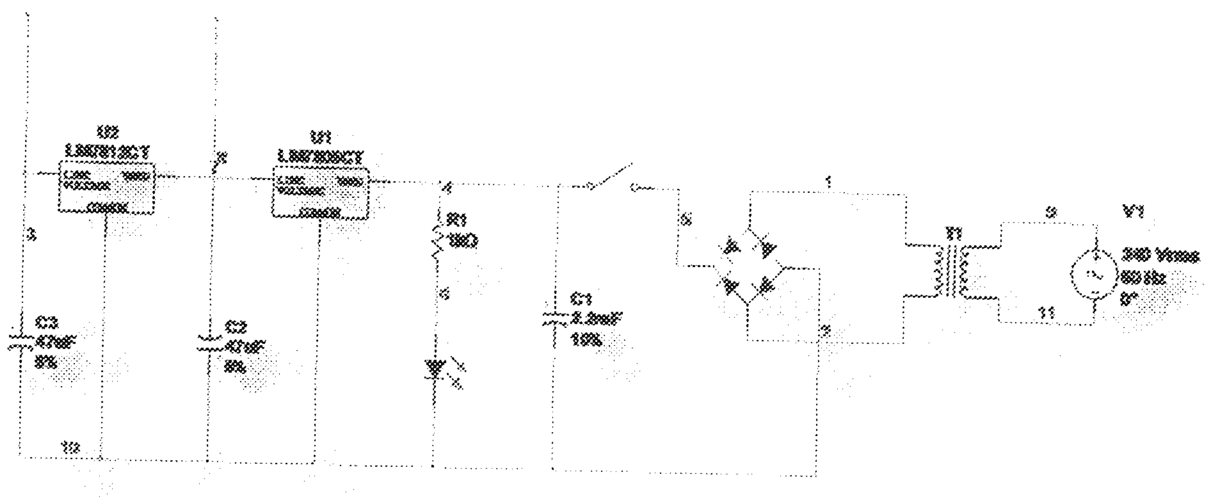


Fig 3.1 circuit diagram of the power module

The power supply unit was designed to supply two regulated voltages (d.c), 5V and 12V respectively.

A 24V step down voltage transformer was used to step the a.c power source voltage from the PHCN and this supplies the power input to the circuit with its secondary terminal connected to a full wave bridge rectifier circuit which converts the 24V(though not really up to this amount) a.c voltage into d.c voltage . The bridge rectifier circuit is made up of four IN4001 diodes. A ripple filtering capacitor C1 was connected in parallel with the output voltage from the rectifier circuit thus making a pure d.c supply. For 17% ripple voltage (VR) after filtering with a peak voltage (VP)

$VR = (17/100) \cdot VP$

$But\ VP = regulated\ voltage + voltage\ drop\ across\ rectifier\ circuit$

$= 24V + 2.4V$

$= 26.4V$

$Hence.\ VR = (17/100) \cdot 26.4 = 4.488V = 4.5V$

The 17% ripple is assumed to prevent charging up the compensation capacitor. Time betwee

$= \frac{1}{2} \cdot T = \frac{1}{2} \cdot 1/F$ *where T is the period of one cycle and f is the PHCN frequency*

$= 50Hz$

$dt = 1/2 \cdot (1/50) = 1/100 = 0.01s$

The current rating of the diode (I) is 1A

$I = C\ dv/dt$

Where dv = VR and C is the capacitor size.

$I = C \cdot (4.5 / 0.01)$

$C = (1A \cdot 0.01)/4.5 = 2.222 \cdot 10E - 3F$

$= 2222\mu F.$

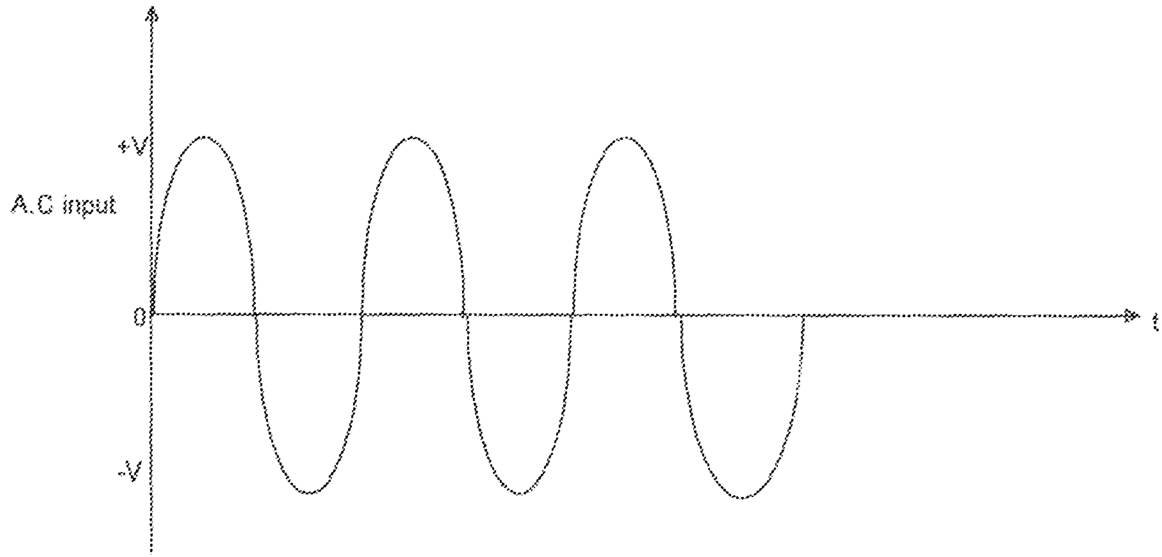


Fig. 3.2 sine wave form of ac power input

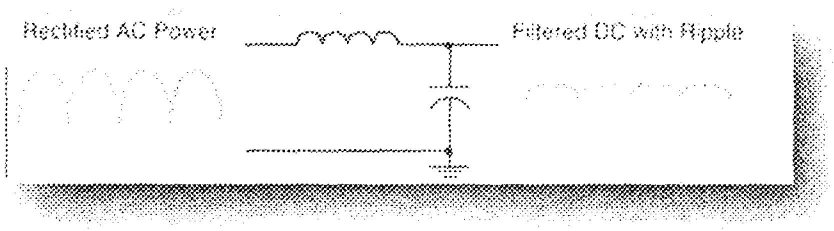


Fig 3.3 Ripple on a rectified a.c power input

A 2200µF 35V was used because it is the closest size capacitor to the calculated value and its availability in the market. The switch SW1 controls the turning ON and OFF of the circuit to the rectifier of the entire power unit. The two voltage regulator; 7812 and 7805 provides constant voltage of 12V and 5v respectively. The light emitting diode serves as an indicator. Since the diode only require a maximum of 2.8V to power ON for indication, a 3K resistor was used as a current limiting resistor to sink current with a voltage drop of Vr across it.

$$Vr = Id \cdot R$$

$$Where\ Id\ is\ the\ current\ rating\ of\ the\ diode\ = 0.7A\ and\ r\ is\ the\ resistor\ value$$
$$= 1.8K$$

$$Vr = 0.7A \cdot 3k = 2.1V$$

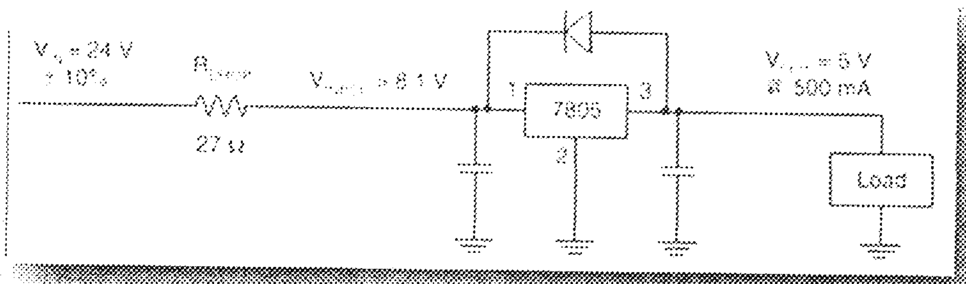


Fig 3.4 Power dissipation on a resistor

3.3 THE INPUT TRANSDUCER MODULE

Sensors for intelligent doors are generally:

1. Pressure sensor; this is mostly a floor mat (mat actuator) which activates the opening or the closing of circuit of the door when some one stands on it.

