P-2648

ELECTRICITY BILLING THROUGH WIRELESS TECHNOLOGY USING EMBEDDED SYSTEM

A PROJECT REPORT

Submitted by

C.MUTHURAMALINGAM - 71205105302

P.PRABHU - 71205105303

K.A.SIVAPRAKASHAM - 71205105305

in partial fulfillment for the award of the Degree

of

BACHELOR OF ENGINEERING

IN

ELECTRICAL AND ELECTRONICS ENGINEERING

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

KUMARAGURU COLLEGE OF TECHNOLOGY
COIMBATORE – 641 006

ANNA UNIVERSITY: CHENNAI 600 025

APRIL – 2009

ANNA UNIVERSITY: CHENNAI 600 025

BONAFIDE CERTIFICATE

Certified that this project report entitled " Electricity Billing Through Wireless Technology Using Embedded System" is the bonafide work of

C.Muthuramalingam	-	Register No 71205105302
P.Prabhu	-	Register No 71205105303
K.A.Sivaprakasham	-	Register No 71205105305

who carried out the project work under my supervision.

Signature of the Head of the Department
Prof.K.Regupathy Subramanian

Signature of the Guide
Mr.M.Mohanraj

Certified that the candidate with university Register No. 71205105302,03,05 was examined in project viva voce Examination held on 27-04-09

Internal Examiner

External Examiner

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

KUMARAGURU COLLEGE OF TECHNOLOGY

COIMBATORE 641 006

ACKNOWLEDGEMET

ACKNOWLEDGEMENT

The completion of this project can be attributed to the combined effort made by us and the contribution made in one from or the other by the individuals we hereby acknowledge.

We express my indebtedness to our guide **Mr.M.MOHANRAJ, M.E** in Electrical and Electronics Engineering department for his guidance, which helped us in the completion of this project.

Last but not the least we thank one and all of my friends and other staff of Electrical & Electronics Engineering department for their whole hearted support.

CONTENTS

LIST OF FIGURES

LIST OF FIGURES & ABBREVATIONS OF NOMENCLATURE

LIST OF ABBREVATIONS OF NOMENCLATURE

GSM	-	Global System for Mobile communications
GAPMR	-	GSM Automatic Power Meter Reading
SMS	-	Short Message Service
PLC	-	Power Line Carrier communications
SCADA	-	Supervisory Control and Data Acquisition
ICT	-	Information Communication Technology
IC	-	Integrated Circuit
EB	-	Electricity Bill
LCD	-	Liquid Crystal Display
PIC	-	Programmable Interface Controller
EPROM	-	Erasable Programmable Read Only Memory
RAM	-	Random Access Memory
SSP	-	Synchronous Serial Port
OST	-	Oscillator Start up Timer
BOR	-	Brown Out Reset
USART	-	Universal Synchronous Asynchronous Receiver & Transmitter
SCI	-	Serial Communication Interface
TTL	-	Transistor Transistor Logic

ABSTRACT

Traditional meter reading for electricity consumption and billing is done by human operator from houses to houses and building to building. This requires huge number of operators and long working hours to achieve complete area data reading and billing. Human operator billing is prone to reading error as sometime the houses electric power meter is placed in a location where it is not easily accessible. The manual billing job is sometime also restricted and is slowed down by bad weather condition. There is a huge increase in residential housing and commercial building. Efficient meter reading, reduce billing error, operation costs, displays warning messages, shutdown information etc., this are can be achieved by using this Automatic Meter Reading system.

AMR is an effective mean of data collection that allow substantial saving through the reduction of meter re- read , greater data accuracy, improved billing and customer service , With the advent of digital technology analogue electro-mechanical meter is continuously replaced by digital electronic meter. Digital energy meters offer greater convenience to implement and establish automatic meter readings system electronically. Efficiency and reliability of retrieving meter reading in the AMR system is a major challenge. With the rapid development of GSM infrastructure and Information Communication Technology has made wireless automatic meter reading system more reliable and possible. The automatic power meter reading system presented in this project takes advantage of the available GSM infrastructure nation wide coverage in the country and the Short Messaging System (SMS).

CHAPTER 1

INTRODUCTION

1. INTRODUCTION

1.1. OBJECTIVE

The aim of the project is to design an Interactive Electricity Billing system through Wireless Technology using Embedded System.

1.2. INTRODUCTION

This project is mainly introduced to reduce the human errors. The energy meter is interfaced with the mobile to transmit the reading to the electricity bill office through wireless from the consumer. This data is received from the mobile and interfaced in the computer using the interfacing circuit. The computer is programmed for receive and calculate the data and also for sending the details and comments for the consumer about the power shut down, last date for paying the bill, warning and about the line disconnect. These details can be sending to customers through the second way of wireless transmission. This data is received by the customer and the data is decoded and send to the microcontroller, which is a programmable IC. The details can be monitored in the display unit connected with the microcontroller. The microcontroller is also programmed to disconnect the load with the power supply if the customer is fail to pay the bill in due date. Thus we can have wireless technology for electricity bill payment.

1.3. EXISTING METHODOLOGY

As per the current status EB workers are collecting the data about power consumption of each consumer. The amount for power consumption will be set by EB office. The consumers will get the amount details through an EB book from the same workers.

There is no predict activities about power shut down and last due date for paying the electricity bill. The EB workers will cut the power supply without any information if the consumer did not pay the amount within that due date.

1.4. DEVELOPMENT

Here, in this project wireless technology is used to set the amount for power consumption without the help of extra worker. The warning message will be sent by EB PC to each consumer if who did not pay the amount within the specific date.

The control circuit will trip the power supply from the consumer if there is no response from the consumer even sends the warning message. The period of power shutdown will be displayed through LCD display before itself by EB office.

The Peripheral Interface Controller Microcontroller is used in this project for do many activities such as get the specific reading about energy consumption from energy meter, conversion , activate the trip circuit , LCD display, etc.,

1.5. BLOCK DIAGRAM DESCRIPTION

In the subscriber side a mobile is used to get the messages from EB office. This mobile is interfaced with the microcontroller. The microcontroller controls the trip circuit and LCD display according to incoming messages. At the same time microcontroller is used to send the messages with the help of mobile through wireless technology by getting the reading from energy meter with conversion circuit.

CHAPTER 2

BLOCK DIAGRAM

2. BLOCK DIAGRAM

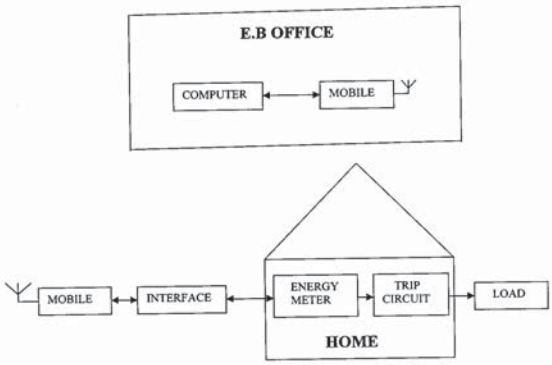


FIG 2.1.BLOCK DIAGRAM

We designed a system to automatically send the number of units consumed by customer to the EB office through GSM technology. Current transformer and potential transformer are used to measure power. The current transformer reduces the secondary current according to the CT ratio and potential transformer reduces the secondary voltage according to the PT ratio.

