Visvesvaraya Technological University, Belagavi.

PROJECT REPORT

on

"SMART PREPAID ENERGY METER"

Project Report submitted in partial fulfillment of the requirement for the award of the degree of

Bachelor of Engineering

in

Electronics and Communication Engineering

For the academic year 2019-20

Submitted by

USN	Name
1CR15EC219	OM PRAKASH SHA KALWAR
1CR16EC410	JAGADIHSA
1CR16EC433	SHIVANANDA L
1CR16EC445	VINAY A.S

Under the guidance of

JYOTHI M ROOGI

Assistant Professor

Department of ECE

CMRIT, Bengaluru

INSTITUTE OF TECHNOLOGY

Department of Electronics and Communication Engineering

CMR Institute of Technology, Bengaluru – 560 037

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CMR INSTITUTE OF TECHNOLOGY

CERTIFICATE

This is to Certify that the dissertation work **"Smart Prepaid Energy Meter"** carried out by 1 OM PRAKASH KALWAR, 2 JAGADISHA, 3 SHIVANANDA L, 4 VINAY A S, USN: 1 1CR15EC219, 2 1CR16EC410,3 1CR16EC433,4 1CR16EC445,bonafide students of **CMRIT** in partial fulfillment for the award of **Bachelor of Engineering** in **Electronics and Communication Engineering** of the**Visvesvaraya Technological University, Belagavi,** during the academic year **2019-20**. It is certified that all corrections/suggestions indicated for internal assessment have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of Project work prescribed for the said degree.

Signature of Guide	Signature of HOD	Signature of Principal
________________	________________	________________
Mrs.Jyothi M ROOGI, Assistant Professor, Dept. of ECE., CMRIT, Bengaluru.	Dr. R. Elumalai Head of the Department, Dept. of ECE., CMRIT, Bengaluru.	Dr. Sanjay Jain Principal, CMRIT, Bengaluru.

External Viva

Name of Examiners — Signature & date

1.

2

ACKNOWLEDGEMENT

The satisfaction and euphoria that accompany the successful completion of any task would be incomplete without the mention of people who made it possible, whose consistent guidance and encouragement crowned our efforts with success.

we consider it as our privilege to express the gratitude to all those who guided in the completion of the project.

We express my gratitude to Principal, **Dr. Sanjay Jain,** for having provided me the golden opportunity to undertake this project work in their esteemed organization.

We sincerely thank Dr. R. Elumalai**,**HOD**,** Department of Electronics and Communication Engineering, CMR Institute of Technology for the immense support given to me.

We express my gratitude to our project guide Mrs.Jyothi M Roogi**,**Assistant Professor, for their support, guidance and suggestions throughout the project work.

Last but not the least, heartful thanks to our parents and friends for their support.

Above all, We thank the Lord Almighty for His grace on us to succeed in this endeavor.

ABSTRACT

Over the past several years, smart cards have achieved a growing acceptance as a powerful tool for security, identification, and authorization. Financial card issuers are moving to replace magnetic stripe cards with chip cards to reduce counterfeiting and fraud. The increasing computational power placed on the chip along with advances in cryptography has made the smart card a very powerful tool for identification. The advent of multi-application smart card operating systems for both contact and contact less applications has put smart cards on the edge of information technology. This paper introduces a novel 3-tier smart card secure solution for prepaid electricity. The proposed system uses an IP-based controller in addition to a power meter, providing efficient online control of the amount of electricity consumed by the user. The user can use the card to log in to the service provider company, as well as toping up his smart card for additional power needed.

Table of Contents

Chapter 1

INTRODUCTION

1.1 INTRODUCTION

In the last decade, smart cards evolved from basic memory cards to complex systems onchips with expanding processing power. This has opened the avenue to many Applications such as financial transactions, e-commerce, physical access control, health, and transportation services [1]. The smart card, an intelligent token, is a credit card sized plastic card embedded with an integrated circuit chip. It provides not only memorycapacity, but computational capability as well. A smart card usually consists of a ROM orflash memory, EEPROM and a CPU. Access to data stored on the card is under thecontrol of the smart card operating system.

The card operating system not only makes the smart card secure for access control, but can also store a private key for a public key infrastructure system. Lately, the industry has come up with 32-bit smart card processors having more than 400Kbytes of EEPROM, as well as being the basis for secure downloading of applications. The self-containment of smart card makes it resistant to attack as it does not need to depend upon potentially vulnerable external resources. Because of this characteristic, smart cards are often used in severalapplications which require strong security protection and authentication [2]. In addition to information security, smart cards achieve greater physical security of services and equipment's, because a smart card restricts access to all but authorized users. Furthermore, the smart card can be used as a credit/debit bank card which allows it to be used effectively in e-commerce applications.It is a cost effective secure way to manage transactions electronically Manufacturers, issuers and users have recognized the value of one card that handles multi-applications.

A multi-application card will be able to automatically update new services and existing applications, change and store user profiles for each application and be accepted by a range of devices-PC, POS, mobile phones [3]. One of the most valuable applications is in using the smart card to buy energy. Domestic consumers could for instance buy energy, from any supplier wherever and whenever they choose. When the customer wants to top up their gas or electricity credit they visit a vending machine which uses the consumption data stored on their card to allocate a tariff and calculates how much energy to offer the consumer for their money [4].

1.2STATEMENT OF THE PROBLEM

In Conventional metering system to measure electricity consumption the energyprovidercompany hire persons to visit each house and record meter reading manually which is used forbilling, the bill then sent to consumer by post or handdelivery, this is not only sluggish butlaborious, with the company having no control over these meters. There is a stark amount ofrevenue loss being incurred by our country due to energy theft which is a serious problem,people try to manipulatemeter reading by adopting various corrupt practices such as currentreversal, partial earth fault condition, bypass meter, magnetic interference etc. [2]. With the aidof this project a definite solution is proffered which allows power companies to have totalcontrol over energy meters and have real time information of same from a remote location withlittle human effort and at reduced cost as compared to conventional methods.

1.3OBJECTIVE

The purpose of this project is the remote monitoring and control of the domesticenergymeter; its aims includes: to design a circuit which continuously monitors the meter reading andsends message to electricity company, programming of the GSMMODEM with AT (Attention)command sequence, interfacing the programmable chip with the personal computer, interfacingthe programmable chip with theenergy meter, interfacing of GSM MODEM with theprogrammable chip, sendingmessages from the remote phone to control device.

1.4ADVANTAGES OF PREPAIDSYSTEM

- It is highly accurate as the whole idea of reading the units and then billing manually or any other means is eliminated.
- Consumer cannot escape from paying the electricity bill and the State Electricity Board gets free from debts.

- On the consumer front, the tedious task of paying the bill and waiting anxiously for the bill is eliminated.
- Wastage of energy is diminished as now only the required energy will be consumed as allotted.
- The power grid can monitor the overall energy consumption and any tampering attempts are actually of no use and can be detected if still prevalent.
- Every smart is linked with private Aadhar card.so good subsidy is applied based on their Annual income.

Chapter 2

LITERATURE REVIEW

An electricity meter or energy meter is a device that measures the amount of electric energy consumed by a residence, business, or an electrically powered device. Electricity meters are typically calibrated in billing units, the most common one being the kilowatt hour (kWh).The electric power company which supplies the electricity installs the electric meters to measure the amount of electricity consumed by each of its customers. [3] Researchers have propose different implementation techniques for Automatic Meter Reading (AMR). One as discussed in this report is the GSM based Automatic Meter Reading System which uses the GSM network for communicating with the meter.

2.1 HISTORY OF ELECTRIC ENERGY METERS

2.1.1 DIRECT CURRENT (DC)

As commercial use of electric energy spread in the 1880s, it become increasingly important that an electric energy meter was required to properly bill customers for the cost ofenergy. Edison at first worked on a DC electromechanical meter with a direct reading register,but instead developed an electrochemical metering system, which used an electrolytic cell tototalize current consumption. At periodic intervals the plates were removed, weighed, and thecustomer billed. [3]An early type of electrochemical meter used in the United Kingdom was the 'Reason Meter. This consisted of a vertically mounted glass structure with a mercury reservoir at thetop of the meter. As current was drawn from the supply, electrochemical action transferred themercury to the bottom of the column. Like all other DC meters, it recorded ampere-hours. Once 20 the mercury pool was exhausted, the meter became an open circuit. It was therefore necessaryfor the consumer to pay for a further supply of electricity.The first accurate, recording electricity consumption meter was a DC meter by DrHermann Aron, who patented it in 1883.

2.1.2 ALTERNATING CURRENT (AC)

The first specimen of the AC kilowatt-hour meter produced on the basis of HungarianOttóBláthy'spatent and named after him. These were the first alternating-current watt-hourmeters, known by the name ofBláthy-meters. Also around 1889, Elihu Thomson of theAmerican General Electric company developed a recording watt meter (watt-hour meter) basedon an ironless commutate or motor. This meter overcame the disadvantages of theelectrochemical type and could operate on either alternating or direct current. [3]In 1894 Oliver Shallenberger of the Westinghouse Electric Corporation applied theinduction principle previously used only in AC ampere-hour meters to produce a watt-hourmeter of the modern electromechanical form, using an induction disk whose rotational speedwas made proportional to the power in the circuit. Although the induction meter would onlywork on alternating current, it eliminated the delicate and troublesome commutate or of theThomson design. [3]

2.1.3 UNIT OF MEASUREMENT

The most common unit of measurement on the electricity meter is the kilowatt hour(kWh), which is equal to the amount of energy used by a load of one kilowatt over a period ofone hour, or 3,600,000 joules. Demand is normally measured in watts, but averaged over aperiod, most often a quarter or half hour. Reactive power is measured in "thousands of volt- ampere reactive-hours", . By convention, a "lagging" or inductive load, such as a motor,will have positive reactive power.