2. Infrared sensor; this is made up of an infrared transmitter (sometimes an LED) which transmit an invisible light ray onto an infrared sensor. When someone or an object blocks the beam, the door opens and closes, when the beam is restored.

3. Motion sensor which uses laid power microwave radar

4. Radio wave sensor which can be triggered by something that someone carries or is installed inside a vehicle. These are popular for garage doors. In other to activate sensor, automatic doors are generally fitted with safety sensor whose purpose is to prevent the

door opening or slows its speed, if an object is detected in its path whilst opening and prevent the door closing or reactivate it if an object is detected in its path whilst closing.

The input transducer unit or sensor for this project is made up of a voltage floor mat (a pressure sensor (type of weight detection) on which the load is to be detected. It is a composition of arranged normally open switches/contact connected between the interrupt pins of the microcontroller and ground potential.

The connection to ground potential is essentially for the activation of the negative edge triggered interrupt.

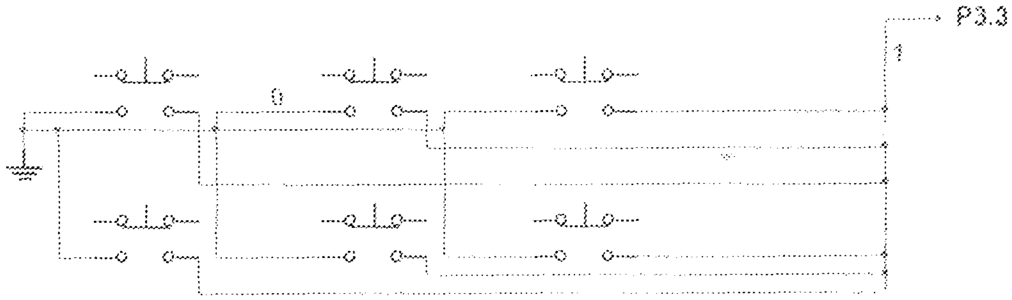


Fig.3.5 input module circuit

3.4 THE CONTROL UNIT

This module was designed to control the switching and bidirectional operation of the motor in the electromechanical module and control the display period and display mode. It is composed of an 89C52 microcontroller, which is the brain behind this project and functions on the basis of the predefined algorithm programmed into using a low level language (assembly language).

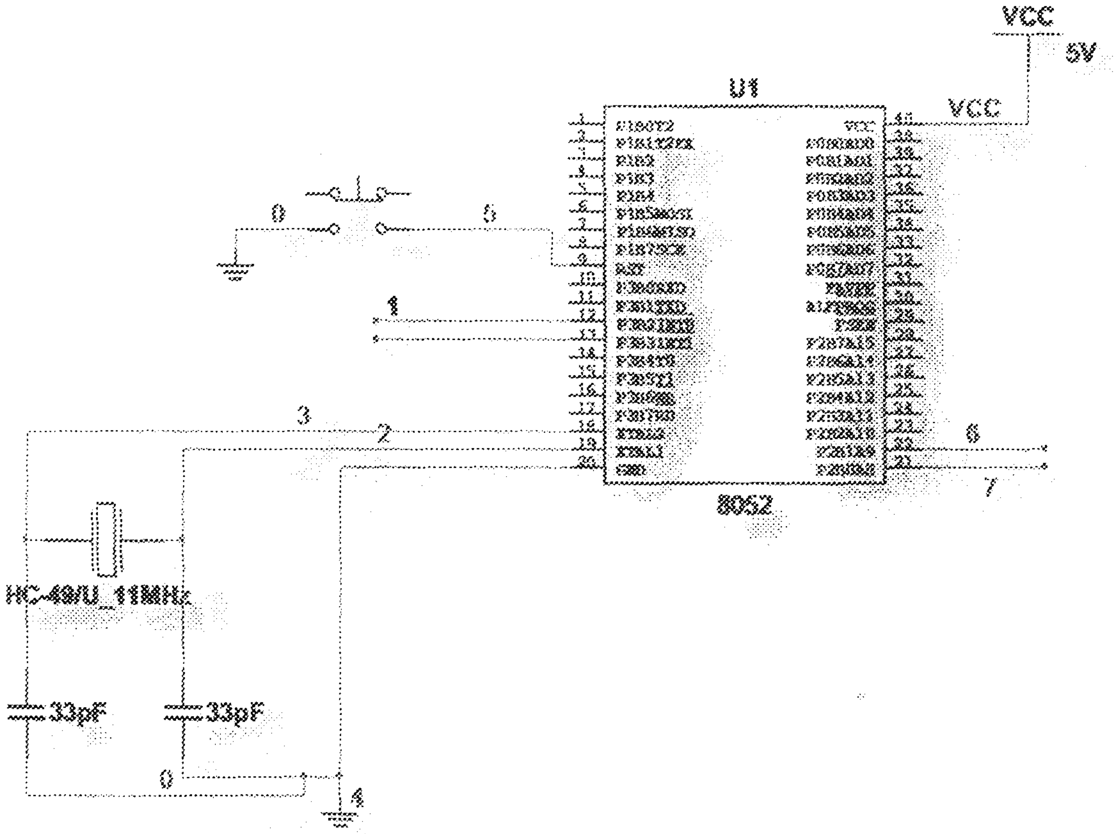


Fig 3.6 Circuit diagram for the control module

3.3.1The Microcontroller (AT89C52)

The AT89C52 is a low power, High performance CMOSS 8-bit microcomputer with 8k byte of flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high density nonvolatile memory technology and is compatible with the industrial standard 89C51 and 89C52 instruction set and pin out. The on-chip flash allows the program to be reprogrammed in-system or by a conventional nonvolatile memory programmer. It has an endurance of 1000write/erase cycles, fully static operation of 0Hz to 24Hz, three level program memory lock. 256 × 8-bit internal RAM, 32 programmable (i.e. they are each bit addressable) input/output lines, three 16-bit timer/counters, eight interrupt sources, programmable serial channel, low power idle mode and low power-down modes.

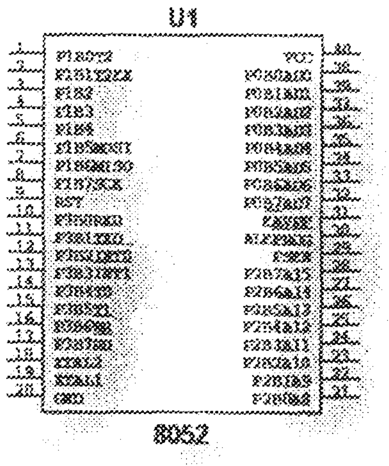


Fig 3.7 pin configuration of AT89c52

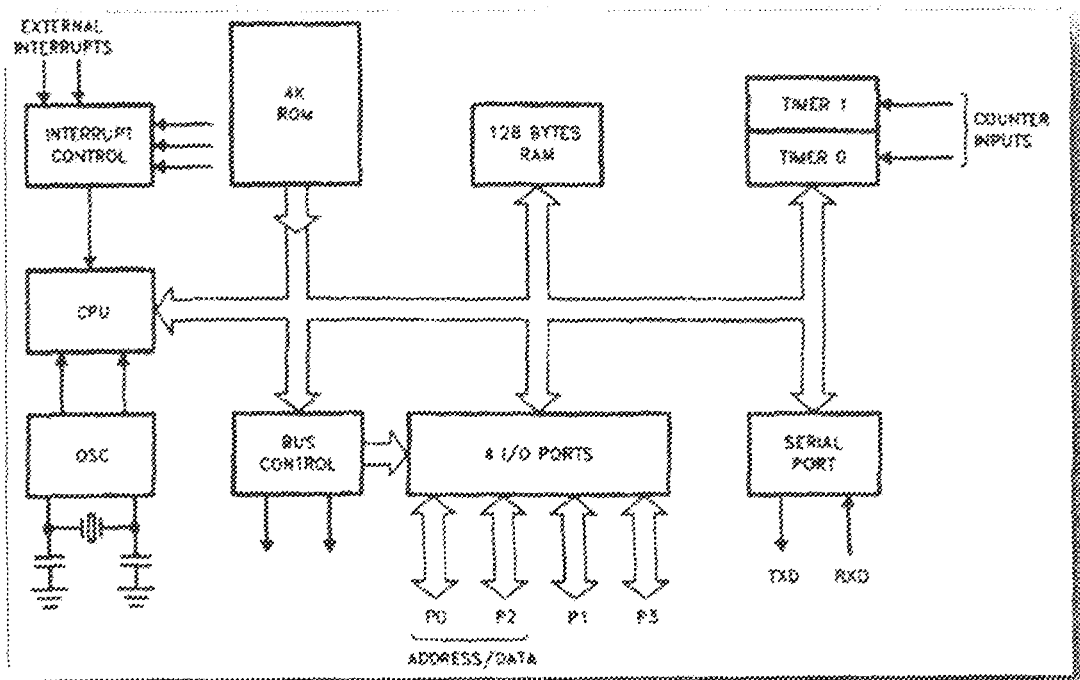


Fig. 3.8 block diagram of the AT89c52

Table 3.1 D.C characteristics of an AT89c52

DC Characteristics

The values shown in this table are valid for T_A = -40°C to 85°C and V_{CC} = 5.0V ± 20%, unless otherwise noted.