These values are given to the microcontroller and it calculate the total energy consumed then it display the number of units consumed and amount using LCD display. Microcontroller has inbuilt timer it programmed to send the total number of units and amount to the server side automatically at particular time period through GSM technology.

In server side a mobile is used to receive the bill information and stored in computer. If the customer fails to pay the bill in particular date a warning message is sent from server to customer it will display in LCD display. Then on the grace period the customer not pay the bill supply is automatically disconnected by activating trip circuit using GSM technology from server side. Then the customer pay the bill supply is automatically connected to the customer by deactivating the trip circuit from server side using GSM technology.

2.1. PROJECT THEME

2.1.1. CONSUMER SIDE

The microcontroller is also programmed to disconnect the load with the power supply if the customer is fail to pay the bill in due date. Thus we can have wireless technology for electricity bill payment. The LCD display used to show the following information in this consumer side.

- Amount
- Last Date
- Warning message
- Shutdown information , etc.,

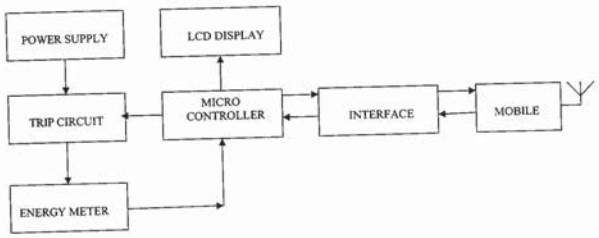


FIG 2.2.SUBSCRIBER PREMISES

2.1.2. SERVER SIDE

The computer is programmed for receive and calculate the data and also for sending the details and comments for the consumer about the power shut down, last date for paying the bill, warning and about the line disconnect.

FIG 2.3.SERVER SIDE

CHAPTER 3

PIC 16F877A

3. PIC 16F877A

3.1. INTRODUCTION:

PIC stands for Peripheral Interface Controller. Microchip Technology first coined it. PIC is very popular micro controller worldwide. Microchip is first to manufacture of 8 pins RISC MCU. It focuses on high performance, cost effective, field programmable embedded control solutions.

PIC (Peripheral Interface Controller) provides the following standard features.

3.2. PIC MICRO CONTROLLER CORE FEATURES:

- ✓ High performance CPU
- ✓ Only 35 single word instructions to learn
- ✓ All single cycle instructions except for program
- ✓ Branches which are two cycle
- ✓ Operating speed: DC - 20 MHz clock input
- ✓ DC - 200 ns instruction cycle
- ✓ Up to 8K x 14 words of FLASH Program Memory,
- ✓ Up to 368 x 8 bytes of Data Memory (RAM)
- ✓ Up to 256 x 8 bytes of EEPROM Data Memory
- ✓ Pin out compatible to the PIC16C73B/74B/76/77
- ✓ Interrupt capability (up to 14 sources)
- ✓ Eight level deep hardware stack
- ✓ Direct, indirect and relative addressing modes
- ✓ Power-on Reset (POR)
- ✓ Power-up Timer (PWRT) and
- ✓ Oscillator Start-up Timer (OST)
- ✓ Watchdog Timer (WDT) with its own on-chip RC
- ✓ Oscillator for reliable operation
- ✓ Programmable code protection
- ✓ Power saving SLEEP mode
- ✓ Selectable oscillator options

- ✓ Low power, high speed CMOS FLASH/EEPROM
- ✓ Technology
- ✓ Fully static design
- ✓ In-Circuit Serial Programming (ICSP) via two pins
- ✓ Single 5V In-Circuit Serial Programming capability
- ✓ In-Circuit Debugging via two pins
- ✓ Processor read/write access to program memory
- ✓ Wide operating voltage range: 2.0V to 5.5V
- ✓ High Sink/Source Current: 25 mA
- ✓ Commercial, Industrial and Extended temperature ranges
- ✓ Low-power consumption:
  - < 0.6 mA typical @ 3V, 4 MHz
  - < 20 µA typical @ 3V, 32 kHz
  - < 1 µA typical standby current

3.3. PERIPHERAL FEATURES:

- ✓ Timer0: 8-bit timer/counter with 8-bit prescaler
- ✓ Timer1: 16-bit timer/counter with prescaler,
- ✓ Can be incremented during SLEEP via external crystal/clock
- ✓ Timer2: 8-bit timer/counter with 8-bit period, register, prescaler and postscaler
- ✓ Two Capture, Compare, PWM modules
  - Capture is 16-bit. max. resolution is 12.5 ns
  - Compare is 16-bit, max. resolution is 200 ns
  - PWM max. resolution is 10-bit
- ✓ 10-bit multi-channel Analog-to-Digital converter
- ✓ Synchronous Serial Port (SSP) with SPI□ (Mastermode) and I2C(Master/Slave)
- ✓ Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 2-bit address detection
- ✓ Parallel Slave Port (PSP) 8-bits wide, with external RD, WR and CS controls (40/44-pin only)

✓ Brown-out detection circuitry for Brown-out Reset (BOR)

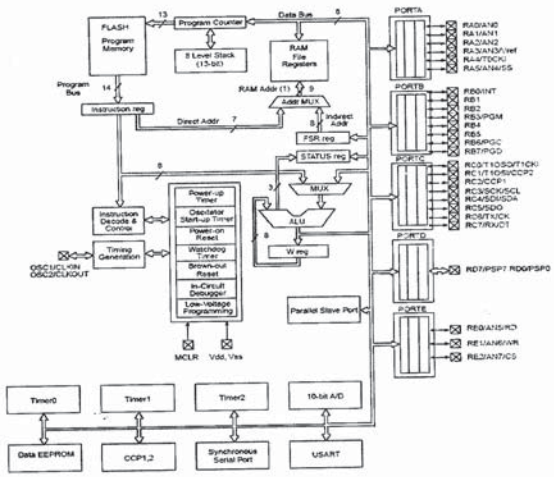
3.4. INPUT-OUTPUT UNIT:

There are several types ports; input/output or bi-directional ports. When working with ports, first of all it is necessary to choose which port we need to work with, and then send data to, or takes it from the port. When working with it the port as like a memory location. Some thing is written into or read from it, and it could be noticed on the pins of the microcontroller.

PORTS:

The "port" refers to a group of pins on a micro controller which can be accessed simultaneously, or on which we can set the desired combination of zeros and ones, or read from them an existing status. Physically, port is a register inside the micro controller, which is connected by wires to the pins of micro controller.

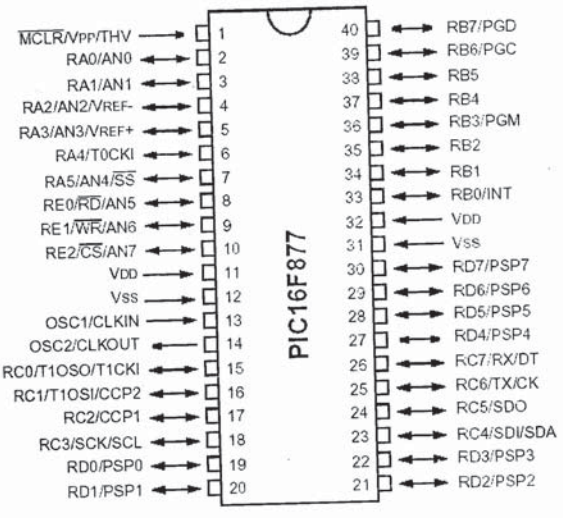
FIG3.1. ARCHITECTURE OF PIC 16F877A



SPECIFICATIONS

DEVICE	PROGRAM FLASH	DATA MEMORY	DATA EEPROM
PIC 16F877	8K	368 Bytes	256 Bytes

FIG3.2. PIN DIAGRAM OF PIC 16F877A



TIMER UNIT:

Timer block is significant to us because it gives as information about time, duration, protocol etc. the basic unit of the timer is a free-run counter which is infect register whose numeric value increments by one in even intervals, so that by taking its value during periods T1&T2 and on the basis of their difference we can determine how much time has elapsed.