2.1.4 TYPES OF METERS

Electricity meters operate by continuously measuring the instantaneous voltage (volts)and current (amperes) to give energy used (in joules, kilowatt-hours etc.). The meters fall intotwo basic categories, electromechanical and electronic

Chapter 3

SYSTEM ANALYSIS AND REQUIREMENTS

3.1 Introduction

This chapter entails the design and construction procedure of the GSM Energy Meterdetailing step by step the theoretical analysis, choice of components and values andconstruction and packaging materials. Indicating calculations, schematics and drawings. Thedesign procedure is divided into hardware and software design as discussed below.

3.2HardwareRequirements

1. Power supply
2. ARM LPC2148
3. RFID
4. Display
5. Relay
6. GSM
7. EPROM
8. Keypad
9. Energy Meter
10. Load

3.3SoftwareRequirements

1. Kiel M Vision
2. Python / Embedded C

3.4Software RequirementSpecification

A Software Requirements Specification (SRS) – a requirements specification for asoftwaresystem –isacompletedescriptionofthebehaviorofasystemtobedeveloped. Inadditiontoadescriptionofthesoftwarefunctions,theSRSalsocontains non-functionalrequirements.Softwarerequirementsareasub-fieldofsoftwareengineering thatdealswith the elicitation, analysis, specification, and validation of requirements forsoftware.

Chapter 4

HARDWARE

4.1 PREPAID ELECTRICITY SYSTEMBLOCK DIAGRAM

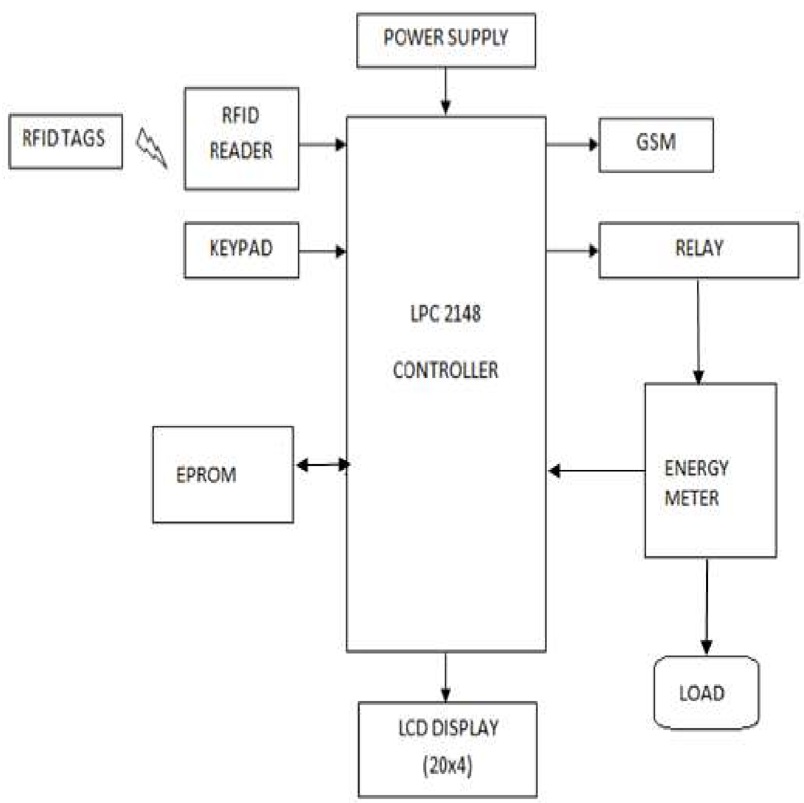

Figure 4.1 Block diagram of prepaid Electricity system

4.2ENERGY METER

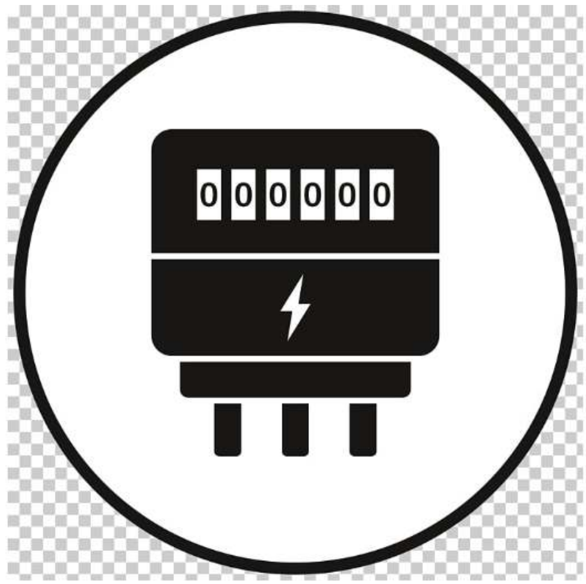

Figure 4.2 Energy meter

The energy meter has the aluminium disc whose rotation determines the power consumption of the load. The disc is placed between the air gap of the series and shunt electromagnet. The shunt magnet has the pressure coil, and the series magnet has the current coil.

The pressure coil creates the magnetic field because of the supply voltage, and the current coil produces it because of the current.

The field induces by the voltage coil is lagging by 90º on the magnetic field of the current coil because of which eddy current induced in the disc. The interaction of the eddy current and the magnetic field causes torque, which exerts a force on the disc. Thus, the disc starts rotating**.**

The force on the disc is proportional to the current and voltage of the coil. The permanent magnet controls Their rotation. The permanent magnet opposes the movement of the disc and equalises it on the power consumption. The cyclometer counts the rotation of the disc.

4.2.1 CIRCUIT DESCRIPTION

A DC power supply which maintains the output voltage constant irrespective of AC mains fluctuations or load variations is known as regulated DCpower supply.It is also referred as full-wave regulated power. Supply as it uses two diodes with the transformer. This laboratory power supply offers excellent line and load regulation and output voltages of +5V & +12 V at output currents up to one ampere.

1. **Step-down Transformer**:The transformer rating is 230V AC at Primary and 12-0-12V, 1Ampers across secondary winding. This transformer has a capability to deliver a current of 1Ampere, which is more than enough to drive any electronic circuit or varying load. The 12VAC appearing across the secondary is the RMS value of the waveform and the peak value would be 12 x 1.414 = 16.8 volts. This value limits our choice of rectifier diode as 1N4007 which is having PIV rating more than 16Volts.

2. Rectifier Stage: The two diodes D1 & D2 are connected across the secondary winding of the transformer as a full-wave rectifier. During the positive half-cycle of secondary voltage, the end A of the secondary winding becomes positive and end B negative. This makes the diode D1 forward biased and diode D2 reverse biased. Therefore diode D1 conducts while diode D2 does not. During the negative half-cycle, end A of the secondary winding becomes negative and end B positive. Therefore diode D2 conducts while diode D1 does not. Note that current across the centre tap terminal is in the same direction for both half-cycles of input AC voltage. Therefore pulsating DC is obtained at point 'C' with respect to Ground.

3. Filter Stage: Here Capacitor C1 is used for filtering purpose and connected across the rectifier output. It filters the AC components present in the rectified DC and gives steady DC voltage. As the rectifier voltage increases it charges the capacitor and also supplies current to the load. When capacitor is charged to the peak value of the rectifier voltage, rectifier voltage starts to decrease. As the next voltage peak immediately recharges the capacitor, the discharge period is of very small duration. Due to this continuous charge-discharge-recharge cycle very little ripple is observed in the filtered output. Moreover, output voltage is higher as it remains substantially near the peak value of rectifier output voltage. This phenomenon is also explained in other form as: the shunt capacitor offers a low reactance path to the AC. components of current and open circuit to DC component.

During positive half cycle the capacitor stores energy in the form of electrostatic field. During negative half cycle, the filter capacitor releases stored energy to the load.

4. Voltage Regulation Stage: Across the point 'D' and Ground there is rectified and filtered DC. In the present circuit KIA 7812 three terminal voltage regulator IC is used to get +12V and KIA 7805 voltage regulator IC is used to get +5V regulated DC output. In the three terminals, pin 1 is input i.e., rectified & filtered DC is connected to this pin. Pin 2 is common pin and is grounded. The pin 3 gives the stabilized DCoutput to the load. The circuit shows two more decoupling capacitors C2 & C3, which provides ground path to the high frequency noise signals. Across the point 'E' and 'F' with respect to ground +5V & +12V stabilized or regulated DC output is measured, which can be connected to the required circuit.

4.3 RFID

4.3.1RFID History

Radio frequency identification (RFID) technology is a wireless communication technology that enables users to uniquely identify tagged objects or people. RFID is rapidly becoming a cost-effective technology. This is in large part due to the efforts of Wal-Mart and the Department of Defense (DOD) to incorporate RFID technology into their supply chains. Although the foundation of the Radio Frequency Identification (RFID) technology was laid by past generations, only recent advances opened an expanding application range to its practical implementation.

RFID is only one of numerous technologies grouped under the term Automatic Identification (Auto ID), such as bar code, magnetic inks, optical character recognition, voice recognition, touch memory, smart cards, biometrics etc. Auto ID technologies are a new way of controlling information and material flow, especially suitable for large production networks.

The RFID technology is a means of gathering data about a certain item without the need of touching or seeing the data carrier, through the use of inductive coupling or electromagnetic waves. The data carrier is a microchip attached to an antenna (together called transponder or tag), the latter enabling the chip to transmit information to a reader (or transceiver) within a given range, which can forward the information to a host computer. The middleware (software for reading and writing tags) and the tag can be enhanced by data encryption for security-critical application at an extra cost, and anti-collision algorithms may be implemented for the tags if several of them are to be read simultaneously.

Additional capabilities are required for RFID tag design and functionality including the ability to package and encapsulate tags and incorporate sensor based technology. RFID tags are being used increasingly in extreme environments requiring exposure to harsh chemicals, high moisture and high heat.