Symbol	Parameter	Condition	Min	Max	Units
V_{IL}	Input Low-voltage	(Except $\overline{EA}$)	-0.5	0.2 V_{CC}-0.1	V
V_{IL1}	Input Low-voltage ($\overline{EA}$)		-0.5	0.2 V_{CC}-0.3	V
V_{IH}	Input High-voltage	(Except XTAL1, RST)	0.2 V_{CC}+0.9	V_{CC}+0.5	V
V_{IH1}	Input High-voltage	(XTAL1, RST)	0.7 V_{CC}	V_{CC}+0.5	V
V_{OL}	Output Low-voltage[1] (Ports 1,2,3)	I_{OL} = 1.6 mA		0.45	V
V_{OL1}	Output Low-voltage[1] (Port 0, ALE, $\overline{PSEN}$)	I_{OL} = 3.2 mA		0.45	V
V_{OH}	Output High-voltage (Ports 1,2,3, ALE, $\overline{PSEN}$)	I_{OH} = -60 µA, V_{CC} = 5V ± 10%	2.4		V
		I_{OH} = -25 µA	0.75 V_{CC}		V
		I_{OH} = -10 µA	0.9 V_{CC}		V
V_{OH1}	Output High-voltage (Port 0 in External Bus Mode)	I_{OH} = -800 µA, V_{CC} = 5V ± 10%	2.4		V
		I_{OH} = -300 µA	0.75 V_{CC}		V
		I_{OH} = -80 µA	0.9 V_{CC}		V
I_{IL}	Logical 0 Input Current (Ports 1,2,3)	V_{IN} = 0.45V		-50	µA
I_{TL}	Logical 1 to 0 Transition Current (Ports 1,2,3)	V_{IN} = 2V, V_{CC} = 5V ± 10%		-650	µA
I_{LI}	Input Leakage Current (Port 0, $\overline{EA}$)	0.45 < V_{IN} < V_{CC}		±10	µA
RRST	Reset Pulldown Resistor		50	300	KΩ
C_{IO}	Pin Capacitance	Test Freq. = 1 MHz, T_A = 25°C		10	pF
I_{CC}	Power Supply Current	Active Mode, 12 MHz		25	mA
		Idle Mode, 12 MHz		6.5	mA
	Power-down Mode[2]	V_{CC} = 6V		100	µA
		V_{CC} = 3V		40	µA

Notes: 1. Under steady state (non-transient) conditions, I_{OL} must be externally limited as follows:
Maximum I_{OL} per port pin: 10 mA
Maximum I_{OL} per 8-bit port:
Port 0: 26 mA Ports 1, 2, 3: 15 mA
Maximum total I_{OL} for all output pins: 71 mA
If I_{OL} exceeds the test condition, V_{OL} may exceed the related specification. Pins are not guaranteed to sink current greater than the listed test conditions.
2. Minimum V_{CC} for Power-down is 2V.

Table 3.2 temperature rating of the AT89c52

Absolute Maximum Ratings*

Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C
Voltage on Any Pin with Respect to Ground	-1.0V to +7.0V
Maximum Operating Voltage	6.6V
DC Output Current	15.0 mA

*NOTICE: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table3.3 A.CcharacteristicsoftheAT89c52

AC Characteristics

Under operating conditions, load capacitance for Port 0, ALE/$\overline{PROG}$ and $\overline{PSEN}$ = 100 pF; load capacitance for all other outputs = 80 pF.

External Program and Data Memory Characteristics

Symbol	Parameter	12 MHz Oscillator		Variable Oscillator		Units
		Min	Max	Min	Max	
$1/t_{CLCL}$	Oscillator Frequency			0	24	MHz
t_{LHLL}	ALE Pulse Width	127		$2t_{CLCL}$-40		ns
t_{AVLL}	Address Valid to ALE Low	43		t_{CLCL}-13		ns
t_{LLAX}	Address Hold After ALE Low	48		t_{CLCL}-20		ns
t_{LLIV}	ALE Low to Valid Instruction In		233		$4t_{CLCL}$-65	ns
t_{LLPL}	ALE Low to $\overline{PSEN}$ Low	43		t_{CLCL}-13		ns
t_{PLPH}	$\overline{PSEN}$ Pulse Width	205		$3t_{CLCL}$-20		ns
t_{PLIV}	$\overline{PSEN}$ Low to Valid Instruction In		145		$3t_{CLCL}$-45	ns
t_{PXIX}	Input Instruction Hold after $\overline{PSEN}$	0		0		ns
t_{PXIZ}	Input Instruction Float after $\overline{PSEN}$		59		t_{CLCL}-10	ns
t_{PXAV}	$\overline{PSEN}$ to Address Valid	75		t_{CLCL}-8		ns
t_{AVIV}	Address to Valid Instruction In		312		$5t_{CLCL}$-55	ns
t_{PLAZ}	$\overline{PSEN}$ Low to Address Float		10		10	ns
t_{RLRH}	$\overline{RD}$ Pulse Width	400		$6t_{CLCL}$-100		ns
t_{WLWH}	$\overline{WR}$ Pulse Width	400		$6t_{CLCL}$-100		ns
t_{RLDV}	$\overline{RD}$ Low to Valid Data In		252		$5t_{CLCL}$-90	ns
t_{RHDX}	Data Hold After $\overline{RD}$	0		0		ns
t_{RHDZ}	Data Float After $\overline{RD}$		97		$2t_{CLCL}$-28	ns
t_{LLDV}	ALE Low to Valid Data In		517		$8t_{CLCL}$-150	ns
t_{AVDV}	Address to Valid Data In		585		$9t_{CLCL}$-165	ns
t_{LLWL}	ALE Low to $\overline{RD}$ or $\overline{WR}$ Low	200	300	$3t_{CLCL}$-50	$3t_{CLCL}$+50	ns
t_{AVWL}	Address to $\overline{RD}$ or $\overline{WR}$ Low	203		$4t_{CLCL}$-75		ns
t_{QVWX}	Data Valid to $\overline{WR}$ Transition	23		t_{CLCL}-20		ns
t_{QVWH}	Data Valid to $\overline{WR}$ High	433		$7t_{CLCL}$-120		ns
t_{WHQX}	Data Hold After $\overline{WR}$	33		t_{CLCL}-20		ns
t_{RLAZ}	$\overline{RD}$ Low to Address Float		0		0	ns
t_{WHLH}	$\overline{RD}$ or $\overline{WR}$ High to ALE High	43	123	t_{CLCL}-20	t_{CLCL}+25	ns

The input signal from the floor mat dictates which action is taken by the microcontroller. The input/output ports are by default in the logic1 state. The floor mat for entrance is connected to pin p3.2 of the microcontroller (external interrupt 0) which toggles from high to low (active low state) when a traffic approaches, the microcontroller (with the aid of its reprogrammed instruction) sends signal of logic 1 and logic 0 via pins P2.5 and P2.4 respectively to the motor driver indicating a forward motion and after 4seconds, a pulse state of 1second after which a final reversal of the motion (a logic 0 and logic1 on pins P2.5 and P2.4 respectively) is directed by the microcontroller to the motor driver.

