PRE-PAID ELECTRICITY CARD

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CERTIFICATE

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CONTENTS

CONTENTS

ACKNOWLEDGEMENT

I. ACKNOWLEDGEMENT

We are highly privileged to thank **Dr.K.K.PADMANABHAN, B.Sc(Engg).,M.Tech.,Ph.D.,** Principal, Kumaraguru college of Technology for allowing us to do this project.

We are highly indebted to **Dr.T.M.Kameswaran B.E,MSc(Engg).,Ph.D, Sr.M.I.E.E.E, MISTE, F.I.E** who wholly encouraged us and kindly agreed to our request for using the various college facilities.

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We shall be failing in our duty if we do not thank all the department staffs , lab technicians and our friends for having encouraged us and supported us morally while doing the project

Finally we thank one and all who co-operated with us in bringing out this project successfully.

SYNOPSIS

II. SYNOPSIS

Our project is mainly concerned with the programming of the microcontroller which has to be programmed in such a way that the number of units required by the consumer is stored in the EEPROM. The implementation started with the study of microcontrollers and searching for a suitable microcontroller for our project.

We chose the PIC microcontroller , since the number of instructions to be studied are less and programming is easy. The EEPROM we used in our project is the internal EEPROM whose memory capacity is 64 bytes and is sufficient.

The microcontroller is also interfaced with the 7447 IC -BCD to seven segment display so that the number of units are displayed as and when consumed, so that the consumer is aware of the number of units being used.

A relay is used in our project to start the energymeter when supply comes in and switch it off when no more units are remaining. A buzzer is also used to give an indication that the number of units are six i.e almost over and that the consumer should reprogram the microcontroller again.

INTRODUCTION

1.INTRODUCTION

This project deals with making electricity bill payment a more sophisticated and time saving one. Here we make use of prepaid energy consumption technique , which is inspired from the cellular phone. Here we make use of microcontrollers for programming the card. An EEPROM is made use of in designing the card.

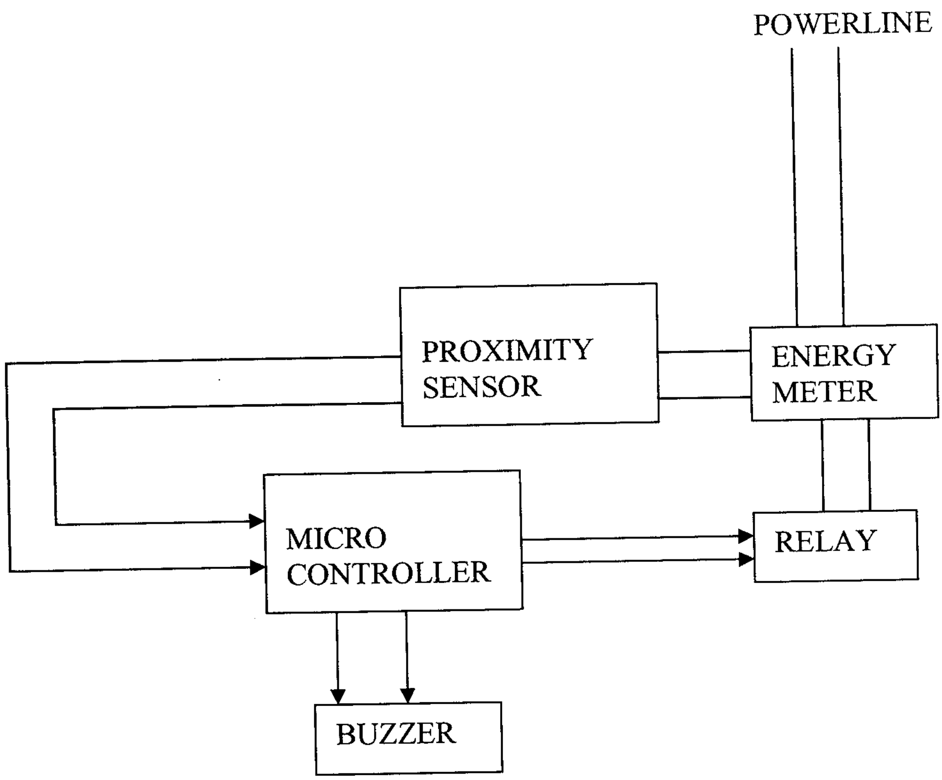
Consumers can make use of the energy for the period for which they have paid while buying the card. After which they can activate the card by reprogramming it. This can be done only when the amount is paid.

Through this project we are making the consumers aware of the number of units being consumed by displaying it with the help of BCD to seven segment display which is interfaced with the microcontroller. This will make them save energy as much as possible.

Saving of Energy is very essential because " Energy saved is twice the energy consumed ".

BLOCK DIAGRAM

2.1 BLOCK DIAGRAM:



2.2 WORKING:

The microcontroller we are using in our project is the PIC microcontroller 16F84. It has two ports , port A and port B. We are using only port A, which has five I/O pins. Port B has eight I/O pins. Three pins of port A are being used ,one for sensing the signal , the other one for warning and the final one for switching on and off the relay. The remaining two pins of port A are unused.

Initially the microcontroller is programmed and the number of units are stored in the EEPROM. The EEPROM , we are using here is the internal EEPROM of the PIC microcontroller, whose memory capacity is 64 bytes. When a signal comes from the Electricity board , the relay which is in the normally open mode gets switched on and the energymeter starts working.

The proximity sensor will sense the pulses and a count is kept of the number of revolutions. A voltage follower is connected to the signal of the proximity sensor so that the output will follow the input. The EEPROM will read the number of units stored initially. When the number of revolutions are ten, one unit is consumed and the microcontroller is programmed to decrease one unit. The EEPROM will now write the number of units after decrementing one unit. The number of units are displayed by interfacing the microcontroller to the BCD to seven segment display.

This process is repeated for the remaining units. When the number of units are reduced to six, the buzzer will start working, and will go on until the card is loaded again. When the number of units are reduced to zero, the relay gets switched off automatically and the energymeter stops working and will not work until a signal is given to the microcontroller. The buzzer also get switched off when all the units are consumed.

The EEPROM can be reprogrammed again for any number of units depending on the consumer's requirement. The coding will remain the same , only the memory of the EEPROM has to be loaded again, depending on the requirement of the consumer.

Thus once the microcontroller is programmed, the process is very simple and makes the consumer cautious of the number of the units being used, as he is aware of the number of units remaining . So, the consumer will try to save electricity as much as possible.

ENERGY METER

CHAPTER 3

3.1 ENERGYMETER

Energy is the total power delivered or consumed over a interval of time, that is,

Energy=power*time.