4.3.2The Four Core Components of an RFID System

An RFID system has four basic components:

- A tag which is composed of a semiconductor chip and an antenna.
- An interrogator (sometimes called a read/write device), which is composed of an antenna, a RF electronics module, and a control electronics module.
- A controller (sometimes called a host), which most often takes the form of a PC or a workstation running database and control (often called middleware) software.
- An antenna, which converts electrical power to RF power.

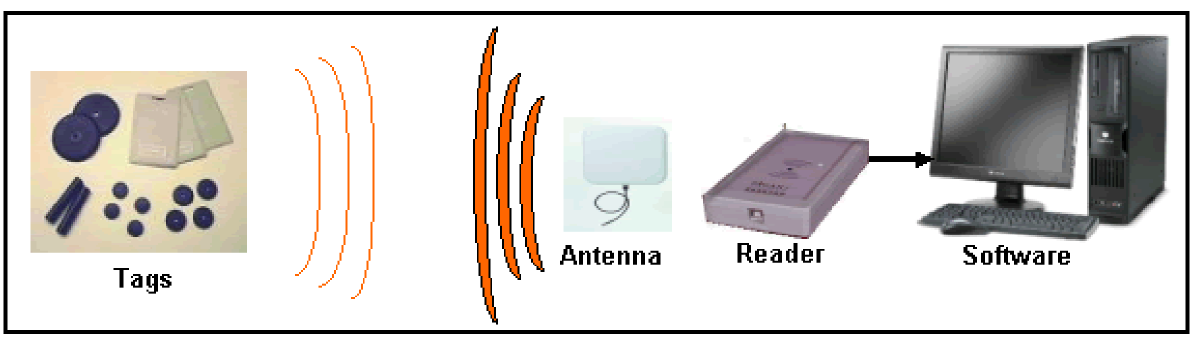

Figure 4.3: Basic Building blocks of an RFID system

4.3.3 RFID Tags

The basic function of an RFID tag is to store data and transmit data to the interrogator. At its most basic, a tag consists of an electronics chip and an antenna encapsulated in a package to form a usable tag, such as a packing label that might be attached to a box. RFID tag is shown in fig 3.2.

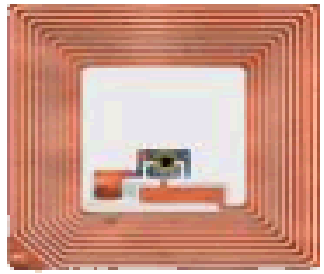

Figure 4.3.1: RFID Tag

Generally, the chip contains memory where data may be stored and read from and sometimes written, too, in addition to other important circuitry. and this is what differentiates active tags from passive tags. In our project we use passive tag.

4.3.4 RFID Interrogators (Reader)

An RFID interrogator acts as a bridge between the RFID tag and the controller and has a few basic functions to perform:

- Read the data contents of an RFID tag
- Write data to the tag (in the case of smart tags)
- Relay data to and from the controller
- Power-up the tag (in the case of passive tags).

4.3.5 Specifications of RFID:

Frequency	125 KHz
Reading distance	>= 50 mm
Interface	UART
Antenna	Built in / External
Supply Voltage	5V
Operating Temperature	-10°C to +50°C
Tag Types	Unique, TK 5530
Output Format	ASCII, Wiegand 26

Table 4.1: Specifications of RFID

4.4OVERVIEW OF ARM MICROCONTROLLER

4.4.1 Architecture of Arm 2148 Microcontroller

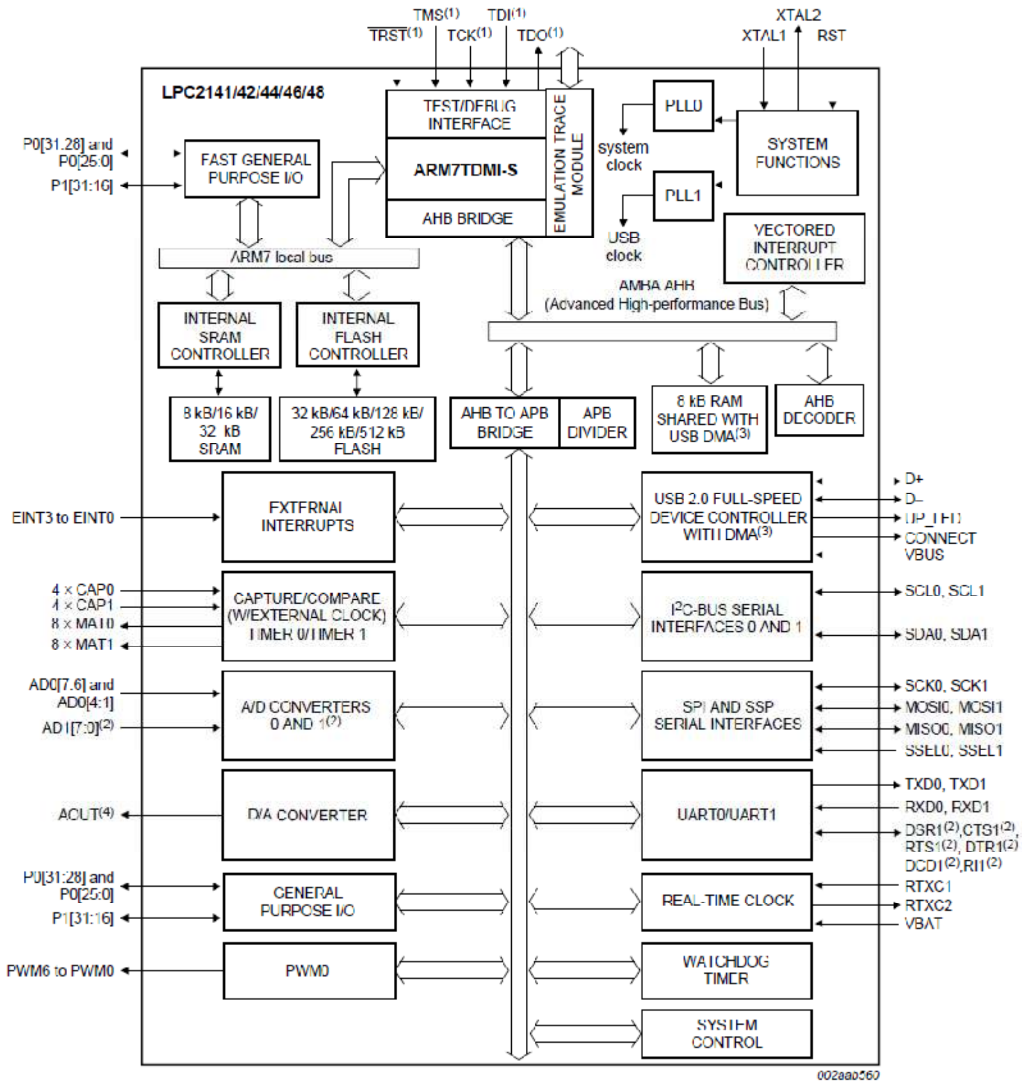

Figure 4.4: Architecture of LPC 2148

The LPC2141/42/44/46/48 microcontrollers are based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and a unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty.

Due to their tiny size and low power consumption, LPC2141/42/44/46/48 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. Serial communications interfaces ranging from a USB 2.0 Full-speed device, multiple UARTs, SPI, SSP to I2C-bus and on-chip SRAM of 8 kB up to 40 kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power.Various 32-bit timers, single or dual 10-bit. ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers suitable for industrial control and medical systems.

4.4.2 Features:

- 16-bit/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package.
- 8 kB to 40 kB of on-chip static RAM and 32 kB to 512 kB of on-chip flash.
- Memory 128-bit wide interface/accelerator enables high-speed 60 MHz operation.
- In-System Programming/In-Application Programming (ISP/IAP) via on-chip boot.
- Loader software. Single flash sector or full chip erase in 400 ms and programming of 256 bytes in 1 ms.
- Embedded ICE RT and Embedded Trace interfaces offer real-time debugging with the on-chip Real Monitor software and high-speed tracing of instruction execution.
- USB 2.0 Full-speed compliant device controller with 2 kB of endpoint RAM. In addition, the LPC2146/48 provides 8 kB of on-chip RAM accessible to USB by DMA.
- One or two (LPC2141/42 vs. LPC2144/46/48) 10-bit ADCs provide a total of 6/14 analog inputs, with conversion times as low as 2.44 μs per channel.
- Single 10-bit DAC provides variable analog output (LPC2142/44/46/48 only).
- Two 32-bit timers/external event counters (with four capture and four compare channels each), PWM unit (six outputs) and watchdog.
- Low power Real-Time Clock (RTC) with independent power and 32 kHz clock input.
- Multiple serial interfaces including two UARTs (16C550), two Fast I2C-bus (400 kbit/s), SPI and SSP with buffering and variable data length capabilities.

- Vectored Interrupt Controller (VIC) with configurable priorities and vector addresses.
- Up to 45 of 5 V tolerant fast general purpose I/O pins in a tiny LQFP64 package.
- Up to 21 external interrupt pins available.
- 60 MHz maximum CPU clock available from programmable on-chip PLL with Settling time of 100µs.
- On-chip integrated oscillator operates with an external crystal from 1 MHz to 25 MHz.
- Power saving modes include Idle and Power-down.
- Individual enable/disable of peripheral functions as well as peripheral clock scaling for additional power optimization.
- Processor wake-up from Power-down mode via external interrupt or BOD.
- Single power supply chip with POR and BOD circuits.
- CPU operating voltage range of 3.0 V to 3.6 V (3.3 V ± 10 %) with 5 V

tolerant I/O pads.