WATCHDOG:

It is infect another free-run counter where our program needs to write a zero in every time it executes correctly. In case that program gets "stuck", zero will not be written in. and counter alone will reset the microcontroller upon achieving its maximum value. This will result in executing program again, and correctly this time around.

ANALOG TO DIGITAL CONVERTER :

As the peripheral signals usually different from the ones that micro controller can understand (zeroes and ones).they have to be converted into a pattern which can be comprehended by the micro controller .The task is performed by a block for analog to digital conversion. The block is responsible for converting an information about some analog value to a binary number and to CPU.

ARITHMETIC LOGIC UNIT :

Arithmetic logic unit is responsible for performing operations of, addition. subtractonand logic operations.PIC 16F84 contains an 8-bit arithmetic logic unit and 8-bit work registers.

POWER- ON RESET :

A power on reset pulse is generated on-chip when VDD rise is detected (in the range of 1.2V-1.7V). To take advantage POR, tie the MCLR Pin directly (or through a resistor) to VDD.This is eliminate external RC components usually needed to create a power- on reset.

POWER -UP TIMER :

The power-up timer provides a fixed 72ms nominal time-out on power- up only from the por.the power up timer operates internal rc oscillators. The chip is kept in reset as long as the pwrt is active. The pwrt 's time delay allows vdd to rise to an acceptable level.

OSCILLATOR START- UP TIMER(OST) :

The oscillator start-up timer (OST) provides a delay of 1024 oscillator cycles (from osc1 input) after the pwrt delay is over (if pwrt is enabled). This helps to ensure that the crystal oscillator or resonator has started and stabilized.

BROWN-OUT RESET (BOR) :

The configuration bit ,BODEN, can enable or disable the Brown-out Reset circuit. If VDD falls below VBOR for longer than TBOR the brown out situation will reset the device .If VDD FALLS BELOW VBOR FOR LESS THAN TBOR,A RESET MAY NOT OCCUR.

TIME-OUT SEQUENCE:

On power-up, the time-out sequence is as follows: The PWRT delay starts (if enabled) when a POR Reset occurs. Then OST starts counting 1024 oscillator cycles when PWRT ends (LP, XT, HS).When the OST ends, the device comes out of RESET.

POWER CONTROL / STATUS REGISTER :

The power control status / register ,PCON ,has up to two bits depending upon the device.Bit0 is brown –out Reset status bit.BOR.Bit BOR is unknown on a power on Reset . It must then be set by the user and checked on subsequent RESETS Thermocouple see if bit BOR cleared, indicating a BOR occurred.

CLOCK GENERATOR – OSCILLATOR:

Oscillator circuit is used for providing a micro controller with a clock. clock is needed so that micro controller could execute a program or program instructions.

XT OSCILLATOR:

Crystal oscillator is kept in metal housing with two pins where you have written down the frequency at which crystal oscillators. One ceramic capacitor of 30pF whose other end is connected to the ground needs to be connected with each pin.

RESET :

Reset is used putting the microcontroller in to a 'known' condition. That practically means that microcontroller can behave rather in accurately under certain undesirable condition .In order to continue functioning it has to be reset, meaning all registers would be placed in a starting position

ARITHMATIC LOGIC UNIT:

Arithmetic logic unit is responsible for performing operations of adding ,subtracting ,moving (Left or Right within a register) and logic

operations .When data inside a register is also known as 'shifting'.PIC 16F877 contains a 8-bit arithmetic logic unit and 8-bit work registers.

PROGRAM COUNTER:

Program counter is a 13-bit register that contains the address of the instruction being executed. It is physically carried out as combination of 5-bit register PCLATH for 5higher bits of address, and the 8 bit registers PCL for lower 8bits of the address. By its incrementing or change (i.e. in case of jumps) micro controller executes program instructions step by step.

STACK POINTER:

The stack pointer register is 13 bit wide. It is incremented before data is stored during execution of "PUSH" and "CALL" instruction while the stack may reside any where in the ON chip RAM, the stack pointer is initialized after reset.

EEPROM AND FLASH MEMORY:

The data EEPROM and Flash memory are readable and writable during normal operation over the entire VDD range. These operations take place on a single byte for data EEPROM memory and the single word for program memory.

INTERRUPTS:

Interrupts are a mechanism of a micro controller which enables it to respond to some events at the moment they occur, regardless of what micro controller is doing at the time.

This is a very important part, because it provides connection between a micro controller and environment, which surrounds it.

TIMER 0 MODULE:

The Timer 0 module timer /counter has the following features.

- ✓ 8-bit timer-counter.
- ✓ Readable and writable.
- ✓ 8-bit software programmable prescaler.
- ✓ Internal or external clock select.
- ✓ Interrupt on over flow from FFh to 00h.
- ✓ Edge select for external clock

TIMER 1 MODULE:

Timer 1 module is a 16 –bit timer/counter consisting of two 8-bit registers (TMR1HandTMR1L), which are readable and writable. The TMR1 Register pair Timer 1 module:(TMR1HandTMR1L), increments from 0000h to FFFFh and rolls over to 0000h

TIMER2 MODULE:

Timer2 is an 8 bit timer with a pre scalar and a post scaler.It can be used as the PWM time-base for the PWM mode of the CCP modules. The TMR2 register is readable and writable, and is cleared on any device RESET.

USART:

The universal Synchronous Asynchronous Receiver Transmitter module is one of the two serial I/O modules. The USART can be configured in the following ways

Asynchronous (full duplex)

Synchronous –Master (half duplex)

Synchronous -Slave (half duplex)

CCP1 Module:

Capture /compare /PWM Register 1 (CCPR1) is comprised of two 8bit registers CCPR1L (low byte) and CCPR1H (high byte). The CCP1CON register controls the

Operations of CCP1. The special event trigger is generated by a compare match and will reset timer 1.

CCP2 Module:

Capture /compare /PWM Register 2 (CCPR2) is comprised of two 8bit registers CCPR2l (low byte) and CCPR2H (high byte). The CCP1CON register controls the operations of CCP2The special event trigger is generated by a compare match and will reset timer 1and start and A/D Conversion.

