Ethernet TCP/IP For Multifunctionmeter and MultifunctionTransducer

Major Project Report

Submitted in fulfillment of the requirements
for the degree of

Master of Technology
in
Electronics & Communication Engineering
(Embedded Systems)

By

Khushbu Patel

(17MECE12)

Electronics & Communication Engineering Department
Institute of Technology
Nirma University
Ahmedabad-382 481
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Under the guidance of

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May 2019

Declaration

This is to certify that

a. The thesis comprises my original work towards the degree of Master of Technology in Embedded Systems at Nirma University and has not been submitted elsewhere for a degree.

b. Due acknowledgment has been made in the text to all other material used.

- **Khushbu Patel**

17MECE12

Disclaimer

"The content of this paper does not represent the technology,opinions,beliefs, or positions of Masibus Automation and Instrumentation Pvt. Ltd.,its employees,vendors, customers, or associates."

Certificate

This is to certify that the Major Project entitled **"Ethernet TCP/IP For Multifunctionmeter and MultifunctionTransducer"** submitted by **Khushbu Patel (17MECE12)**, towards the partial fulfillment of the requirements for the degree of Master of Technology in Embedded Systems, Nirma University, Ahmedabad is the record of work carried out by her under our supervision and guidance. In our opinion, the submitted work has reached a level required for being accepted for examination.The results embodied in this major project, to the best of our knowledge, haven't been submitted to any other university or institution for award of any degree or diploma.

Date: Place: Ahmedabad

Dr. Nagendra Gajjar,

Guide & PG Coordinator,

M.Tech - ECE

Institute of Technology,Nirma University

Dr. Dilip Kothari   Dr. Alka Mahajan

Professor and Head,EC   Director

Certificate

This is to certify that the Major Project entitled **"Ethernet TCP/IP For Multi-functionmeter and MultifunctionTransducer"** submitted by **Khushbu Patel (17MECE12)**, towards the partial fulfillment of the requirements for the degree of Master of Technology in Embedded Systems, Nirma University, Ahmedabad is the record of work carried out by her under our supervision and guidance. In our opinion, the submitted work has reached a level required for being accepted for examination.

Mr. Nirav Patel

Executive Engineer(R & D)

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Statement of Originality

I, **Khushbu Patel**, Roll. No. **17MECE12**, give undertaking that the Major Project entitled "**Ethernet TCP/IP For Multifunction meter and Multifunction Transducer**" submitted by me, towards the partial fulfillment of the requirements for the degree of Master of Technology in **Electronics and communication (Embedded System)** of Institute of Technology, Nirma University, Ahmedabad, contains no material that has been awarded for any degree or diploma in any university or school in any territory to the best of my knowledge. It is the original work carried out by me and I give assurance that no attempt of plagiarism has been made.It contains no material that is previously published or written, except where reference 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.

—————————————

Date:

Place:

Endorsed by

Dr. Nagendra Gajjar

Acknowledgements

I would like to express my gratitude and sincere thanks to **Dr.N.P.Gajjar**, PG Coordinator of M.Tech Embedded Systems and **Dr.N.P.Gajjar** for guidelines during the review process.

I take this opportunity to express my profound gratitude and deep regards to **Dr.N.P.Gajjar**, guide of my internship project for her exemplary guidance, monitoring and constant encouragement.

I would also like to thank **Mr. Nirav Patel**, external guide of my internship project from **Masibus Automation and instrumentation Pvt. Ltd.**, for guidance, monitoring and encouragement regarding the project.

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- **Khushbu Patel**

17MECE12

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Abstract

Multi-function energy meters are equipped in power plant to remotely monitor the electricity consumption and measurement of instantaneous parameters likes voltage, current, power, active power, reactive power, power factor and some other important factors. Ethernet interface is provided to remotely communicate with Multi-function meter which involves sending commands from the system to the Multifunction Meter(PM2160-A) for reading and writing the particular register and receiving data from Multi-function meters via Universal asynchronous reciever/transmitter to Ethernet Gateway. Ethernet interface uses MODNET Protocol in Remote Terminal Unit Mode.Ethernet based Multi-function meter is used in LAN network and it can be accessed from any where through the established network. Modbus is a serial master/slave protocol and can be run over any serial type media with high noise immunity, while Modnet is only Ethernet based protocol, and as the speed of ethernet communication is faster than Modbus,modnet is better than modbus in transmission rate. So existing Multi-function meter(MFM) is connected to ethernet LAN access through Modnet protocol with nominal cost addition to existing product using an add on module and few physical design changes.The same task has been performed for Multifunction Transducer(MFT).It is a solid state TRANSDUCER Which gives corresponding Analog output 4-20mA or 0-10V w.r.t. electrical parameter measured except energies.

Abbreviation Notation and Nomenclature

TCP . . . . Transmission control protocol

IP . . . . Internet protocol

MFM . . . . MultifunctionMeter

MFT . . . . MultifunctionTransducer

RTU . . . . Remote terminal unit

S2E . . . . Serial to Ethernet

TI . . . . Texas Instruments

SPI . . . . Serial Peripheral Interface

DHCP . . . . Dynamic Host Configuration Protocol

TQFP . . . . Thin Quad Flat Package

CCS . . . . Code composer studio

IDE . . . . Integrated development environment

UART . . . . Universal Asynchronous Receiver/Transmitter

LAN . . . . Local Area Network

HVAC . . . . Heating,ventilation and air conditioning

OEM . . . . Original Equipment Manufacturer

Chapter 1

Introduction

1.1   Motivation

Existing Multifunctionmeter(MFM) and MultifunctionTransducer(MFT) can be connected to ethernet LAN access with nominal cost addition to existing product using add on module and few design/mechanical changes.

1.2   Limitations

Ethernet based meter and transducer basically used in LAN network and its access any where from the LAN network or establish any wireless server Also the speed of ethernet communication is faster than Modbus.

1.3   Company Overview

The Brand Masibus started its journey in 1975 as a tiny low company with some of individuals, and has currently fully grown into an outsized organization with over two hundred individuals in its men. Having been around for over four decades, the corporate continues to be powerfully stock-still within the moral principles ordered down by the institution fathers. when the initial baby steps, and with the Indian

economy gap up in 1991, Masibus steady distended operations and stirred to our current headquarters in Gandhinagar, Gujarat. Since then, we have a tendency to still function answer suppliers in industrial automation and instrumentation phase to customers at intervals the country and across the world.[1]

I am operating with Power Products team.Applications Of power products are management Relay Panel,Motor Control Center Panels,Power center Panels,Process management,Original instrumentation Manufacturers(OEMs),HVAC Building Management System,Energy Management System.Recognized united of the premier industrial automation answer suppliers, Masibus serves nearly 10,000 customers in regarding fifty vertical industrial segments, giving product, solutions and services through eight regional offices and a large network of Dealers and System Integrators.

Masibus has been fast to adopt and incorporate new technologies like local area network and Wireless into the economic automation solutions that are offered.The export-worthy quality of our product and solutions stands out as someone for Masibus changing into a globally accepted company, facultative U.S. to seek out our footing within the Near East, Africa, Europe and much East countries.Masibus operates a global workplace in Sharjah,UAE.[1]

1.4   Scope of Work

To design a hardware device PCB that solves for local area network communication problem spacecraft in Multifunctionmeter Becuase local area network based meter mostly primarily utilized in LAN Network and conjointly the speed distinction between modbus and local area network.The MFT is a solid state TRANSDUCER Which accurately measures all quantities of the supply including all types of energies and gives corresponding Analog output 4-20mA or 0-10V w.r.t. electrical parameter measured except energies. it also have fully programmable Digital output for all energies. First Schematic Was designed in Orcad capture(Orcad 16.6 tool)which is cadence tool.PCB was designed in PCB editor.The system is especially composed of

Energy meters that are connected in RS 485 and supports MODBUS RTU protocol for communication accustomed live the assorted parameters associated with electric power, Serial to local area network(ethernet) device to convert the serial knowledge to local area network packets vice versa,Router for LAN, Central watching system server.After that Code Composer studio used for software package.

1.5   Outline of Thesis

In this thesis six chapters are there.First chapter is all about motivation of project, Limitation of Project,overview of company and Scope of work.Multifunction energy meters with ethernet TCP/IP Protocol.So Here the Ethernet interface uses modnet Protocol in Remote Terminal Unit Mode. The Internet Protocol address of Multi-function meter is dynamic so it can be changed through MODNET Protocol.Second Chapter is all about literature survey in that I have read all the manuals of ethernet,overview of Multifunction meter,Modbus,difference between modbus and modnet and then I have referred one IEEE papaer for my project.Third chapter is all about Block Diagram,Schematic and PCB Design which I have Designed in orcad 16.6 and there are different sections involved in the Schematic of the Device.After that I have added Hands ON and results of my project.Fourth chapter is all about Software flow chart.It describes about programming flow.Last and fifth chapter is about what are the tools and technologies required in my project.All the work done is described in fifth chapter.Six chapter is all about the conclusion of my project.So the conclusion of project is Basically receiving data from Multi-function meters via Universal asynchronous reciever/transmitter to Ethernet Gateway.