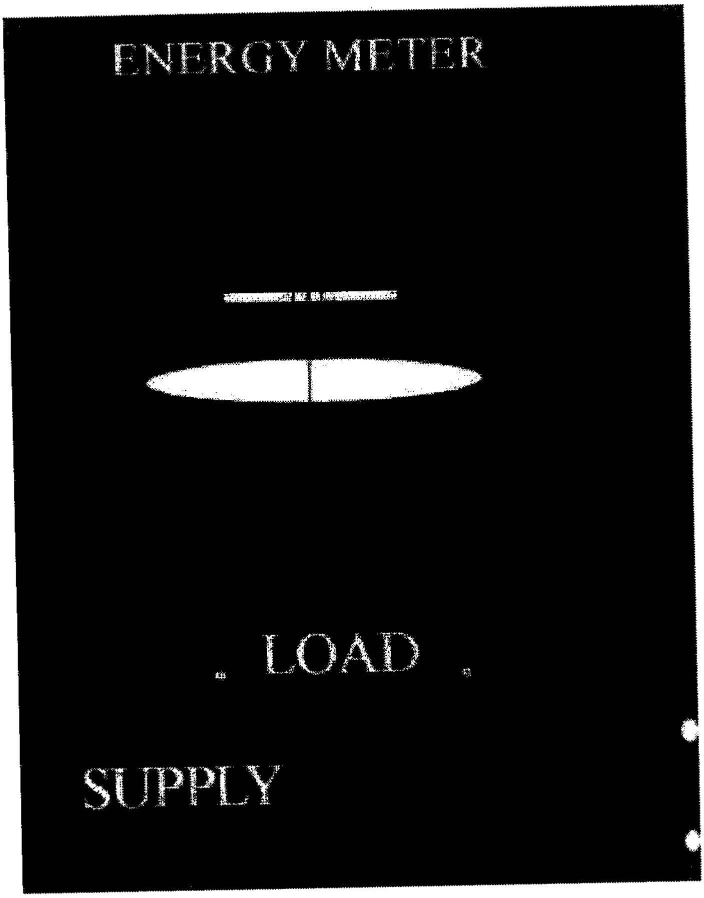
Energy meters are used for measurement of energy in both D.C. and A.C. circuits. For D.C. circuits ,the meter may be an ampere-hour meter or watthour meter. We here deal with A.C.meter for house-hold consumers. Single-phase induction meter is used in this project.

3.2 CONSTRUCTION:

The construction of energymeter varies in details of one manufacturers products to the other.

The four main parts of the operating mechanism:

I) Driving system
II) Moving system
III) Braking system
IV) Registering system



Driving system:

The driving system of the meter consists of two electromagnets. The core of these electromagnets is made up of silicon steel stamping. The coil of one of the electromagnets is excited by load current. The coil is called current coil. The coil of second electromagnet is connected across the supply and, therefore carries a current proportional to the supply voltage . This coil is called the pressure coil. Consequently two electromagnets are known as series and shunt magnets respectively.

Copper shading bands are provided on the central limb. The position of these bands is adjustable. The functions of these bands is to bring the flux produced by the shunt magnet exactly in quadrature with the applied voltage.

Moving system:

This consists of an aluminium disc mounted on a light alloy shaft. This disc is placed in the air gap between series and shunt magnets. The upper bearing of the rotor is asteel pin located in a hole in the bearing cap fixed to the top of the shaft. The rotor runs on a hardened steel pivot ,screwed to the foot of the shaft. The pivot is supported by a jewel bearing . A pinion engages the shaft with the counting or registering mechanism.A unique design of the suspension of disc is used in floating-shaft energymeter.

Here the rotating shaft has a small magnet at each end , where the upper magnet of the shaft is attracted to a magnet in upper bearing and the lower magnet of the shaft is attracted to a magnet in the lower bearing. The moving system thus floats without touching either bearing surface, and the only contact with the movement is that of the gear connecting the shaft with the gear of the train, thus the friction is drastically reduced.

Braking system:

A permanent magnet positioned near the edge of the aluminium disc forms the braking system. The aluminium disc moves in the field of this magnet and thus provides a braking torque. The position of the permanent magnet is adjustable , and therefore, braking torque can be adjusted by shifting the permanent magnet is adjustable, and therefore different radial positions.

Registering (counting) mechanism:

The function of registering system is to record continuously a number which is proportional to the revolutions made by the moving system. By a suitable system a train of reduction gears the pinion on the rotor shaft drives a series of 5 or 6 pointers. These rotates on a round dials which are marked with 10 equal divisions. The types used are:

1. Pointer type register
2. Cyclo meter register

3.3 Theory and Operation:

The supply voltage is applied across the pressure coil. The pressure coil winding is highly inductive as it has very large number of turns and the reluctance of its magnetic circuit is very small owing to presence of air gaps of very small length. Thus the current through the pressure coil is proportional to the supply voltage and lags it by a few degrees less than 90 degrees. This is because the winding has a small resistance and there are iron losses in the magnetic circuit.

Current produces a flux. This flux divides itself into two parts. The major portion flows across the side gaps as reluctance of this path is small. This flux goes across aluminium disc and hence is responsible for production of driving torque. Flux is in phase with current and is proportional to it. Therefore flux is proportional to voltage and lags it by an angle few degrees less than 90 degree. Since flux is alternating in nature, it induces an eddy emf in the disc which in turn produces eddy current.

The load current flows through the current coil and produces a flux and this flux is proportional to the load current and is in phase with it. This flux produces an eddy current in the disc. Now the eddy current interacts with flux which produces a torque and eddy current which interacts with other flux and produces another torque. These two torques are in opposite in direction and the net torque is difference of these.

3.3 Errors in Single Phase Energy Meters:

1.Incorrect Magnitude of Fluxes:

This may be due to abnormal values of current or voltage.The shunt magnet flux may be in error due to changes in resistance of the coil or due to abnormal frequencies.

2.Incorrect Phase Angles:

There may not be proper relationship between the various phasors.This may be due to improper lag adjustments, abnormal frequencies, change in resistance with temperature etc.

3.Lack of symmetry in Magnetic Circuit:

In case the magnetic circuit is not symmetrical, a driving torque is produced which makes the meter creep.

The errors caused by the braking system are:

a. changes in strength of brake magnet

b. changes in disc resistance

c. abnormal friction of moving parts.

3.4 Adjustments in Single Phase Energy Meters:

Some adjustments are carried out in energy meters so that they read correctly and their errors are within allowable limits. The sequence of these adjustments is:

1. **Preliminary Light Load Adjustment**

   The disc is so positioned that the holes are not underneath the electromagnets. Rated voltage is applied to the potential coil with no current through the current coil. The light load device is adjusted until the disc just fails to start.

2. **Full Load Unity Factor Adjustment**

   The pressure coil is connected across the rated supply voltage and rated full load current at unity power factor is passed through the current coils. The position of the brake magnet is adjusted to vary the braking torque so that the meter revolves at the correct speed within required limits of error.

3. **Lag Adjustment :**

   The pressure coil is connected across rated supply voltage and rated full load current is passed through the current coil of 0.5 power factor lagging.The lag device is adjusted till the meter runs at correct speed.

4. With rated supply voltage, rated full load current and unity power factor ,the speed of the meter is checked and full load unity power

factor and low p.f adjustments are repeated until the desired accuracy limits are reached for both the conditions.

5. **Light Load Adjustment**

Rated supply voltage is applied across the pressure coil and a very low current (about 5 percent of full load) is passed through the meter at unity power factor. The light load adjustment is done so that the meter runs at correct speed.

6.Full load unity power factor and light load adjustments are again done until speed is correct for both loads i.e full load as well as light load.

7.The performance is rechecked at 0.5 p.f lagging.

8. **Creep Adjustment**

As a final check on light load adjustment , the pressure coil is excited by 110 percent of rated voltage with zero load current. If the light load adjustment is correct , The meter should not creep under these conditions.