CHAPTER 4

POWER SUPPLY UNIT

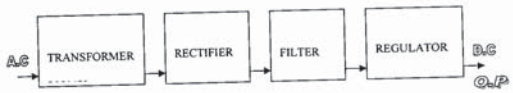
4. POWER SUPPLY UNIT

4.1. INTRODUCTION:

Since all electronic circuits work only with low D.C voltage we need a powersupply unit to provide the appropriate voltage supply . This unit consists of transformer ,rectifier, filter, regulator . A.C voltage typically 230V rms is connected to a transformer whichsteps that A.C voltage down to the level to the desired A.C voltage . A diode rectifier thenprovides a full-wave rectified voltage that is initially filtered by a simple capacitor filter toproduce a DC voltage. This resulting D.C voltage usually has some ripple or AC voltagevariations . A regulator circuit can use this D.C input to provide D.C voltage that not only hasmuch less ripple voltage but also remains the same DC value even the DC voltage varies somewhat,or the load connected to the output DC voltages changes.

4.2. BLOCK DIAGRAM:

FIG4.1.BLOCK DIAGRAM



4.3. TRANSFORMER:

Transformer is a static (or stationary) piece of which electric power in one circuit is transformed into electric power of the same frequency in another circuit . It can raise or lower the voltage in a circuit , but with a corresponding increase or decrease in current . It works with the principle of mutual induction . In our project we are using step down transformer for providing a necessary supply for the electronic circuits.In our project we are using a 15-0-15 centre tapped transformer.

4.4. RECTIFIER:

The DC level obtained from a sinusoidal input can be improved 100% using a process called as full-wave rectification. It uses 4 diodes in a bridge configuration . From the basic bridge configuration we see that two diodes (say D1 & D3) are conducting while the other two diodes (D1 & D4) are in "off" state during the time period t=0 to t=T/2. Accordingly for the negative of the input the conducting diodes are D1 &D4. Thus the polarity across the load is the same.

4.5. FILTER:

The filter circuit used here is the capacitor filter circuit where a capacitor is connected at the rectifier output. and a DC is obtained across it. The filtered waveform is essentially a DC voltage with negligible ripples, which is ultimately fed to the load.

4.6. REGULATOR:

The output voltage from the capacitor is more filtered and regulated. The voltage regulator is a device , which maintains the output voltage constant irrespective of the supply variations,load variation and temperature changes. Here we use two fixed regulators namely LM 7812, LM 7805 and LM 7912. The IC 7812 is a +12V regulator and IC 7912 is a –12V regulator and IC 7805 is a +5 regulator.

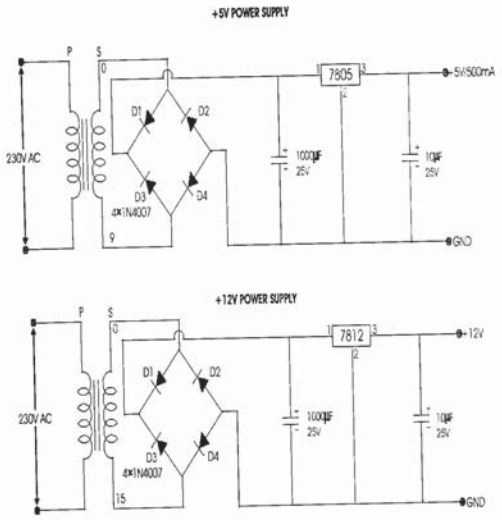


FIG4.2. POWER SUPPLY UNIT

CHAPTER 5

VOLTAGE SENSING UNIT

5.VOLTAGE SENSING CIRCUIT

The voltage sensing circuit of 230/6v potential transformer; op-amp-741 (2 nos), diode-4148 (2 nos), dual op-amp-4558, capacitor 220 F/16v, pot of 10k and various biasing and feed back resistor.

The primary of the 230v/6v potential transformer is connected to load voltage via M and V terminals. The respective secondary voltage signal is given as input to the precision rectifier, which is absolute value circuit, which is obtained by summing the output of half wave and its input with the proper phase and amplitude relations.

Here A1 is an inverting rectifier. The output from A1 is added to the original input single A2 with the single amplitude and phase relations shown. Negative alterations of Ein , result in no output at E1 due to the rectification. Ein feeds A2 through a 20K resistor and E1 feeds A2 through a 10K resistor. The net effect of this scaling is that for equal amplitude of Ein and E1, E1 will provide twise as much current into the summing point. This tact is used to advantage here, as the negative alternation of E1 produces twice the input current of that caused by the positive alternation of Ein. This causes a current of precisely half the amplitude, which W1 alone would generate due to the substation of Ein. It is thw equivalent of having E1 feed through a 20K input resistor and having Ein non-existing during this half cycle, and it result in a positive going output at A2. During negative alterations of Ein, E1 is absent and Ein produces the alternate positive output swing that, in summation, produces the desired full wave rectified response. As before, operation with opposite output polarity is possible by reversing D1 and D2.

Potential Transformer rating

Primary : 230VAC
Secondary : 6V AC

Current Transformer rating

Primary :15A
Secondary :5A

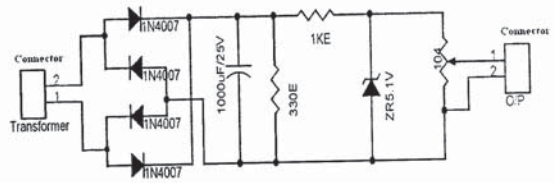


FIG5.1. VOLTAGE SENSING UNIT

CHAPTER 6

CURRENT SENSING UNIT

6.CURRENT SENSING CIRCUIT

The primary of the 15/5A current transformer is connected to the load current Via M and L terminals. The respective secondary current signal is given as input to I to V converter, which is a series connected resister of 47 , 2W. Then the output of the I to V converter is given as input to the precision rectifier, which is an absolute value circuit, which is obtained by summing the output of half wave and its input with the proper phase and amplitude relation.

Here A1 is an inverting rectifier. The output from A1 is added to the original input signal A2, with the signal amplitude and phase relations shown. Negative alternation of Ein result in no output at E1 due to the rectification. Ein feeds A2 through a 20K resistor, and E1 feeds A2 through a 10K resistor. The net effect of this scaling is that, for equal amplitude point. This tact is used to advantage here, as the negative alternation of E1 produces twice the input current as that caused by the positive alternation of Em. This causes a current of precisely half the amplitude, which W1 alone would generate due to the subtraction of Ein. It is the equivalent of having E1 fed through a 20K input resistor and having Ein non-existent during this half cycle, and it results in a positive going output at A2. During negative alternate positive output swing that in summation produces the desired full wave rectified response. As before, operation with opposite output polarity is possible by reversing D1 and D2.

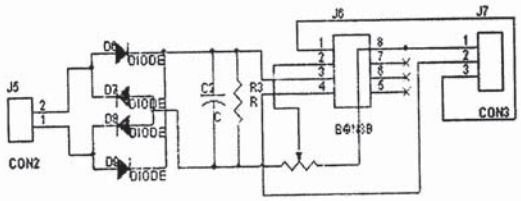


FIG6.1. CURRENT SENSING UNIT

CHAPTER 7

RELAY CIRCUIT

7. RELAY

7.1. INTRODUCTION

A relay is a switch worked by an electromagnet. It is useful if we want a small current in one circuit to control another circuit containing a device such as a lamp or electric motor which requires a large current, or if we wish several switch contacts to be operated simultaneously.

When the controlling current flows though the coil, the soft iron core is magnetized and attracts the L-shaped soft iron amature.This rocks on its pivot and opens. closes or changes over, the electrical contacts in the circuits being controlled as it closes the contacts. The current needed to operate a relay coil is called pull in current and the dropout current in the coil when the relay just stops working.