Chapter 2

Overview of Modbus TCP/IP and MFM/MFT

2.1 About Modbus

The Modbus protocol was developed in 1979 by Modicon, Integrated, for industrial automation systems and modicon programmable controllers. it's since develop an business customary technique for the transfer of discrete/analog I/O information and register knowledge between industrial management and watching devices. Modbus is currently a widely-accepted, open, public-domain protocol that needs a license, however doesn't need royal payment to its owner.

Modbus devices communicate employing a master-slave(client-server) technique during which just one device (the master/client) will initiate transactions that's known as queries.The other devices like slaves or servers respond by supply the requested knowledge to the master,or by taking the exploit requested within the question. A slave is any peripheral device (I/O electrical device,valve, network drive, or different activity device) that processes information and sends its output to the master victimization Modbus.Masters will address individual slaves, or will

initiate a show message to any or all slaves. Slaves come a response to any or all queries addressed to them singly, however don't reply to show queries. Slaves don't initiate messages on their own,they solely respond to queries from the master[2]

A masters question can include a slave address a operate code shaping the requested action, any required knowledge, and miscalculation checking field. A slaves response consists of fields approving the action taken, any knowledge to be came back, and miscalculation checking field.

2.2   Modbus TCP/IP

Modbus protocol/IP is solely the Modbus RTU protocol with a TCP interface that runs on LAN.The Modbus electronic messaging structure is that the application protocol that defines the foundations for organizing and taking the information freelance of the information transmission medium.TCP/IP refers to the Transmission management Protocol and net Protocol,which provides the transmission medium for Modbus TCP/IP electronic messaging.TCP/IP permits blocks of binary knowledge to be changed between computers.

Modbus TCP/IP usages TCP/IP and LAN to hold the information of the Modbus message structure between compatible devices. That is, Modbus TCP/IP combines a physical network (Ethernet), with a networking normal (TCP/IP), and a regular methodology of representing knowledge (Modbus because the application protocol).

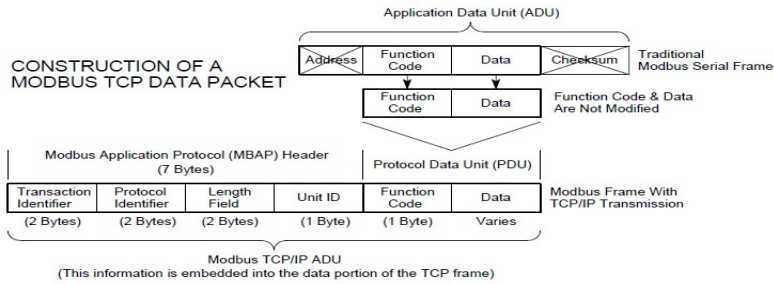Modbus protocol embeds a regular Modbus knowledge frame into a protocol

Figure 2.1: Modbus TCP Data packet

frame, without the Modbus verification, as shown within the following diagram.The Modbus frame address field is supplanted by the unit symbol in Modbus TCP/IP, and becomes a part of the Modbus Application Protocol(MBAP) header. The MBAP header is seven bytes long and it includes the subsequent fields:

Transaction/invocation Identifier (2 Bytes): This identification field is employed for dealing pairing once multiple messages are sent on the identical protocol affiliation by a shopper while not watching for a previous response.

Protocol Identifier (2 bytes): This field is often zero for Modbus services and different values are reserved for future extensions.

Length (2 bytes): This field could be a computer memory unit count of the remaining fields and contains the unit symbol computer memory unit, perform code computer memory unit and also the knowledge fields.

Unit Identifier (1 byte):This field is employed to spot a far off server placed on a non TCP/IP network for serial bridging.In a typical Modbus TCP/IP server application, the unit ID is ready to 00 or FF, unnoticed by the server, and easily recovered back within the response[2]

2.3   Combine Modbus With Ethernet

IEEE 802.3 LAN could be a long-standing workplace networking protocol that has inflated universal world-wide acceptance.It's conjointly an open common place that's supported by several makers and its infrastructure is generally on the market and primarily put in.Modbus protocol with the IEEE 802.3 LAN transmission forms a robust industrial communication common place in Modbus TCP/IP.And because Modbus TCP/IP shares the identical physical and link layers of ancient IEEE 802.3 LAN and uses the identical TCP/IP suite of protocols,it remains totally compatible with the already connected LAN infrastructure of cables,connectors,network interface cards,hubs and switches.[3]

2.4   Modbus Functions and Registers

The TCP/IP protocol suite provides all the resources for 2 devices to speak with one another over an local area network computer network or world WAN.Modbus is associate degree application protocol or electronic messaging structure that defines rules for organizing and decoding information freelance of the information transmission medium. ancient serial Modbus may be a register-based protocol that defines message transactions that occur between masters and slaves. Slave devices listen for communication from the master and easily respond as tutored. The master always that controls the communication and should communicate on to one slave, or all connected slaves, however the slaves cannot communicate directly with one another..[2]

The Modbus information model incorporates a straight forward structure that solely differentiates between four basic information types: 1) Discrete Inputs 2) Coils(Outputs) 3) Input Registers(Input Data) 4) Holding Registers(Output Data)

CODE	FUNCTION	REFERENCE
01 (01H)	Read Coil (Output) Status	0xxxx
03 (03H)	Read Holding Registers	4xxxx
04 (04H)	Read Input Registers	3xxxx
05 (05H)	Force Single Coil (Output)	0xxxx
06 (06H)	Preset Single Register	4xxxx
15 (0FH)	Force Multiple Coils (Outputs)	0xxxx
16 (10H)	Preset Multiple Registers	4xxxx
17 (11H)	Report Slave ID	*Hidden*

Figure 2.2: Modbus Functions and Registers

The client request information field provides the slave(server) with any extra data needed by the slave to complete the action nominal by the perform code within the client request.The information field usually includes register addresses,count values, and written information. for a few messages,this field might not exist(has zero length), as not all messages would require information..[3]

When the slave device responds to the master, it uses the perform code field to point either a traditional (error-free) response, or that some quite error has occurred (an exception response). a traditional response merely echoes the initial perform code of the question, whereas associate degree exception response returns a code that's equivalent to the initial perform code with its most vital bit(msb) set to logic one..

The Read Holding Registers command has the perform code 0000 0011 (03H). If the slave device takes the requested action while not error, it returns the identical code in its response. However, if associate degree exception happens, it returns a thousand 0011 (83H) within the perform code field and appends a singular code within the information field of the response message that tells the master device what quite error occurred, or the explanation for the exception..[2]

2.5   Multifunction Meter PM2160-A

OVERVIEW

The 2160-A MULTIFUNCTION METER may be a solid state Multifunction Meter that accurately measures all quantities of the availability as well as all sorts of energies. The 2160-A Multifunction Meter is predicated on Microcontroller,with a high degree of programmability.

The Meter is generally provided pronto preprogrammed for operation and may be directly put in within the usual manner. The Meter may be scan manually or through a Master using MODNET-RTU Protocol.

Figure 2.3: PM2160-1 MultifunctionMeter

Figure 2.4: PM2160-A MultifunctionMeter

FEATURES

a. **Accuracy category 0.5s as per IS14697 IEC 62053-22**

b. **Accuracy category 0.2s as per IS14697 IEC 62053-22 also available**

c. **Accuracy category 1.0 as per IS13779 IEC 62053-21 also available**

d. **Field programmable CT/PT primary secondary values**

e. **True RMS, Microcontroller based mostly**

f. **Auto Scrolling feature for simple readability for all parameters**

g. **Light-weight Weight,Rugged, Reliable Safe for User**

h. **Isolated RS485 (Modbus-RTU protocol)**

i. **Four Quadrant measuring for PF, Power and Energy (Active Reactive)**

j. **ON Hour,RUN(LOAD)HOUR and IDLE HOUR register in Non-Volatile Memory**

k. **Power Interruption count with(Last Power OFF Latest Power ON)Time Date [With MD+RTC possibility only]**

l. **Data Logging: Daily Energy Log [With MD+RTC possibility only], Min-Max[Low-High] Logging**

2.6 Ethernet Details

Ethernet interface is provided to remotely communicate with the ability Meter (PM2160-A). The RJ-45 connection provided on the rear aspect of meter (PM2160-A).The local area network interfaces use MODNET Protocol in RTU Mode.Communicating with meter involves causing commands to the PM2160-A for reading and writing the actual register. The scientific discipline address may be modified through Modnet Register or S2E Utility.

Modnet Register Map for 3P4W parameters

This is modnet register map for 3P4W parameters In which Function Code is 0X03 (Read Holding Register),Address is between 40001 to 40121 No. of data word 122 and in multiple of 2 as all data are of 4 Bytes [Long Real].Enter only Even value (data word length).

