Installation of advanced power management system for reduced operation and maintenance

Major Project Report

Submitted in Partial Fulfillment of the Requirements for the *Degree of*

MASTER OF TECHNOLOGY

IN

ELECTRICAL ENGINEERING
(Electrical Power Systems)

By

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Undertaking For Originality of the Work

I, **Mr. Jayesh H. Karavadara**, (**Roll No:11MEEE08**), give undertaking that the Major Project entitled **"Installation of Advanced Power Management Sysyem for Reduced Operation and Maintenance"** submitted by me, towards the partial fulfillment of the requirement for the degree of Master of Technology in **Electrical Power Systems**, **Electrical Engineering**,under Institute of Technology, Nirma University, Ahmedabad is the original work carried out by me and I give assurance that no attempt of Plagiarism has been made. I understand that in the event of any similarity found subsequently with any published work or any dissertation work elsewhere; it will result in severe disciplinary action.

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This is to certify that the Major Project Report (Part-II) entitled **"Installation of Advanced Power Management System for Reduced Operation and Maintenance"** submitted by **Mr.Jayesh H. Karavadara (11MEEE08)**, towards the partial fulfillment of the requirements for Semester-III of **Master of Technology (Electrical Engineering)** in the field of **(Electrical Power System)** of Nirma University is the record of work carried out by him under our supervision and guidance. The work submitted has reached a level required for being accepted for examination. The results embodied in this major project, to the best of my knowledge, have not been submitted to any other University or Institution for award of any degree or diploma.

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Abstract

PC based power management system is implemented with the latest microprocessor based system. Protective relay have power system operating dynamic of their system in new and unique ways. The multifunction relay and meter have enable a reduction in the number of components and increase the reliability of power distribution system. The PC based software allows for set points adjustment parameters trending waveforms analysis and event recording with time and date stamping. This system includes features such as an interactive one-line diagram that can show system. Chips AD7751 will be in the form of frequency and is converted into digital form. Fault indicator is also provided and if phase or neutral any one is remove, the reading will be noted. The purpose of this project is to develope a digital energy meter which should be computer interfaced using dedicated chip.

Contents

List of Figures

Chapter 1

Introduction

An electricity meter or energy meter is a device that measures the amount of electric energy consumed by aresidence, business, or an electrically powered device. Electricity meters are typically calibrated in billing units, the most common one being the kilowatt hour [kWh]. Periodic readings of electric meters establishes billing cycles and energy used during a cycle. In settings when energy savings during certain periods are desired, meters may measure demand, the maximum use of power in some interval. "Time of day" metering allows electric rates to be changed during a day, to record usage during peak high-cost periods and o-peak, lower-cost, periods. Also, in some areas meters have relays for demand response shedding of loads during peak load periods.

1.1 History of Energy Meter

1.1.1 Types of Energy Meter

- Electromechanical meters:

  The most common type of electricity meter is the electromechanical induction watt-hour meter. The electromechanical induction meter operates by counting the revolutions of a non-magnetic, but electrically conductive, metal disc which is made to rotate at a speed proportional to the power passing through the meter. The number of revolutions is thus proportional to the energy usage. The voltage coil consumes a small and relatively constant amount of power,typically around 2 watts which is not registered on the meter. The current coil similarly consumes a small amount of power in proportion to the square of the current owing through it, typically up to a couple of watts at full load, which is registered on the meter.

The disc is acted upon by two coils. One coil is connected in such a way that it produces a magnetic ux in proportion to the voltage and the other produces a magnetic ux in proportion to the current. The field of the voltage coil is delayed by 90 degrees, due to the coil's inductive nature, and calibrated using a lag coil.This produces eddy currents in the disc and the eect is such that a force is exerted on the disc in proportion to the product of the instantaneous current, voltage and phase angle (power factor) between them.

A permanent magnet exerts an opposing force proportional to the speed of rotation of the disc. The equilibrium between these two opposing forces results in the disc rotating at a speed proportional to the power or rate of energy usage. The disc drives a register mechanism which counts revolutions, much like the odometer in a car, in order to render a measurement of the total energy used. The type of meter described above is used on a single-phase AC supply. Different phase configurations use additional voltage and current coils.

- Electronic Meter:
  Electronic meters display the energy used on an LCD or LED display, and some can also transmit readings to remote places. In addition to measuring energy used, electronic meters can also record other parameters of the load and supply such as instantaneous and maximum rate of usage demands,voltages, power factor and reactive power used etc. They can also support time-of-day billing, for example, recording the amount of energy used during on-peak and of-peak hours.

Figure 1.1: Electro Mechanical Meter

As in the block diagram as shown in figure1.1, the meter has a power supply, a metering engine, a processing and communication engine (i.e. a microcontroller), and other addon modules such as RTC, LCD display, communication ports/modules and so on. The metering engine is given the voltage and current inputs and has a volt- age reference, samplers and quantisers followed by an ADC section to yield the digitised equivalents of all the inputs. These inputs are then processed using a digital signal processor to calculate the various metering parameters such as powers, energies etc.

The largest source of long-term as shown in figure 1.2 errors in the meter is drift in the preamp, followed by the precision of the voltage reference. Both of these vary with temperature as well, and vary wildly because most meters are outdoors. Char- acterizing and compensating for these is a major part of meter design. The processing and communication section has the responsibility of calculating the various derived quantities from the digital values generated by the metering en- gine. This also has the responsibility of communication using various protocols and interface with other addon modules connected as

Figure 1.2: Electronic Meter

slaves to it.

RTC and other add-on modules are attached as slaves to the processing and communication section for various input/output functions. On a modern meter most if not all of this will be implemented inside the microprocessor, such as the real time clock (RTC), LCD controller, temperature sensor, memory and analog to digital converters.

1.2 Objective of Project

Electronic energy meter has got various advantage over the conventional electro- mechanical meters, due to this many country of the world has switch to electronic meter system.In this project setup we will measure Voltage and Current through digital devices. That device will interface with micro-controller 89S52 further it will communicate with PC with help of Serial communication RS232. This meter also include

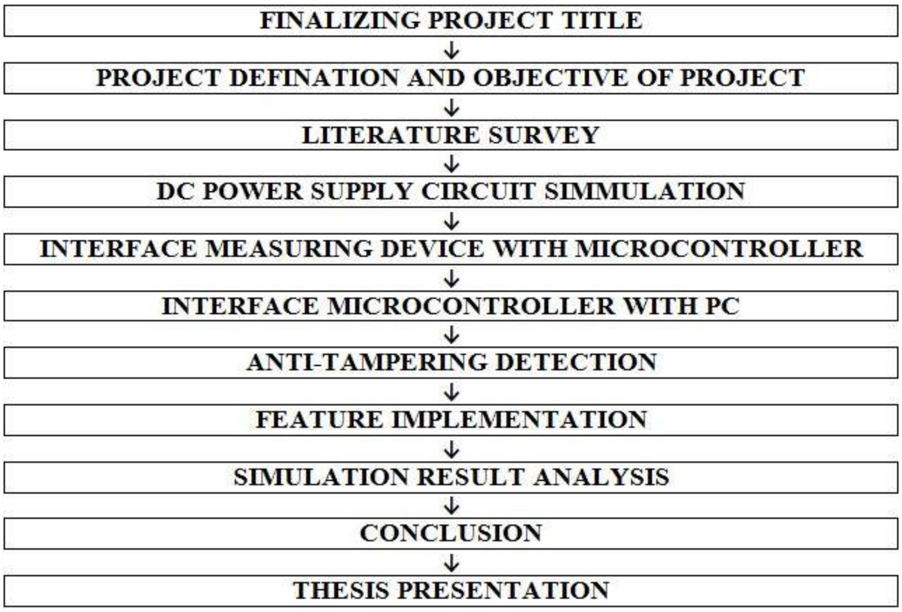

Figure 1.3: Project Planning

one more features of anti temporing function.Output result will generated in Multi-sim.Main diagram is shown in figure1.3