Similarly, when the exit floor mat connected the pin P3.3 of the microcontroller (external interrupt 1) toggles from logic1 to logic 0, a reverse action on pins P2.5 and P2.4 are also carried out by the microcontroller.

3.4 THE VISUAL DISPLAY UNIT

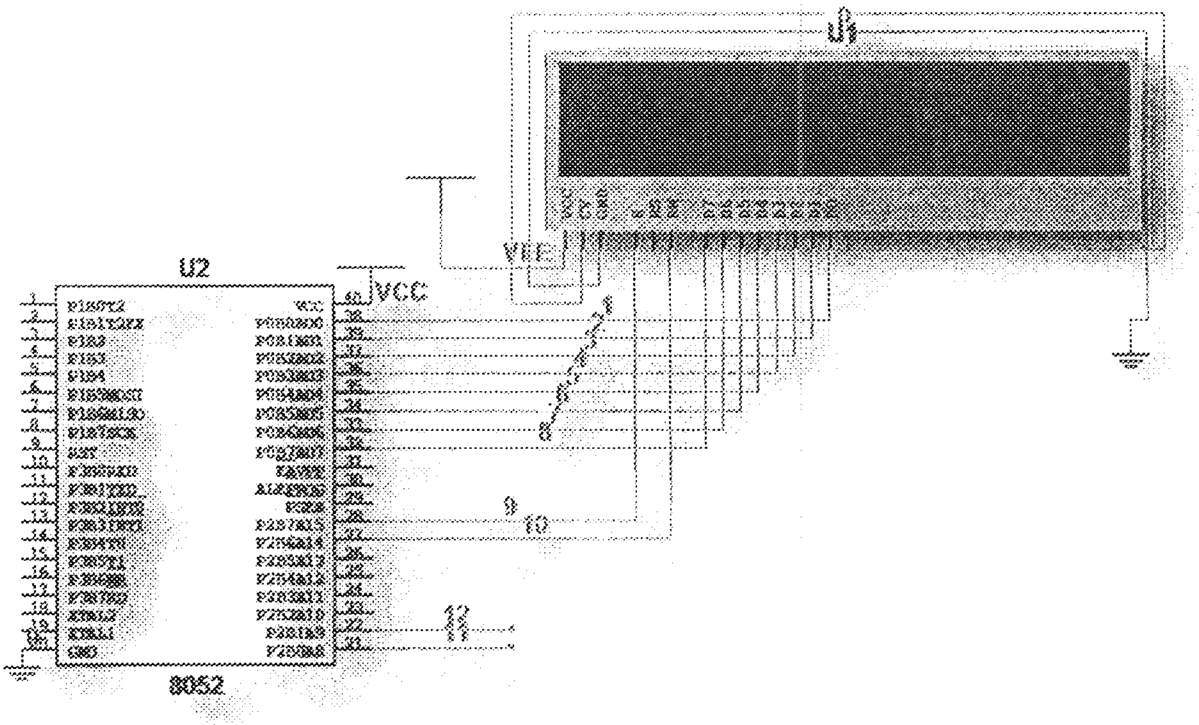


Fig 3.9 circuit diagram of the display module

The display unit has as its major constituent a 16 line x 2 line LCD. At power up, the microcontroller sends data to the LCD to display the 'open hour' within which both entrance and exit motion are allowed but after some time (for the sake of this project, a 3 minutes open hour and a 4 minutes closed hour was scheduled) a 'closed hour' data is sent to the to the LCD within which only the exit motion is allowed. This however will last for a certain duration after which the microcontroller repeats the overall process again in a continuous loop.

3.4.1 The 16 line by 2 line LCD

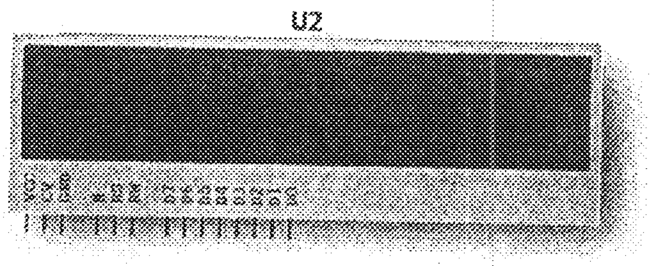


Fig 3.10 a typical 16line by 2 line LCD

The 16 line by 2 line LCD displays is built in a LSI controller; the controller has two 8-bit registers, an instruction register, and a data register. The instruction register stores instruction code, such as display clear and cursor shift, and address information for the display data RAM (DDRAM) and character generator (CGRAM). The instruction register can only be written from the microcontroller. The data register temporarily stores data to be written from DDRAM or CGRAM. When the address information is written into the instruction register, then data is stored into the data register from the DDRAM or the CGRAM.

Table 3.4 Pin interface function

Pin No.	Symbol	Level	Description
1	V_{SS}	0V	Ground
2	V_{DD}	5.0V	Supply Voltage for logic
3	VO	(Variable)	Operating voltage for LCD
4	RS	H/L	H: DATA, L: Instruction code
5	R/W	H/L	H: Read(MPU→Module) L: Write(MPU→Module)
6	E	H,H→L	Chip enable signal
7	DB0	H/L	Data bit 0
8	DB1	H/L	Data bit 1
9	DB2	H/L	Data bit 2
10	DB3	H/L	Data bit 3
11	DB4	H/L	Data bit 4
12	DB5	H/L	Data bit 5
13	DB6	H/L	Data bit 6
14	DB7	H/L	Data bit 7
15	A	-	LED +
16	K	-	LED -