S. No.	Address	Measured parameter	words	Multiplication Factor (if data type is long)
1	40001	Frequency	2	0.01
2	40003	1. PF	2	0.001
3	40005	2. PF	2	0.001
4	40007	3. PF	2	0.001
5	40009	A. PF	2	0.001
6	40011	1. Vrms	2	0.1
7	40013	2. Vrms	2	0.1
8	40015	3. Vrms	2	0.1
9	40017	A. Vrms	2	0.1
10	40019	Vrms 1*2	2	0.1
11	40021	Vrms 2*3	2	0.1
12	40023	Vrms 3*1	2	0.1
13	40025	1. Irms	2	0.001
14	40027	2. Irms	2	0.001
15	40029	3. Irms	2	0.001
16	40031	A. Irms	2	0.001
17	40033	Reserved	-	-
18	40035	1. Watt	2	1
19	40037	2. Watt	2	1
20	40039	3. Watt	2	1

Figure 2.5: Register map for 3P4W Parameters

2.7 Multifunction Transducer

OVERVIEW

The MFT is a solid state TRANSDUCER Which accurately measures all quantities of the supply including all types of energies and gives corresponding Analog output 4-20mA or 0-10V w.r.t. electrical parameter measured except energies. it also have fully programmable Digital output for all energies. The MFT is based on Microcontroller, with a high degree of programmability.

The MFT has been programmed to operate as an intelligent front end measuring and storing device and to communicate continuously to a Master, all the data relevant for the purpose of SCADA, through isolated RS-485 port using MODBUS-RTU protocol. The MFT can be read manually or through a Master using MODBUS-RTU

Protocol.

Figure 2.6: Multifunction Transducer

FEATURES

a. **Four Analog Two Digital Outputs [Isolated to each other]**

b. **Up to 30 parameter can be mapped to Analog Output**

c. **Fully Programmable**

d. **Analog o/p accuracy as per IEC60688**

e. **Compact, Light weight, Rugged, Reliable Safe for User**

f. **Aux powered uses Switch mode power supply**

g. **Ethernet communication(optional)**

h. **ABS enclosure an insulator so safe for user**

i. **Front panel LED output for calibration measurement of selected type of energy**

j. **Store energy register efficiently during power failure**

k. **Four Quadrant measurement for Power factor, Power Energy (Active Reactive)**

l. **Fast response time**

m. **GUI based site configuration software for MFT**

n. **Microcontroller based TRUE RMS Measurement of electrical parameters.**

APPLICATIONS

- Interface with PLC / SCADA / RTU

- Remote monitoring and Indicating Instruments

- Energy monitoring Management System (EMS)

- Process monitoring control

- Electric Utility-Generation, Transmission and Distribution

- Control Relay Panels

- Motor Control Center Panels

- HV & LV Switchgear Panels

2.8 Ethernet Details

The Ethernet interfaces use MODNET Protocol in RTU Mode. Communicating with MFT involves sending commands to the transducer for reading and writing the particular register.

Modnet Register Map for 3P4W parameters

S. No.	Address	Measured parameter	words	Multiplication Factor (if data type is long)
1	40001	Frequency	2	0.01
2	40003	R. PF	2	0.001
3	40005	Y. PF	2	0.001
4	40007	B. PF	2	0.001
5	40009	System. PF	2	0.001
6	40011	R. Vrms	2	0.1
7	40013	Y. Vrms	2	0.1
8	40015	B. Vrms	2	0.1
9	40017	A. Vrms	2	0.1
10	40019	Vrms R_Y	2	0.1
11	40021	Vrms B_Y	2	0.1
12	40023	Vrms B_R	2	0.1
13	40025	R. Irms	2	0.001
14	40027	Y. Irms	2	0.001
15	40029	B. Irms	2	0.001
16	40031	A. Irms	2	0.001
17	40033	Reserved	-	-
18	40035	R. Watt	2	1
19	40037	Y. Watt	2	1
20	40039	B. Watt	2	1
21	40041	S. Watt	2	1
22	40043	R. Var	2	1
23	40045	Y. Var	2	1
24	40047	B. Var	2	1
25	40049	S. Var	2	1
26	40051	R. VA	2	1
27	40053	Y. VA	2	1
28	40055	B. VA	2	1
29	40057	S. VA	2	1
30	40059	R. Wh-Import	2	0.1
31	40061	Y. Wh-Import	2	0.1

Figure 2.7: 3P4W Parameters

This is modnet register map for 3P4W parameters In which Function Code is 0X03 (Read Holding Register),Address is between 40001 to 40097 No. of data word 98 and in multiple of 2 as all data are of 4 Bytes [Long Real].

2.9 Application-S2E Utility

This Application is used in our company for S2E.For changing of device IP Address,connect PM2160-A with PC through Ethernet.Now open the TCP/IP connection and set Default Gateway as per device IP.Now open the S2E Utility
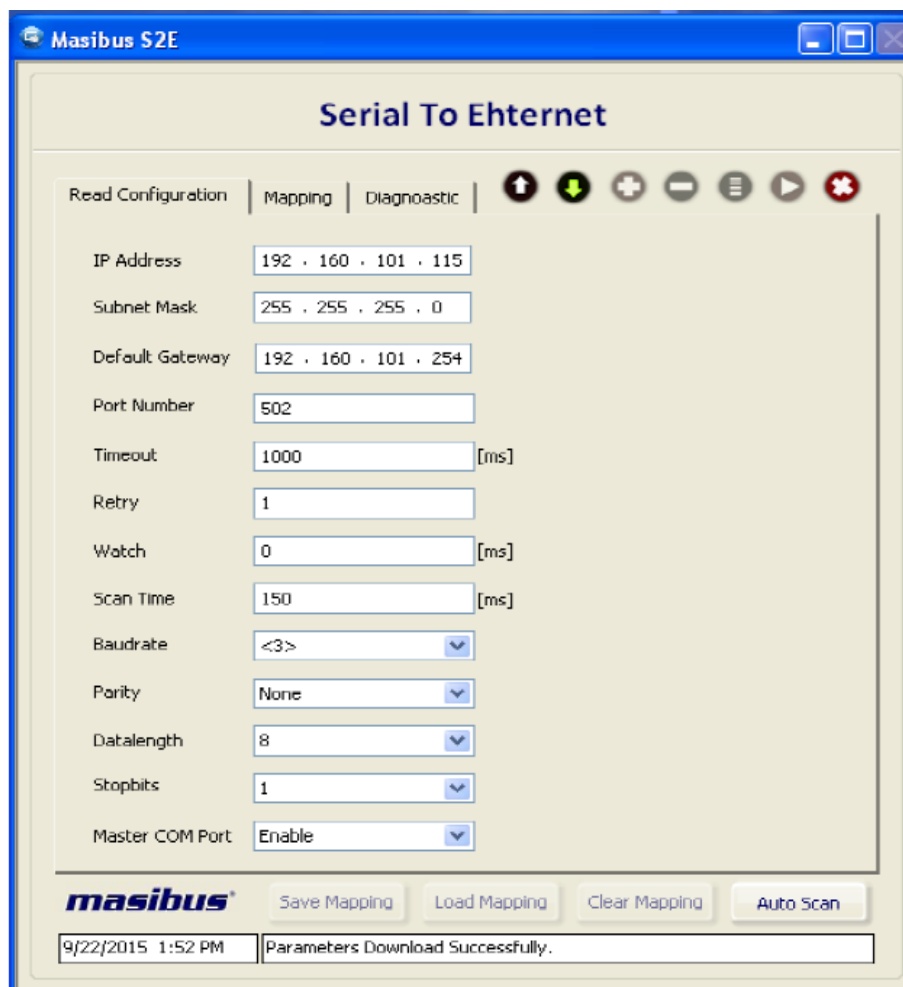
Figure 2.8: S2E Utility

Chapter 3

Hardware Design

3.1 Block Diagram for MFM
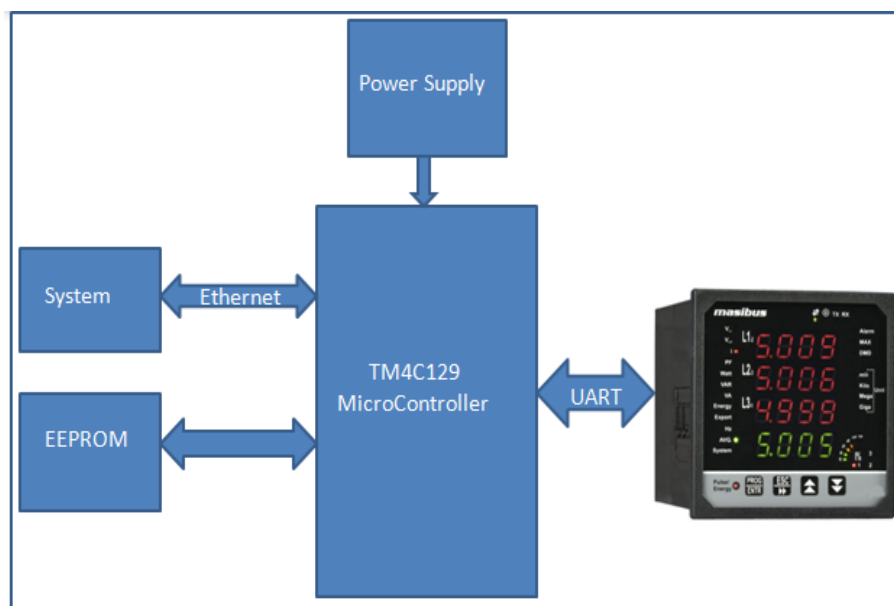
The block diagram can be shown as below:

Figure 3.1: BLOCK DIAGRAM

The Monitoring system primarily consists of Electronic Energy Meters a Serial to local area network device.The choice of energy meters depends upon application

here the energy meters selected on the communication basics with serial (RS-485) communication and supports MODBUS RTU protocol. The energy meter utilized in this project is PM2160-A.This serial to local area network device is entryway module that converts RS-485 protocol into TCP/IP protocol.This device permits remote management and management of a tool through the TCP/IP network by connecting to the prevailing instrumentation with RS-485 serial interface.