7.2. WORKING PRINCIPLE

In our project we use relays to cut the power supply going to the load. The relay is controlled by the computer via microcontroller. The signals sent from the computer are sensed by the Microcontroller and it sends necessary signals to activate the relay. The activation of relay is done using the relay circuit.

In this circuit transistor BC547 is used as a switch. The control signal is given to the base terminal of the transister.The collector is attached to the relay coil. There are two types of relays Normally closed Normally opened .

We are using normally closed type relay. When the controller output from the controller is low, the transistor will be in OFF state, so the relay is not energised.When the output from the controller is high the transistor will be in ON state, so the relay is energized and the power supply is cut-off from the load. When the relay is de-energized the power supply to the load is resumed. So according to the controller output the power supply to the load is varied.

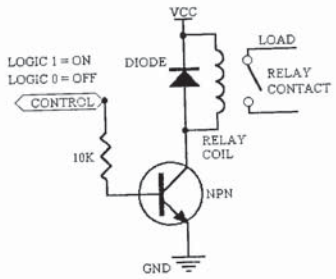


FIG7.1. RELAY CIRCUIT

CHAPTER 8

INTERFACE CIRCUIT

8.1. SERIAL DATA TRANSMISSION

The need to send and receive data from one location to another location is a vital importance. The most importance cost effective way to meet this demand is to send the data as a serial stream of bits in order to reduce the cost (and bulk) of multiple conductor cable. Optical fiber bundles, which are physically small, can be used for the parallel data transmission. However, the cost incurred for the fibers, the termination, and the optical interface are so high.

The optimal way of transmitting the data is by serial data transmision.Special integrated circuits dedicated solely to serial data transmission and reception appeared commercially in the early 1970s.These chips, commonly called asynchronous receiver transmitter or USARTS,perform all the s serial data transmission and reception tasks. The most popular data communication scheme still in use today is the transmission of serial 8-bit ASCII coded character at predefined bit rates of 300 to 19,200 bits pr second.

The serial port transmits a '0' as -3 to -25 volts where as a parallel port transmits a '0' as 0 volts and a '1' as 5 volts. Therefore the serial port have a maximum swing of 50 v compared to the parallel port which has a maximum swing of 5 volts. Therefore cable loss is not going to be much of a problem of parallel.

It requires less number of wires than parallel transmission. If the device needs to be mounted a far distance away from the computer than 3 core cable (Null Modem Configuration)id cheaper than running 19 to 25b cable.

Many of the microcontroller have in built SCI(Serial Communication Interface) which can be used to the outside world serial communication reduces the pin count of these pin count of these Microcomtrollers.Only two pins are commonly used , Transmit Data (TXD) and Receive Data(Rxd) compared with at least 8 pins if you use 8 bit parallel method.

Communication works with voltages -15V to +15V for high and low. On the other hand, TTL logic operates between 0V and +5V . Modern low power consumption logic operates in the range of 0V and +3.3V or even lower.

RS-232	TTL	Logic
-15V ... -3V	+2V ... +5V	High
+3V ... +15V	0V ... +0.8V	Low

Thus the RS-232 signal levels are far too high **TTL electronics,** and the negative RS-232 voltage for high can't be handled at all by computer logic. To receive serial data from an RS-232 interface the voltage has to be reduced. Also the low and high voltage level has to be inverted.

This level converter uses a **Max232** and five **capacitors** .

The MAX232 from **Maxim** was the first IC which in one package contains the necessary drivers and receivers to adapt the RS-232 signal voltage levels to TTL logic. It became popular, because it just needs one voltage (+5V or +3.3V) and generates the necessary RS-232 voltage levels.

The required parts:

- 1 x female serial port connector
- 1 x max 232
- 4 x 1uF capacitor
- 1 x 10uF capacitor

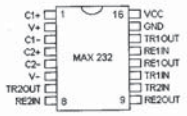


FIG8.1. MAX 232 PIN DIAGRAM

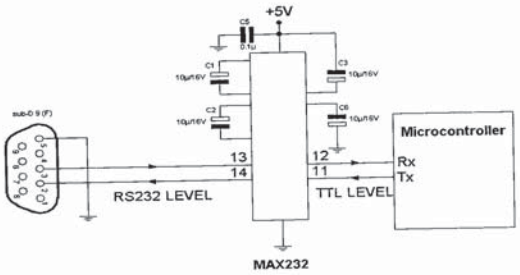


FIG8.2. INTERFACE WITH MICRO CONTROLLER

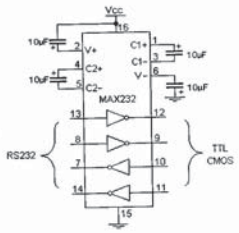


FIG8.3. CONNECTION DIAGRAM

CHAPTER 9

LCD DISPLAY

9. LCD DISPLAY

9.1. INTRODUCTION

Liquid crystal displays (LCDs) have materials , which combine the properties of both liquids and crystals . Rather than having a melting point , they have a temperature range within which the molecules are almost as mobile as they would be in a liquid,but are grouped together in an ordered from similar to a crystal.

An LCD consists of two glass panes , with the liquid crystal material`s and switched in between them.The inner surface of the glass plates is coated with transparent electrodes , which define a character , symbols or patterns to be displayed . Polymeric layers are present in between the electrodes and the liquid crystal ,which makes the liquid crystal molecules to maintain a defined orientation angle.

One each polarisers are pasted outside the two glass panels these polarisers would rotate the light rays passing through them to a definite angle, in a particular direction .

When the LCD is in the off state, light rays are rotated by the two polarisers and the liquid crystal , such that the light rays come out of the LCD without any crientation , and hence the LCD appears transparent.

When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in specific directions.The light rays passing through the LCD would be rotated by the polarisers , which would result in activating / highlighting the desired characters . The LCD's are light weight with only a few millimeters thickness.Since the LCD consume less power ,they are compatible with low power electronic circuits,and can be powered for long durations.

The LCD's don't generate light and so light is needed to read the display. By using backlighting ,reading possible in the dark.The LCD's have long life and a wide operating temperature range.Changing the display size or the layout size is relatively simple which makes the LCD's more customers friendly.

The LCD's used exclusively in watches ,calculators and measuring instruments are the simple seven segment displays ,having a limited amount of numeric data .The recent advances in technology have resulted in better legibility , more information displaying capability and a wider temperature ranges . These have resulted in the LCD's being extensively used in telecommunications and entertainment electronics . The LCD's have even started replacing the cathode ray tubes(CRT)used for the display of text and graphics , and also in small TV applications.

9.2. POWER SUPPLY

The power supply should be of +5v , with maximum allowable transients of 10mv. To achieve a better / suitable contrast for the display, the voltage (VL) at pin 3 should be adjusted properly.

A module should not be inserted or removed from a live circuit .The ground terminal of the power supply must be isolated properly so that no voltage is induced in it. The module should be isolated from the other circuits, so that stray voltages are not induced , which could cause a flickering display.

9.3. HARDWARE

Develop a uniquely decoded `E' strobe pulse , active high ,to accompany each module transactions .Address or control lines can be assigned to drive the RS and R/W

inputs.

Utilize the Host's extended timing mode ,if available , when transacting with the module . Use instructions , which prolong the read and write or other appropriate data strobes ,so as to realize the interface timing requirements.