5.5 Tariffs:

The rating of a power generating plant must be equal to the simultaneous maximum demand it has to meet. This means that a fixed sum proportional to the maximum demand to be met has to be spent for the plant required. This type of expenses which include the cost of plant, buildings, transmission and distribution equipment, part of staff salaries are called **"Fixed Charges".** In addition to the above , expenses have to be incurred for fuel and also for maintaining the plant .These expenses are proportional to the number of units generated and are called **"Running Charges".**

Thus if the total cost of electric supply is to be shared equitably by various consumers, every consumer should pay a fixed sum proportional to the maximum demand in addition to a sum proportional to the energy consumed. Consumers should be encouraged to draw power at high power factors because a system working at low power factor has the following

Disadvantages:

a. Cost of power station and distribution equipment is more for low power factor loads.
b. Low power factor makes the regulation poor so that it becomes increasingly difficult to maintain the supply voltage within specified limits.
c. The current drawn from the supply by low power factor loads is high. Therefore the loss in the cables, lines and other equipment will be higher at lower power factors.

Tariffs for industrial users should take the above factors into account. There are various types of tariffs which try to balance the costs incurred with the nature of the consumers load. Some of the Industrial tariffs are:

1. Kilo Watt-Hour Tariff

The most straight forward but not the most usual form , is a charge per kilowatt-hour consumed. Thus the consumers bill is directly proportional to the energy used. It is also known as "Flat Rate" charge.

2. Maximum Demand Tariff

It is a two part tariff. The total charges are divided into two parts, one being simple charge per kilowatt-hour of energy consumed with another fixed charge which is based upon the maximum demand. The maximum demand is actually the average over a predetermined period of time. The period is usually 15 to 30 minutes.

3. Power Factor Tariffs

They are devised to make a distinction between overall charge to be recovered from 2 types of consumers

i) those having good power factors (who should be charged less)

ii) those having poor power factors (who should be charged more)

The Flat rate tariff for Domestic Consumers is as follows:

UNITS	CHARGE (Rs)
0-50	0.75
51-100	0.85
101-200	1.50
201-600	2.20
Above 600	3.05

For Industrial consumers , the tariff is fixed at Rs five/unit. The tariff varies for other consumers and is not constant.

PIC Microcontrollers

CHAPTER 4

PIC Microcontrollers 16F84

4.1 GENERAL DESCRIPTION:

All PICmiro™ microcontrollers employ an advanced RISC architecture.PIC16F84 has enhanced core features, eight–level deep stack, and multiple internal and external interrupt sources. The instruction and data buses of the Harvard structure allow a 14 bit wide instruction word with a separate 8-bit wide databus. The two stage instruction pipeline allows all instruction s to execute in a single cycle, except for program branches,which require two cycles. A total of 35 instructions (reduced instruction set) are available. Additionally, a large register set is used to achieve a very high performance level.

PIC16F84 microcontrollers typically achieve a 2:1 code compression and upto a 4:1 speed improvement (at 20 MHz)over other 8-bit microcontrollers in their class. It has upto 68 bytes of RAM ,64 bytes of data EEPROM,and 13 I/O pins . A timer/counter is also available.

The PIC family has special features to reduce external components thus reducing cost enhancing system reliability and reducing power consumption.There are four oscillator options,of which the single Rc pin oscillator which minimizes power consumption .A highly reliable Watch Dog Timer with its own on chip RC oscillator provides protection against software lock-up.

The devices with Flash memory allow the same device to be used for prototyping and production.In-circuit reprogrammability allows the code to be updated without the device from being removed from the end application,where the device may not be easily accessible,but the prototypes may require code updates.

The PIC16F84 fits perfectly in applications ranging from high speed automotive and application motor control to low power remote sensors, electronic locks, security devices and smart cards. The Flash/EEPROM technology makes customization of application programs extremely fast and convenient. The small footprint packages make this microcontroller series perfect for all applications with space limitations. Low-cost, high-performance , ease-of-use and I/O flexibility make the 16F84 very versatile even in areas where no microcontroller has been considered before. The serial in system programming feature offers flexibility of customizing the product after complete assembly and testing.This feature can be used to serialize a product, store calibration data or program the device with the current firmware .

High performance RISC CPU features:

- Only 35 single word instructions to learn
- All instructions single cycle except for program branches which are two cycle
- Operating speed-DC-10MHZ clock input

DC-400ns instruction cycle

- 14 bit wide instructions
- 8 bit wide data pattern
- 15 special function registers
- 8 level deep hardware stack
- Four interrupt sources:External RB0/INT pin,TMR0 overflow ,Port B interrrupt on change,Data EEPROM write complete
- EEPROM data retention > 40 years.
- 10,000,000 erase/write cycles EEPROM data memory.

4.1.1 PERIPHERAL FEATURES:

- High current sink/source for direct LED drive-25ma sink max per pin 20ma source max per pin
- TMR0:8 bit timer/counter with 8 bit programmable prescalar
- Watch dog timer with its own on chip RC oscillator for reliable operation
- Code protection.
- Power saving SLEEP mode.

4.1.2 FLASH DEVICES:

These devices are offered in the lower cost plastic package even though the device to be used for prototype development and pilot programs are well as production.A further advantage of the electrically erasable Flash version is that it can be erased and reprogrammed in circuit or by the device programmers such as microchips pic start plus or promate 2 programmers.

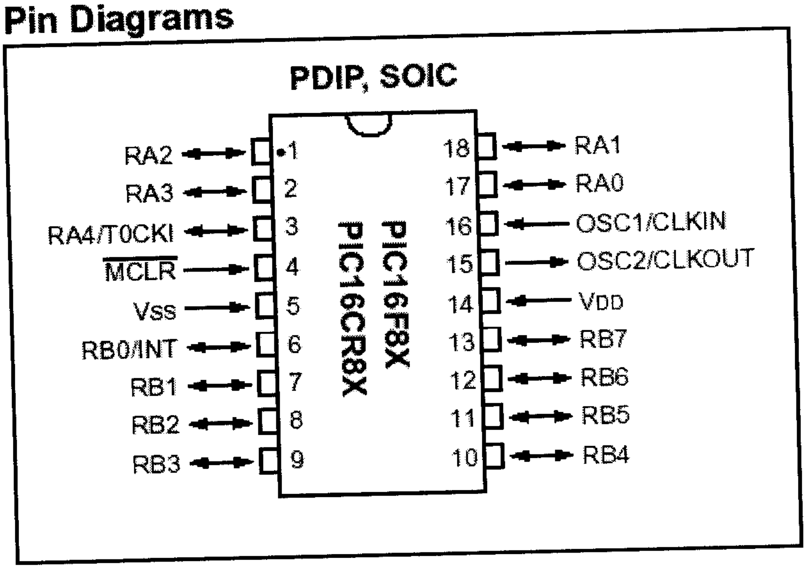
4.2 ARCHITECTURAL OVERVIEW:

To begin with, the PIC16F84 uses a Harvard architecture. This architecture has the program and data accessed from separate memories. So the device has a program memory bus and a data memory bus. This improves bandwidth over traditional von Neumann architecture where program and data are fetched from the same memory (accesses over the same bus). Separating program and data memory further allows instructions to be sized differently than the 8-bit wide data word. PIC16CXX opcodes are 14-bits wide, enabling single word instructions. The full 14-bit wide program memory bus fetches a 14-bit instruction in a single cycle.

A two stage pipeline overlaps fetch and execution of instructions. Consequently, all instructions execute in a single cycle except for program branches. The PIC16F83 and PIC16CR83 address 512 x 14 of program memory, and the PIC16F84 and PIC16CR84 address 1K x 14 program memory. All program memory is internal. The PIC16CXX can directly or indirectly address its register files or data memory. All special function registers including the program counter are mapped in the data memory. An orthogonal (symmetrical) instruction set makes it possible to carry out any operation on any register using any addressing mode. This symmetrical nature and lack of 'special optimal situations' make programming with the PIC16CXX simple yet efficient. In addition, the learning curve is reduced significantly.