The local area network interfaces use MODNET Protocol in RTU Mode. Communicating with meter involves causing commands to the PM2160-A for reading and writing the actual register. The scientific discipline address are often modified through Modnet Register or S2E Utility.

3.2 Block Diagram for MFT
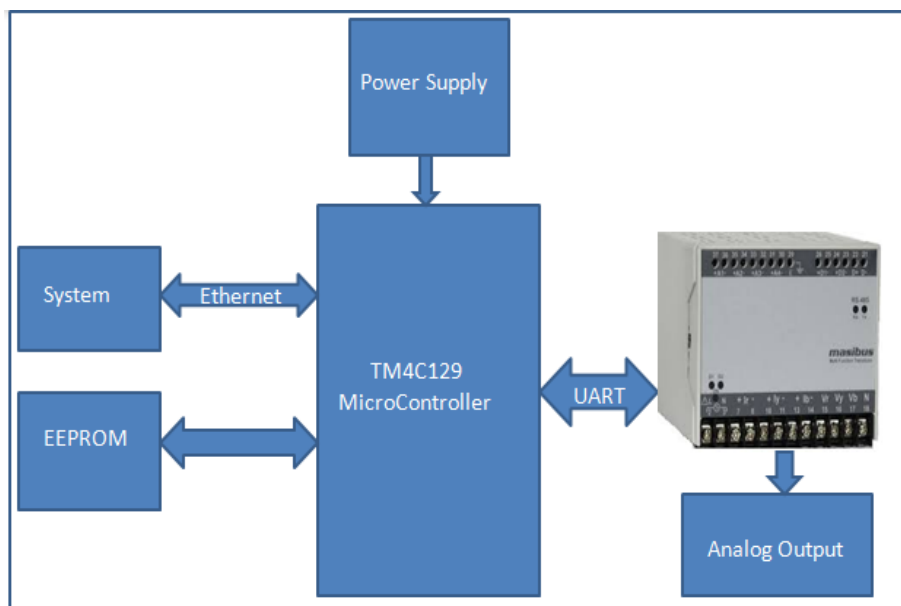
Figure 3.2: BLOCK DIAGRAM

The only difference between Multifunction meter and Multifunction Transducer is MFT gives corresponding Analog output 4-20mA or 0-10V w.r.t. electrical pa-

rameter measured except energies.It also have fully programmable Digital output for all energies.

3.3 Schematic Design

Different sections involved in the device can be described as below:

a. **Power supply :** The most important part of any circuit design is power supply. The device is charged by USB type-B connector with an inbuilt protection circuit.The IC shown in the figure.Battery is 3.3V.

b. **MAC EEPROM :**The Micro chip Technology INC. 25AA02E48 may be a 2k bit Serial Electrically erasable Programmable computer memory (EEPROM).The memory is accessed via a straight forward Serial Peripheral Interface (SPI) compatible serial bus. The bus signals needed are a clock input (SCK) and separate knowledge in (SI) and knowledge out (SO)lines.Access to the device is controlled through a Chip Select(CS) input.

c. **CPU Programming :**
It is 10 pin GPS Connector.Pins are TMS,TCK,TDO,TDI,RESET.

d. **MicroController:** The TM4C1294NCPDTI may be a 32-bit ARM Cortex-M4F primarily based microcontroller with 1024-kB non-volatile storage, 256-kB SRAM, 6-kB EEPROM, and 120 Mhz operation; integrated 10/100 LAN mack and PHY; integrated USB 2.0 property with external high-speed USB 3.0 PHY capability; a hibernation module, a mess of serial property and motion management PWM; moreover as a large vary of alternative peripherals.The TM4C1294NCPDTI microcontroller is factory-programmed with a quick start
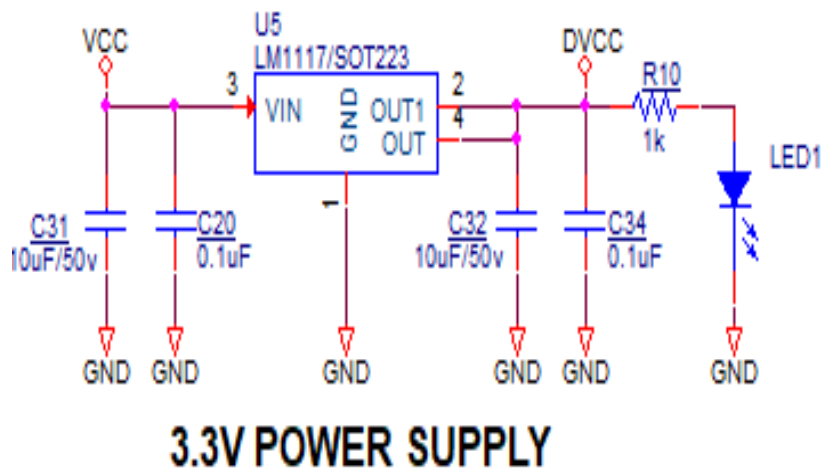
Figure 3.3: Power Supply
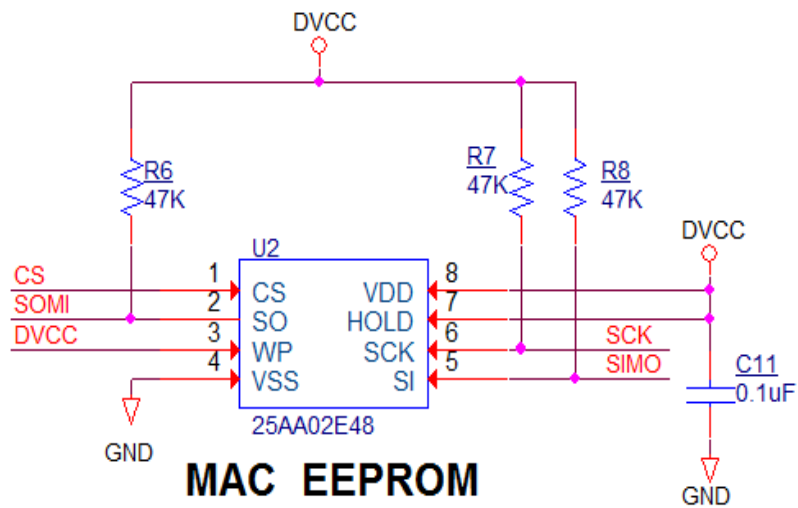
Figure 3.4: MAC EEPROM
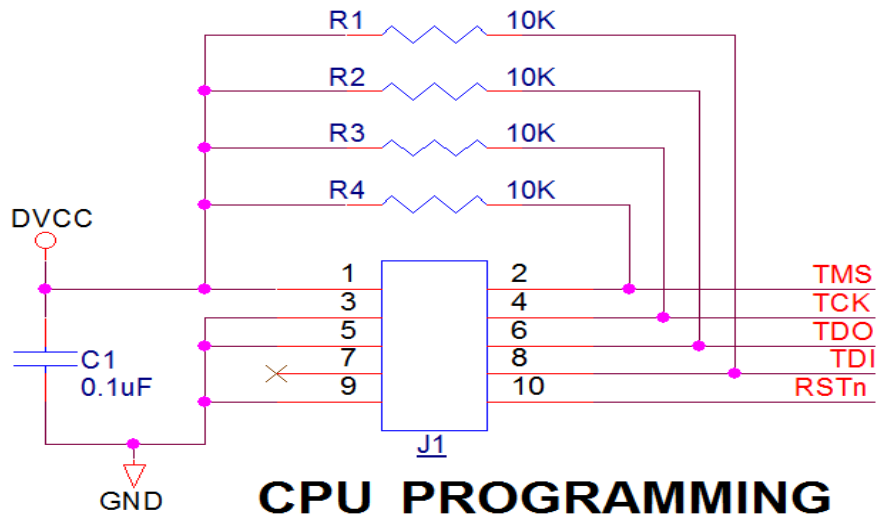
Figure 3.5: CPU Programming

demo program. The quick start program resides in on-chip non-volatile storage and runs on every occasion power is applied, unless the quick start application has been replaced with a user program.[4]

e. **Ethernet:** The Connected launching pad is meant to attach on to an LAN network using RJ45 vogue connectors. The microcontroller contains a completely integrated LAN MAC and PHY. This integration creates a straightforward, elegant and cost-saving LAN circuit style. The embedded LAN on this device is programmed to act as an communications protocol server,client or each