4.4.3 Functional Description of ARM Microcontroller:

The functional descriptions of the ARM microcontroller are

1. On-chip Flash Memory:

The LPC2148 incorporate a 32kB, 64kB, 128kB, 256kB and 512kB flash memory system respectively. This memory may be used for both code and data storage. Programming of the flash memory may be accomplished in several ways. It may be programmed In System via the serial port. The application program may also erase and/or program the flash while the application is running, allowing a great degree of flexibility for data storage field firmware upgrades, etc. Due to the architectural solution chosen for an on-chip boot loader, flash memory available for user's code on LPC2148 is 32kB, 64kB, 128kB, 256kB and 500kB respectively. The LPC2148 flash memory provides a minimum of 100,000 erase/write cycles and 20 years of data-retention.

2. On-Chip Static RAM:

On-chip static RAM may be used for code and/or data storage. The SRAM may be accessed as 8-bit, 16-bit, and 32-bit. The LPC2141, LPC2142/44 and LPC2146/48 provide 8kB, 16kB and 32kB of static RAM respectively. In case of LPC2146/48 only, an

8kB SRAM block intended to be utilized mainly by the USB can also be used as a general purpose RAM for data storage and code storage and execution.

3. Interrupt Controller:

The Vectored Interrupt Controller (VIC) accepts all of the interrupt request inputs and categorizes them as Fast Interrupt Request (FIQ), vectored Interrupt Request (IRQ), and non-vectored IRQ as defined by programmable settings. The programmable assignment scheme means that priorities of interrupts from the various peripherals can be dynamically assigned and adjusted.

Fast interrupt request (FIQ) has the highest priority. If more than one request is assigned to FIQ, the VIC combines the requests to produce the FIQ signal to the ARM processor. The fastest possible FIQ latency is achieved when only one request is classified as FIQ, because then the FIQ service routine does not need to branch into the interrupt service routine but can run from the interrupt vector location. If more than one request is assigned to the FIQ class, the FIQ service routine will read a word from the VIC that identifies which FIQ source(s) is (are) requesting an interrupt.

Vectored IRQs have the middle priority. Sixteen of the interrupt requests can be assigned to this category. Any of the interrupt requests can be assigned to any of the 16 vectored IRQ slots, among which slot 0 has the highest priority and slot 15 has the lowest. Non-vectored IRQs have the lowest priority.

4. Pin Control Block:

The pin connect block allows selected pins of the microcontroller to have more than one function. Configuration registers control the multiplexers to allow connection between the pin and the on chip peripherals. Peripherals should be connected to the appropriate pins prior to being activated, and prior to any related interrupt(s) being enabled. Activity of any enabled peripheral function that is not mapped to a related pin should be considered undefined.

The Pin Control Module with its pin select registers defines the functionality of themicrocontroller in a given hardware environment. After reset all pins of Port 0 and 1 are configured as input with the following exceptions: If debug is enabled, the JTAG pins will assume their JTAG functionality; if trace is enabled, the Trace pins will assume their trace functionality. The pins associated with the I2C0 and I2C1 interface are open drain.

5. Fast General Purpose Parallel I/O (GPIO):

Device pins that are not connected to a specific peripheral function are controlled by the GPIO registers. Pins may be dynamically configured as inputs or outputs. Separate registers allow setting or clearing any number of outputs simultaneously. The value of the output register may be read back, as well as the current state of the port pins. LPC2141/42/44/46/48 introduce accelerated GPIO functions over prior LPC2000.The features are

• Bit-level set and clear registers allow a single instruction set or clear of any number of bits in one port.

• Direction control of individual bits.

• Separate control of output set and clear.

• All I/O default to inputs after reset.

6. 10-Bit ADC:

The LPC2141/42 contains one and the LPC2144/46/48 contain two analog to digital converters. These converters are single 10-bit successive approximation analog to digital converters. While ADC0 has six channels, ADC1 has eight channels. Therefore, total number of available ADC inputs for LPC2141/42 is 6 and for LPC2144/46/48 are 14.The features are:

• 10 bit successive approximation analog to digital converter.

• Each converter capable of performing more than 400,000 10-bit samples per second.

• Every analog input has a dedicated result register to reduce interrupt overhead.

• Burst conversion mode for single or multiple inputs.

• Optional conversion on transition on input pin or timer match signal.

7. 10-Bit DAC:

The DAC enables the LPC2148 to generate a variable analog output. The maximum DAC output voltage is the VREF voltage. The features are:

• 10-bit DAC.

• Buffered output.

• Power-down mode available.

8.USB 2.0 Device Controller:

• Fully compliant with USB 2.0 Full-speed specification.

• Endpoint maximum packet size selection (up to USB maximum specification) bysoftware at run time.

• RAM message buffer size based on endpoint realization and maximum packet size.
• Supports Soft Connect and Good Link LED indicator. These two functions are sharing one pin.
• Supports bus-powered capability with low suspend current.
• Supports DMA transfer on all non-control endpoints (LPC2146/48 only).
• One duplex DMA channel serves all endpoints (LPC2146/48 only).
• Allows dynamic switching between CPU controlled and DMA modes (only in LPC2146/48).

9.UARTs:

The LPC2148 each contains two UARTs. In addition to standard transmit and receive data lines, the LPC2144/46/48 UART1 also provide a full modem control handshake interface. The features are:
• 16 byte Receive and Transmit FIFOs.
• Built-in fractional baud rate generator covering wide range of baud rates without a need for external crystals of particular values.
• LPC2144/46/48 UART1 equipped with standard modem interface signals. Thismodule also provides full support for hardware flow control (auto-CTS/RTS).

10.General Purpose Timers/External Event Counters:

The Timer/Counter is designed to count cycles of the peripheral clock (PCLK) or an externally supplied clock and optionally generate interrupts or perform other actions at specified timer values, based on four match registers. It also includes four capture inputs to trap the timer value when an input signals transitions, optionally generating an interrupt. Multiple pins can be selected to perform a single capture or match function, providing an application with ‘or’ and ‘and’, as well as ‘broadcast’ functions among them. The LPC2141/42/44/46/48 can count external events on one of the capture inputs if the minimum external pulse is equal or longer than a period of the PCLK. In this configuration, unused capture lines can be selected as regular timer capture inputs, or used as external interrupts. The features are:

1.A 32-bit timer/counter with a programmable 32-bit pre-scaler.
2.External event counter or timer operation.
3.Four 32-bit match registers that allow.
4. Continuous operation with optional interrupt generation on match.

5. Stop timer on match with optional interrupt generation.
6. Reset timer on match with optional interrupt generation.
7. Four external outputs per timer/counter corresponding to match registers.Following capabilities for above:

- Set LOW on match.
- Set HIGH on match.
- Toggle on match.
- Do nothing on match.

11.Watchdog Timer:

The purpose of the watchdog is to reset the microcontroller within a reasonable amount of time if it enters an erroneous state. When enabled, the watchdog will generate a system reset if the user program fails to 'feed' (or reload) the watchdog within a predetermined amount of time. The features are:

• Internally resets chip if not periodically reloaded.
• Debug mode.
• Enabled by software but requires a hardware reset or a watchdog reset/interrupt to be disabled.
• Incorrect/Incomplete feed sequence causes reset/interrupt if enabled.
• Flag to indicate watchdog reset.
• Programmable 32-bit timer with internal pre-scaler.
• Selectable time period from (TPCLK × 256 × 4) to (TPCLK × 232 × 4) in multiples of TPCLK× 4.

12.Real-Time Clocks:

The RTC is designed to provide a set of counters to measure time when normal or idle operating mode is selected. The RTC has been designed to use little power, making it suitable for battery powered systems where the CPU is not running continuously (Idle mode).

• Measures the passage of time to maintain a calendar and clock.
• Ultra-low power design to support battery powered systems.
• Provides Seconds, Minutes, Hours, Day of Month, Month, Year, Day of Week, and Day of Year.

• Can use either the RTC dedicated 32 kHz oscillator input or clock derived from theexternal crystal/oscillator input at XTAL1. Programmable reference clock dividerallows fine adjustment of the RTC.

• Dedicated power supply pin can be connected to a battery or the main 3.3V.

13.Crystal Oscillator:

On-chip integrated oscillator operates with external crystal in range of 1MHz to 25MHz. The oscillator output frequency is called fosc and the ARM processor clock frequency is referred to as CCLK for purposes of rate equations, etc. fosc and CCLK are the same value unless the PLL is running and connected.

14. PLL (Phase Locked Loop):

The PLL accepts an input clock frequency in the range of 10MHz to 25MHz. The Input frequency is multiplied up into the range of 10MHz to 60MHz with a Current Controlled Oscillator (CCO). The multiplier can be an integer value from 1 to 32 (in practice, the multiplier value cannot be higher than 6 on this family of microcontrollers due to the upper frequency limit of the CPU). The CCO operates in the range of 156 MHz to 320MHz, so there is an additional divider in the loop to keep the CCO within its frequency range while the PLL is providing the desired output frequency. The output divider may be set to divide by 2, 4, 8, or 16 to produce the output clock. Since the minimum output divider value is 2, it is insured that the PLL output has a 50 % duty cycle. The PLL is turned off and bypassed following a chip reset and may be enabled by software. The program must configure and activate the PLL, wait for the PLL to Lock, then connect to the PLL as a clock source. The PLL settling time is 100μs.

15.Reset and Wake Up Timer:

Reset has two sources on the LPC2141/42/44/46/48: the RESET pin and watchdog reset. The RESET pin is a Schmitt trigger input pin with an additional glitch filter. Assertion of chip reset by any source starts the Wake-up Timer (see Wake-up Timer description below), causing the internal chip reset to remain asserted until the external reset is de-asserted, the oscillator is running, a fixed number of clocks have passed, and the on-chip flash controller has completed its initialization.

When the internal reset is removed, the processor begins executing at address 0, which is the reset vector. At that point, all of the processor and peripheral registers have been initialized to predetermined values.

The Wake-up Timer ensures that the oscillator and other analog functions required for chip operation are fully functional before the processor is allowed to execute instructions. This is important at power on, all types of reset, and whenever any of the aforementioned functions are turned off for any reason. Since the oscillator and other functions are turned off during Power-down mode, any wake-up of the processor from Power-down mode makes use of the Wake-up Timer.