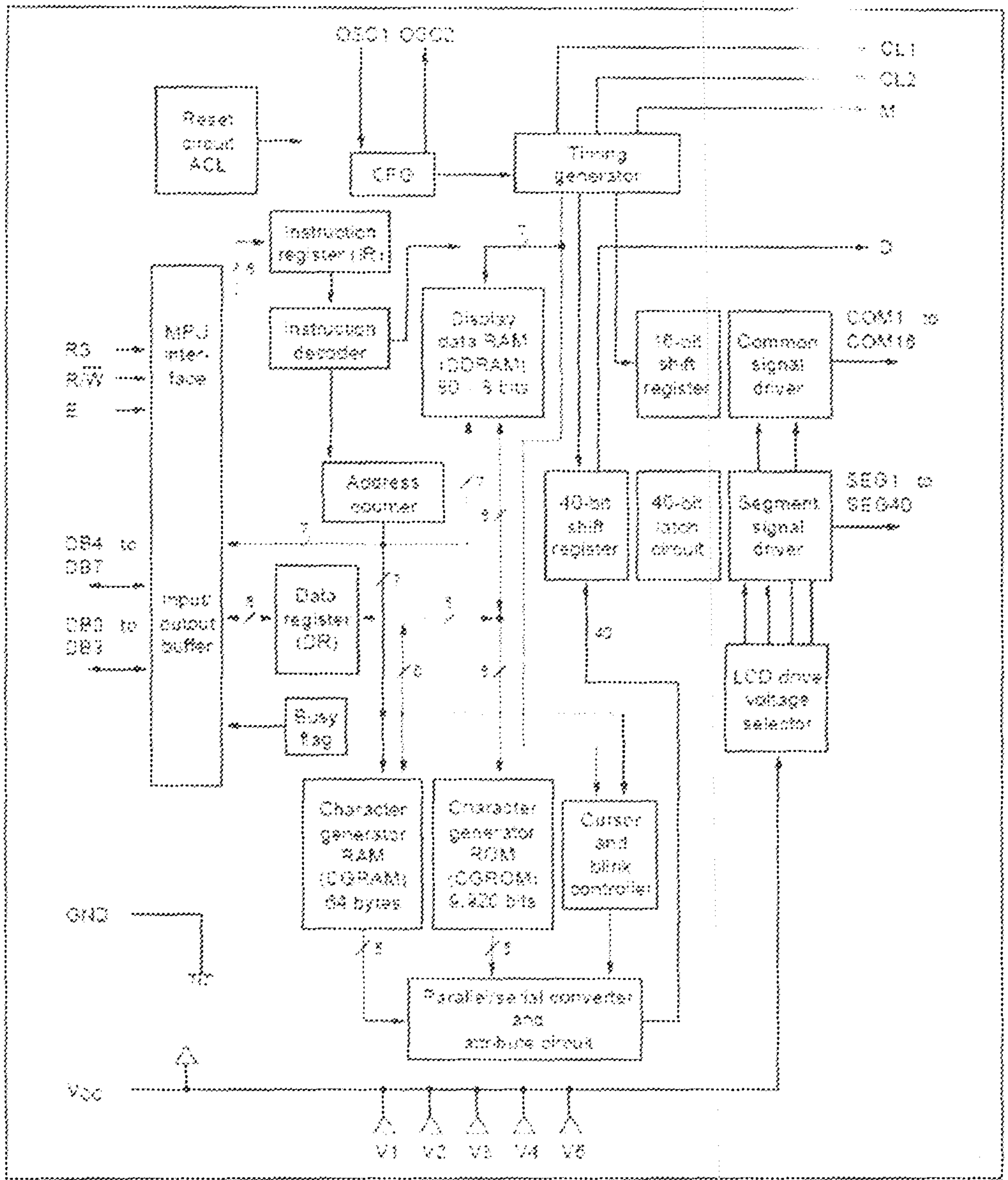


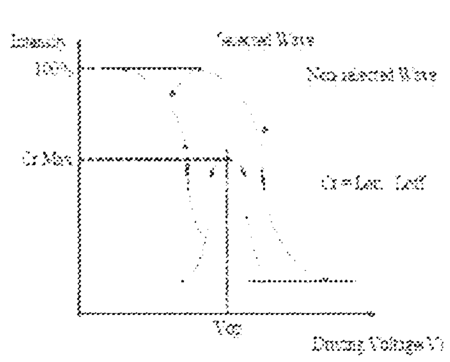
Fig.3.11 block diagram of 16 line by 2 line LCD

Table 3.5 optical characteristics of a 16 line by 2 line LCD

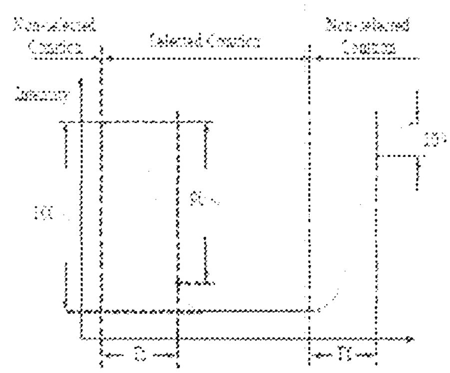
Optical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit
View Angle	(V)θ	CR≥2	10	-	105	deg
	(H)φ	CR≥2	-30	-	30	deg
Contrast Ratio	CR	-	-	3	-	-
Response Time	T rise	-	-	150	200	ms
	T fall	-	-	150	200	ms

finition of Operation Voltage (Vop)   Definition of Response Time (Tr , Tf)



[positive type]



[positive type]

onditions :

Operating Voltage : Vop   Viewing Angle(θ , φ) : 0° , 0°

Frame Frequency : 64 HZ   Driving Waveform : 1/N duty 1/a bias

Fig 3.12 operational voltage versus response time curve

Table 3.6 Electrical characteristic of 16line x 2line LCD

Item	Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage For Logic	$V_{DD}-V_{SS}$	-	4.5	-	5.5	V
Supply Voltage For LCD	$V_{DD}-V_{0}$	Ta=0°C	-	-	4.2	V
		Ta=25°C	-	3.8	-	V
		Ta=50°C	3.6	-	-	V
Input High Volt.	V_{IH}	-	2.2	-	V_{DD}	V
Input Low Volt.	V_{IL}	-	-	-	0.6	V
Output High Volt	V_{OH}	-	2.4	-	-	V
Output Low Volt.	V_{OL}	-	-	-	0.4	V
Supply Current	I_{DD}	V_{DD}=5V	-	1.2	-	mA

Table 3.7 temperature characteristics of 16 line by 2 line LCD

Item	Symbol	Min	Typ	Max	Unit
Operating Temperature	T_{OP}	-20	-	+70	°C
Storage Temperature	T_{ST}	-30	-	+80	°C
Input Voltage	V_{I}	V_{SS}	-	V_{DD}	V
Supply Voltage For Logic	$V_{DD}-V_{SS}$	-0.3	-	7	V
Supply Voltage For LCD	$V_{DD}-V_{0}$	-0.3	-	13	V

3.5 THE ELECTROMECHANICAL UNIT

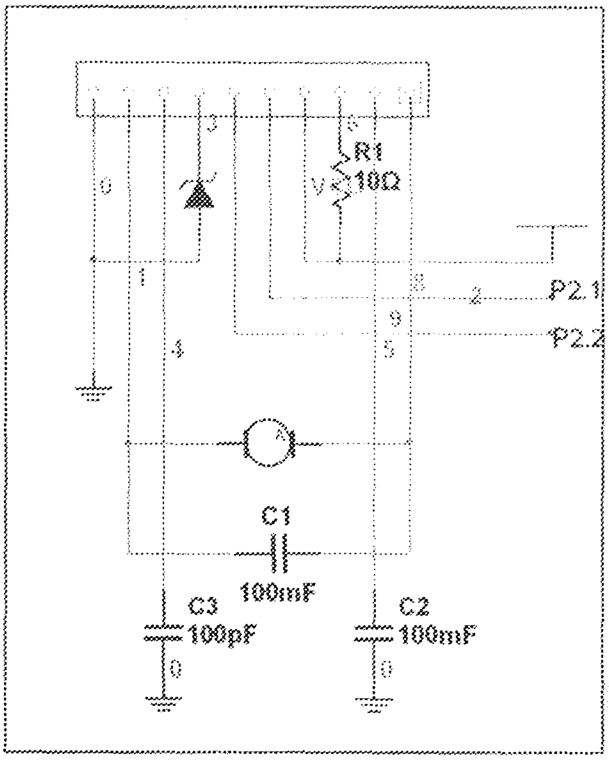


Fig 3.13 circuit diagram of the electromechanical module

This unit is made up of a model of a one way door with a bidirectional motor controlled by a motor driver (BA6209N) reversible motor driver. Two logic inputs from the microcontroller allow three output modes; forward, backward and pulse. For a forward motion, the microcontroller sends signals of logic1 and logic0 and then wait for 3 seconds and afterwards, logic0 and logic0 are sent to the driver for a brake condition which spans for 1seconds and then, logic 0 and logic 1 are sent for a reverse motion for a duration of 3 seconds to pins 5 and 6 respectively. The motor is a 12V d.c motor which is powered directly by the BA6209N motor driver.

3.5.1 Motor driver (BA6209N)

The BA6209N is a reversible motor driver capable of driving brush and even a brushless motor. Two logic inputs allows three output modes; forward, reversing and breaking. The motor revolving speed can be set arbitrarily by controlling the voltage applied to the motor with the control pin *Vr*.

Features

- Power transistor can handle a large current (1.6a maximally).
- Brake is applied when stopping the motor.
- Built-in function to absorb rush current generated by reversing and braking.
- Motor speed control pin.
- Small standby current (Vcc= 12V, I=5.5mA typically).
- Stable operation during mode changes either from forward to reverse or vice versa.
- Interface with CMOS device.