Chapter 2

Literature Review

Reference [1]Electronic energy meter has got numerous advantages over the con- ventional electromechanical meter and due to this; many countries of the world have switched to electronic metering system. But unfortunately Pakistan is still deprived of such meters. The paper is based on the final year project of the design implementation of prepaid electronic energy meter which we are designing in order to eliminate the problems being faced by the Pakistani people. By the introduction of prepaid system in Pakistan the problem of overcharging and over billing and the trouble being faced by the customers in paying the bills will be removed all together. Since our meter is electronic in nature, it has got no moving parts and hence the problem of stability accuracy due to temperature changes are solved. Our meter is also tamper resistant which eradicates the chances of the theft of electricity.

Reference [2] In this paper, the design and simulation of Intelligent Prepaid Energy Meter (IPEM) has been presented. The objectives of this work are :(i) to model an IPEM,(ii) to show its reliability on load measurement ; and (iii) to show graphical behavior of energy consumption pattern of different loads connected to power supply. The design methodology is Artificial Intelligent (AI) based-using knowledge-based and cognitive simulation approach. The intelligentce properties and expected results of the proposed digital meter was modeled into the system; and was simulated using Matlab /Simulation tool. Results obtained were very satisfactory. If fully implemented, on one hand, the estimated bills or irregular billing imposed by Power

Holding Company of Nigeria(PHCN) on her customers will stop; and on the other hand ,revenue loss through unpaid bills suffered by PHCN will greatly reduce. This will have an overall effects on the nations economy as revenue collection will increase.

Reference [3] presents the design and implementation of a microprocessor based intelligent three phase energy meter that measures accurate energy, even at the presence of harmonics. Moreover if a fault occurs in anyone of the potential transformer (PT) secondary circuits or the potential coil in the measuring device, the unit can sense the fault and registers the actual energy. Microprocessor provides a simple, accurate, reliable and economical solution of these problems. A framework of hardware circuitry and assembly language program for evaluation of energy values has been given and the problems which should be paid attention to execute the proposed algorithm using microprocessor has been discussed. Illustrative laboratory test results confirm the validity and accurate performance ofthe proposed method in real-time.

Reference [4]Electronic energy meter has got numerous advantages over the conventional electromechanical meter and due to this; many countries of the world have switched to electronic metering system. But unfortunately Pakistan is still deprived of such meters. The paper is based on the final year project of the design implementation of prepaid electronic energy meter which we are designing in order to eliminate the problems being faced by the Pakistani people. By the introduction of prepaid system in Pakistan the problem of overcharging and over billing and the trouble being faced by the customers in paying the bills will be removed all together. Since our meter is electronic in nature, it has got no moving parts and hence the problem of stability accuracy due to temperature changes are solved. Our meter is also tamper resistant which eradicates the chances of the theft of electricity.

Paper [5] presents Electricity-stealing defense is one of the chief steps in distribution network reconstruction. The electronic energy meter is an important invention for measurement energy power system, which is an effective measures for the electricity-stealing defense. And one-time seal technology makes stealing ways reduced to the limited several specific ways that are undercurrent tecnology, undervoltage teconology and phase-shifted teconology. All these ways are stealing electricity in front of the energy meter. Due to these methods of electricity-stealing and actual demand of defending stealing electricity, based on a digital three-phase electric energy meter, The equipment of electricity-stealing defense electronic energy meter is designed, which adopts Atmega128 as the control core, uses a low power consumption and a high accuracy ADE7758 as the energy metering unit, takes use of the output impulse of standard electricy measure module and user electric energy meter to calculate and judge electricitystealing by comparing the reading RMS voltage and current from the ADE7758 with the ZigBee wireless acquisition module. Energy meter can communicates with the concentrator by 485, infraned or carrier module. The energy meter sends the eective data back to the concentrator. It is showed that this system can not only accurate measurement of electrical energy, but also to accurately determine the occurrence and electricity-stealing and the time of stealing is also recorded, which bring great convenience to the power system.

Reference [6] design a Wireless Prepayment Energy Meter, which is used to measure single-phase energy with 50/60Hz rated frequency. It realizes the functions of pre- payment management and load control that pay of energy first use it afterwards. the data can be exchanged between Energy meters and Energy supplying department by RF cards. The information can be transmitted in a non-contact way. In this way, the purpose of automatic identification can be achieved. The paper describes hardware design firstly, then software designs.

Chapter 3

Project Detail

3.1 MCU (micro controller unit)

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmels high-density nonvolatile memory technology and is compatible with the industry standard 80C51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly- exible and cost-effective solution to many embedded control applications.

The AT89S52 provides the following standard features as shown in figure3.1: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, se- rial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.8-bit Microcontroller with 8K Bytes In-System Programmable Flash AT89S52 1919D.

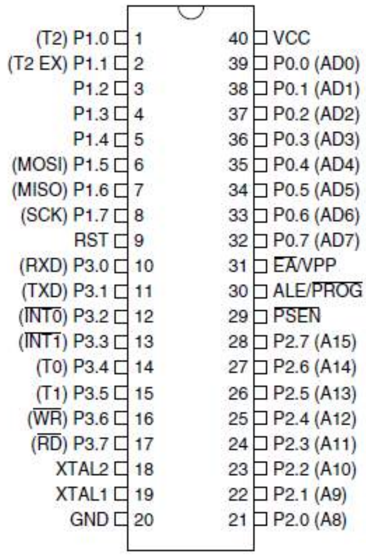

Figure 3.1: Micro-Controller Pin diagram

3.2 Microcontroller 89S52

- Reset Circuit circuit
- Lcd interfacing
- Adc interfacing
- Ad 7751 interfacing
- RS232 interfacing

3.2.1 Reset Circuit

The RST (Reset) Pin Of Microcontroller Is Used To Reset The Execution Of Software. It Is Active High Pin So Whenever It Receives High Signal On This Pin, Microcontroller Gets Reset And Whole Execution Is Starts From Beginning. The Reset Circuit

Is As Shown In Figure. Initially When Capacitor Is In Fully Discharged Stage, It Acts As A Short Circuit. Hence When We Switch On The Power, +5V Is Transferred To RST Pin Of Microcontroller Via Capacitor. This Reset Is Known As Power On Reset. After Some Time, Capacitor Gets Fully Charged And Hence It Acts As A Open Circuit. So No Current Flows Through This Capacitor. We Have Connected One Switch Across Capacitor. This Switch Is Used To Give Manual Reset Whenever Required During Operation. When Switch Is Pressed, the RST Pin Gets High Signal and microcontroller Is Gets Reset. During Normal operation this pin is latched to ground.