The Wake-up Timer monitors the crystal oscillator as the means of checking whether it is safe to begin code execution. When power is applied to the chip, or some event caused the chip to exit Power-down mode, some time is required for the oscillator to produce a signal of sufficient amplitude to drive the clock logic. The amount of time depends on many factors, including the rate of VDD ramp (in the case of power on), the type of crystal and its electrical characteristics (if a quartz crystal is used), as well as any other external circuitry (e.g. capacitors), and the characteristics of the oscillator itself under the existing ambient conditions.

16.External Interrupt Inputs:

The LPC2148 include up to nine edge or level sensitive External Interrupt Inputs as selectable pin functions. When the pins are combined, external events can be processed as four independent interrupt signals. The External Interrupt Inputs can optionally be used to wake-up the processor from Power-down mode. Additionally capture input pins can also be used as external interrupts without the Option to wake the device up from Power-down mode.

17.Power Control:

The LPC2141/42/44/46/48 supports two reduced power modes: Idle mode and Power-down mode. In Idle mode, execution of instructions is suspended until either a reset or interrupt occurs. Peripheral functions continue operation during Idle mode and may generate interrupts to cause the processor to resume execution. Idle mode eliminates power used by the processor itself, memory systems and related controllers, and internal buses. In Power-down mode, the oscillator is shut down and the chip receives no internal clocks. The processor state and registers, peripheral registers, and internal SRAM values are preserved throughout Power-down mode and the logic levels of chip output pins remain static. The Power-down mode can be terminated and normal operation resumed by either a reset or certain specific interrupts that are able to function without clocks. Since all dynamic operation of the chip is suspended, Power-down mode reduces chip Power consumption to nearly zero. Selecting an external 32 kHz clock instead of the PCLK as a clock-source for the on-chip RTC will enable the microcontroller to have the RTC active during Power-down mode. Power-down current is increased with RTC active. However, it is significantly lower than in idle mode.

A Power Control for Peripherals feature allows individual peripherals to be turned off if they are not needed in the application, resulting in additional power savings during active and idle mode.

4.5 GSM (GLOBAL SYSTEM FOR MOBILE COMMUNICATION)

4.5.1 INTRODUCTION

Figure 4.5 GSM Module

Global System for Mobile (GSM) is a second generation cellular standard developed to cater voice services and data delivery using digital modulation.

Global System for Mobile communications is the most popular standard for mobile phones in the world. Its promoter, the GSM Association, estimate that 82% of the global mobile market uses the standard. GSM is used by over 2 billion people across more than 212 countries and territories. Its ubiquity makes international roaming very common between mobile phone operators, enabling subscribers to use their phones in many parts of the world.

GSM has used a variety of voice codecs to squeeze 3.1 kHz audio into between 5.6 and 13kbit/s. Originally, two codecs, named after the types of data channel they were allocated, were used, called Half Rate (5.6kbit/s) and Full Rate (13kbit/s). These used a system based upon linear predictive coding (LPC). In addition to being efficient with bit rates, these codecs also made it easier to identify more important parts of the audio, allowing the air interface layer to prioritize and better protect these parts of the signal.

There five different cell sizes in a GSM network-macro, micro, Pico, femto and umbrella cells. The coverage area of each cell varies according to the implementation environment. Macro cells can be regarded as cells where the base station antenna is installed on a mast or a building above average roof top level. Micro cells are cells whose antenna height is under average roof top level; they are typically used in urban areas. Pico cells are small cells whose coverage diameter is a few dozen meters; they are mainly used indoors. Femtocells are cells designed for use in residential or small business environments and connect to the service provider's network via a broadband internet connection. Umbrella cells are used to cover shadowed regions of smaller cells and fill in gaps in coverage between those cells. Cell horizontal radius varies depending on antenna height, antenna gain and propagation conditions from a couple of hundred meters to several tens of kilometers. The longest distance the GSM specification supports in practical use is 35 kilometers (22 mi).

Indoor coverage is also supported by GSM and may be achieved by using an indoor picocell base station, or an indoor repeater with distributed indoor antennas fed through power splitters, to deliver the radio signals from an antenna outdoors to the separate indoor distributed antenna system. These are typically deployed when a lot of call capacity is needed indoors, for example in shopping centers or airports. However, this is not a prerequisite, since indoor coverage is also provided by in-building penetration of the radio signals from nearby cells.

4.5.2 SUBSCRIBER IDENTITY MODULE (SIM)

One of the key features of GSM is the Subscriber Identity Module (SIM), commonly known as a SIM card. The SIM is a detachable smart card containing the user's subscription information and phonebook. This allows the user to retain his or her information after switching handsets. Alternatively, the user can also change operators while retaining the handset simply by changing the SIM. Some operators will block this by allowing the phone to use only a single SIM, or only a SIM issued by them; this practice is known as SIM locking, and is illegal in some countries.

A subscriber can usually contact the provider to remove the lock for a fee, utilize private services to remove the lock, or make use of ample software and websites available on the Internet to unlock the handset themselves. While most web sites offer the unlocking for a fee, some do it for free. The locking applies to the handset, identified by its International Mobile Equipment Identity (IMEI) number, not o the account (which is identified by the SIM card). It is always possible to switch to another (non-locked) handset if such a handset is available.

4.5.3 GSM MODEMS

A modem is a communication device that converts binary into analog acoustic signals for transmission over telephone lines and converts these acoustics signals back into binary form at the receiving end. Conversion to analog signal is known as**modulation**, conversion back to binary signal is known as **demodulation**.

In the terminology used in the RS-232C communication standard, modems are DCEs, which mean the connected at one end to a DTE (e.g. computer) device. Low-speed modems are designed to operate asynchronously. Each data frame conforms an asynchronous transmission mechanism.

High-speed modems as well as leased-lines modems use synchronous transmission. The two modems use a common time base and operate continuously at substantially the same frequency and the phase relationship by circuit that monitors the connection.

A half-duplex modem must alternately send and receive signals. Half-duplex allows more of the channel bandwidth to be put to use but slows data communications.

A full-duplex modem can simultaneously handle two signals using two carriers to transmit and receive data. Each carrier uses a half of the bandwidth available to it and its modulation.

ASK is not used for data communications because it is very susceptible to electrical noise interference. Low-speed modems use FSK, higher speed modems use PSK, and the very high speed modems use a conjunction of ASK and PSK.

The SMS/MMS Gateway requires a connection to an SMSC (Short Messaging Service Centre) to interface with SMS and MMS networks.

An SMSC connection can consist of one or more of the following:

- GSM Modem – A GSM modem or phone connected to a PC serial port (or to a USB port with an appropriate modem driver).
- SMPP (Short Message Peer to Peer Protocol) – A TCP/IP connection over the internet or a private network to a service that supports v3.3 or v3.4 of the SMPP protocol.
- UCP/EMI (Universal Computer Protocol/ External Machine Interface) – A TCP/IP connection over the internet or a private network to a service that supports v3.5 or v4.0 of the UCP/EMI protocol.
- HTTP (Hyper Text Transfer Protocol, e.g., the standard protocol for the “web”) – A TCP/IP connection over the internet or private network to a service that accepts SMS messages via an HTTP “GET” based protocol allows you to chain multiple Now SMS/MMS Gateways together.)

For all microcontroller DIYer’s out there, connect the DTR pin to a +3 to 12 Volt supply and RTS to a -3 to -12Volt supply. The easy way to achieve this is by using a Max232 or similar transceiver for the RS232 TX and RX pins and then connecting the DTR pin on the serial cable to the V+ pin on the Max232. Do the same for the RTS, however connect it to the V- pin on the Max232. The V+ and V- pins are derived from internal charge pumps that double the input voltage. I.e. For a 5V Max232, the V+ will +10V and the V- will be -10V. I hope this clears up this issue for most people!

The next step is to synchronize the UART in the phone with your PC or microcontroller. This is done by sending a string of 0x55 or ‘U’ 128 times. Simple! The bus is now ready to be used for sending frames.

4.5.4 GSM SERVICES

- Tele-services.
- Bearer or Data Services.
- Supplementary service.

Tele-services:

Telecommunication services enable voice communication via mobile phones and offers services like Mobile telephony and Emergency calling.

Bearer or Data Services:

- Include various data services for information transfer between GSM and other networks like PSTN, ISDN etc at rates from 300 to 9600 bps.
- Short Message Service (SMS): Up to 160 character alphanumeric data transmission to/from the mobile Terminal.
- Unified Messaging Services(UMS).
- Group 3 fax.
- Voice mailbox.
- Electronic mail.

Supplementary services:

Call related services

- Call Waiting- Notification of an incoming call while on the handset.
- Call Hold- Put a caller on hold to take another call.
- Call Barring- All calls, outgoing calls, or incoming calls.
- Call Forwarding- Calls can be sent to various numbers defined by the user.
- Multi Party Call Conferencing - Link multiple calls together.
- CLIP – Caller line identification presentation.
- CLIR – Caller line identification restriction.
- CUG – Closed user group.

4.5.5 WORKING OF GSM MODEM

A GSM modem is a wireless modem that works with GSM wireless networks. A wireless modem is similar to a dial-up modem. The main difference is that a wireless modem transmits data through a wireless network whereas a dial-up modem transmits data through a copper telephone line. Most mobile phones can be used as a wireless modem.

To send SMS messages, first place a valid SIM card into a GSM modem, which is then connected to microcontroller by RS232 cable. After connecting a GSM modem to a microcontroller, you can controlthe GSM modem by sending instructions to it. The instructions used for controlling the GSM modem are called AT commands. GSM modems support a common set of standard AT commands. In addition to this common set of standard AT commands, GSM modems support an extended set of AT commands. One use of the extended AT commands is to control the sending and receiving of SMS messages.