If a parallel port is used to drive the RS,R/W and 'E' control lines , setting the 'E' bit simultaneously with RS and R/W would violate the module's set up time . A separate instruction should be used to achieve proper interfacing timing requirements .

9.4. MOUNTING

Cover the display surface with a transparent protective plate , to protect the polarizer. Don't touch the display surface with bare hands or any hard materials.This will stain the display area and degrade the insulation between terminals.

Do not use organic solvents to clean the display panel as these may adversely affect tape or with absorbent cotton and petroleum benzene. The processing or even a slight deformation of the claws of the metal frame will have effect on the connection of the output signal and cause an abnormal display.

Do not damage or modify the pattern wiring, of drill attachment holes in the PCB. When assembling the module into another equipment , the space between the modules and the fitting place should have enough height,to avoid causing stress to the module surface.

Make sure that there is enough space behind the module , to dissipate the heat generated by the IC's while functioning for longer durations . When an electrically powered screw driver is used to install the module , round it properly. While cleaning by a vacuum cleaner , do not bring sucking mouth near the module . Static electricity of

the electrically powered driver the vacuum cleaner may destroy the module.

9.5.ENVIRONMENTAL PRECAUTIONS

Operate the LCD module under the relative condition of 40 degree Celsius and 50% relative humidity. Lower temperature can cause retardation of the blanking speed of the display , while higher temperature makes the over all display discolour . When the temperature gets to be within the normal limits ,the display will be normal . Polarization degradation , bubble generation or polarizer peel-off may occur with high temperature and humidity.

Contact with water or oil over a long period of time may cause deformation or color fading of the display. Condensation on the terminals can cause electro-chemical reaction disrupting the terminal circuit.

9.6.TROUBLE SHOOTING

When the power supply is given to the module with the pin 3 (VL) connected to ground ,all the pixels of a character gets activated in the following manner.

All the characters of a single line display , as in CDM 16108 . The first eight characters of a single line display , operated in the two-line display mode, as in CDM 16116.The first line of characters of a two line display as in CDM 16216 and 40216 . The first and third line of character of a four line display operated in the two line display mode , as in CDM 20416.

If the above mentioned does not occur , the module should be initialized by software. Make sure that the control signals 'E', R/W and RS are according to the interface timing requirements.

9.7. IMPROPER CHARACTER DISPLAY

When the characters to be displayed are missing between the data read / write is too fast. A slower interfacing frequency would rectify the problem.

When uncertainly is there in the start of the first characters other that the specified ones are rewritten , check the initialization and the software routine . In a multi-line display ,if the display of characters in the subsequent lines does not take place properly, check the DD RAM addresses set for the corresponding display lines.

When it is unable to display data , even though it is present in the DD RAM , either the display on / off flag is in the off state or the display shift function is not set properly.When the display shift is done simultaneous with the data write operation, the data may not be visible on the display.

If a character is not found in the font table is displayed, or a character is missing, the CG ROM is faulty and the controller IC has to be changed.

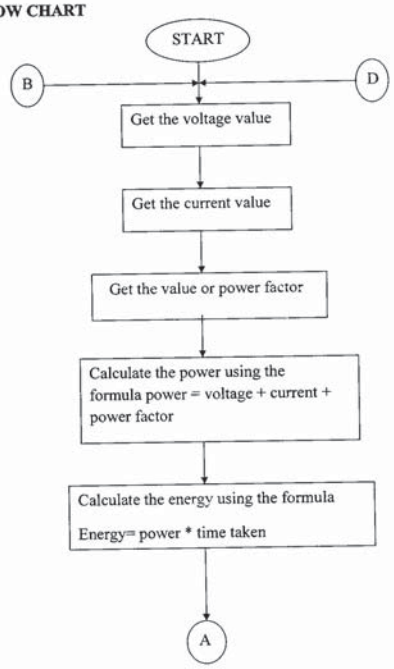
If particular pixels of the character are missing,or not getting activated properly, there could be an assembling problem in the modules.

In case any other problems are encountered you could send the module to the factory for testing and evaluations.