PIC16F84 devices contain an 8-bit ALU and working register. The ALU is a general purpose arithmetic unit. It performs arithmetic and Boolean functions between data in the working register and any register file. The ALU is 8-bits wide and capable of addition, Subtraction, shift and logical operations. Unless otherwise mentioned, arithmetic operations are two's complement in nature. In two-operand instructions, typically one operand is the working register (W register), and the other operand is a file register or an immediate constant. In single operand instructions, the operand is either the W register or a file register. The W register is an 8-bit working register used for ALU operations. It is not an addressable register.

Pin Diagrams



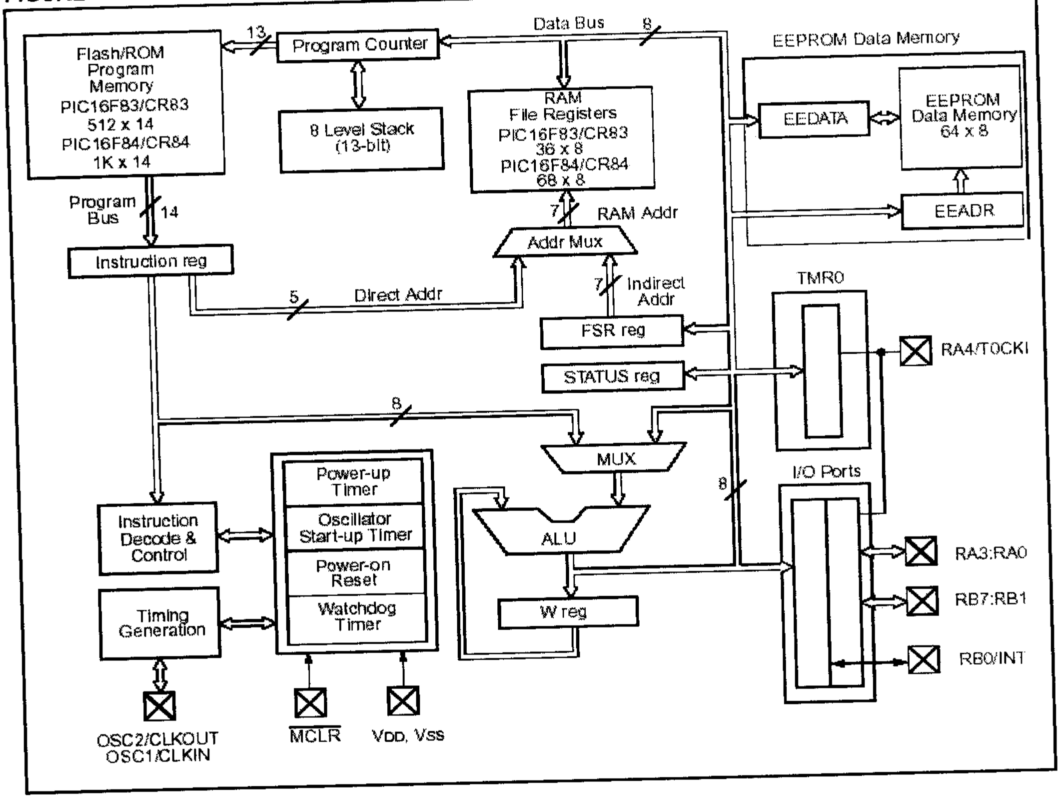
PINOUT DESCRIPTION

Pin Name	DIP No.	SOIC No.	I/O/P Type	Buffer Type	Description
OSC1/CLKIN	16	16	I	ST/CMOS (3)	Oscillator crystal input/external clock source input.
OSC2/CLKOUT	15	15	O	--	Oscillator crystal output. Connects to crystal or resonator in Crystal Oscillator mode. In RC mode, OSC2 pin outputs CLKOUT, which has 1/4 the frequency of OSC1 and denotes the instruction cycle rate.
MCLR	4	4	I/P	ST	Clear (Reset) input/programming voltage input. This pin is an active low RESET to the device.
RA0	17	17	I/O	TTL	. PORTA is a bi-directional I/O port
RA1	18	18	I/O	TTL	
RA2	1	1	I/O	TTL	
RA3	2	2	I/O	TTL	
RA4/T0CKI	3	3	I/O	TTL	Can also be selected to be the clock input to the TMR0 timer/counter. Output is open drain type
RB0/INT	6	6	I/O	TTL/ST(1)	PORTB is a bi-directional I/O port. PORTB can be software programmed for internal weak pull-up on all inputs .RB0/INT can also be selected as an external interrupt pin.
RB1	7	7	I/O	TTL	
RB2	8	8	I/O	TTL	
RB3	9	9	I/O	TTL	
RB4	10	10	I/O	TTL	Interrupt-on-change pin.
RB5	11	11	I/O	TTL	Interrupt-on-change pin.
RB6	12	12	I/O	TTL/ST(2)	Interrupt-on-change pin.Serial programming data.
RB7	13	13	I/O	TTL/ST(2)	Interrupt-on-change pin.Serial programming data.
VSS	5	5	P	--	Ground reference for logic and I/O pins.
VDD	14	14	P	--	Positive supply for logic and I/O pins.

Legend: I= input O = Output I/O = Input/Output P = Power
— = Not used TTL = TTL input ST = Schmitt Trigger input

Note 1: This buffer is a Schmitt Trigger input when configured as the external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured in RC oscillator mode and a CMOS input otherwise.

FIGURE 3-1: PIC16F8X BLOCK DIAGRAM



MEMORY ORGANIZATION:

There are two memory blocks in the PIC16F84. These are the program memory and the data memory. Each block has its own bus, so that access to each block can occur during the same oscillator cycle. The data memory can further be broken down into the general purpose RAM and the Special Function Registers.The operation of the SFRs that control the "core" are described here. The SFRs used to control the peripheral modules are described in the section discussing each individual peripheral module.The data memory area also contains the data EEPROM memory. This memory is not directly mapped into the data memory, but is indirectly mapped.That is, an indirect address pointer specifies the address of the data EEPROM memory to read/write. The 64 bytes of this memory have the address range 0h-3Fh..

4.3.1 PROGRAM MEMORY ORGANIZATION:

The PIC16FXX has a 13-bit program counter capable of addressing an 8K x 14 program memory space. For the PIC16F83 and PIC16CR83, the first 512 x 14 (0000h-01FFh) are physically implemented . For the PIC16F84 and PIC16CR84, the first 1K x 14 (0000h-03FFh) are physically implemented .

Accessing a location above the physically implemented address will cause a wraparound. For example, for the PIC16F84 locations 20h, 420h, 820h, C20h, 1020h, 1420h, 1820h, and 1C20h will be the same instruction. The reset vector is at 0000h and the interrupt vector is at 0004h.

4.3.2 DATA MEMORY ORGANIZATION:

The data memory is partitioned into two areas. The first is the Special Function Registers (SFR) area, while the second is the General Purpose Registers (GPR) area. The SFRs control the operation of the device. Portions of data memory are banked. This is for both the SFR area and the GPR area. The GPR area is banked to allow greater than 116 bytes of general purpose RAM. The banked areas of the SFR are for the registers that control the peripheral functions. Banking requires the use of control bits for bank selection. These control bits are located in the STATUS Register.