3.2.2 Crystal circuit

The Crystal Oscillator Is Used To Provide Clock Pulses To Microcontroller. The Crystal Is Connected Between Xtal1 and Xtal2 (Pin No- 18 19) Pins of Microcontroller. Two Ceramic Capacitors (Range Of Value Is 20 Pf To 40Pf) Is Grounded From Xtal1 And Xtal2 Pins To Provide Stability In Crystal Oscillator.

3.2.3 LCD Interfacing

In Our Project We Will Use 20 X 4 LCD. Which Has 4 Lines, Every Line Contains 20 Characters. Any Alphanumeric Characters Can Be Seen On LCD. It Contains 16 Pins. (Explain Pin Diagram Here). The Data Pins Are Connected To One Port Of Microcontroller. The Control Pins Of LCD Is Connected With 3 I/O Pin Of Microcontroller Which Handles Internal Operation Of LCD. In Our Project We Will Show Instantaneous AC Voltage, Current, Real Energy (KWH).

3.3 Power Supply

- Step down transformer
- Bridge rectifier

- Capacitor filter regulator
- Tank capacitor

The Purpose of Power Supply Is To Get +12V and +5V DC from 230V Ac. To Do This We First Use Step Down Transformer (0-12V), Which Converts 230V AC In To 12V AC. This 12V AC Is Rms Value. The Peak Value Is 12 X 1.41= 16.92V AC. Hence the Secondary Winding of Transformer Contains 12V AC (Rms) or 16.92V (Peak). This Voltage Is Then Fed To Full Wave Bridge Rectifier To Convert Into DC. The Bridge Rectifier Converts AC Voltage to DC Voltage. The Output of Bridge Rectifier Is Pulsating DC I.E It Contains AC and DC Component. To Remove AC Component From Rectified DC Voltage, We Use Capacitor As A Filter. This Capacitor Filter Removes Ripple from Pulsating DC Signal and Make It Pure DC. The Ceramic Capacitor Is Used To Remove Any Noise In The Output. The 7812 Regulator IC Gives Constant +12 V DC Till Its Input Has More Than 12 Volts. The Capacitor After This Regulator IC Is Used To Reduce Dv/Dt Rating For +12V. The Output Of 7812 Is Given To 7805 Regulator IC Which Gives Steady +5V DC Output Till Its Input Has More Than 5 Volts. The Current Limiting Resistor Along With Led Is Used To Get Visual Indication For Presence Of Regulated +12V And +5V DC. By This Way We Can Convert 230V AC To +12V DC And +5V DC Voltage.

3.4 AD7751 Introduction

- Working principle
- Pin diagram
- features

3.4.1 Features

- High Accuracy, Supports 50 Hz/60 Hz IEC 521/1036 Less than 0.1 Percentage Error Over a Dynamic Range of 500 to 1 The AD7751 Supplies Average Real Power On the Frequency Outputs F1 and F2

- The High Frequency Output CF Is Intended for Calibration and Supplies Instantaneous Real Power Data
- Continuous Monitoring of the Phase and Neutral Current Allows Fault Detection in Two-Wire Distribution Systems
- The AD7751 Uses the Larger of the Two Currents (Phase or Neutral) to BillEven During a Fault Condition
- Two Logic Outputs (FAULT and REVP) Can Be Used to Indicate a Potential Miswiring or Fault Condition
- Direct Drive for Electromechanical Counters and Two-Phase Stepper Motors (F1 and F2)
- A PGA in the Current Channel Allows the Use of Small Values of Shunt and Burden Resistance
- Proprietary ADCs and DSP Provide High Accuracy Over Large Variations in Environmental Conditions and Time
- On-Chip Power Supply Monitoring
  On-Chip Creep Protection (No Load Threshold)
  On-Chip Reference 2.5 V 6 8 (30 ppm/8C Typical) with External Overdrive.

3.4.2 General description

The AD7751 is a high accuracy fault tolerant electrical energy measurement IC intended for use with two-wire distribution systems. The part specifications surpass the accuracy requirements as quoted in the IEC1036 standard.

The only analog circuitry used on the AD7751 is in the ADCs as shown in figure3.2 and reference circuit. All other signal processing (e.g., multiplication and filtering) is carried out in the digital domain. This approach provides superior stability and accuracy over extremes in environmental conditions and over time.

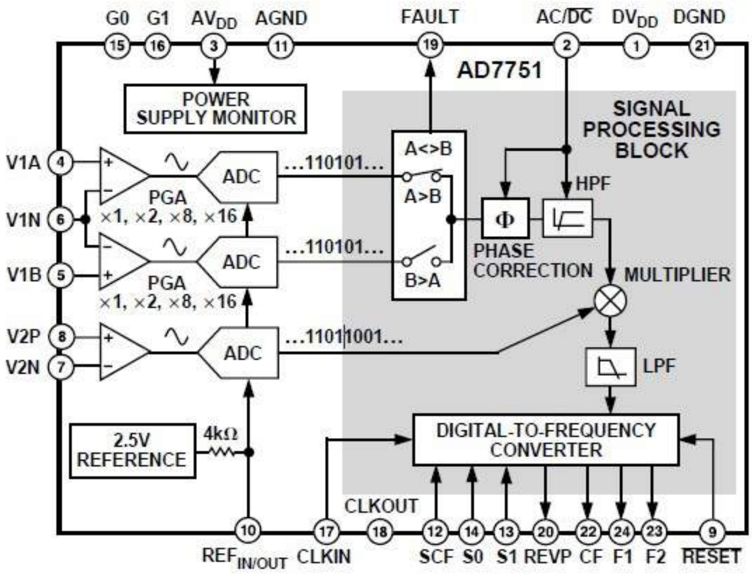

Figure 3.2: Function Block diagram AD7751

The AD7751 incorporates a novel fault detection scheme that both warns of fault conditions and allows the AD7751 to continue accurate billing during a fault event. The AD7751 does this by continuously monitoring both the phase and neutral (return) currents. A fault is indicated when these currents differ by more than 12.5of the two currents when the difference is greater than 14.

The AD7751 supplies average real power information on the low frequency outputs F1 and F2. These logic outputs may be used to directly drive an electromechanical counter or interface to an MCU. The CF logic output gives instantaneous real power information. This output is intended to be used for calibration purposes.

The AD7751 includes a power supply monitoring circuit on the AVDD supply pin. The AD7751 will remain in a reset condition until the supply voltage on AVDD reaches 4 V. If the supply falls below 4 V, the AD7751 will also be reset and no pulses will be issues on F1, F2 and CF.

Internal phase matching circuitry ensures that the voltage and current channels are matched whether the HPF in Channel 1 is on or off. An internal no-load threshold ensures that the AD7751 does not exhibit any creep when there is no load.