f. **Clocking:** The Connected launching pad uses 25MHz crystal (Y1) to drive the most TM4C1294NCPDTI internal clock circuit. Most code examples use the interior PLL to multiply this clock to higher frequencies up to 120MHz for core and peripheral temporal order. The 25-MHz crystal is needed once using the integrated LAN MAC and PHY.
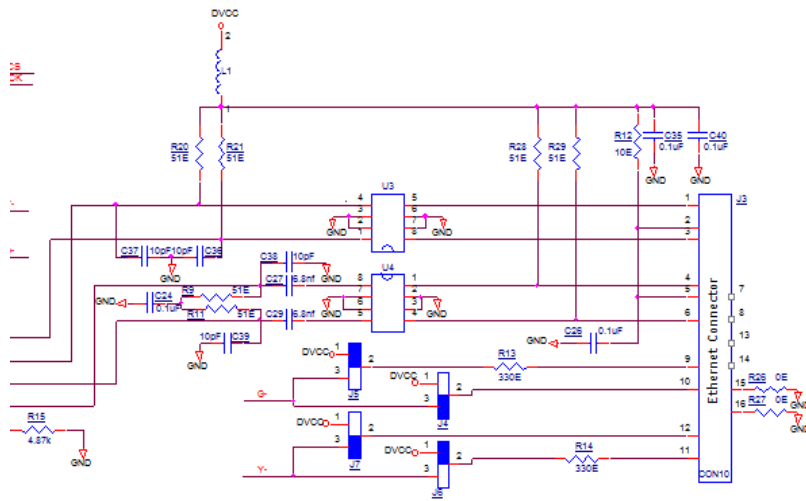
Figure 3.6: ethernet
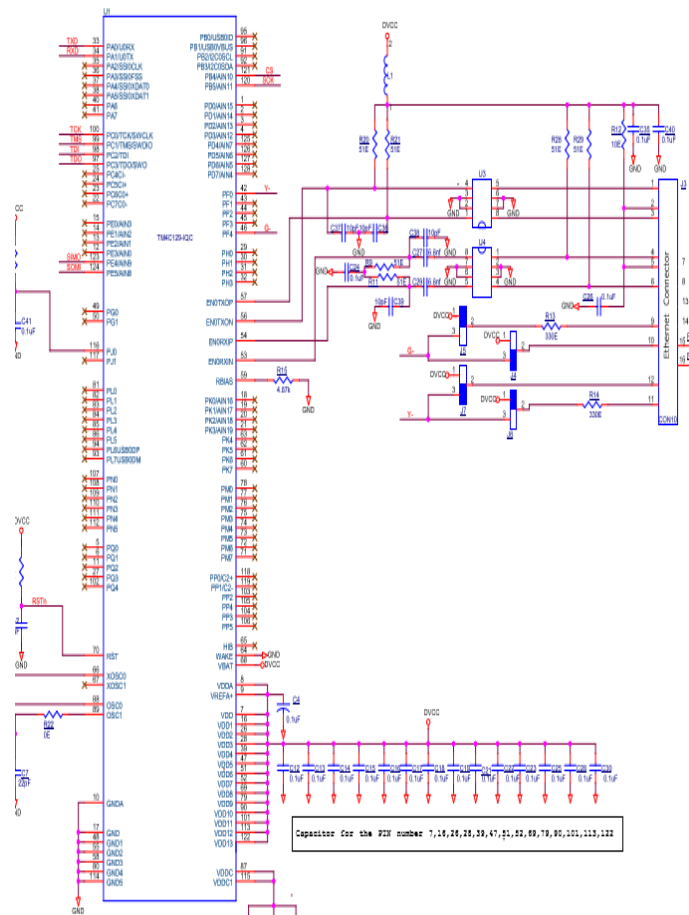
Figure 3.7: TM4C129-Microcontroller

3.4 MFT Analog Section

Multi Function Transducer device MFT has versatile capabilities for electrical parameter watching and communication. It measures all wanted of electrical parameters as well as Voltage, Current, PF, Power and Energy. All essential mensuration values is programmed to the output and are accessible through Modbus / Modnet communication, the affiliation of the input signals is freely programmed for three section 3 wire in addition as 3 phase four wire, for each balanced and unbalanced load.[5]

High rate and true RMS activity of Multi operate electrical device offers correct reading under all harmonic conditions; measured electrical parameters in MFT is regenerate to equivalent current or voltage signals. These signals are flexibly allotted to four analog o/p channels. Any parameter is allotted to any channel in addition as single parameter can be assigned to multiple channels. MFT has isolated interface between device internal physics and field to confirm personal safety.[5]

It provides two digital pulse o/p for Energy and RS485 port supporting Modbus-RTU protocol for communication, and elective RJ45 port supporting Modnet protocol is additionally accessible.

With a wide range of analog, digital output and communication choices Multi-function Transducers is utilized in several applications from an easy analog electrical device to an local area network transducer.
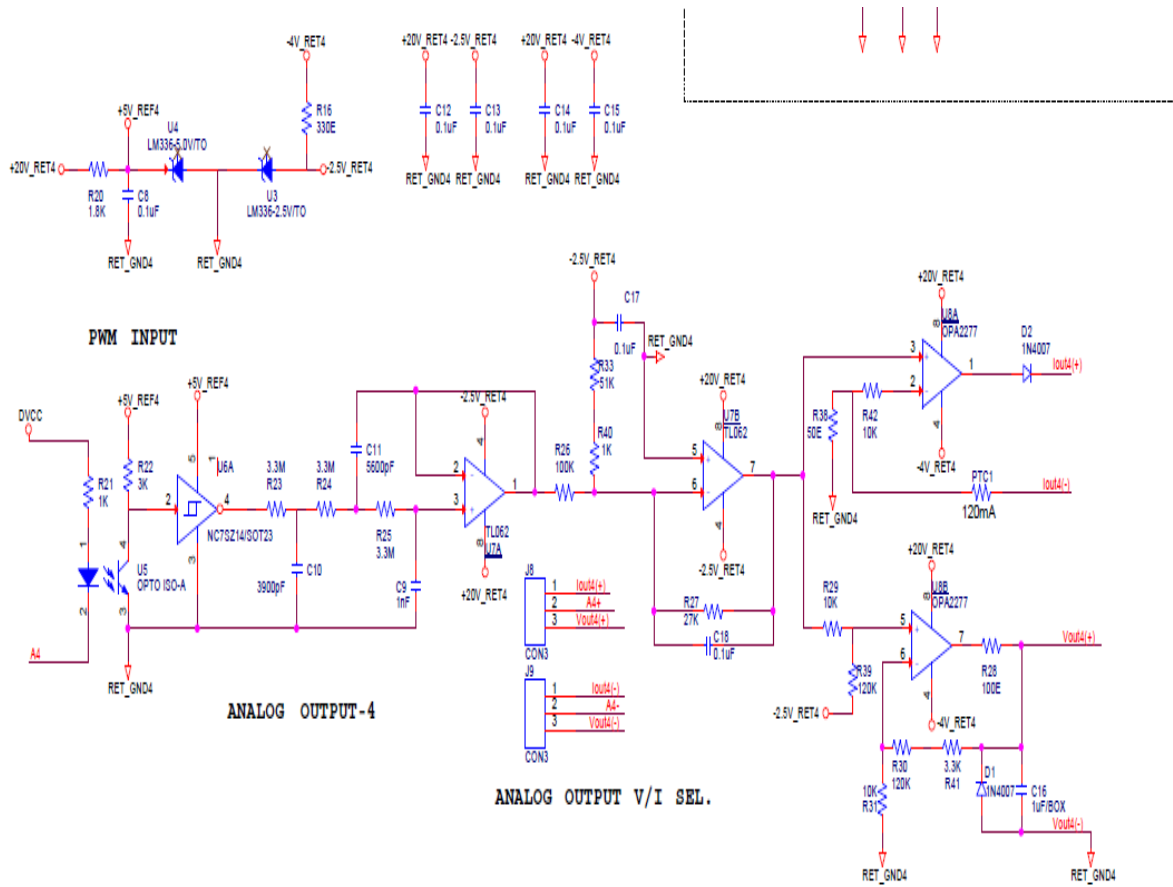
Figure 3.8: Analog Section Of MFT