Instructions MOVWF and MOVF can move values from the W register to any location in the register file and vice-versa. The entire data memory can be accessed either directly using the absolute address of each register file or indirectly through the File Select Register (FSR). Indirect addressing uses the present value of the RP1:RP0 bits for access into the banked areas of data memory. Data memory is partitioned into two banks which contain the general purpose registers and the special function registers. Bank 0 is selected by clearing the RP0 bit (STATUS<5>). Setting the RP0 bit selects Bank 1. Each Bank extends up to 7Fh (128 bytes). The first twelve locations of each Bank are reserved for the Special Function Registers. The remainder are General Purpose Registers implemented as static RAM.

4.3.3 GENERAL PURPOSE REGISTER FILE :

All devices have some amount of General Purpose Register (GPR) area. Each GPR is 8 bits wide and is accessed either directly or indirectly through the FSR . The GPR addresses in bank 1 are mapped to addresses in bank 0. As an example, addressing location 0Ch or 8Ch will access the same GPR.

4.3.4 SPECIAL FUNCTION REGISTERS:

The Special Function Registers (Figure 4-1, Figure 4-2 and Table 4-1) are used by the CPU and Peripheral functions to control the device operation. These registers are static RAM. The special function registers can be classified into two sets, core and peripheral. Those associated with the core functions are described in this section. Those related to the operation of the peripheral features are described in the section for that specific feature.

4.4 I/O PORTS:

The PIC16F84 has two ports, PORTA and PORTB. Some port pins are multiplexed with an alternate function for other features on the device.

4.4.1 PORTA AND TRISA REGISTERS:

PORTA is a 5-bit wide latch. RA4 is a Schmitt Trigger input and an open drain output. All other RA port pins have TTL input levels and full CMOS output drivers. All pins have data direction bits (TRIS registers) which can configure these pins as output or input. Setting a TRISA bit (=1) will make the corresponding PORTA pin an input, i.e., put the corresponding output driver in a hi-impedance mode. Clearing a TRISA bit (=0) will make the corresponding PORTA pin an output, i.e., put the contents of the output latch on the selected pin. Reading the PORTA register reads the status of the pins whereas writing to it will write to the port latch. All write operations are read-modify-write operations. So a write to a port implies that the port pins are first read, then this value is modified and written to the port data latch. The RA4 pin is multiplexed with the TMR0 clock input.

Note: Similar performance is seen in the PORT B and TRIS B register

4.4.2 PRESCALAR:

An 8 bit counter is available as a prescalar for the timer module or as a post scalar for the watchdog timer.The prescalar is fully under software control ie it can be changed during program execution.It can be set to any ratio such that once prescalar is full the timer increments by one the prescalar becoming full depends on the ratio set by the user.

4.4.3 OSCILLATOR:

The PIC can operate in four oscillator modes.In the mode that we area adopting ie cthe XT mode a crystal is connected to the OSC1/CLKIN and OSC2/CLKOUT pins to establish oscillation.

4.4.4 RESET:

Of the different Reset options available in PIC family the option that we adopt is the POWER-ON -RESET mode of reset.

4.4.4.1 Power-on Reset (POR)

A Power-on Reset pulse is generated on-chip when VDD rise is detected .To take advantage of the POR, just tie the MCLR pin directly to VDD. This will eliminate external RC components usually needed to create Power-on Reset. A minimum rise time for VDD must be met for this to operate properly. When the device starts normal operation device operating parameters (voltage, frequency, temperature, ...) must be meet to ensure operation. If these conditions are not met, the device must be held in reset until the operating conditions are met., " Power-up Trouble Shooting." The POR circuit does not produce an internal reset when VDD declines.

4.5 INTERRUPTS:

The PIC16F84 has 4 sources of interrupt:

- External interrupt RB0/INT pin
- TMR0 overflow interrupt
- PORTB change interrupts (pins RB7:RB4)
- Data EEPROM write complete interrupt

The interrupt control register (INTCON) records individual interrupt requests in flag bits. It also contains the individual and global interrupt enable bits. The global interrupt enable bit, GIE (INTCON<7>) enables (if set) all un-masked interrupts or disables (if cleared) all interrupts. Individual interrupts can be disabled through their corresponding enable bits in INTCON register. Bit GIE is cleared on reset. The "return from interrupt" instruction, RETFIE, exits interrupt routine as well as sets the GIE bit, which re-enable interrupts.

The RB0/INT pin interrupt, the RB port change interrupt and the TMR0 overflow interrupt flags are contained in the INTCON register. When an interrupt is responded to; the GIE bit is cleared to disable any further interrupt, the return address is pushed onto the stack and the PC is loaded with 0004h. For external interrupt events, such as the RB0/INT pin or PORTB change interrupt, the interrupt latency will be three to four instruction cycles. The exact latency depends when the interrupt event occurs . The latency is the same for both one and two cycle instructions.

Once in the interrupt service routine the source(s) of the interrupt can be determined by polling the interrupt flag bits. The interrupt flag bit(s) must be cleared in software before re-enabling interrupts to avoid infinite interrupt requests.

4.5.1 INT INTERRUPT:

External interrupt on RB0/INT pin is edge triggered: either rising if INTEDG bit (OPTION_REG<6>) is set, or falling, if INTEDG bit is clear. When a valid edge appears on the RB0/INT pin, the INTF bit (INTCON<1>) is set. This interrupt can be disabled by clearing control bit INTE (INTCON<4>). Flag bit INTF must be cleared in software via the interrupt service routine before re-enabling this interrupt. The INT interrupt can wake the processor from SLEEP only if the INTE bit was set prior to going into SLEEP. The status of the GIE bit decides whether the processor branches to the interrupt vector following wake-up.

4.5.2 TMR0 INTERRUPT:

An overflow (FFh ® 00h) in TMR0 will set flag bit T0IF (INTCON<2>). The interrupt can be enabled/disabled by setting/clearing enable bit T0IE (INTCON<5>).

4.5.3 PORT B INTERRUPT :

An input change on PORTB<7:4> sets flag bit RBIF (INTCON<0>). The interrupt can be enabled/disabled by setting/clearing enable bit RBIE (INTCON<3>) .

4.5.4 CONTEXT SAVING DURING INTERRUPTS:

During an interrupt, only the return PC value is saved on the stack. Typically, users wish to save key register values during an interrupt (e.g., W register and STATUS register). This is implemented in software. The User defined registers, W_TEMP and STATUS_TEMP are the temporary storage locations for the W and STATUS registers values.

Example does the following:

a) Stores the W register.

b) Stores the STATUS register in STATUS_TEMP.

c) Executes the Interrupt Service Routine code

d) Restores the STATUS (and bank select bit) register.

e) Restores the W register.

4.6 ROLE OF PIC IN THE PROJECT:

The PIC microcontroller acts as the complete controlling unit of the whole set up. It gets the signal from the energy meter and does the following:

- ***It programs the EEPROM memory such that the number of units can be read and written.***
- ***It turns on the relay when a signal is given to the energy meter.***
- ***It turns on the buzzer to give an indication that the number of units remaining are six.***
- ***The microcontroller switches off the relay when all the units are consumed.***
- ***It is used to interface with 7447-BCD to seven segment display***

EEPROM

CHAPTER 5
EEPROM

5.1 INTRODUCTION:

The EEPROM data memory is readable and writable during normal operation (full V_{dd} range) .This memory is not directly mapped in to the register file space. Instead it is indirectly addressed through the Special Function Registers.There are four SFR's used to read and write this memory.