The AD7751 is available in 24-lead DIP and SSOP packages.

3.4.3 AD7751 Pin function Description

- DVdd : Digital Power Supply. This pin provides the supply voltage for the digital circuitry in the AD7751. The supply voltage should be maintained at 5 V 5 for specified operation. This pin should be decoupled with a 10 F capacitor in parallel with a ceramic 100 nF capacitor.

- AC/DC : High-Pass Filter Select. This logic input is used to enable the HPF in Channel 1 (the current channel). A Logic 1 on this pin enables the HPF. The associated phase response of this filter has been internally compensated over a frequency range of 45 Hz to 1 kHz. The HPF filter should be enabled in energy metering applications.

- AVdd : Analog Power Supply. This pin provides the supply voltage for the analog circuitry in the AD7751. The supply should be maintained at 5 V 5 for specified operation. Every effort should be made to minimize power supply ripple and noise at this pin by the use of proper decoupling. This pin should be decoupled to AGND with a 10 F capacitor in parallel with a ceramic 100 nF capacitor.

- V1A,V1B : Analog Inputs for Channel 1 (Current Channel). These inputs are fully differential voltage inputs with a maximum signal level of 660 mV with respect to Pin V1N for specified operation. The maximum signal level at these pins is 1 V with respect to AGND. Both inputs have internal ESD protection circuitry and an overvoltage of 6 V can also be sustained on these inputs without risk of permanent damage

- V1N : Negative Input Pin for Differential Voltage Inputs V1A and V1B. The maximum signal level at this pin is 1 V with respect to AGND. The input has internal ESD protection circuitry and in addition, an overvoltage of 6 V can be sustained without risk of permanent damage. This input should be directly connected to the burden resistor and held at a fixed potential, i.e., AGND. See Analog Input section

- V2N,V2P : Negative and Positive Inputs for Channel 2 (Voltage Channel). These inputs provide a fully differential input pair. The maximum differential input voltage is 660 mV for specified operation. The maximum signal level at these pins is 1 V with respect to AGND. Both inputs have internal ESD protection circuitry and an overvoltage of 6 V can also be sustained on these inputs without risk of permanent damage.

- RESET : Reset Pin for the AD7751. A logic low on this pin will hold the ADCs and digital circuitry in a reset condition. Bringing this pin logic low will clear the AD7751 internal registers.

- AGND : Provides the Ground Reference for the Analog Circuitry in the AD7751, i.e., ADCs and Reference. This pin should be tied to the analog ground plane of the PCB. The analog ground plane is the ground reference for all analog circuitry, e.g., antialiasing filters, current and voltage transducers, etc. For good noise suppression the analog ground plane should only be connected to the digital ground plane at one point. A star ground configuration will help to keep noisy digital return currents away from the analog circuits.

- SCF : Select Calibration Frequency. This logic input is used to select the frequency on the calibration output CF. Table IV shows how the calibration frequencies are selected.

- S1,S2 : These logic inputs are used to select one of four possible frequencies for the digital-to-frequency conversion. This offers the designer greater flexibility when designing the energy meter. See Selecting a Frequency for an Energy Meter Application section.

- G1, G0 : These logic inputs are used to select one of four possible gains for the analog inputs V1A and V1B. The possible gains are 1, 2, 8 and 16. See Analog Input section.

- CLKIN : An external clock can be provided at this logic input. Alternatively, a parallel resonant AT crystal can be connected across CLKIN and CLKOUT to provide a clock source for the AD7751. The clock frequency for specified operation is 3.579545 MHz. Crystal load capacitors of between 22 pF and 33 pF (ceramic) should be used with the gate oscillator circuit.

- CLKOUT : A crystal can be connected across this pin and CLKIN as described above to provide a clock source for the AD7751. The CLKOUT pin can drive one CMOS load when an external clock is supplied at CLKIN or by gate oscillator circuit.

- FAULT : This logic output will go active high when a fault condition occurs. A fault is defined as a condition under which the signals on V1A and V1B differ by more than 12.5. The logic output will be reset to zero when a fault condition is no longer detected. See Fault Detection section.

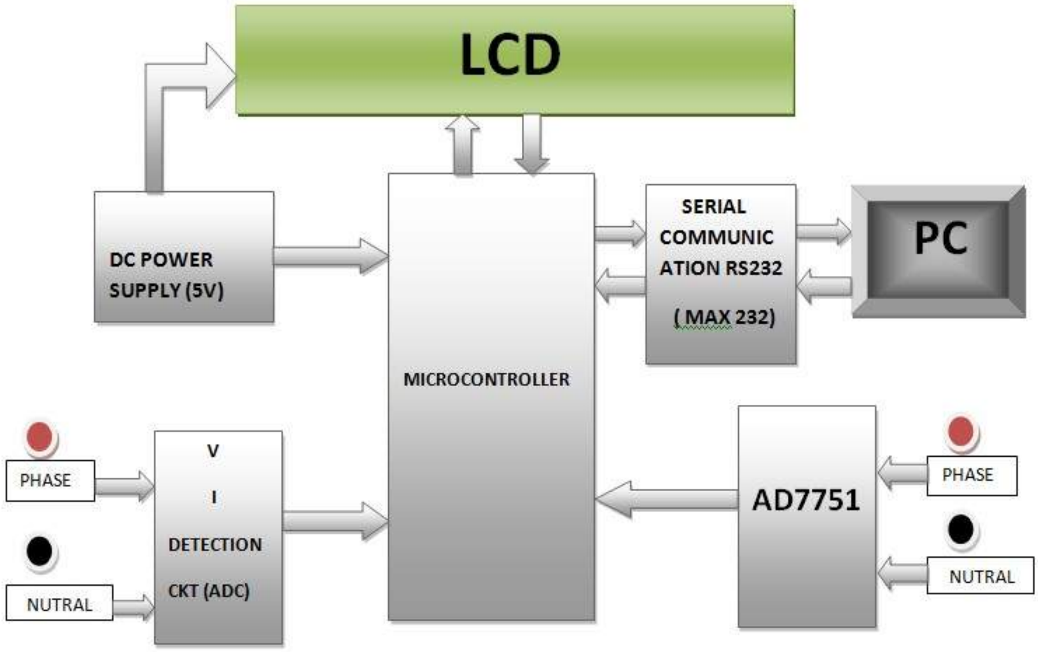

Figure 3.3: Energy meter Block diagram

– REVP : This logic output will go logic high when negative power is detected, i.e., when the phase angle between the voltage and current signals is greater that 90. This output is not latched and will be reset when positive power is once again detected. The output will go high or low at the same time as a pulse is issued on CF.

– DGND : This provides the ground reference for the digital circuitry in the AD7751, i.e., multiplier, filters and digital-to-frequency converter. This pin should be tied to the analog ground plane of the PCB. The digital ground plane is the ground reference for all digital circuitry, e.g., counters (mechanical and digital), MCUs and indicator LEDs. For good noise suppression the analog ground plane should only be connected to the digital ground plane at one point, e.g., a star ground as shown in figure5.3.