3.5   PCB Design

3.5.1   Main Board

There are two layers in PCB Top and Bottom So Two layer PCB was designed for UART to Ethernet Communication and PCB was designed in Orcad 16.6 tool. Each layer can be shown as follows:
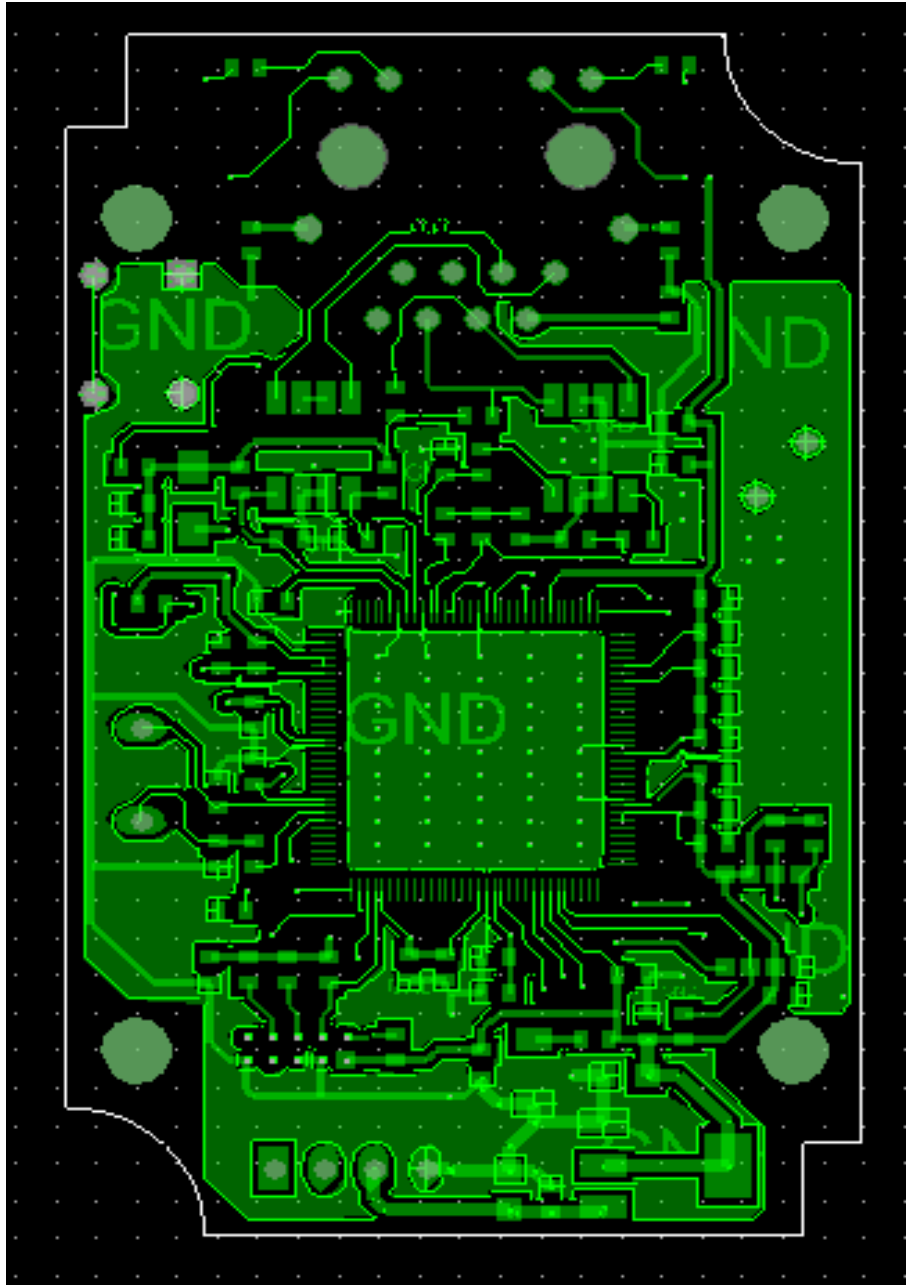
Figure 3.9: TM4C129-PCB TOP
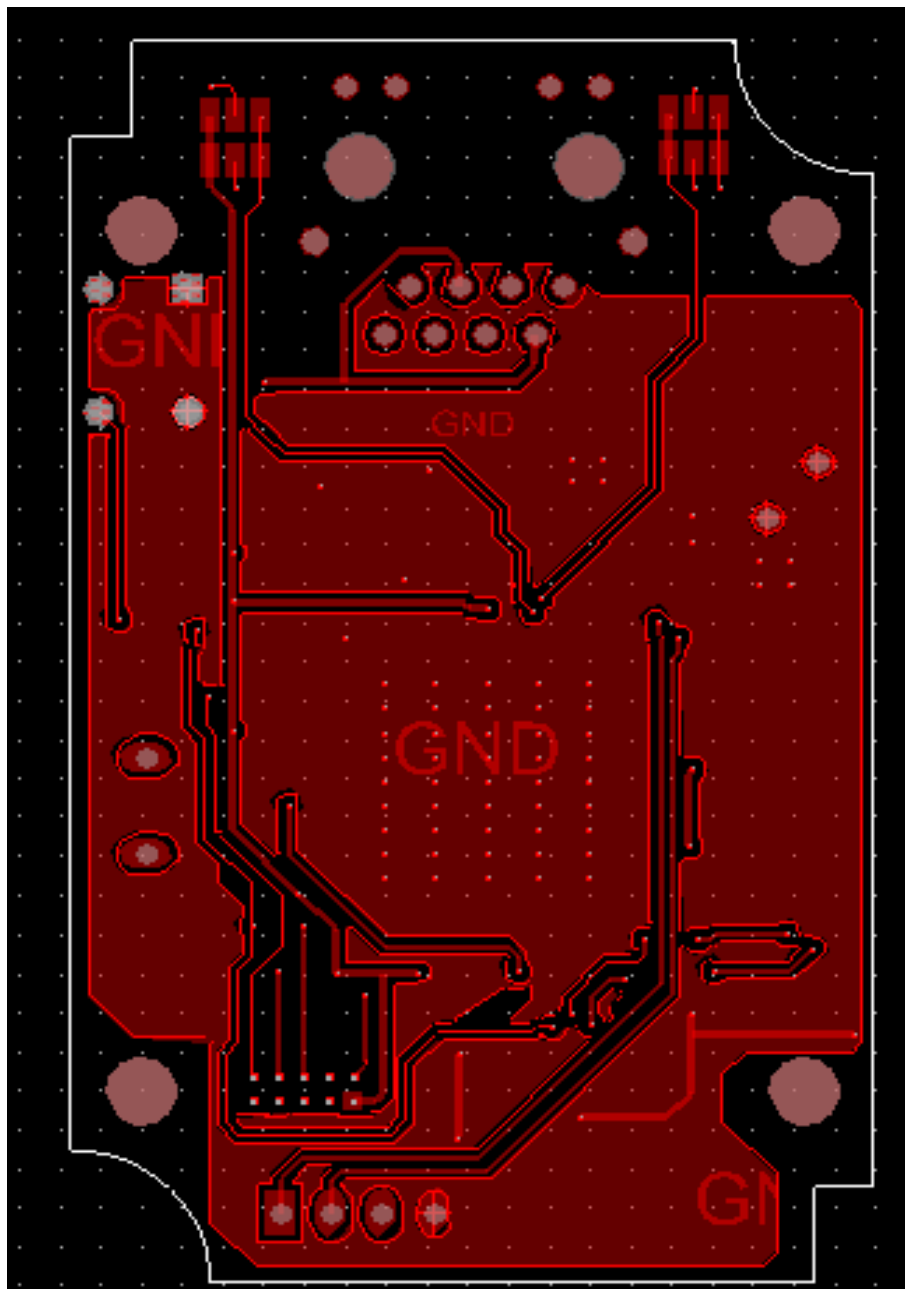
Figure 3.10: TM4C129-PCB: Top Side View of PCB

Figure 3.11: TM4C129-PCB BOTTOM

3.5.2 Ethernet card of MFT-PCB Design

A basic PCB consists of a flat sheet of building material and a layer of copper foil, laminated to the substrate. Chemical etching divides the copper into separate conducting lines referred to as tracks OR gate traces, pads for connections, vias to pass connections between layers of copper, and options like solid semi conductive areas for EM shielding or different functions. The tracks perform as wires mounted in situ, and are insulated from one another by air and also the board substrate material. The surface of a PCB might have a coating that protects the copper from corrosion and reduces the probabilities of solder shorts between traces or unsought tangency with stray vacant wires. For its perform in serving to to stop solder shorts, the coating is termed solder resist.

A computer circuit board will have multiple copper layers. A two-layer board has copper on each sides; multi layer boards sandwich further copper layers between layers of building material. Conductors on totally different layers are connected with vias, that are copper-plated holes that perform as electrical tunnels through the insulating substrate. Through-hole part leads generally additionally effectively perform as vias. when two-layer PCBs, the following improve is typically four-layer. usually 2 layers are dedicated as power provide and ground planes, and also the different 2 are used for signal wiring between parts.