4.5.6 Characteristics of GSM Standard:

- Fully digital system using 900, 1800 MHz frequency band.
- TDMA over radio carriers (200 KHz carrier spacing.
- 8 full rate or 16 half rate TDMA channels per carrier.
- User/terminal authentication for fraud control.
- Encryption of speech and data transmission over the radio path.
- Full international roaming capability.
- Low speed data services (up to 9.6 Kb/s).
- Compatibility with ISDN.
- Support of Short Message Service (SMS).

4.5.7 Advantages of GSM over Analog system:

- Capacity increases.
- Reduced RF transmission power and longer battery life.
- International roaming capability.
- Better security against fraud (through terminal validation and user authentication).
- Encryption capability for information security and privacy.
- Compatibility with ISDN, leading to wider range of service.

4.5.8 GSM Applications:

- Mobile telephony.
- GSM-R.
- Value Added Services.
- Telemetry System.
- Fleet management.
- Automatic meter reading.
- Toll Collection.
- Remote control and fault reporting of DG sets.

4.6Liquid Crystal Display

In recent years the LCD is finding widespread use replacing LEDs this is due to following reasons-

- The declining prices of LCDs.
- The ability to display numbers, characters and graphics. This is in contrast to LEDs, which are limited to numbers and few characters.
- Incorporation of a refreshing controller in to LCD, there by relieving the CPU of the task of refreshing the LCD. In contrast LCD must be refreshed by CPU to keep displaying the data.

Figure 4.6: LCD display

4.6.1 Basic reading

This section deals with the character based LCD module which use Hitachi HD44780 controller chip. These modules are not quite as advanced as the latest generation, full size, full color, back lit types used in today's laptop computers, but far from being "phased out", Character based LCDs, are still used extensively in commercial and industrial equipment ,particularly where display requirements are reasonably simple.

4.6.2 Shapes and sizes of LCD

Even limited to character based modules, there is still a wide variety of shapes and Sizes available. Line lengths 8, 16,2,024,32 and 40 character are all standard, in one, two and 4 lines versions.

Several different liquid crystal technologies based exist. "Supertwist" types, for Example, offer improved contrast and viewing angle over the older "twisted pneumatic" types. Some modules are available with backlighting, so that they can view in dimly lit conditions.

4.6.3 Connections of LCD

A 14 pin access is provided having 8 data lines, 3 control lines and 3 power lines. The connections are laid out in one of two common configurations, either two row of seven pins, or a single row of 14 pins. The two layout alternatives are displayed in fig2.7

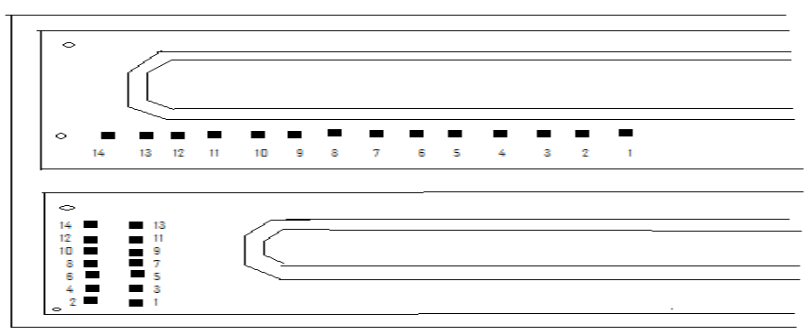

Figure 4.6.1: Pin out of the 2 basic LCD formats.

On most displays, the pins are numbered on the LCD's PCB, but if not, it is quite easy to locate pin1.Since this pin is connected to ground, it often has a thicker PCB track connected to it and it is generally connected to the metal work at some point.

The block diagram of an LCD module with all the pin details is shown in figure 4.3.The function of each of the connections is shown in table 2.Pin 1 and 2 are the power supply lines, Vss and Vdd. The Vdd pin should be connected to positive supply and Vss to 0V supply or ground. Although the LCD module data sheets specify a 5VDC supply, Supplies of 6V and 4-5V both work well, and even 3V is sufficient for some modules.Pin 3 is a control pin, Vee, which is used to alter the contrast of the display. Ideally, this pin should be connected to a variable voltage supply.

Pin 4 is the (RS) register select line. When this line is low, data bytes transferred to the display are treated as commands and data bytes read from the display indicate its status.By setting the RS line high, character data can be transferred to and from the module.Pin 5 is read/write line. This line is pulled low in order to write commands or character data to the module, or pulled high to read character data or status informationfrom its registers.

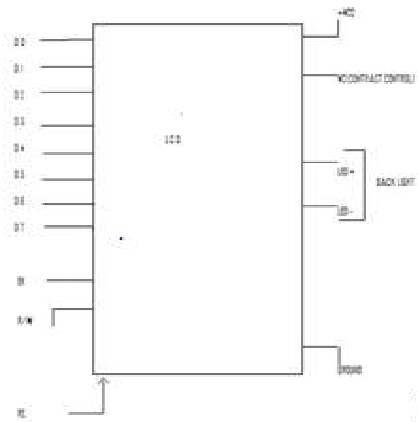

Figure 4.6.2: pin details of an LCD module

pin	name	function
1	Vss	Gnd
2	Vdd	+ve supply
3	Vee	contrast
4	RS	regester select
5	R/W	read/write
6	E	enable
7	D0	data bit0
8	D1	data bit1
9	D2	data bit2
10	D3	data bit3
11	D4	data bit4
12	D5	data bit5
13	D6	data bit6
14	D7	data bit7

Table 4.2: Pin out functions for all the LCD type

Pin 6 is the enable line. This input is used to initiate the actual transfer of commands or character data between the module and the data lines. When writing to the display, data is transferred only on high to low transition of this signal.

Pin 7 to 14 are data bus lines (D0 to D7).data can be transferred to and from the display either as a single 8 bit byte or two 4 bit nibbles. The other two pins LED+ and LED- are used for back light of the LCD.

Now let us try to display a single character on LCD. When powered up, the display should show a series of dark squares, possibly on a part of the display. These character cells are actually in their off state, so the contrast control should be adjusted anti clock wise until the squares are only just visible.

The display module resets itself to an initial state when power is applied, which curiously the display has blanked off, so that even if the characters are entered, they cannot be seen. It is therefore necessary to issue a command at this point, to switch the display on.

The display on/off and cursor command turns on the display, but also determines the cursor style at the same time. Initially it is better to select a blinking cursor with under line, so that its position can be clearly seen. i.e. Code 00001111(0F).set the data switches (s1 to s8) to 00001111(0F) and ensure that RS switch (S10) is “down” (logic 0).so that the device is in command mode.

Now presses E switch (S9) momentarily, which enables the chip to accept the data. Now set RS switch to “up” position (logic 1), switching the chip from command mode to character mode and enter the binary value 01000001(41) on data switches. This is ASCII code for a capital A. Press the switch and marvel as the display fills up with capital as. Clearly, something is not right.

4.6.4 Liquid crystal

Liquid crystals are substances that exhibit a phase of matter that has properties between those of a conventional liquid, and those of a solid crystal. For instance, a liquid Crystal (LC) may flow like a liquid, but have the molecules in the liquid arranged and/or Oriented in a crystal-like way.

Each pixel of an LCD typically consists of a layer of molecules aligned between two transparent electrodes, and two polarizing filters, the axes of transmission of which are (most of the cases) perpendicular to each other. The surfaces of the electrodes that are in contact with the liquid crystal material are treated so as to align the liquid crystal molecules in a particular direction. This treatment typically consists of a thin polymer layer that is unidirectional rubbed using, for example, a cloth. The direction of the liquid crystal alignment is then defined by the direction of rubbing. Electrodes are made of a transparent conductor called Indium Tin Oxide (ITO).

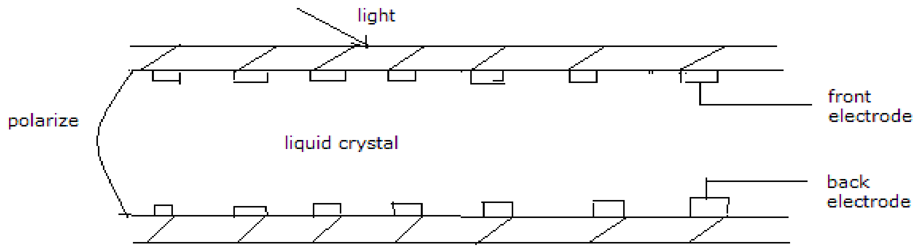

Figure4.6.3 liquid crystal molecule alignment

4.6.5 Definitions

- Resolution: The horizontal and vertical size expressed in pixels (e.g., 1024x768).
- Dot pitch: The distance between the centers of two adjacent pixels. The smaller the dots pitch size, the less granularity is present, resulting in a sharper image. Dot pitch may be the same both vertically and horizontally, or different (less common).
- Viewable size: The size of an LCD panel measured on the diagonal (more specifically known as active display area).
- Response time: The minimum time necessary to change a pixel's color or brightness.

4.6.6 Interfacing LCD with microcontroller

Interfacing LCD with microcontroller is very easy task. You just have to know the proper LCD programming algorithm. LCD used here has HD44780u dot matrix LCD controller. LCD module has 8-bit data interface and control pins. One can send data as 8-bit or in pair of two 4-bit nibbles.

To display any character on LCD micro controller has to send its ASCII value to the data bus of LCD. For e.g. to display 'AB' microcontroller has to send two hex bytes 41h and 42h respectively. LCD display used here is having 16x2 size. It means 2 lines each with 16 characters.