Chapter 4

8-bit Microcontroller with 8K Bytes In-System Programmable Flash AT89S52

4.1 Features

- Compatible with MCS-51 Products
- 8K Bytes of In-System Programmable (ISP) Flash Memory
- Endurance: 1000 Write/Erase Cycles
- 4.0V to 5.5V Operating Range
- Fully Static Operation: 0 Hz to 33 MHz
- Three-level Program Memory Lock
- 256 x 8-bit Internal RAM
- 32 Programmable I/O Lines
- Three 16-bit Timer/Counters
- Eight Interrupt Sources
- Full Duplex UART Serial Channel

- Low-power Idle and Power-down Modes
- Interrupt Recovery from Power-down Mode
- Watchdog Timer
- Dual Data Pointer
- Power-off Flag

4.2 Description

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmels high-density nonvolatile memory technology and is compatible with the industry- standard 80C51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

4.3 Pin Description

- VCC

  Supply voltage.

- GND

  Ground.

- Port 0

  Port 0 is an 8-bit open drain bidirectional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as highimpedance inputs.

  Port 0 can also be configured to be the multiplexed loworder address/data bus during accesses to external program and data memory. In this mode, P0 has internal pullups.

  Port 0 also receives the code bytes during Flash programming and outputs the code bytes during program verification. External pullups are required during program verification.

- Port 1

  Port 1 is an 8-bit bidirectional I/O port with internal pullups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins, they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pullups.

- Port 2

  Port 2 is an 8-bit bidirectional I/O port with internal pullups. The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins, they are pulled high by the internal pullups and can be used as inputs.

As inputs, Port 2 pins that are externally being pulled low will source current (IIL) because of the internal pullups.

Port 2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that use 16-bit addresses (MOVX @ DPTR). In this application, Port 2 uses strong internal pullups when emitting 1s. During accesses to external data memory that use 8-bit addresses (MOVX @ RI), Port 2 emits the contents of the P2 Special Function Register.

Port 2 also receives the high-order address bits and some control signals during Flash programming and verification.

- Port 3:
  Port 3 is an 8-bit bidirectional I/O port with internal pullups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins, they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pullups.

- RST
  Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device. This pin drives High for 96 oscillator periods after the Watchdog times out. The DISRTO bit in SFR AUXR (address 8EH) can be used to disable this feature. In the default state of bit DISRTO, the RESET HIGH out feature is enabled.

- ALE
  Address Latch Enable (ALE) is an output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during Flash programming.

In normal operation, ALE is emitted at a constant rate of 1/6 the oscillator frequency and may be used for external timing or clocking purposes. Note, however, that one ALE pulse is skipped during each access to external data memory. If desired, ALE operation can be disabled by setting bit 0 of SFR location 8EH. With the bit set, ALE is active only during a MOVX or MOVC instruction. Otherwise, the pin is weakly pulled high. Setting the ALE-disable bit has no effect if the microcontroller is in external execution mode.

- PSEN

  Program Store Enable (PSEN) is the read strobe to external program memory.

  When the AT89S52 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

- VPP

  External Access Enable. EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH

  Note, however, that if lock bit 1 is programmed, EA will be internally latched on reset.
  EA should be strapped to VCC for internal program executions. This pin also receives the 12-volt programming enable voltage (VPP) during Flash programming.

- XTAL1

  Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

- XTAL2

  Output from the inverting oscillator amplifier

Chapter 5

Simulation Results

THIS PROJECT IS MAINLY DIVIDED IN FOLLOWING CIRCUITS.

a. CURRENT SENSING CIRCUIT (FOR CURRENT CHANNEL).

b. VOLTAGE SENSING CIRCUIT (FOR VOLTAGE CHANNEL).

c. AD7751 CIRCUIT.

d. ADC (ANALOG TO DIGITAL CONVERTER).

e. PDC (PEAK DETECTOR CIRCUIT).

f. MICROCONTROLLER CIRCUIT.

g. GSM MODEM.

THE OVERALL DISCRIPTION OF PROJECT IS AS BELOW. THE VALUE OF CURRENT FLOWING THROUGH PHASE AND NUTRAL IS MEASURED USING CURRENT TRANSFORMERS. AS LOAD INCREASES, THE OUTPUT OF CURRENT TRANSFORMER ALSO INCREASES. SIMILARLY THE AC VOLTAGE IS MEASURED USING PT (POTENTIAL TRANSFORMER). IN OUR CASE WE HAVE USED STEP DOWN TRANSFORMER (3-0V AC) TO REDUCE 230V AC TO 3V AC.

a. CURRENT AND VOLTAGE SENSING CITCUITS:

THE POWER IS MEASURED BY AD7751 AND IT GIVES DIGITAL FREQUENCY ACCORDING TO POWER CONSUMPTION. THE INPUT TO AD7751 IS CURRENT AND VOLTAGE QUENTITY. HERE THE OPTIMUM MAXIMUM VALUE OF CURRENT AND VOLTAGE IS 660mv AC OR DC. SO WE NEED TO DO SIGNAL CONDITIONING FOR BOTH CHANNEL. HERE WE HAVE USED C.T FOR CURRENT QUENTITY. THE OUTPUT OF C.T FOR MAXIMUM LOAD IS FEW VOLTS, THIS VOLTS IS APPLIED TO VARIABLE RESISTOR (POTENTIO METER) TO GET OUTPUT WITHIN SPECIFIED RANGE (660mv). BY VARYING THE POTENTIOMETER, WE CAN GET VARIABLE OUTPUT VOLTAGE IN mv RANGE. FOR VOLTAGE, WE HAVE STEPPED DOWN 230V AC TO 3V AC USING STEP DOWN TRANSFORMER AND THEN USING VARIABLE RESISTOR THE VALUE IS CALIBRATED TO REQUIRED RANGE (660mv).

b. AD7751 CIRCUIT.

THE AD7751 IS USED TO CALCULATE POWER CONSUMPTION. THE AD7751 MULTIPLIES VOLTAGE AND CURRENT VALUE (WHICH ARE INPUT TO IT) IN DIGITAL DOMAIN. AS THE MULTIPLICATION IS OCCURRED IN DIGITAL DOMAIN, THERE IS VERY LESS ERROR IN CALCULATION. THE OUTPUT OF AD7751 IS DIGITAL PULSES ACCORDING TO THE LOAD. AS THE LOAD IS INCREASED, THE FREQUENCY OF PULSES ALSO INCRESES. IN OUR CASE THE METER IS CALIBRATED TO GIVE 100 IMPULSES PER KWH. (100imp/KWH). HENCE AD7751 GIVES 100 PULSES FOR THE CONSUMPTION OF 1 UNIT (1KWH). OTHE FEATURES OF AD7751 IS DISCUSSED IN OTHER CHAPTER.

c. ADC (ANALOG TO DIGITAL CONVERTER).