Through hole parts are mounted by their wire leads passing through the board and soldered to traces on the opposite aspect. "Surface mount" parts are connected by their ends up in copper traces on the identical aspect of the board. A board might use each ways for mounting parts. PCBs with solely through-hole mounted parts are currently uncommon. Surface mounting is employed for transistors, diodes, IC chips, resistors and capacitors. Through-hole mounting could also be used for a few massive parts like electrolytic capacitors and connectors.
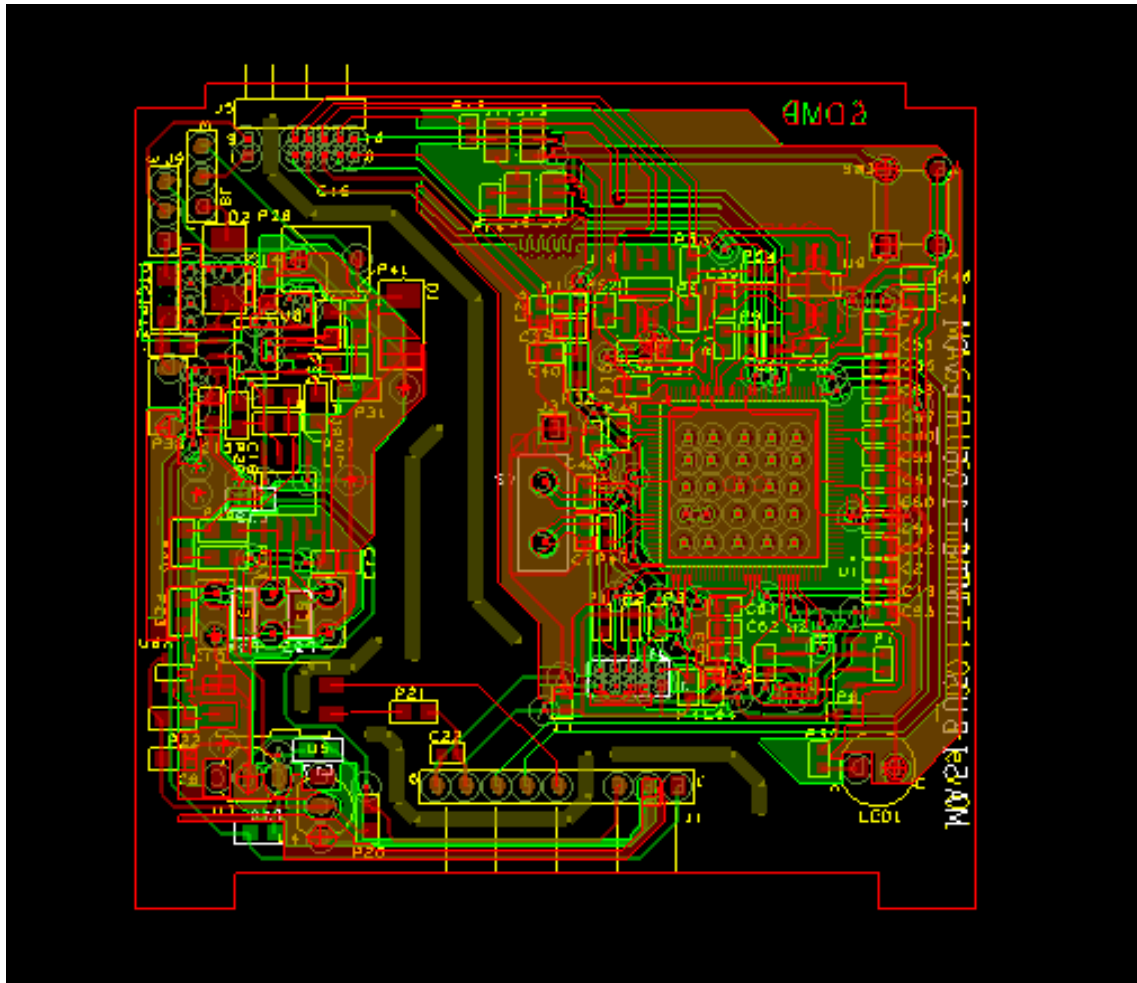
Figure 3.12: Ethernet card of MFT

3.6   Hands on
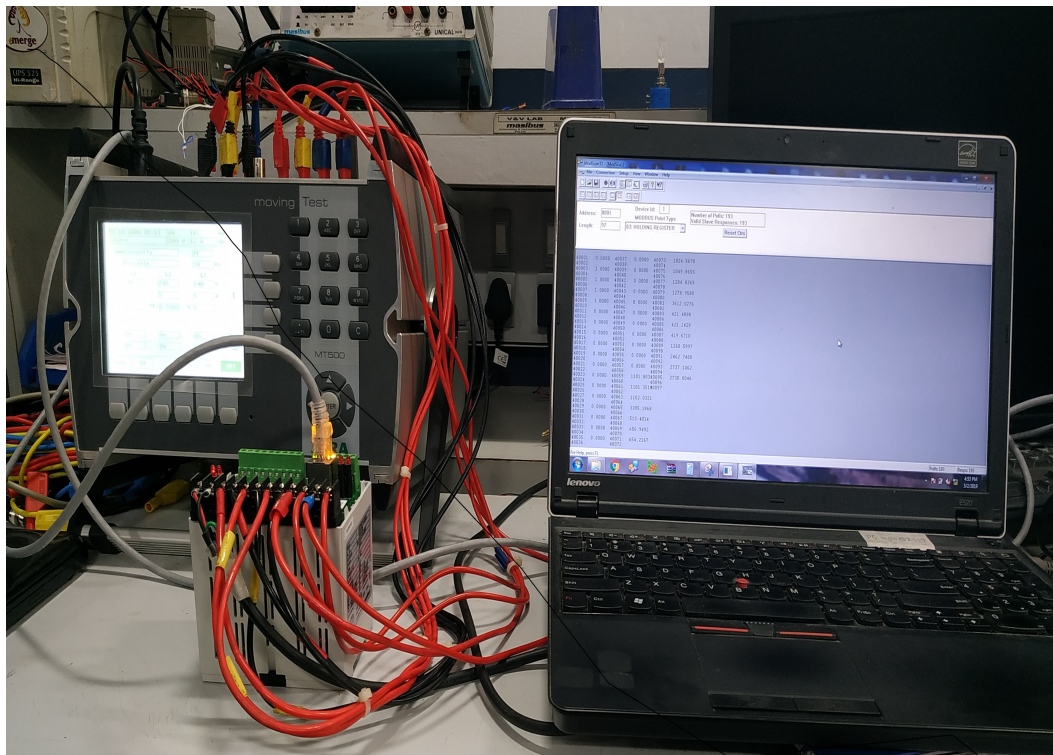
3.6.1   Testing with zera

Figure 3.13: TM4C129 :   Multifunction Transducer

The MT320 could be a moveable Reference Meter supported newest technology in power and energy measuring. varied activity options combined with its straightforward operation conception give the best doable flexibility for a comprehensive testing of metering installations on web site. Its stable housing made from double isolated plastic already reveals the top quality of the system[6].

The MT320 system is distinguished by its exemplary combination of practicality and style. The instrumentality is giving best applied science and practicality combined

with a wonderful menu guided operation via intrinsic soft-keys and a 6.4 LCD-display.

3.7 Features

a. **Testing of electricity meter installations with 2-wire, 3-wire and 4-wire circuits**

b. **Testing of energy and power registers**

c. **Power and energy measurement of active, reactive and apparent energy**

d. **4 quadrant measurement**

e. **Frequency-, phase angle- and power factor measurement**

f. **Harmonic waveform analysis for voltage and current up to the 40th THD**

g. **Distortion factor measurement**

h. **Determination of the operating burden on instrument transformers for CT and PT**