These registers are:

- EECON1
- EECON2(not a physically implemented register)
- EEDATA
- EEADR

EEDATA holds the 8-bit data for read/write , and EEADR holds the address of the EEPROM location being accessed. The 8-bit EEADR register can access up to 256 locations of data EEPROM. The EEADR register can be thought of as the indirect addressing register of the data EEPROM. EECON1 contains the control bits, while EECON2 is the register used to initiate the read/write. Some devices will implement less than the entire memory map.The address range always starts at 0h, and goes throughout the memory available. Table 5.1 shows some of the possible common device memory sizes and the address range for those sizes.

Table 5.1 Possible EEPROM Memory size

Data EEPROM size	Address Range
64	0h-3Fh
128	0h-7Fh
256	0h-FFh

The EEPROM data memory allows byte read and writes . A byte write automatically erases the location and writes the new data (erase before write). The EEPROM data memory is rated for high erase /write cycles. The write time is controlled by an on chip timer. The write time will vary with voltage and temperature as well from chip to chip. When the device is code protected, the CPU may continue to read and write the data EEPROM memory. The device programmer can no longer access this memory.

5.2 CONTROL REGISTER:

Register 1:EECON1 Register

U	U	U	R/W-1	R/W-1	R/W-X	R/S-0	R/S-X
------	------	------	**EEIF**	**WRER**	**WREN**	**WR**	**RD**

Bit 5-7: Unimplemented :Read as '0'

Bit 4 **EEIF:** EEPROM Write operation Interrupt Flag Bit

1= The write operation completed

0 = The write operation is not complete or has not yet been started.

Bit 3 **WRERR:** EEPROM error flag bit

1= A write operation is prematurely terminated.

0= The write operation completed.

Bit 2 **WREN:** EEPROM write enable bit

1= Allows write cycles

0= Inhibits write to the data EEPROM.

Bit 1 **WR:** Write Control bit

1= Initiates a write cycle. This bit is cleared by hardware once write is complete.

0= Write cycle to the data EEPROM is complete.

Bit 0 **RD:** Read Control bit

1= Initiates an EEPROM read.Read takes one cycle.RD is cleared in hardware.

0= Does not initiate an EEPROM read.

EEADR:

The EEADR register can address up to a maximum of 256 bytes of data EEPROM. The unused address bits are decoded. This means that these bits must always be '0' to ensure that the address is in the data EEPROM memory space.

EECON1 and EECON2 Registers:

EECON1 is the control register with five low order bits physically implemented. The upper three bits are implemented and read as 0's. Control bits RD and WR initiate read and write. These bits cannot be cleared, only set in software. They are cleared in hardware at competion of the read or write operation. The inability to clear the WR bit in software prevents the accidental , premature termination of a write operation.

The WREN bit , when set , will allow a write operation. On power up, the WREN bit is clear. The WRERR bit is set when a write operation is interrupted by a MCLR reset or a WDT time-out reset during normal operation. In these situations following reset,the user can check the WRERR bit and rewrite the location. The data and address will be unchanged in the EEADR and EEDATA registers. Interrupt flag bit EEIF is set when write is complete. It must be cleared in software. EECON2 is not a physical register. Reading EECON2 will read all '0's. It is used exclusively in the data EEPROM write sequence.

Reading The EEPROM Data Memory:

To read a data memory location, the user must write the address to the EEADR register and then set control bit RD. The data is available in the very next instruction cycle , in the EEADR register; therefore it can be read by the next instruction. EEDATA will hold this value until another read or until it is written to by the user.

Example : Data EEPROM Read

```
BCF STATUS,RP0          ; Bank 0
MOVLW CONFIG_ADDR       ; Any location in data EEPROM
                          Memory space.
MOVWF EEADR             ; Address to read
BSF STATUS,RP0          ; Bank1
BSF EECON1,RD           ; EE read
BCF STATUS,RP0          ; Bank0
MOVF EEDATA,W           ; W=EEDATA
```

Writing to the EEPROM data Memory:

To write an EEPROM data location, the user must first write the address to the EEADR register and the data to the EEDATA register. Then the user must follow a specific sequence to initiate the write for each byte.

Example: Data EEPROM Write

```
BSF STATUS,RPO          ; Bank1
BCF INTCON,GIE          ; Disable INT's
BSF EECON1,WREN         ; Enable write

MOVLW 55h               ;
MOVWF EECON2            ;55h must be written to EECON2
MOVLW AAh               ;To start write sequence
MOVWF EECON2            ;Write AAh
BSF EECON1,WR           ; Set WR bit begin write
```

```
BSF INTCON,GIE                ;Enable INT's.
```

The write will not initiate if the above sequence is not exactly followed for each byte. The WREN bit in EECON1 must be set to enable write. This mechanism prevents accidental writes to data EEPROM due to errant code execution. The user should keep the WREN bit clear at all times , except when updating EEPROM. The WREN bit is not cleared by hardware.

After a write sequence has been initiated, clearing the WREN bit will not affect the write cycle.The WR bit will be inhibited from being set unless the WREN bit is set. At the completion of the write cycle, the WR bit is cleared in hardware and the EE write completion interrupt flag is set. The user can either enable the interrupt or poll this bit.

5.3 Protection against Spurious Writes:

There are conditions when the device may not want to write to the data EEPROM memory . To protect against spurious EEPROM writes , various mechanisms have been built in. On power on ,WREN is cleared . Also the Power-up timer prevents EEPROM write. The write initiate sequence and the WREN bit together help prevent an accidental write during power glitches and software malfunction.

Data EEPROM Operation During Code Protected Configuration:

When the device is code protected, the CPU is able to read and write data to the data EEPROM . For ROM devices, there are two code protection its. One for ROM program memory and one for the data EEPROM memory.

PROXIMITY SENSOR

CHAPTER 6
PROXIMITY SENSOR

6.1 INTRODUCTION

The Proximity Sensor is a micro-electronic based device that can detect the presence of both moving and stationary objects through solid materials. Its ability to operate through any non-conductive material (upholstery, carpets, sheet rock, wood) permits complete invisibility.

The sensor functions by detecting minute changes in an ultra-low-power electric field generated between two remotely locatable antenna electrodes. Its range is adjustable from inches to over 12 feet and can be used to cover an entire room of concrete slab floor construction or any full room using techniques described within the operating instructions. The device utilizes advanced four quadrant analog multipliers toachieve virtually flawless false alarm rejection. It has application in home automation, security, manufacturing process control and safety.

In the case of home automation, there is the need to detect the presence of a person in a room to control lighting.The challenge has been that if the person was seated quietly in a chair or lying in bed, the lights would turn on or off at inappropriate times because the detector required movement. The Proximity Sensor solves that problem. For security, the Proximity Sensor's complete invisibility improves aesthetics and reduces alarm system detectability.

The Proximity Sensor offers significant advantages over competing technologies. Mechanical detectors (spring, membrane, etc.) often fail in applications where the spring is left compressed for an extended period--it eventually stops springing back when the pressure is removed. Photoelectric detectors, although able to sense stationary objects, are visible and must be carefully positioned. Photoelectric detectors can also be unreliable in applications subject to changes in lighting and object reflectivity.

PIR (infrared) sensing is less position-sensitive than photoelectric, but requires a moving, heated body to respond, and the detector is still visible. PIR is also particularly susceptible to false alarms often requiring masking of sensed areas around windows and heating vents. Doppler Radar can solve the false alarm and sensor visibility problems, but still requires a moving object, and prolonged exposure to microwaves can present a health concern. Capacitive detectors have proven useful only in short range detection applications. The Proximity Sensor addresses all of these issues.