TO KNOW THE LOAD CONDITION, WHETHER IT IS REGULAR, CRITICAL OR OVER LOAD, WE NEED TO INTERFACE LOAD VALUE TO MI-

CROCONTROLLER. THE MICROCONTROLLER UNDERSTANDS ONLY DIGITAL VALUE AND THE CURRENT AND VOLTAGE WE NEED TO CHECK IS ANALOG QUENTITY. HENCE TO CONVERT THESE ANALOG QUENTITY TO DIGITAL, WE NEED TO USE ADC CIRCUIT. IN OUT PROJECT WE HAVE USED ADC0804 TO CONVERT ANALOG QUENTITY TO DIGITAL. ADC 0804 GIVES DIGITAL OUTPUT OF 8 BITS WHICH IS CONNECTED TO MICROCONTROLLER CIRCUIT.

d. PDC (PEAK DETECTOR CITCUIT)
THE CURRENT AND VOLTAGE VALUES ARE ANALOG (CONTINEOUSLY VARYING) QUENTITY. SO EVERYTIME WE CONVERT IT TO DIGITAL USING ADC WE WILL GET DIFFERENT VALUES. SO WE CAN NOT MEASURE THE VALUE PROPERLY. TO AVOID THIS PROBLEM WE HAVE USED PDC (PEAK DETECTOR CIRCIUT). PDC DETECTS THE PEAK VALUE OF ANALOG QUENTITY. THIS PEAK VALUE IS THEN GIVEN TO ADC. HENCE USING THIS PDC WE CAN AVOID MISCALCULATION OF ANALOG QUENTITY.

e. MICROCONTROLLER CIRCUIT
THE MICROCONTROLLER AT89S52 CIRCUIT IS THE HEART OF OUR PROJECTS. IT DOES MANY FUNCTIONS IN OUR PROJECTS. IT CALCULATES POWER CONSUMED, VALUE (TYPE) OF LOAD. THE DIGITAL PULSES FROM AD7751 IS FED TO MICROCONTROLLER. MICROCONTROLLER COUNTS THE PULSES AND ACCORDINGLY UPDATES THE METER READING (ENERGY CONSUMPTION READING). SIMULTANEOUSLY IT ALSO CHECKS THE TYPE OF LOAD (NO LOAD, REGULAR, CRITICAL OF OVER LOAD). IN ADDITION TO IT, MICROCONTROLLER ALSO INTERFACED WITH GSM MODEM UNIT TO SEND TEXT MESSAGE ON MOBILE CONTAINING CURRENT METER READING AND TYPE OF LOAD AS AND WHEN REQUIRED. ALL THESE PARAMETER IS SHOWN ON LCD (LIQUIFIED CRYSTAL DISPLAY) CON-

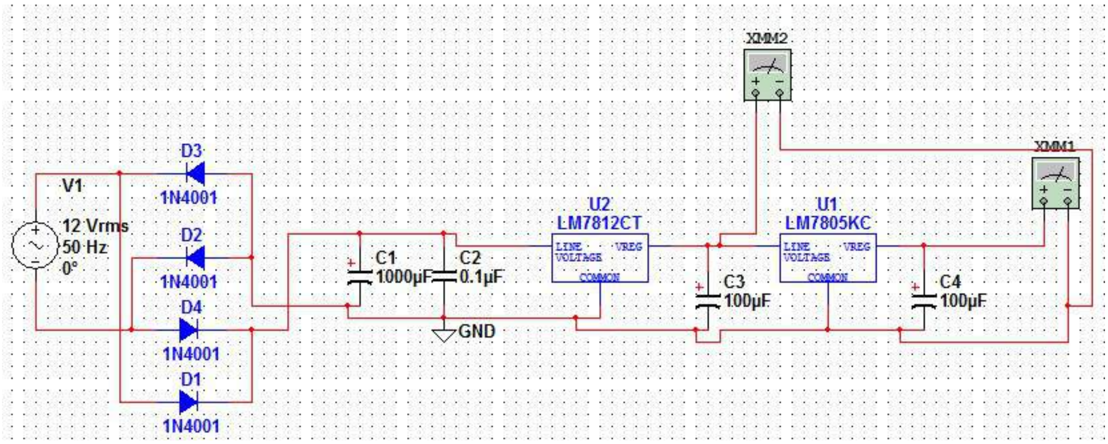

Figure 5.1: Power supply Circuit

NECTED TO MICROCONTROLLER. MICROCONTROLLER ALSO SENDS THE CURRUNT CONSUMPTION TO COMPUTER USING RS 232 TO DEVELOP DATA BASE OF POWER CONSUMPTION.

f. GSM UNIT

HERE THE GSM UNIT IS USED TO SEND ALL INFORMATION (ENERGY CONSUMPTION AND TYPE OF LOAD) IN TEXT MESSAGE ON PERTIGULAR GSM MOBILE NUMBER. IT IS INTERFACED TO MICROCONTROLLER SERIALLY i.e. RS 232. GSM MODEM WORKS USING AT COMMANDS AND AT 9600 BAUD RATE.