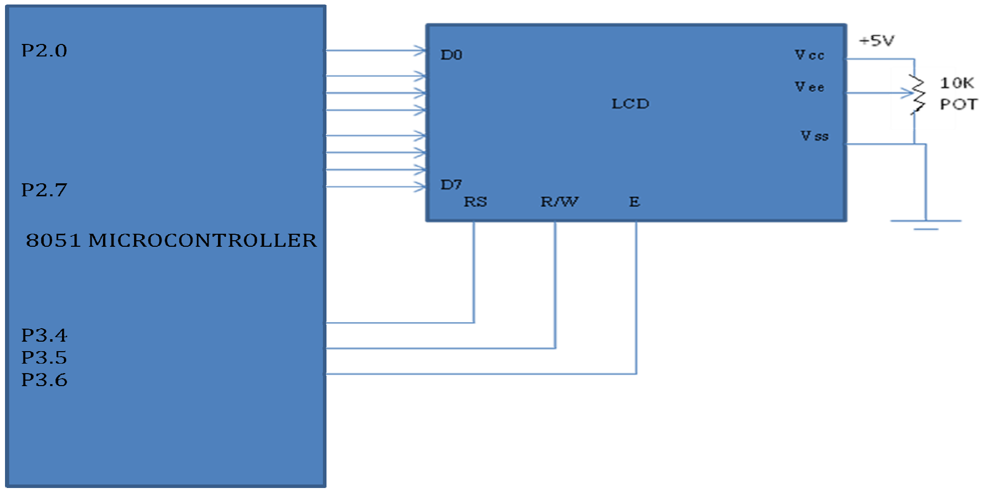

Figure 4.6.4: Interfacing LCDwith Microcontroller

4.6.7 Role of LCD

The LCD module is used in the vehicle anti-collision system to display the range information which is calculated by LV Max Sonar-EZ1 and also to display one of the three zones in which the vehicle is present. If the distance displayed is above 20 inches it displays “safe” zone.If the distance is between 15 and 19 inches, then it displays “alert” zone. If the distance is below 15 inches, the LCD will display “stop” zone.

16X2 LCD

This LCD can be used to display 16 characters in 2 rows. It has the ability to display numbers, characters and graphics. It has an inbuilt refreshing circuit, thereby relieving the CPU from the task of refreshing. LCD discussed has total of 14 pins.

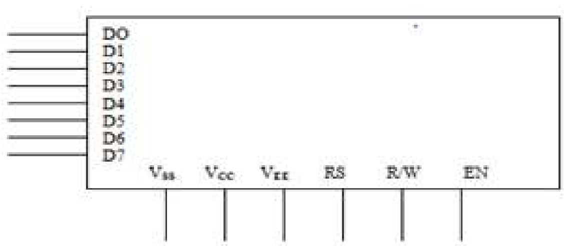

Figure 4.6.5: Pin Out Of A Generic 16 X 2 LCD

4.6.8 LCD pin Description

Pin	Symbol	I/O	Description
1	Vss	-	Ground
2	Vcc	-	+5V Power Supply
3	Vee	-	Power Supply to contrast
4	RS	I	RS = 0 to select command register
5	R/W	I	RS = 1 to select data register
6	EN	I/O	Enable
7 to 14	D0 to D8	I/O	8 bit data bus

Table 4.3: LCD Pin Description

4.6.9 LCD Command Codes

Code(HEX)	Command to LCD Instruction Register
1	Clear display screen
2	Return home
4	Decrement cursor (shift cursor to left)
6	Increment cursor (shift cursor to right)
80	Force cursor to the beginning of first line
C0	Force cursor to the beginning of second line
38	2 lines and 5x7 matrix

Table 4.4 : LCD Command Codes

Chapter 5

SOFTWARE DESCRIPTION

5.1 Introduction to keilµVision3

The µVision3 IDE is a Windows-based software development platform that combines a robust editor, project manager, and makes facility. µVision3 integrates all tools including the C compiler, macro assembler, linker/locator, and HEX file generator. The µVision3 IDE offers numerous features and advantages that help you quickly and successfully develop embedded applications. They are easy to use and are guaranteed to help you achieve your design goals.The features are:

- The µVision3 Simulator is the only debugger that completely simulates all on-chip peripherals.
- Simulation capabilities may be expanded using the Advanced Simulation Interface (AGSI).
- µVision3 incorporates project manager, editor, and debugger in a single environment.
- The µVision3 Device Database automatically configures the development tools for the target microcontroller.
- The µVision3 IDE integrates additional third-party tools like VCS, CASE, and FLASH/Device Programming.
- The ULINK USB-JTAG Adapter supports both Debugging and Flash programming with configurable algorithm files.
- Identical Target Debugger and Simulator User Interface.
- The Code Coverage feature of the µVision3 Simulator provides statistical analysis of your program's execution.

5.2Embedded C:

When designing software for a smaller embedded system with the 8051, it is very common place to develop the entire product using assembly code. With many projects, this is a feasible approach since the amount of code that must be generated is typically less than 8 kilobytes and is relatively simple in nature. If a hardware engineer is tasked with designing both the hardware and the software, he or she will frequently be tempted to write the software in assembly language.

The trouble with projects done with assembly code can is that they can be difficult to read and maintain, especially if they are not well commented. Additionally, the amount of code reusable from a typical assembly language project is usually very low. Use of a higher-level language like C can directly address these issues. A program written in C is easier to read than an assembly program.

Since a C program possesses greater structure, it is easier to understand and maintain. Because of its modularity, a C program can better lend itself to reuse of code from project to project. The division of code into functions will force better structure of the software and lead to functions that can be taken from one project and used in another, thus reducing overall development time. A high order language such as C allows a developer to write code, which resembles a human's thought process more closely than does the equivalent assembly code. The developer can focus more time on designing the algorithms of the system rather than having to concentrate on their individual implementation. This will greatly reduce development time and lower debugging time since the code is more understandable.

By using a language like C, the programmer does not have to be intimately familiar with the architecture of the processor. This means that someone new to a given processor can get a project up and running quicker, since the internals and organization of the target processor do not have to be learned. Additionally, code developed in C will be more portable to other systems than code developed in assembly. Many target processors have C compilers available, which support ANSIC.

All of this is not to say that assembly language does not have its place. In fact, many embedded systems (particularly real time systems) have a combination of C and assembly code. For time critical operations, assembly code is frequently the only way to go. One of the great things about the C language is that it allows you to perform low-level manipulations of the hardware if need be, yet provides you the functionality and abstraction of a higher order language.

5.3 Flash Magic Software:

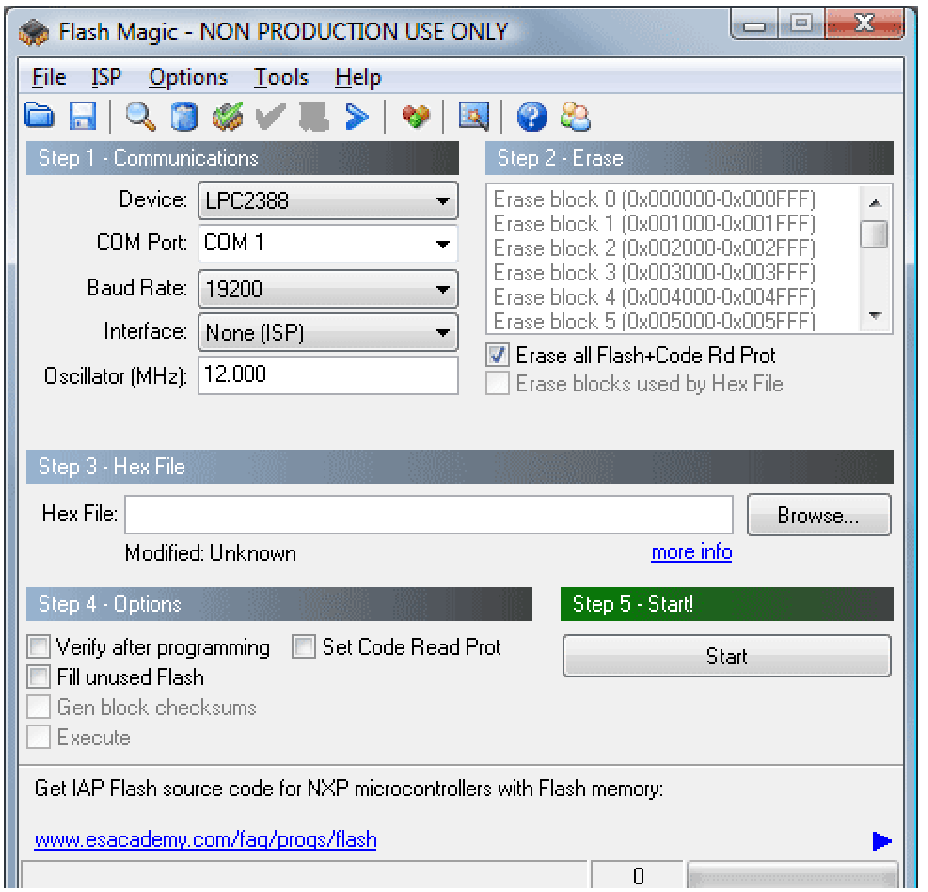

Figure 5.1: Main window Flash magic

Flash Magic is a PC tool for programming flash based microcontrollers from NXP using a serial or Ethernet protocol while in the target hardware.

If your converter does not have DTR and RTS lines, "hold down the ISP/PRI_BLD switch, RESET the board(press and release reset switch) and then release the ISP switch ". Now the Boot Controller will be in ISP/PRI_BLD mode and you can flash the hex file using flash magic. Flash Magic works on Windows Vista, 7, 8 and 10. 50Mb of disk space is required.

Now open the flash magic software and follow the below steps.

1. Select the IC from Select Menu.
2. Select the COM Port. Check the device manager for detected Com port.
3. Select Baud rate from 9600-115200.
4. Select None Isp Option.
5. Oscillator Freq 12.000000(12Mhz).
6. Check the Erase blocks used by Hex file option.
7. Browse and Select the hex file.
8. Check the Verify After Programming Option.
9. If DTR and RTS are used then go to Options->Advanced Options-> Hardware Configuration and select the Use DTR and RTS Option.
10. Hit the Start Button to flash the hex file.
11. Once the hex file is flashed, Reset the board. Now the controller should run your application code.