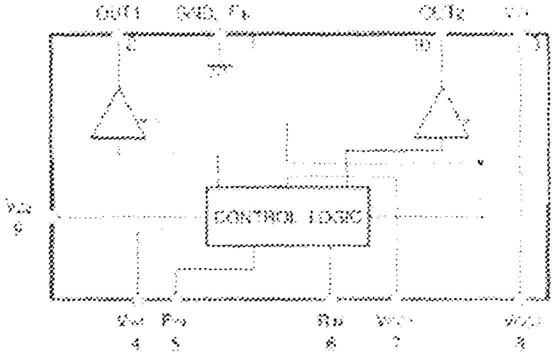


Fig 3.13 Block diagram of BA6209N

Table3.8 pin description of BA6209N

●Pin descriptions

Pin No.	Pin name	Function
1	GND	GND
2	OUT 1	Motor output
3	V_{Z1}	Capacitor connection pin for preventing both output transistors being turned on at the same time
4	V_R	Output HIGH voltage setting
5	F_{IN}	Logic input
6	R_{IN}	Logic input
7	V_{CC1}	Control circuit power supply
8	V_{CC2}	Output power supply
9	V_{Z2}	Capacitor connection for preventing both output transistors being turned on at the same time
10	OUT 2	Motor output

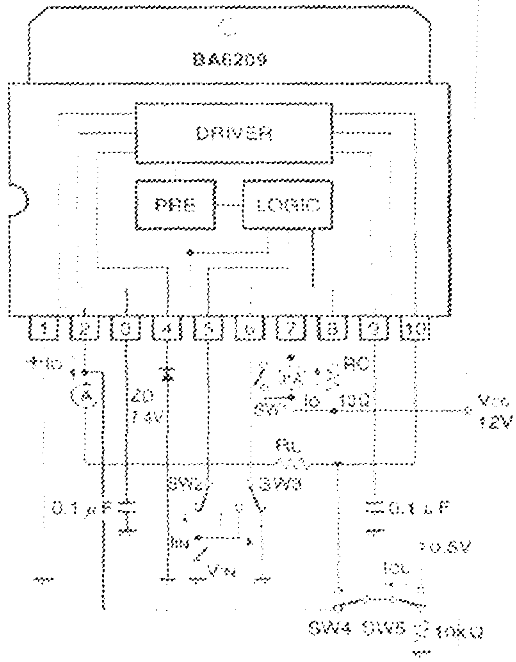


Fig 3.14 Measurement circuit of BA6209N

Table 3.9 Truth table of BA6209N

Input / output truth table

Input		Output	
F_{IN}	R_{IN}	OUT1	OUT2
L	L	L	L
H	L	H	L
L	H	L	H
H	H	L	L

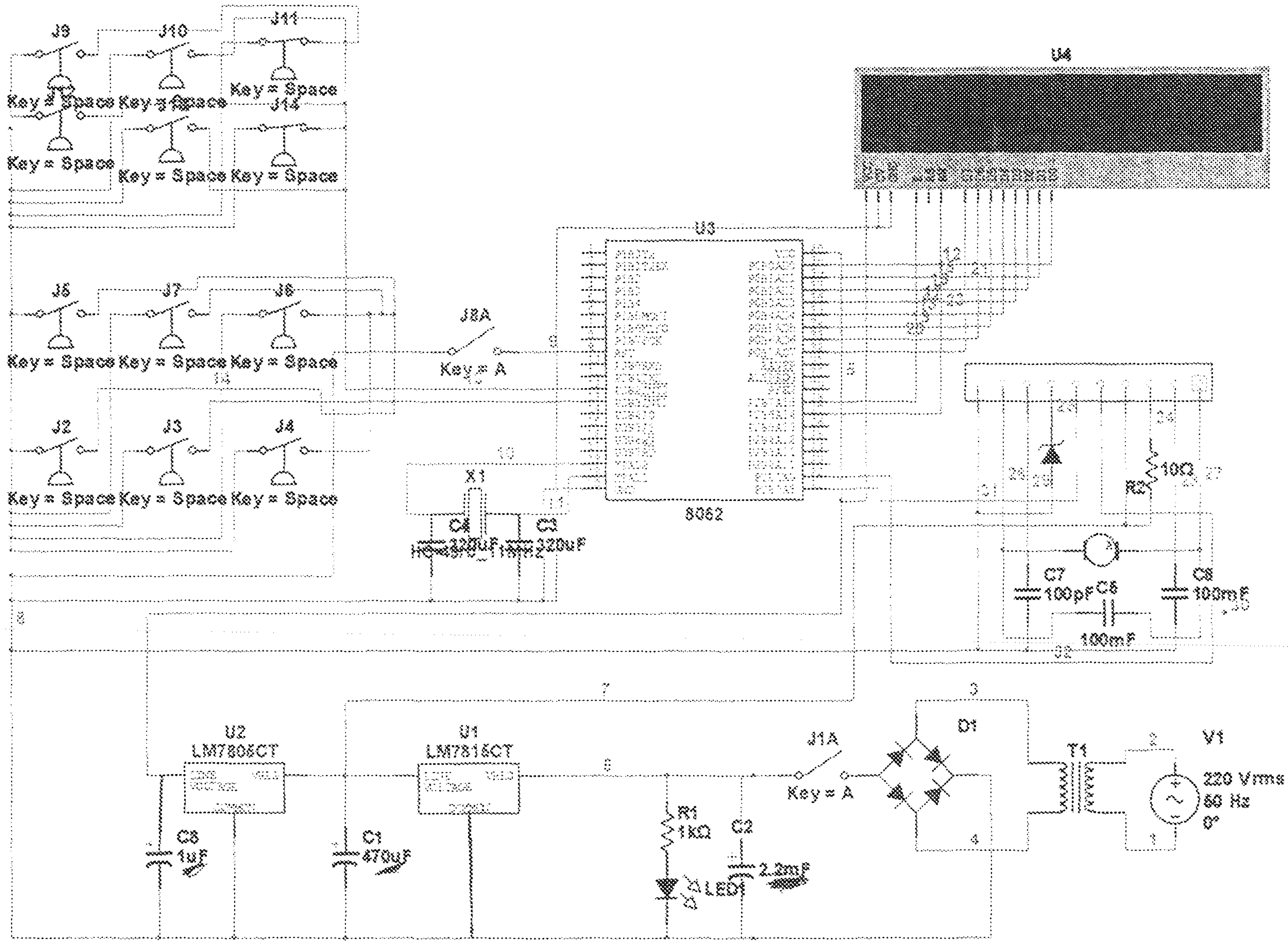


Fig. 3.15 complete circuit diagram

CHAPTER FOUR

TEST, RESULT AND DISCUSSION

4.1 TEST

The construction was done in units; the first involved the design and acquisition of the circuit diagram. To ease the construction procedure and troubleshooting, the circuitry was segmented into functional blocks. The circuit was first tested on a bread board but due to the complexity of realizing the circuitry, the work was fully shifted to a Vero board. After series of mistakes and series of adjustment on the circuitry, the final circuit was realized.

The Vero board was first scrapped with a razor blade for operation to encourage smooth and neat soldering of the component on the board. Numerous changes were made on the initial proposal to obtain effective result. This was followed by the final construction. On completion of the construction, a thorough test and assessment of the component connection were carried out.

The following steps were followed;

- Continuity and the connectivity test were taken using a multimeter while the circuit was not powered and the various pin layouts well mounted on board.
- The construction was tested module by module
- Measurement of the capacitance current, resistance and voltage were taken and compared with designed values

- The programmed microcontroller was not verified with the circuit at the stage of testing until the final testing. But a simulator was used to study the program behavior. In the simulator, a lamp was used to indicate the state of the expected output from the microcontroller to the motor driver. The forward motion was observed to work in the exact mode in which it was programmed in accordance to direction of traffic. Additionally, the time delay for each indication was equally noticed to function in the exact time duration for each instance and the LCD displayed the expected display with its time duration.
- A general package was fitted into each module after which, the microcontroller was plugged into its socket for the real sight view to observe the operation of the motor motion.
- At power up the LCD displayed OPEN HOUR, YOU ARE WELCOME. This lasted for duration of three minutes during which the entrance and exit motion was tested and found to function. After the three minutes was over, the LCD was observed to display BYE CLOED HOUR during which only exit motion was allowed which corresponds to the algorithm written into the microcomputer.

4.2 RESULT

EVENT	DURATION	EVENT	DURATION
Normally open hour	4minutes	Normally open hour	4minutes
Normally closed hour	8minutes	Normally closed hour	8minutes
Forward motion speed	3seconds	Forward motion speed	3seconds
Reverse motion speed	3seconds	Reverse motion speed	3seconds
Pulse motor	1seconds	Pulse motor	1seconds
Entrance emergency	within 3seconds	Entrance emergency	within 3seconds

Exit emergency within 3seconds	Exit emergency within 3seconds

4.3 DISCUSSION OF RESULT

At power up, the display module indicated the status of the code and each section of this code was monitored. The floor mats were activated and the expected duration of the motor motion was carefully calculated and noted. This however correlated with the time span programmed in the control module.