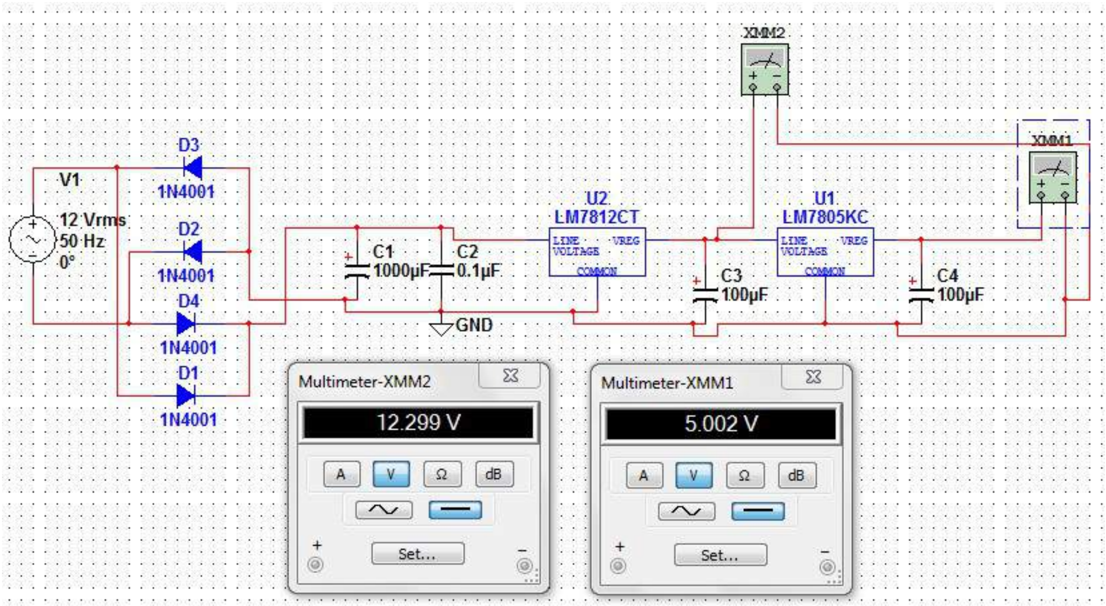

Figure 5.2: Power supply Circuit Results

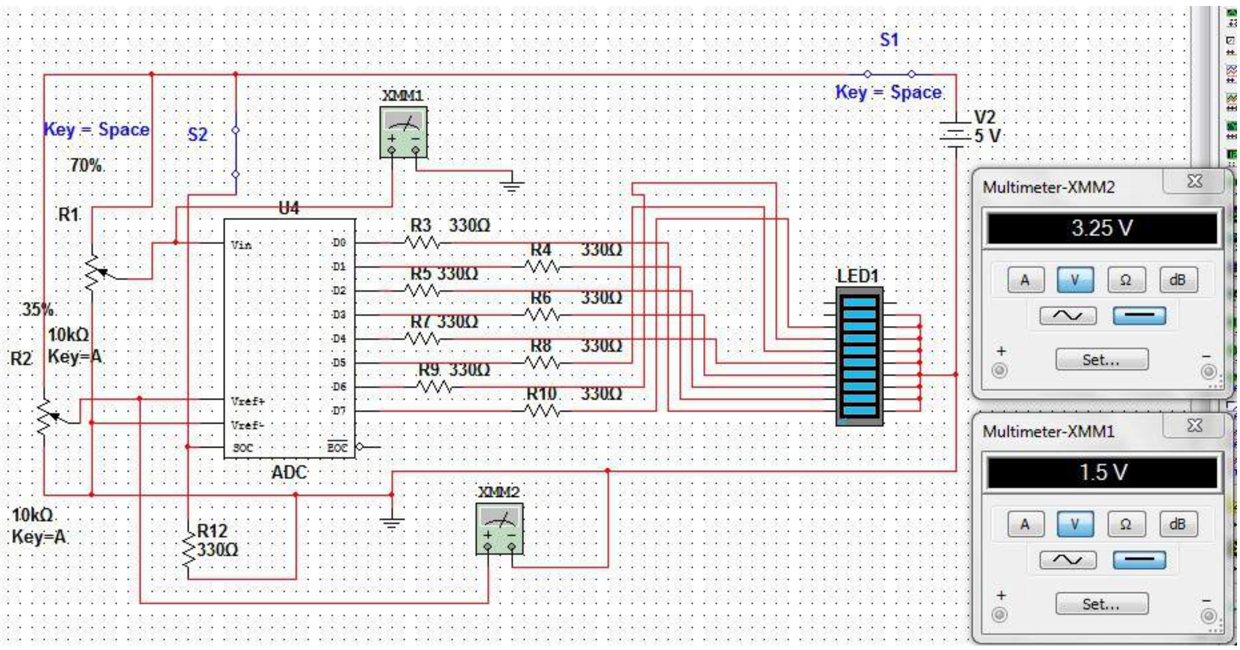

Figure 5.3: Analog to digital Circuit

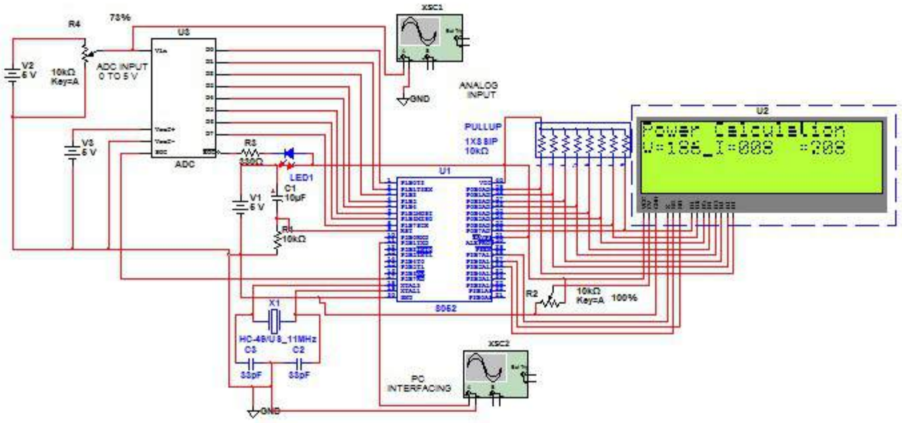

Figure 5.4: Final Circuit Simulation

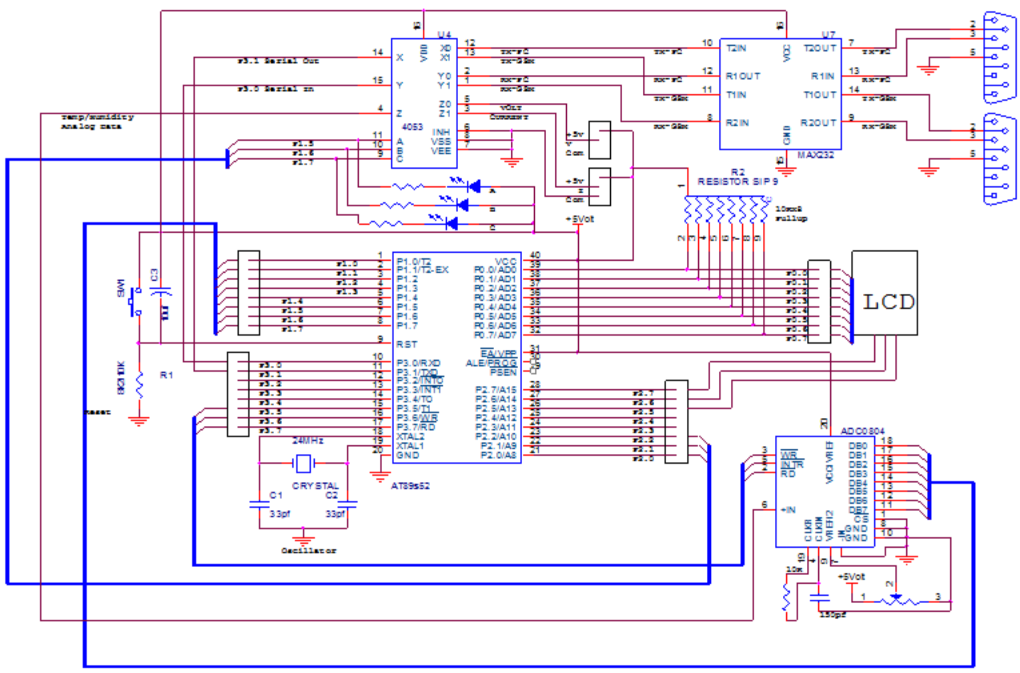

Figure 5.5: Main Circuit

Chapter 6

Hardware Results

Hardware Result of 'Energy meter' is shown.Here single phase digital energy meter with GSM via PC interface hardware results are as following:

Figure 6.1: Energy Meter Circuit

Figure 6.2: No load Connected at Energy meter

Figure 6.3: Output result when no load connected

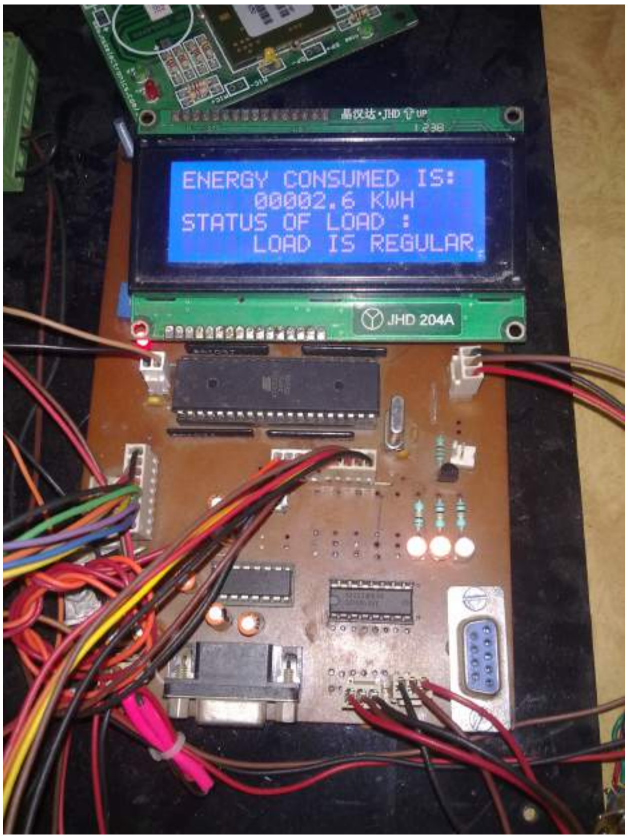

Figure 6.4: Rated Load Connected at energy meter

Figure 6.5: Output result when rated load connected

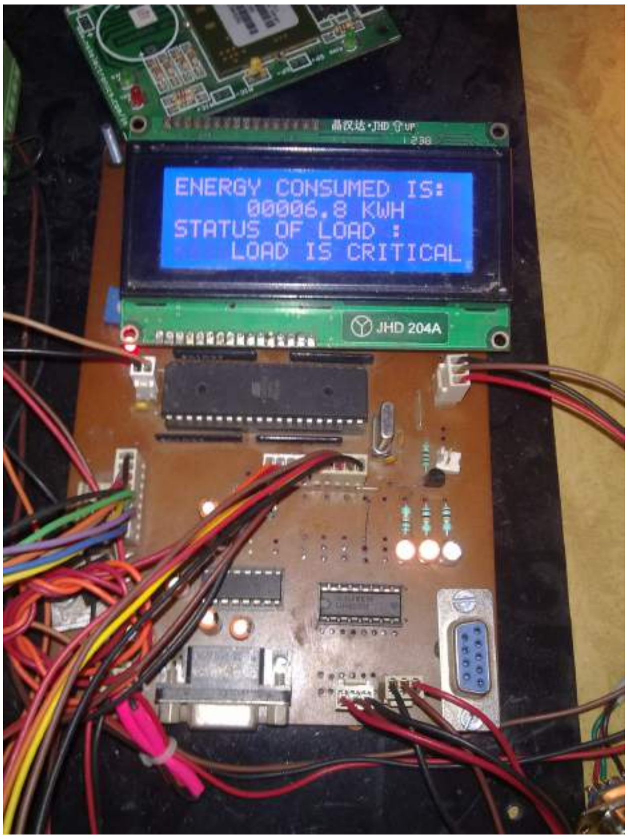

Figure 6.6: Critical Load connected at energy meter

Figure 6.7: Output result when critical load connected

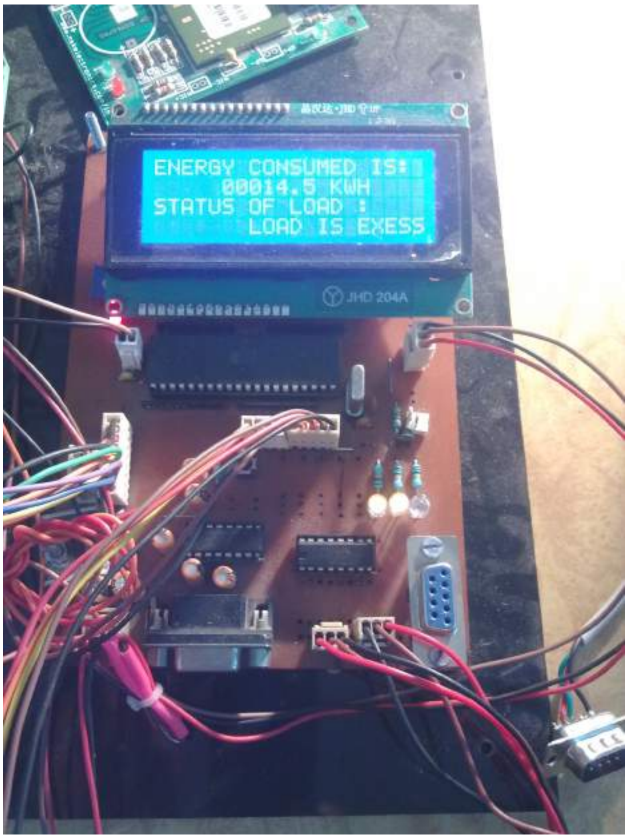

Figure 6.8: Final result

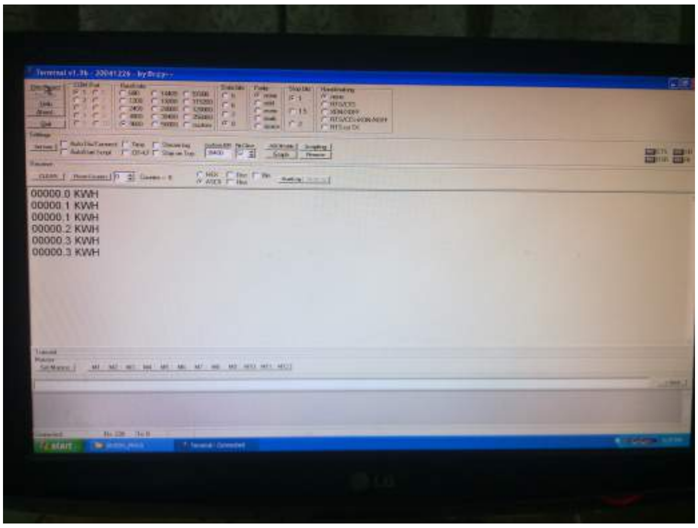

Figure 6.9: Energy Meter Programming

Chapter 7

Conclusion

A low cost microprocessor based Single-phase energy measurement unit has been developed that can sense the fault in the PT secondary circuit or the potential coil in the measuring appliance and always displays the actual consumed energy both under normal and faulty conditions provided the power circuit is in healthy condition. The proposed energy meter also affords significant accuracy at the presence of harmonics. The absence of rotating parts in the measuring unit helps in the prevention of frauds due to tempering which is another attractive feature for the utilities. The developed scheme is cheap, fast, highly reliable and provides enough flexibility to suit the requirements of different systems. Moreover, a lot of extra facilities such as monitoring power factor, indication of maximum demand, calculation of unit cost including fuel surcharge, government duty, meter rent etc can be introduced changing only the software.

7.1 Future Work

- 1-phase energy meter can be further inplement in 3-phase systems
- Implement function of thef detection

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