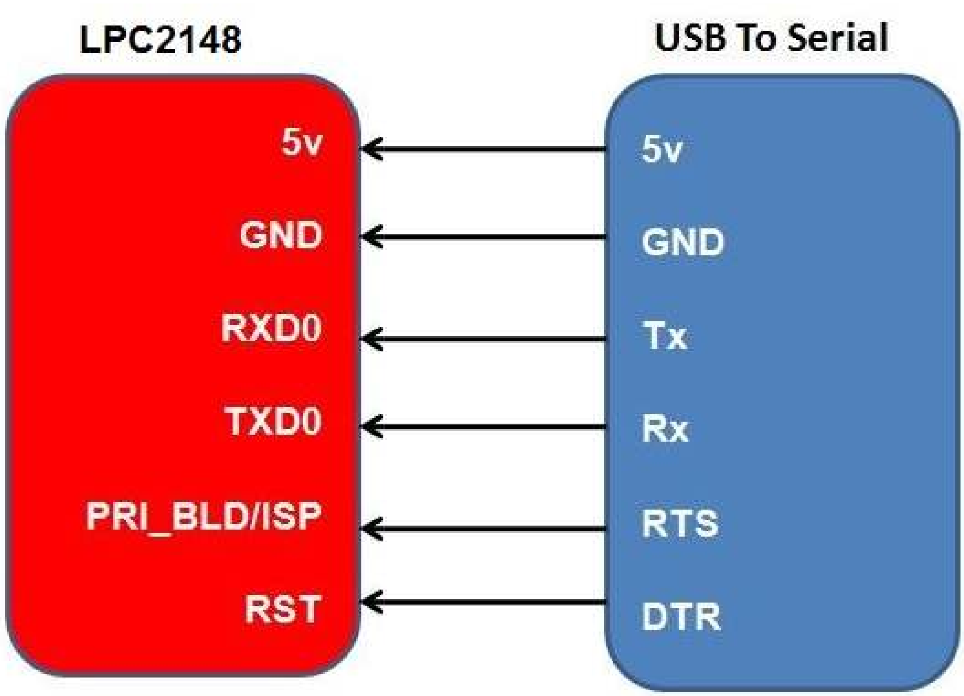

Figure 5.2: USB to serial converter

Chapter 6

METHODOLOGY

The purpose of this project is the remote monitoring and control of the domesticenergymeter; its aims includes: to design a circuit which continuously monitors the meter reading andsends message to electricity company, programming of the GSMMODEM with AT (Attention)command sequence, interfacing the programmable chip with the personal computer, interfacingthe programmable chip with theenergy meter .

6.1Smart Card System:

The smart card reader incorporated into the system uses RFID tags for communication and reading the smart card. RFID is a tracking technology used to identify and authenticate tags that are applied to any product, individual or animal. Radio frequency Identification and Detection is a general term used for technologies that make use of radio waves in order to identify objects and people. Its purpose is to facilitate data transmission through the portable device known as tag that is read with the help of RFID reader and process it as per the needs of an application. Information transmitted with the help of tag offers location or identification along with other specifics of the product tagged.

6.2Flow Chart

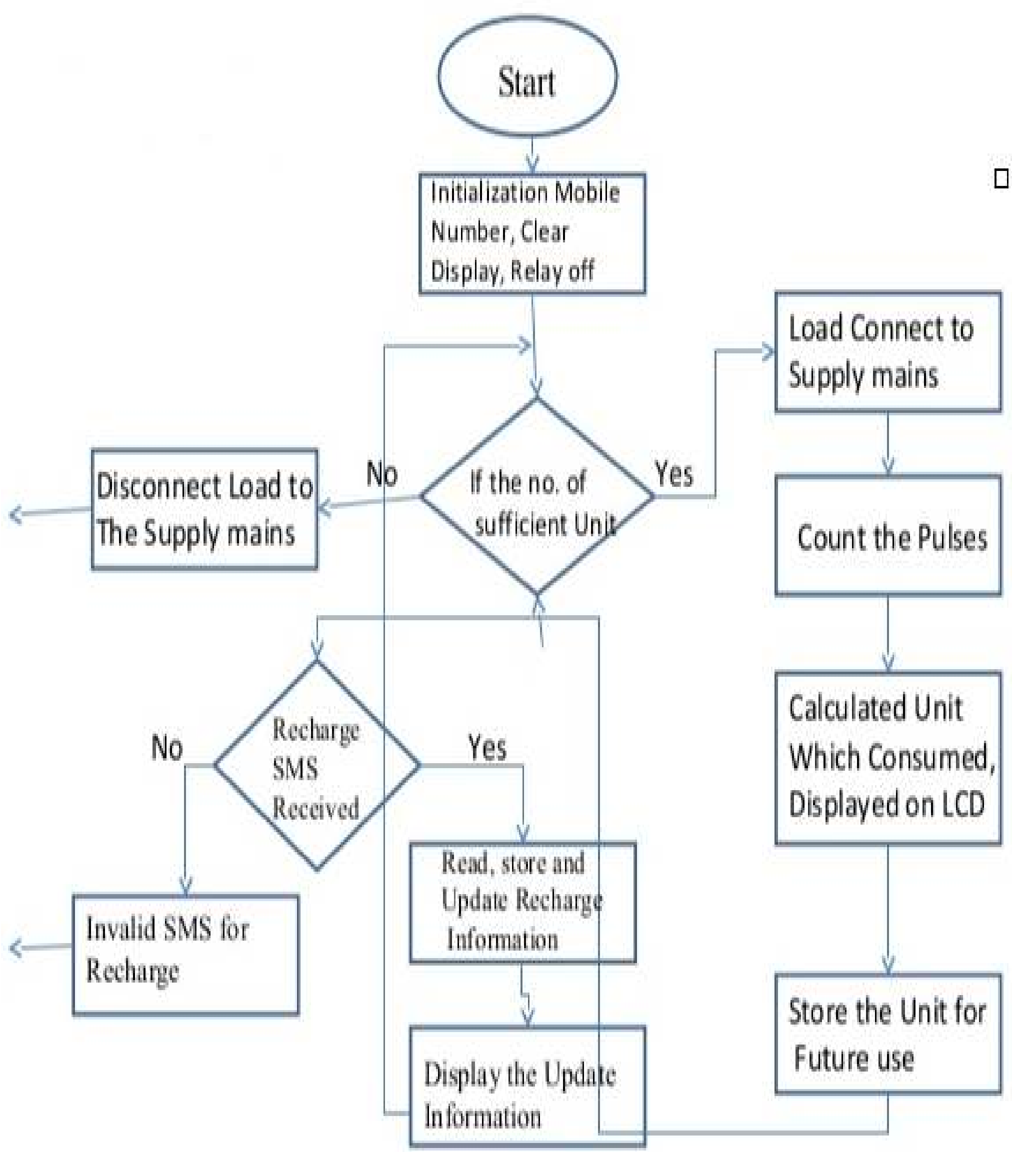

Figure 6.1 Flow chart for main process

Chapter 7

Conclusion and Future Scope

7.1 SUMMARY

The GSM Based Energy Meter project as stated proffers solution to the deficiencies oftraditional metering system. With the implementation of the GSM network system which isreadily available. Man is on the way to ultimately derive the benefits in remote automationand control of electrical system. With this design fully implemented the cost associated withmetering is reduced. Power theft at minimum, proper documentation and even distribution ofpower to consumers is found to be more effective.Therefore it avoids human intervention, provides efficient meter reading, avoid the billingerror and reduce the maintenance cost. It displays the corresponding information on LCD foruser notification

7.2 Conclusion:

Modern civilization would be brought to its knees, if a crisis of electricity scarcity everlooms. The cusp of society would collapse. Therefore, the undeniable need for uninterruptibleelectricity is the prelude to development of any nation in the world today. From the design ofthe system and development, it is realized that the implementation of the GSM BASEDENERGY METER meets the objectives of its design as it was able to fully remote control theactivities of the meter unit by doing the following making it beneficial to both utilitycompany and consume

- Connect the unit to power Grid.
- Disconnect the unit from power Grid.
- Take meter reading.
- Recharge the meter unit.
- Reset the meter unit

Therefore meeting the requirements of providing a solution to power theft, loadcontrol, proper documentation of individual consumer energy usage over a period oftime. Providing the power utility company to proper plan and design sufficientinfrastructure equipment for power transmission

Chapter 8

REFERENCES

[1]Electronic Energy Prepayment Meter Overview,Nigeria Technology News, http://www.nairaland.com/electronicenergyprepaymentoverview6486487/hrfh

[2]https://html1-f.scribdassets.com/td4uzzcn45aqwo3/images/80-8d5ce851a0.png

[3]Abhinandan Jain, Department of Electronics &Electrical Communication, PECUniversity of Technology, Chandigarh, India, Dilip Kumar, Department of Academic andConsultancy Services Division C-DAC, Mohali, India. JyotiKedia, Department ofElectronics & Electrical Communication PEC University of Technology, Chandigarh, India. Design and Development of GSM based Energy Meter ,

[4]H.G.Rodney, Tan IEEE, C.H.Lee and V.H.Mok, (2007), Automatic Power MeterReading system using GSM Network. The 8th International Power Engineering Conference, pp. 465 -469

[5]A. Abdollahi, M. Dehghani, and N.Zamanzadeh,"SMS-based reconfigurableautomatic meter reading system, IEEE International Conference Control Applications., Oct. 2007.

[6]Mr.RahulGanesh Sarangle, ProfDr.UdayPanditKhot, Prof. JayenModi , GSM BasedPower Meter Reading And Control System , International Journal of Engineering Researchand Applications (IJERA)

[7]PIC18F2550 Data Sheet, Microchip Technology Inc.www.datasheetcatalog.com

[8]Printed circuit Processes & Instructions, Comprehensive Datak Instructions for PrintedCircuit Prototyping