CHAPTER 10

SOFTWARE

10.1.FLOW CHART



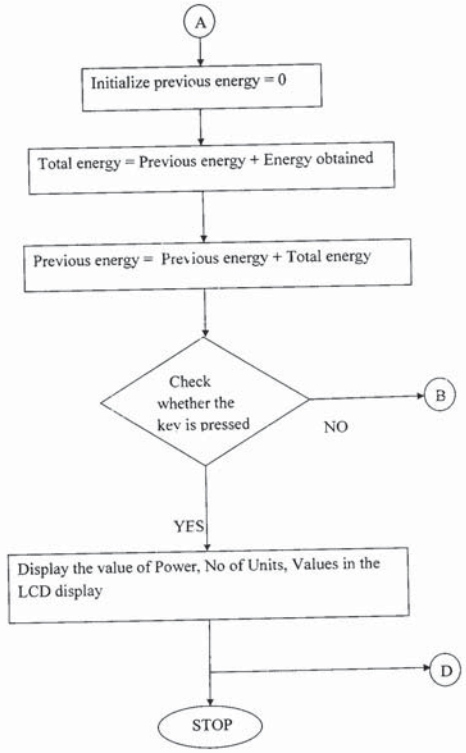


FIG10.1.FLOWCHART

10.2. PIC MICRO CONTROLLER PROGRAM

```
#include<pic.h>
static volatile bit     cr      @ ((unsigned)&PORTA*8)+0;
static volatile bit     vl      @ ((unsigned)&PORTA*8)+1;
void serial_init();
void ser_out(unsigned char);
void msg_send();
void msg_read();
void ser_conout(const unsigned char *, unsigned char);
unsigned int count=0,unit=0,vol=0,cnt=0,tmp1=0,tmp2=0;
void hex_dec(unsigned char);
void hex_dec_m(unsigned char);
unsigned int sun;
unsigned char tmp;
bit a;
bank1 unsigned char  v[77],i,cu=0xc0,g;
//unsigned int abc=1000;
void main()
{
TRISB=0x01;
TRISD=0x00;
TRISA=0xff;
TRISC=0xc0;
ADCON1=0x06;
RB6=RB7=0;
RB1=RB2=0;
a=1;
```



```
serial_init();
lcd_init();
LCD_CLR;
print_line("EB METER BILLING",0X80);
print_line("THROUGH GSM SYS ",0XC0);
delay(40000);
tmp1=0,tmp2=0,unit=0;
LCD_CLR;
delay(40000);
print_line("  SYSTEM OFF  ",0X80);
print_line("WAITING FOR MSG ",0XC0);
delay(10000);
ser_conout("AT+CMGF=1",9);
ser_out(0x0d);
delay(65000);
msg_read();
while(1)
{
s:if(a==1)
{
msg_read();
}
if(a==0)
{
RB6=1;while(1)
{
print_line("AMT:    PWR:  ",0X80);
```

```
print_line("VALUE:  UNT:  ",0XC0);
cnt=take_adc(0);
if(cnt>=100  &&  cnt<=250)
{
tmp1++;
delay(5000);
lcd_command(0xc6);
hex_dec(tmp1);
print_line("040",0x8d);
if(tmp1>10)
{
tmp1=0;
unit++;
lcd_command(0xcd);
hex_dec(unit);
lcd_command(0x84);
hex_dec(unit*2);
}msg_read();
}
//delay(65000);
else if(cnt>=250)
{
tmp1++;
//delay(30000);
lcd_command(0xc6);
hex_dec(tmp1);
print_line("100",0x8d);
```



```
if(tmp1>10)
{
tmp1=0;
unit++;
lcd_command(0xcd);
hex_dec(unit);
lcd_command(0x84);
hex_dec(unit*2);
}
msg_read();
}
if(a==1)
goto s;
if(RB0==0)
{
RB6=0;
RB1=RB2=0;
goto d;
}
}
d:msg_send();
unit=0;
msg_read();
}
}
}
if(i>70)
```



```
{
print_line("Measage Received",0x80);
print_line("              ",0xc0);
cu=0xc0;
if(v[74]=='O'&&v[75]=='n')
                {LCD_CLR;
                 print_line("  SYSTEM ON    ",0x80);
      RB6=1;
                 a=0;
                }
      else if(v[74]=='O'&&v[75]=='f')
                {LCD_CLR;
                 print_line("  SYSTEM OFF   ",0x80);
       RB6=0;
                 a=1;
                }
      else if(v[74]=='W'&&v[75]=='r')
                {LCD_CLR;
                 print_line("    WARNING    ",0x80);
       RB1=1;
       RB7=1;
       delay(65000);
                 RB7=0;
                }
      else if(v[74]=='S')
                {LCD_CLR;
                 print_line("TMRO POWER CUT ",0x80);
```



```
      lcd_command(0xc0);
      lcd_data(v[75]);
      print_line("to",0xc1);
      lcd_data(v[76]);
      RB2=1;
      RB7=1;
      delay(65000);
                RB7=0;
               }
               else
      {LCD_CLR; print_line("Invalid Format ",0x80);}
void interrupt rcc(void)
{
 if(RCIF==1)
 {
  RCIF=0;

       v[i]=RCREG;
  if(i<85)i++;
 }
}
void hex_dec_m(unsigned char dd)
{
       ser_out('0'+dd%1000/100);
       ser_out('0'+dd%100/10);
       ser_out('0'+dd%10/1);  }
```

CHAPTER 11

ADVANTAGES & APPLICATIONS

ADVANTAGES

- Need of man to collect the electricity readings.
- Low cost.
- No maintenance.
- Displays emergency messages.
- This Project displays number of units consumed and amount of that particular customer
- It displays number of units consumed and amount of that particular customer
- More suitable for hill area's to collect the energy.

APPLICATIONS

- EB billing systems.
- Water billing systems.
- Remote Areas

CHAPTER 12

FUTURE ENHANCEMENT

FUTURE ENHANCEMENT

1. Power Factor Measurement:- The current and voltage signal are given to zero crossing detector. It will calculate the time difference between these signals. Microcontroller converts time to corresponding to phase angle Φ and then calculate the power factor (cos Φ) and display the value. If the value falls below the particular level the power factor will be send to the server using GSM technology.
2. Power Theft Identification:- We fix this system to distribution transformer and measures the total energy and compared with sum of energy consumed by all the customers.
3. Acknowledgment Message:- When the message is sent from server to customer indicates the message is delivery or not.
4. Automatic shut down:- It is done by fixing relay to the distribution transformer and it is activated by relay circuit from the server side.

CHAPTER 13

CONCLUSION

CONCLUSION

The 'INTERACTIVE ELECTRICITY BILLING THROUGH WIRELESS TECHNOLOGY USING EMBEDDED SYSTEM' has been designed, constructed and tested successfully. This can be used for all kind of energy billing systems. The usage of this kind of system will definitely make difference among the Electricity board and workers. By implementing this project for electricity billing system we can reduce the human operators to collect the meter reading and processing the data and maintain the record of the customer. It also displays the emergency, warning message and also it automatically disconnect the supply to the customer if they fails to pay the bill in particular date. This project is mainly used for automate the electricity billing.

CHAPTER 14

REFERENCES

REFERENCES

BOOKS REFERED:

[1] T. Y. Lim and T. W. Chan "Experimenting Remote Kilo Watt Hour Meter Reading Through Low-Voltage Power Lines at Dense Housing Estates", Mar/Apr.1998.

[2] B. Ludden, E. Villier ,L. Lopes, B. Saleh "Mobile Subscriber Location using Handset-Assisted Positioning Techniques" August 2001.

[3] Ali I. Maswood, Senior Member, IEEE, and Fangrui Liu, Student Member, IEEE. "wireless communication system." IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 20, NO. 4, JULY 2005

[4] Nabil A. Ahmed' and Emad H. El-Zohri,"GSM communication", 0-7803-8294-3/04/$20.00 ©2004 IEEE

WEBSITES VISITED:

[1] www.microchip.com

[2] www.issi.com

[3] www.ieee.org

[4] www.wikipedia.org

CHAPTER 15

APPENDIX

Global System for Mobile Communication (GSM)

Definition

Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication. GSM is the name of a standardization group established in 1982 to create a common European mobile telephone standard that would formulate specifications for a pan-European mobile cellular radio system operating at 900 MHz. It is estimated that many countries outside of Europe will join the GSM partnership.

Overview

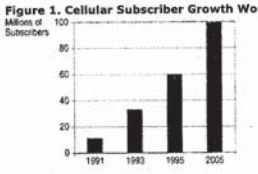
This tutorial provides an introduction to basic GSM concepts, specifications, networks, and services. A short history of network evolution is provided in order set the context for understanding GSM.

Topics

1. Introduction: The Evolution of Mobile Telephone Systems

Cellular is one of the fastest growing and most demanding telecommunications applications. Today, it represents a continuously increasing percentage of all new telephone subscriptions around the world. Currently there are more than 45 million cellular subscribers worldwide, and nearly 50 percent of those subscribers are located in the United States. It is forecasted that cellular systems using a digital technology will become the universal method of telecommunications. By the year 2005, forecasters predict that there will be more than 100 million cellular subscribers worldwide. It has even been estimated that some countries may have more mobile phones than fixed phones by the year 2000 (see *Figure 1*).

Figure 1. Cellular Subscriber Growth Worldwide



The concept of cellular service is the use of low-power transmitters where frequencies can be reused within a geographic area. The idea of cell-based mobile radio service was formulated in the United States at Bell Labs in the early 1970s. However, the Nordic countries were the first to introduce cellular services for commercial use with the introduction of the Nordic Mobile Telephone (NMT) in 1981.

Cellular systems began in the United States with the release of the advanced mobile phone service (AMPS) system in 1983. The AMPS standard was adopted by Asia, Latin America, and Oceanic countries, creating the largest potential market in the world for cellular.

In the early 1980s, most mobile telephone systems were analog rather than digital, like today's newer systems. One challenge facing analog systems was the inability to handle the growing capacity needs in a cost-efficient manner. As a result, digital technology was welcomed. The advantages of digital systems over analog systems include ease of signaling, lower levels of interference, integration of transmission and switching, and increased ability to meet capacity demands. *Table 1* charts the worldwide development of mobile telephone systems.