Similarly, the entrance and exit emergency control were activated and found to conform to the programmed duration as well as its necessary action to be executed. The normal closing hour duration was strictly monitored and found to conform to the programmed duration within which the entrance floor mat was automatically deactivated.

Generally, the programmed values were found to conform to experimented values with a very precise real time clocking system.

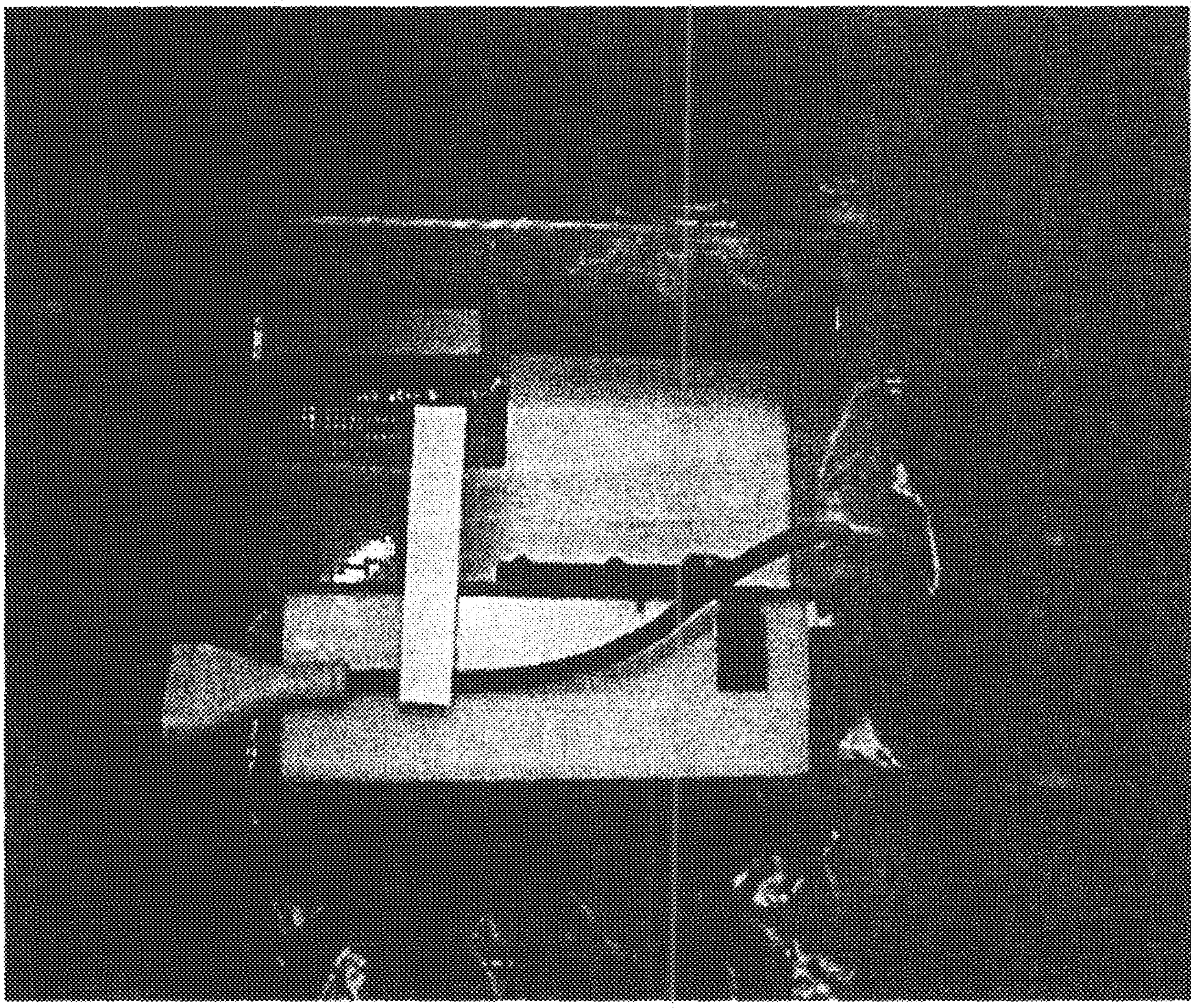
4.4 PROBLEMS ENCOUNTERED

Selecting an input for the input module was a big problem at first since constructing a prototype of a load cell is required as the input signal. Finally however, a floor mat was designed.

After the program for the project was written, programming the chip to the design specification became a difficult task. Logical errors were discovered in the program and were ascertained to be the reason why the program could not work. Also, subroutines were

4.5 CASING

The casing for the project was designed with a transparent plastic with dimension 40cm by 28cm by 16cm. the door was designed with a wooden frame with dimension 1cm by 28cm by 14cm . it was suspended on a flat surface connected to the motor through a tightly fitted adhesive.



CHAPTER FIVE

5.1 CONCLUSION

The project was carried out and tested to conform to the design analysis of the circuitry and the program indicating a successful project. The casing was constructed to fit the desired illustration of a one way slide door. The timing features of the circuit performed to expectation. It allowed for the coordination of the door. The real time clocking system was practically exhibited by the display module; four minutes open hour and eight minutes closed hour was display to demonstrate the program embedded in the microcontroller within which the expected condition of functioning was exhibited.

The project exposed me to more electronics and their application. It is indeed a demonstration of the acquired experience and knowledge in the course of my study in the university.

5.2 RECOMMENDATION

Intelligent door controller finds its application in various areas of life. Any one who would want to work on this project can develop into:

i. A security device by incorporating an intruder alarm unit.
ii. An overweight detector with the aid of an analogue/digital converter.
iii. An embedded system in a small personal computer unit.

5.3 PRECAUTION

- During the bread boarding, it was ensured that the microcomputer was not inserted into the circuitry to prevent any form of damage to the microcomputer.
- In programming the microcomputer, it was ensured that the proper manner of inserting the chip into the programmer was ensured
- The Vero board was properly scrapped before any form of soldering was made on it to ensure firm and neat soldering.
- Continuity test was carried out on each component before they were soldered on the Vero board to ensure safety of component and to confirm polarity where needed
- The circuit diagram was strictly followed to avoid wrong connection and also to avoid short circuiting.
- After all connections and soldering were made, continuity was carried out and likely faults were rectified to prevent short circuiting.