Specifications and Features:

- Range adjustable from inches to over 12 feet.
- High signal-to-noise ratio (72dB).
- Single, low-profile, printed circuit board (5.5" X 3.35" X 0.7").
- Completely safe due to an RF power output of less than 1 milliwatt.
- Relay switched output (SPST 1.0 A @ 250VDC/125VAC)
- Power Requirements: 50 mA @ +12 VDC and 27 mA @ -12VDC

6.2 Principle Of Operation:

It is helpful to think of the Proximity Sensor as a small radio transmitter and receiver combination (transceiver). There are both input and output connectors on the board used to connect the sensor to transmit and receive antennas(electrodes) which can be located at some distance from the sensor. These connections are made through two shielded (coaxial) cables. Shielded cables have an insulated center conductor with a metal foil and/or woven wire braid surrounding it. The use of coaxial cables allows the user to control the point at which the wire leaving the sensor begins to function as an antenna. It starts as soon as it leaves the shielded cable.

The antenna electrodes can be composed of lengths of any type of wire (i.e. bare, insulated, stranded or solid), flat adhesive metal tape, metal window screen or ordinary kitchen aluminum foil to which the center conductor of the shielded cable has been connected. The type of wire or other material used depends on the type of field you wish to establish between them. The larger the electrodes, the greater the range. Smaller electrodes provide more precise detection.

The field lines emanate out in all directions, but the ones we are most interested in are the lines passing between the two points. For the sensor to function, the body being sensed must intersect the field generated between the two electrodes. We must therefore position the electrodes such that whatever it is you are trying to detect, will move into that field. As the electrodes are moved farther apart, the field strength decreases. If the distance is doubled, the signal strength will be only one-quarter as strong (varies inversely to the distance cubed between the electrodes).

Reductions in field strength can be compensated for by using larger electrodes up to the limits of the output amplifiers. You will have no problem driving antennas of 10-12 feet in length over separation distances of over 12 feet through 50 foot coaxial cables. The specific limits will depend on your particular situation. There are adjustments on the board for both transmitter power and receiver sensitivity.

6.3 Modes of Operation:

Shunt Mode:

Shunt Mode is the first of two categories of operation. The effect of objects entering the field between electrodes depends on their range and if they are grounded.The electrodes are aluminum foil plates rather than wires, but the principles are the same. For each pair, the electrode on the left is radiating and the one on the right is receiving. The signal source is represented below the radiating plate by a sine wave source, and the strength of the signal being received by the plate on the right is shown by the meter indication.

When a hand, body or any other conductive object is placed in the field, an electric current will be induced in it. If that object is grounded, a portion of the radiated field will be shunted to ground. This is where the term "Shunt Mode" comes from. In Shunt Mode, the sensor is adjusted so that when there is no object in the field, the signal strength arriving at the receive electrode is just enough to cause a relay on the board to close. When an object enters the field, the signal strength is reduced, and the power to the relay is no longer enough to hold it closed. It opens and will remain open until the object exits the field.

An important consideration for the use of Shunt Mode is that the object entering the field be grounded. If the object is not grounded, it is unlikely that it will draw off enough of the radiated signal to cause the relay to open. Frequently, second floor commercial construction also provides a good ground because of the use of steel.

It makes little difference what the floor covering is or what the person may be wearing on their feet. They can be wearing thick socks, shoes, and the floor can be covered with carpet, wood, rubber mats or any combination of these, and they will have little effect. The signal will be conducted through all of them to ground.

Shunt Mode is the method to use for any application where you are attempting to sense people moving through a doorway, down a hallway, entering a room, or applications similar to these. But there are many applications where it is impossible to ground the sensed object. For these situations, Transmit Mode is the way to go. The worse the ground, the better it likes it.

Transmit Mode:

Referring to the figure on the right, when a personstands, sits, or is otherwise near the transmit electrode, the signal will be capacitively coupled into their body making the entire person a transmit electrode. The effect will actually be to make the ransmitted signal stronger. When a body first enters the field from a distance, it will attempt to shunt the radiated signal to ground. As the body gets closer to an electrode, the system changes from Shunt Mode to Transmit Mode. Actually both modes occur simultaneously. Some portion of the signal is always being coupled to the body and re-radiated to the receiver, but until the body is very close to the transmit electrode, the amount being shunted exceeds the amount being coupled and radiated.

To take advantage of this effect and operate in Transmit Mode, the Proximity Sensor relay is adjusted using a method just opposite from that used for Shunt Mode. When there is nothing in the field, the relay is adjusted so that it first closes but then the adjustment is backed off just to the point where it opens. At that point, any increase in signal would cause it to close. When a body enters the field from a distance, the field strength drops, but since the relay is already open, it has no effect. As the body gets closer and closer to one of the electrodes, the signal strength increases and the relay closes. It will remain closed until the body moves away.

In practice it often makes no difference which of the two electrodes the body approaches because a better receiving antenna can often help as much as a better transmitting antenna.

RELAYS

CHAPTER 7
RELAYS

7.1 INTRODUCTION:

Relays are used to cut off the supply promptly to any element of power system which undergoes short circuit or it starts operating abnormally. They also provide a very good indication of the type of fault which has occurred. The location of the fault or the area in which the fault has occurred is also provided. They thus help in localization of the fault and help in expediting repair work.

There are basically two types of relays.

1.Normally Open
2. Normally Closed

We are using the normally open relay in our project so that when the supply comes in , the relay gets closed and will remain closed when the supply is cut off.

7.2 Relay Construction

Relays are amazingly simple devices. There are four parts in every relay:

- **Electromagnet**
- **Armature** that can be attracted by the electromagnet
- **Spring**
- **Set of electrical contacts**

7.2.1 Features:

- ❖ Compact, Light weight, ultra low profile with high density.
- ❖ Low Power Consumption.
- ❖ Extremely durable plastic sealing.
- ❖ Small but high withstanding voltage.

7.3 Relay Applications

In general, the point of a relay is to use a small amount of power in the electromagnet -- coming, say, from a small dashboard switch or a low-power electronic circuit -- to move an armature that is able to switch a much larger amount of power. For example, you might want the electromagnet to energize using 5 volts and 50 milliamps (250 milliwatts), while the armature can support 120V AC at 2 amps (240 watts).

Relays are quite common in home appliances where there is an electronic control turning on something like a motor or a light. They are also common in cars, where the 12V supply voltage means that just about everything needs a large amount of current. In later model cars, manufacturers have started combining relay panels into the fuse box to make maintenance easier.

In places where a large amount of power needs to be switched, relays are often cascaded. In this case, a small relay switches the power needed to drive a much larger relay, and that second relay switches the power to drive the load. Relays can also be used to implement Boolean logic

Relays are one of the oldest, simplest, and yet, easiest and most useful devices. Before the advent of the mass produced transistor, computers were made from either relays or vacuum tubes, or both.

A relay, quite simply, is a small machine consisting of an electromagnet (coil), a switch, and a spring. The spring holds the switch in one position, until a current is passed through the coil. The coil generates a magnetic field which moves the switch. It's that simple. You can use a very small amount of current to activate a relay, and the switch can often handle a lot of current.