Table 1. The Development of Mobile Telephone Systems

Year	Mobile System
1981	Nordic Mobile Telephone (NMT) 450
1983	American Mobile Phone System (AMPS)
1985	Total Access Communication System (TACS)
1986	Nordic Mobile Telephony (NMT) 900
1991	American Digital Cellular (ADC)
1991	Global System for Mobile Communication (GSM)
1992	Digital Cellular System (DCS) 1800
1994	Personal Digital Cellular (PDC)
1995	PCS 1900—Canada
1996	PCS—United States

2. GSM

Throughout the evolution of cellular telecommunications, various systems have been developed without the benefit of standardized specifications. This presented many problems directly related to compatibility, especially with the development of digital radio technology. The GSM standard is intended to address these problems.

From 1982 to 1985 discussions were held to decide between building an analog or digital system. After multiple field tests, a digital system was adopted for GSM. The next task was to decide between a narrow or broadband solution. In May 1987, the narrowband time division multiple access (TDMA) solution was chosen. A summary of GSM milestones is given in *Table 2*.

Table 2. GSM Milestones

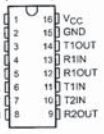
Year	Milestone
1982	GSM formed
1986	field test
1987	TDMA chosen as access method
1988	memorandum of understanding signed

MAX232, MAX232I
DUAL EIA-232 DRIVERS/RECEIVERS

SLLS047L – FEBRUARY 1989 – REVISED MARCH 2004

- Meets or Exceeds TIA/EIA-232-F and ITU Recommendation V.28
- Operates From a Single 5-V Power Supply With 1.0-μF Charge-Pump Capacitors
- Operates Up To 120 kbit/s
- Two Drivers and Two Receivers
- ±30-V Input Levels
- Low Supply Current . . . 8 mA Typical
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model (A114-A)
- Upgrade With Improved ESD (15-kV HBM) and 0.1-μF Charge-Pump Capacitors is Available With the MAX202
- Applications
  - TIA/EIA-232-F, Battery-Powered Systems, Terminals, Modems, and Computers

MAX232 . . . D, DW, N, OR NS PACKAGE
MAX232I . . . D, DW, OR N PACKAGE
(TOP VIEW)



description/ordering information

The MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply TIA/EIA-232-F voltage levels from a single 5-V supply. Each receiver converts TIA/EIA-232-F inputs to 5-V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V, a typical hysteresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input levels into TIA/EIA-232-F levels. The driver, receiver, and voltage-generator functions are available as cells in the Texas Instruments LinASIC™ library.

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	PDIP (N)	Tube of 25	MAX232N	MAX232N
	SOIC (D)	Tube of 40	MAX232D	MAX232
		Reel of 2500	MAX232DR	
	SOIC (DW)	Tube of 40	MAX232DW	MAX232
		Reel of 2000	MAX232DWR	
	SOP (NS)	Reel of 2000	MAX232NSR	MAX232
−40°C to 85°C	PDIP (N)	Tube of 25	MAX232IN	MAX232IN
	SOIC (D)	Tube of 40	MAX232ID	MAX232I
		Reel of 2500	MAX232IDR	
	SOIC (DW)	Tube of 40	MAX232IDW	MAX232I
		Reel of 2000	MAX232IDWR	

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

MICROCHIP

PIC16F87XA

28/40/44-Pin Enhanced Flash Microcontrollers

Devices Included in this Data Sheet:

- PIC16F873A
- PIC16F874A
- PIC16F876A
- PIC16F877A

High-Performance RISC CPU:

- Only 35 single-word instructions to learn
- All single-cycle instructions except for program branches, which are two-cycle
- Operating speed: DC – 20 MHz clock input
  DC – 200 ns instruction cycle
- Up to 8K x 14 words of Flash Program Memory, Up to 368 x 8 bytes of Data Memory (RAM), Up to 256 x 8 bytes of EEPROM Data Memory
- Pinout compatible to other 28-pin or 40/44-pin PIC16CXXX and PIC16FXXX microcontrollers

Peripheral Features:

- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, can be incremented during Sleep via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
- Two Capture, Compare, PWM modules
  - Capture is 16-bit, max. resolution is 12.5 ns
  - Compare is 16-bit, max. resolution is 200 ns
  - PWM max. resolution is 10-bit
- Synchronous Serial Port (SSP) with SPI™ (Master mode) and I²C™ (Master/Slave)
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection
- Parallel Slave Port (PSP) – 8 bits wide with external RD, WR and CS controls (40/44-pin only)
- Brown-out detection circuitry for Brown-out Reset (BOR)

Analog Features:

- 10-bit, up to 8-channel Analog-to-Digital Converter (A/D)
- Brown-out Reset (BOR)
- Analog Comparator module with:
  - Two analog comparators
  - Programmable on-chip voltage reference (VREF) module
  - Programmable input multiplexing from device inputs and internal voltage reference
  - Comparator outputs are externally accessible

Special Microcontroller Features:

- 100,000 erase/write cycle Enhanced Flash program memory typical
- 1,000,000 erase/write cycle Data EEPROM memory typical
- Data EEPROM Retention > 40 years
- Self-reprogrammable under software control
- In-Circuit Serial Programming™ (ICSP™) via two pins
- Single-supply 5V In-Circuit Serial Programming
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable code protection
- Power saving Sleep mode
- Selectable oscillator options
- In-Circuit Debug (ICD) via two pins

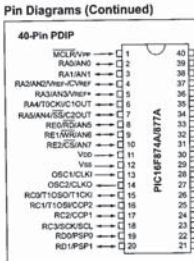
CMOS Technology:

- Low-power, high-speed Flash/EEPROM technology
- Fully static design
- Wide operating voltage range (2.0V to 5.5V)
- Commercial and Industrial temperature ranges
- Low-power consumption

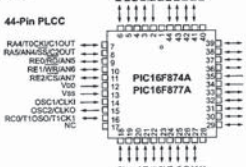
Device	Program Memory		Data SRAM (Bytes)	EEPROM (Bytes)	I/O	10-bit A/D (ch)	CCP (PWM)	MSSP		USART	Timers 8/16-bit	Comparators
	Bytes	# Single Word Instructions						SPI	Master I²C			
PIC16F873A	7.2K	4096	192	128	22	5	2	Yes	Yes	Yes	2/1	2
PIC16F874A	7.2K	4096	192	128	33	8	2	Yes	Yes	Yes	2/1	2
PIC16F876A	14.3K	8192	368	256	22	5	2	Yes	Yes	Yes	2/1	2
PIC16F877A	14.3K	8192	368	256	33	8	2	Yes	Yes	Yes	2/1	2

Pin Diagrams (Continued)

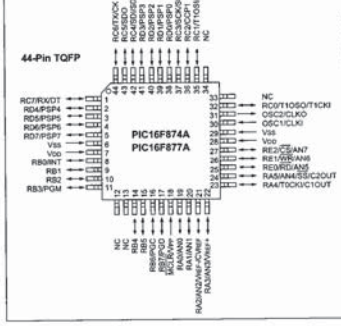
40-Pin PDIP



44-Pin PLCC

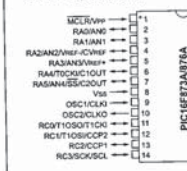


44-Pin TQFP

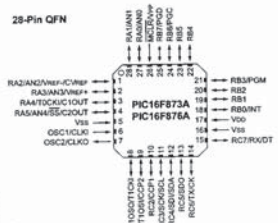


Pin Diagrams

28-Pin PDIP, SOIC, SSOP



28-Pin QFN



44-Pin QFN