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APPENDIX

Asembly language code for an intelligent door controller with display incorporated.

```
INCLUDE 89C51.MC
;***************************

;***************************

;DESIGNED_BY: IKUESAN RICHARD
ADEYEMI

;MATRIC. NUMBER: 2003|15381EE

;PROJECT: INTELLIGENT DOOR
CONTROLLER INCORPORATED:
ASSSEMBLER:BATRONIX PROG_STUDIO

; SUPERVISOR: ENG'R ABOLARINWA J.A

;************************

;*****************************

; DEFINITIONS

;***************************

LCD_PORT EQU P0

LCD_rS BIT P2.7

LCD_EN BIT P2.6

motor_Dx1 BIT P2.3

motor_Dx2 BIT P2.2

EMG_IN BIT P2.0

EMG_OUT BIT P2.1

;*****************************

STACK EQU 60

;*****************************

;BIT ADDRESSES

;*****************************

4_sEC_DONE BIT 00H

8_SEC_DONE BIT 01H

;*****************************

;ADDRESS LOCATION

;*****************************

COUNT1 DATA 09H

COUNT2 DATA 0AH

COUNT3 DATA 0BH

COUNT4 DATA 0CH

count5 DATA 0dh

count6 DATA 0eh

;*****************************

;*****************************

;VECTOR INTERRUPT ADDRESS

;*****************************

;*****************************

ORG 0000H

LJMP START_UP

;***************************

ORG 0003H
```

```
LJMP ENTRANCE_ISR
;***************************
ORG 000BH
LJMP GET_TIME
;***************************
ORG 0013H
LJMP EXIT_ISR
;***************************
ORG 0030H
START_UP:        CLR EA
                 MOV SP,#STACK
                 ACALL SYS_INIT
;*****************************
MAINLOOP:        call show_msg3
chk_1:      JBC 4_sEC_DONE,
NO_ENTRY
                 JMP chk_1
;******************************
NO_ENTRY:        CLR ex0
                 ACALL
show_no_entry
                 JNB 4_Sec_done,$
                 CLR 4_sec_done
                 JNB 4_sec_done,$
                 CLR 4_Sec_done
                 SJMP START_UP
;**********************************
show_no_entry:       MOV
DPTR,#no_entry_msg
                     call write_string
                     call write_string
                     call long_delay
                     call long_delay
                     call write_String
                     call write_String
                     call long_delay
                     call long_delay
                     RET
;????????????????????????????????????
??????????????????????????????

no_entry_msg:        DB
01h,80h,"...UNDERSTAND...
",0,0C0H,0C0H,"GOD CARES FOR U  ",0
ID_MESSAGE7:    DB 01H,80H,"... SORRY
NO... ",0,0C0H,0C0H,"ENTRANCE
ANYMORE..."
;????????????????????????????????????
?????????????????????????????/
show_msg3:           MOV DPTR,#id_3
                     call write_String
                     call write_String
                     call long_Delay
                     call long_delay
```

```
                call write_String
                call write_String
                call long_delay
                call long_delay
                RET
;*******************************

id_3:   DB 01h,80h," DO YOU KNOW ",0,0C0H,0C0H,"GOD LOVES YOU... ",0
id_6:   DB 01H,80H," STILL OPEN ",0,0C0H,0C0H," COME IN PLEASE ",0
;**********************************

SYS_INIT:       MOV TCON,#00000101B
                MOV TMOD,#00000010B
                MOV TH0,#06H
                MOV TL0,#06H
                MOV IE,#00000111B
                CLR 4_sEC_DONE
                CLR LCD_rS
                MOV R0,#250
                MOV R1,#240
                MOV R2,#16
                ACALL INIT_LCD
                SETB tr0
                SETB ea
                ACALL show_id
                RET
;**********************************
INIT_LCD:       MOV A, #38h
                ACALL write_lcd_cmd
                MOV R0,#10
delay_Again:    ACALL dly_2ms
                DJNZ R0, delay_again
                MOV A, #38h
                ACALL write_lcd_cmd
                ACALL dly_100us
                MOV A,#38h
                ACALL write_lcd_cmd
                ACALL dly_100us
                MOV A,#38h
                ACALL write_lcd_cmd
                ACALL dly_100us
                MOV A,#0fh
                ACALL write_lcd_cmd
```

```
            ACALL dly_100us
            MOV A,#01h
            ACALL write_lcd_cmd
            ACALL dly_2ms
            MOV A,#06h
            ACALL write_lcd_cmd
            ACALL dly_2ms
            RET
;*********************************
write_String:       CLR A
            MOVC A,@a+dptr
            ACALL write_lcd_cmd
            ACALL dly_2ms
            CLR A
            INC DPTR
            MOVC A,@a+dptr
            ACALL write_lcd_cmd
            ACALL dly_2ms
write_String_lp:    CLR A
            INC DPTR
            MOVC A,@a+dptr
            JZ exit_Write_string
            ACALL write_lcd_Data
            ACALL dly_100us
            SJMP write_String_lp
exit_write_string:  INC DPTR
            RET
;*****************************
Dly_2ms:            MOV R7,#0
dly_2ms_lp:         NOP
            NOP
            NOP
            NOP
            NOP
            NOP
            NOP
            NOP
            NOP
            NOP
            NOP
            NOP
            DJNZ R7,dly_2ms_lp
            RET
;*********************************
```

```
dly_100us:      MOV R7,#50
                DJNZ R7,$
                RET
;********************************
long_Delay:         MOV R6,#0
long_delay_lp:      ACALL dly_2ms
                    DJNZ R6,
long_delay_lp
                    RET
;********************************
write_lcd_cmd:      MOV lcd_port, A
                    CLR lcd_rs
                    CLR lcd_en
                    SETB lcd_en
                    CLR lcd_En
                    ACALL dly_2ms
                    RET
;********************************
write_lcd_data:         MOV
lcd_port, A
                    SETB lcd_rs
                    CLR lcd_en
                    SETB lcd_en
                    CLR lcd_en
                    ACALL dly_100us
                    RET
;********************************
ENTRANCE_ISR:       JB 4_SEC_DONE,
EXIT_ENTRANCE_ISR
                    CALL DOOR_OPEN
EXIT_ENTRANCE_ISR:RETI
;********************************
EXIT_ISR:           CALL door_OPEN
                    RETI
;********************************
id_message:         DB 01H,80H," YOU
WELCOME ",0,0C0H,0C0H," OPEN
HOUR. ",0
ID_MESSAGE2:        DB 01H,80H,"
2003/15381EE ",0,0C0H,0C0H," IKUESAN
ADEYEMI ",0
ID_MESSAGE3:        DB 01H,80H,"
SUPERVISOR ",0,0C0H,0C0H,"ENG'R
ABOLARINWA ",0
;********************************
SHOW_ID:            MOV
DPTR,#id_message
                    ACALL write_String
                    ACALL write_String
                    ACALL long_delay2
                    MOV
DPTR,#id_message2
                    ACALL write_String
                    ACALL write_String
                    ACALL long_delay2
```

```
                        MOV DPTR,#id_message3
                        ACALL write_String
                        ACALL write_String
                        ACALL long_delay2
                        RET
;**********************************
;**********************************
id_messageC:        DB 01H,80H,"BYE
CLOSED HOUR ",0,0C0H,0C0H,"HAVE A
NICE REST ",0
ID_MESSAGE4:        DB 01H,80H,"
2003/15381EE  ",0,0C0H,0C0H," IKUESAN
ADEYEMI ",0,
;*****************************
;*****************************
SHOW_DISPLAY2:    MOV
DPTR,#id_messageC
                        ACALL write_String
                        ACALL write_String
                        ACALL long_delay2
                        MOV
DPTR,#id_message4
                        ACALL write_String
                        ACALL write_String
                        ACALL
LONG_DELAY2
                        RET
;??????????????????????????????
????
GET_TIME:               DJNZ R0,
EXIT_TF0_ISR
                        MOV R0,#250
                        DJNZ R1,EXIT_TF0_ISR
                        MOV R1,#240
                        DJNZ R2,
EXIT_TF0_ISR
                        MOV R2,#16
                        SETB 4_sEC_DONE

EXIT_TF0_ISR:  RETI
;**********************************
DOOR_OPEN:                  SETB
motor_Dx1
                        CLR motor_Dx2
                        CALL DELAY3
                        SETB motor_Dx2
                        CALL COUNTER1
                        CLR motor_Dx1
                        CALL DELAY3
                        CLR motor_Dx2
                        RET
;**********************************
AUTO_1:
                        CLR motor_Dx1
                        CALL LIT2
                        SETB motor_Dx2
```

```
        CALL LIT1
        CPL motor_Dx2
        CALL LIT2
        SETB motor_Dx1
        CALL COUNTER1
        RET
;*******************************
AUTO_2:
        CLR motor_Dx2
        CALL LIT1
        SETB motor_Dx1
        CALL LIT1
        CPL motor_Dx1
        CALL LIT1
        SETB motor_Dx2
        CALL LIT1
        CPL motor_Dx2
        CALL COUNTER1
        RET
;*********************************
DELAY2:
LIT0:   MOV count6, #03
        CALL LIT1
        DJNZ count6, LIT0
        RET
;*********************************
LIT1:
                MOV count5, #250
                CALL LIT2
                CALL LIT2
                CALL LIT2
                CALL LIT2
                DJNZ count5, LIT1
                RET
;*********************************
LIT2:
                MOV count4, #250
                NOP
                NOP
                DJNZ count4, LIT2
                RET
;*********************************
DELAY3:
COUNT_0:        MOV count3, #01
                CALL COUNTER1
                JNB EMG_IN,
AUTO_1
                JNB EMG_OUT,
AUTO_2
                CALL COUNTER1
                DJNZ count3,
COUNT_0
```

```
        RET
;*********************************
COUNTER1:
        MOV count2, #250
        CALL COUNTER2
        CALL COUNTER2
        CALL COUNTER2
        CALL COUNTER2
        DJNZ count2,
COUNTER1
        RET
;*********************************
COUNTER2:
        MOV count1, #250
        NOP
        NOP
        DJNZ count1,
COUNTER2
        RET
;*********************************
long_Delay2: ACALL long_Delay
        ACALL long_Delay
        ACALL long_Delay
        RET

END
```