7447- BCD to 7 Segment Decoder

CHAPTER 8

BCD to 7 Segment Decoder

8.1 INTRODUCTION

Seven Segment Display is the most popular display device used in digital systems.For displaying data using this device , the data have to be converted from BCD to seven segment code. A number of IC's are available for performing this function. The decoder circuit has four input lines for BCD data and seven output lines to drive a 7- segment display. Output terminals a through g of the decoder are to be connected to a through g terminals of the display. If the outputs are active-low,then the 7-segment LED must be of common anode type, whereas if the outputs are active high then 7-segment LED must be of the common cathode type. In our project we are using the 7447 IC.

FEATURES:

1. Output -- Active- Low; Open Collector
2. Rating
   * Max Voltage -- 15 v
   * Sink current -- 40 mA
3. Facilities available
   * Lamp Test (LT)
   * Ripple blanking Input (RBI)
   * Ripple blanking Output (RBO)

* Blanking Input (BI)

Lamp Test (LT):

This is used to check the segments of LED. If it is connected to logic 0 level, all the segments of the display connected to the decoder will be ON. For normal decoding operation, this terminal is to be connected to logic1 level.

Ripple Blanking Input (RBI):

It is to be connected to logic 1 level for normal decoding operation. If it is connected to logic 0 level, the segment outputs will generate data for normal 7-segment display switches off. This is used for blanking out leading zeroes in multi-digit displays.

Blanking Input (BI):

If it is connected to logic 0 level , the display is switched off irrespective of BCD inputs. This is used for conserving power in multiplexed displays.

Ripple Blanking Output (RBO):

This output is normally at logic 1 goes to logic 0 during zero blanking interval. This is used for cascading purposes and is connected to RBI of succeeding stage.

DISPLAY FORMAT:

Each segment is made up of a material that emits light when current is passed through it. Most commonly used materials include LEDs and incandescent filaments.Note the letters a,b,c,d,e,f and g run clockwise from the top for each segment.For instance,to display a 1,we need to light up segments b and c.To light up a 0,we need segments a,b,c,d,e and f.

CONCLUSION

Conclusion:

Thus the microcontroller was tested with the number of units initially stored in the EEPROM memory. As the signal was given, the relay was switched on and the number of units were decremented from the EEPROM memory. The same process was observed from the remaining units.

When the number of units kept on decrementing and became six, the buzzer was switched on to give an indication that the number of units are almost over and it is time to load the EEPROM again. When all the units are consumed, the relay gets switched off and will switch on again only when the signal is given again.

FUTURE SCOPE OF THE PROJECT:

This project can be extended to include an external EEPROM so that the microcontroller need not be reprogrammed again and again.The cost Of this circuit can be minimized with further miniaturization of circuit.

APPENDIX

Appendix:

;Prepaid eb card

;In this project internal EEPROM is used.

```
                list p=16f84
#define status  0x03
#define rpo     0x05
#define porta   0x05
#define portb   0x06
#define TMR0    0x01
#define INTCON  0x0B

#define psense  porta,0x04
#define pwarn   porta,0x03
#define preoff  porta,0x02
#define pcarry  status,0x00
#define zero    0x02
#define w       0x00
#define f       0x01
#define WR      0x01
#define RD      0x00
#define WREN    0x02
#define EEIF    0x04
#define EEdata  0x08
#define EEcon1  0x88
#define EEadr   0x09
#define EEcon2  0x89
```

```
;________________________________________________________________
                        cblock 0x10
deliveryreg
tempdelivery
vaDelayCnt
varUnit
varTen
varHun
tempcount
dispCount
dispreg
        endc
;
________________________________________________________________


        org     0x00
        goto    0x30


;________________________________________________________________

        org     0x04
        labTim0Int
        bcf     INTCON,0x02
        labUnit
        movlw       .0
        xorwf       dispCount,W
```

```
        btfss       status,zero
        goto        labTen
        incf        dispCount,f
        movf        varUnit,W
        movwf       dispreg
        bcf         dispreg,0x05
        bcf         dispreg,0x06
        bsf         dispreg,0x04
        movf        dispreg,W
        movwf       portb
        retfie

labTen

        movlw       .1
        xorwf       dispCount,W
        btfss       status,zero
        goto        labHun
        incf        dispCount,f
        movf        varTen,W
        movwf       dispreg
        bsf         dispreg,0x05
        bcf         dispreg,0x06
        bcf         dispreg,0x04
        movf        dispreg,W
        movwf       portb
        retfie
```

```
labHun
        movlw       .2
        xorwf       dispCount,W
        btfss       status,zero
        goto        labUnit
        incf        dispCount,f
        movf        varHun,W
        movwf       dispreg
        bcf         dispreg,0x05
        bsf         dispreg,0x06
        bcf         dispreg,0x04
        movf        dispreg,W
        movwf       portb
        clrf        dispCount
        retfie

;______________________________________________________________________
        org     0x30

  main
        call    fninitio
        clrf    dispCount

 remain
        call    fnreadeeprom
        call    fnConvertBinToBCD
```

```
        movf    deliveryreg,f
        btfsc   status,zero
        goto    $
        bsf     preoff
        call    fnsense
        call    fnDelay
        call    fnmanipdeliver
        goto    remain
;________________________________________________________________
fninitio:
        bsf             porta,0x00
        bsf             status,rpo
        movlw           b'11110010'
        movwf           porta
        movlw           b'10000000'
        movwf           portb
        clrf            TMR0
        bcf             status,rpo
        bsf             INTCON,0x07     ;GIE
        bsf             INTCON,0x05     ;TOIE
        clrf            TMR0
        bcf             pwarn
        bcf             preoff
        return

;________________________________________________________________
```

```
fnsense:
        btfss   psense
        goto    $-1
        btfsc   psense
        goto    $-1

        return
;________________________________________________________________
fnwriteeeprom

        movlw       0x00
        movwf       EEadr
        movf        deliveryreg,W
        movwf       EEdata

        bsf         s tatus,rpo
        btfsc       EEcon1,WR
        goto        $-1
        bsf         EEcon1,WREN
        movlw       0x55
        movwf       EEcon2
        movlw       0xAA
        movwf       EEcon2
        bsf         EEcon1,WR
        bcf         status,rpo

        return
```

```
;________________________________________________________________
fnreadeeprom

        movlw       0x00
        movwf       EEadr
        bsf         status,rpo
        bsf         EEcon1,RD
        bcf         status,rpo
        movf        EEdata,W
        movwf       deliveryreg

        return
;________________________________________________________________



fnmanipdeliver:
        decf        deliveryreg,f
        call        fnwriteeeprom
        movlw       .6
        xorwf       deliveryreg,w
        btfsc       status,zero
        bsf         pwarn
        movf        deliveryreg,f
        btfss       status,zero
        return
        bcf    preoff
        return
```

```
;______________________________________________________________

fnDelay
        movlw       .255
        movwf       vaDelayCnt
        decfsz      vaDelayCnt,f
        goto        $-1
        return
;______________________________________________________________

fnConvertBinToBCD
        movf        deliveryreg,W
        movwf       tempdelivery
        clrf        tempcount
        clrf        varUnit
        clrf        varTen
        clrf        varHun

        movlw       .100            ;Hundreds count
        incf        varHun,F
        subwf       tempdelivery,F
        btfsc       pcarry
        goto        $-3
        decf        varHun,F
        addwf       tempdelivery,F
        movlw       .10
```

```
incf      varTen,F
subwf     tempdelivery,F
btfsc     pcarry
goto      $-3
decf      varTen,F
addwf     tempdelivery,F
movf      tempdelivery,w
movwf     varUnit

return
;
end
```

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