i. **Operation without mains power supply possible**

j. **Ratio test by simultaneous measurement of both primary and secondary currents in CT connected metering systems[7]**
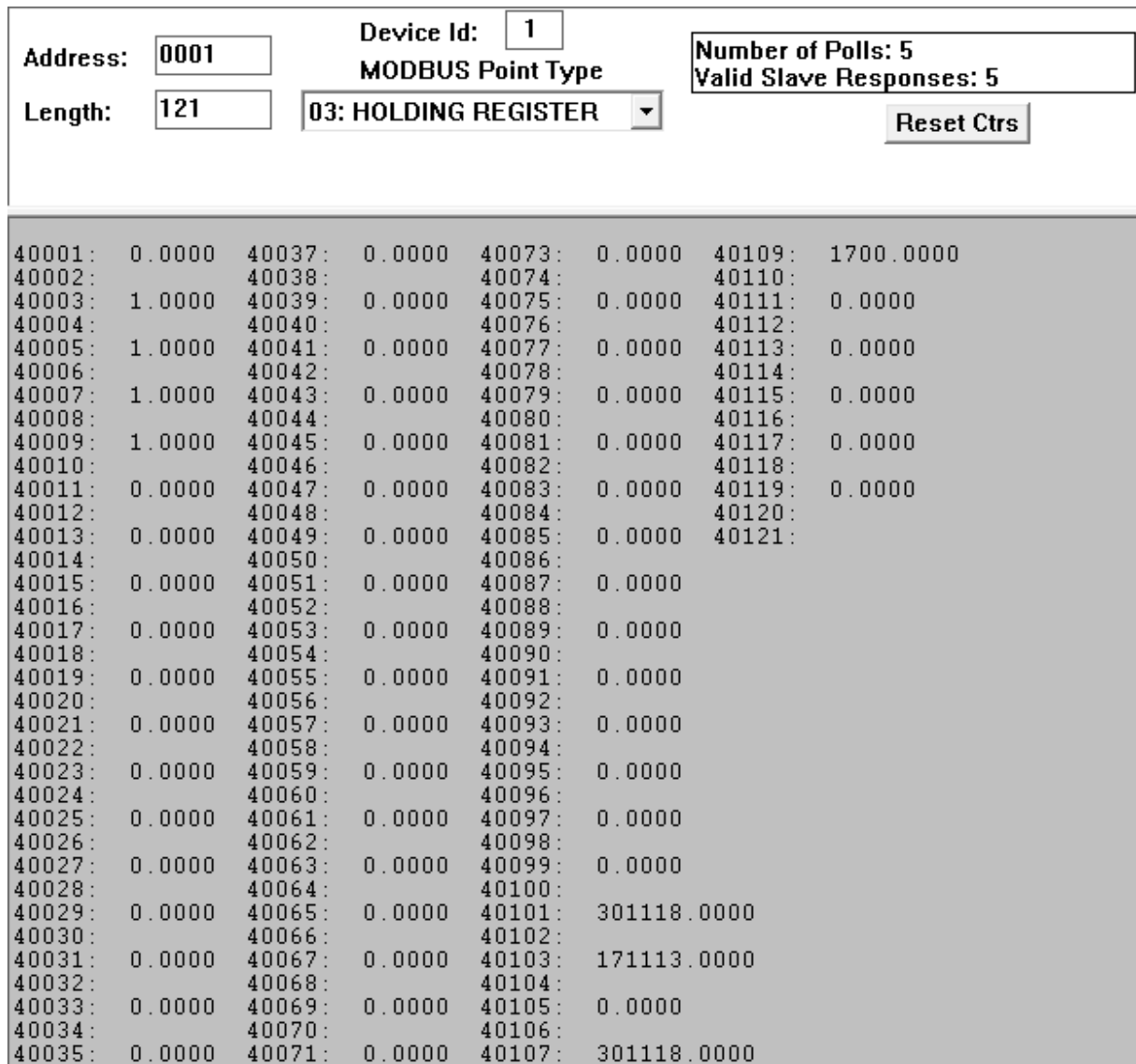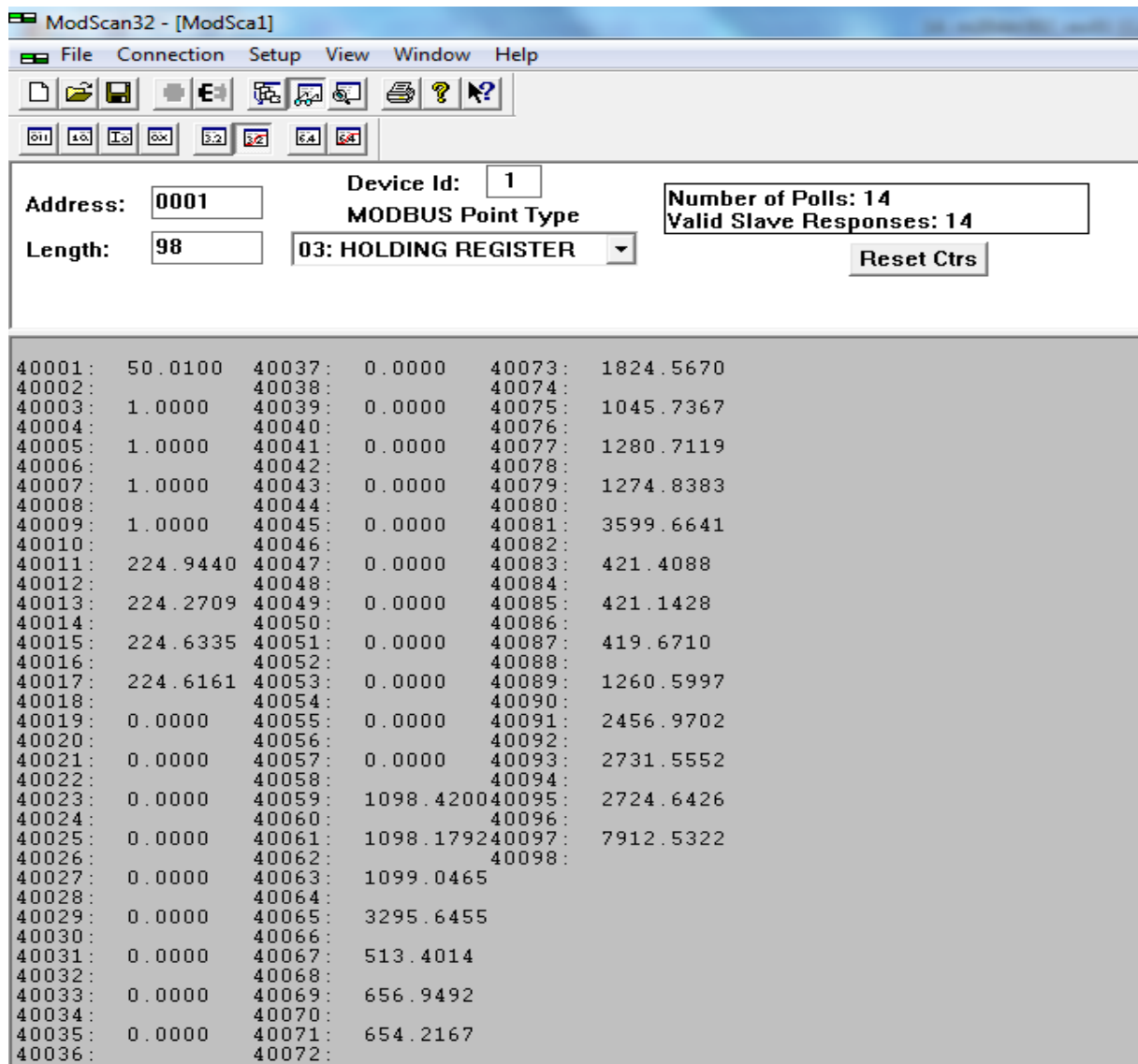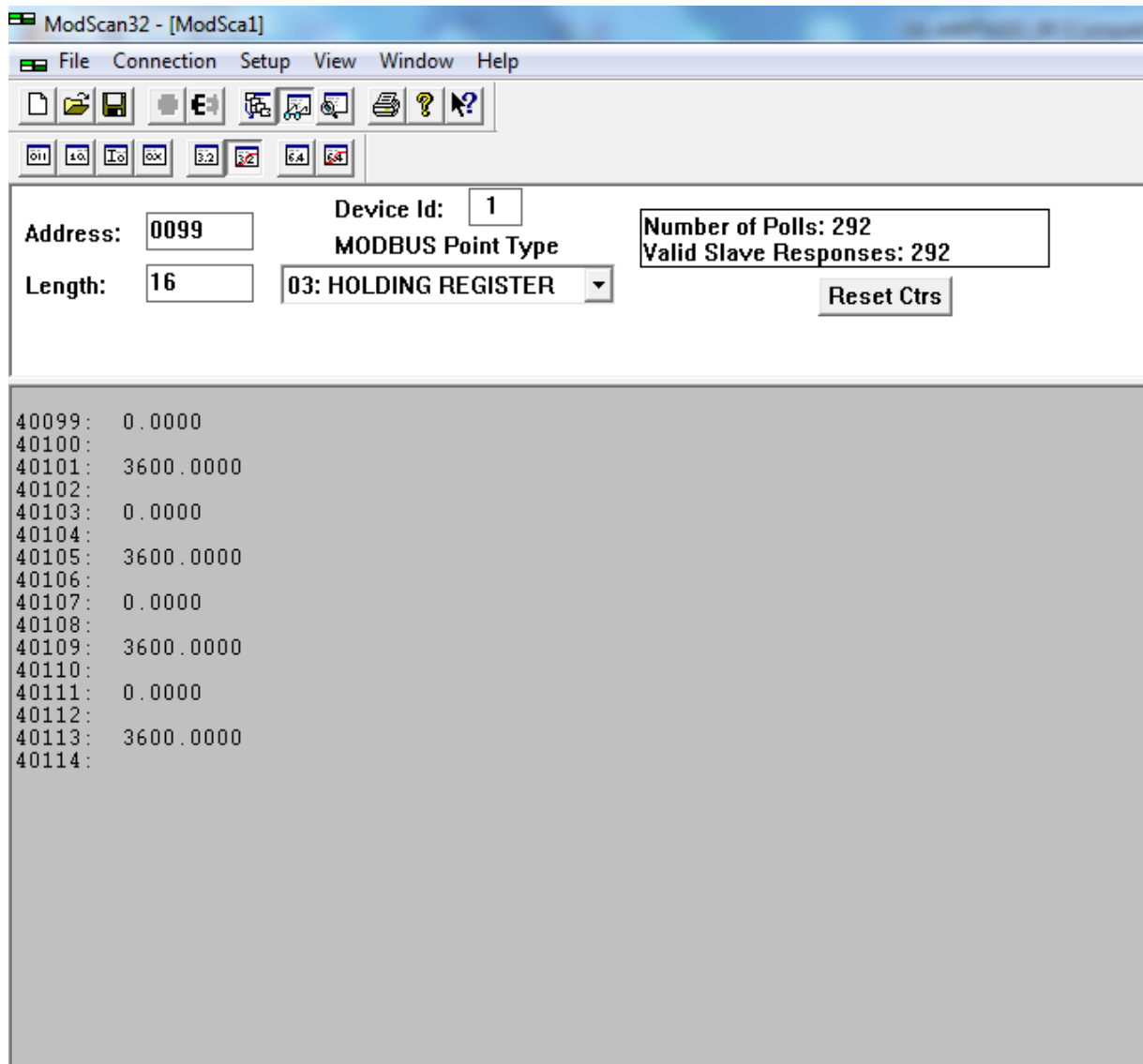
3.8   Results
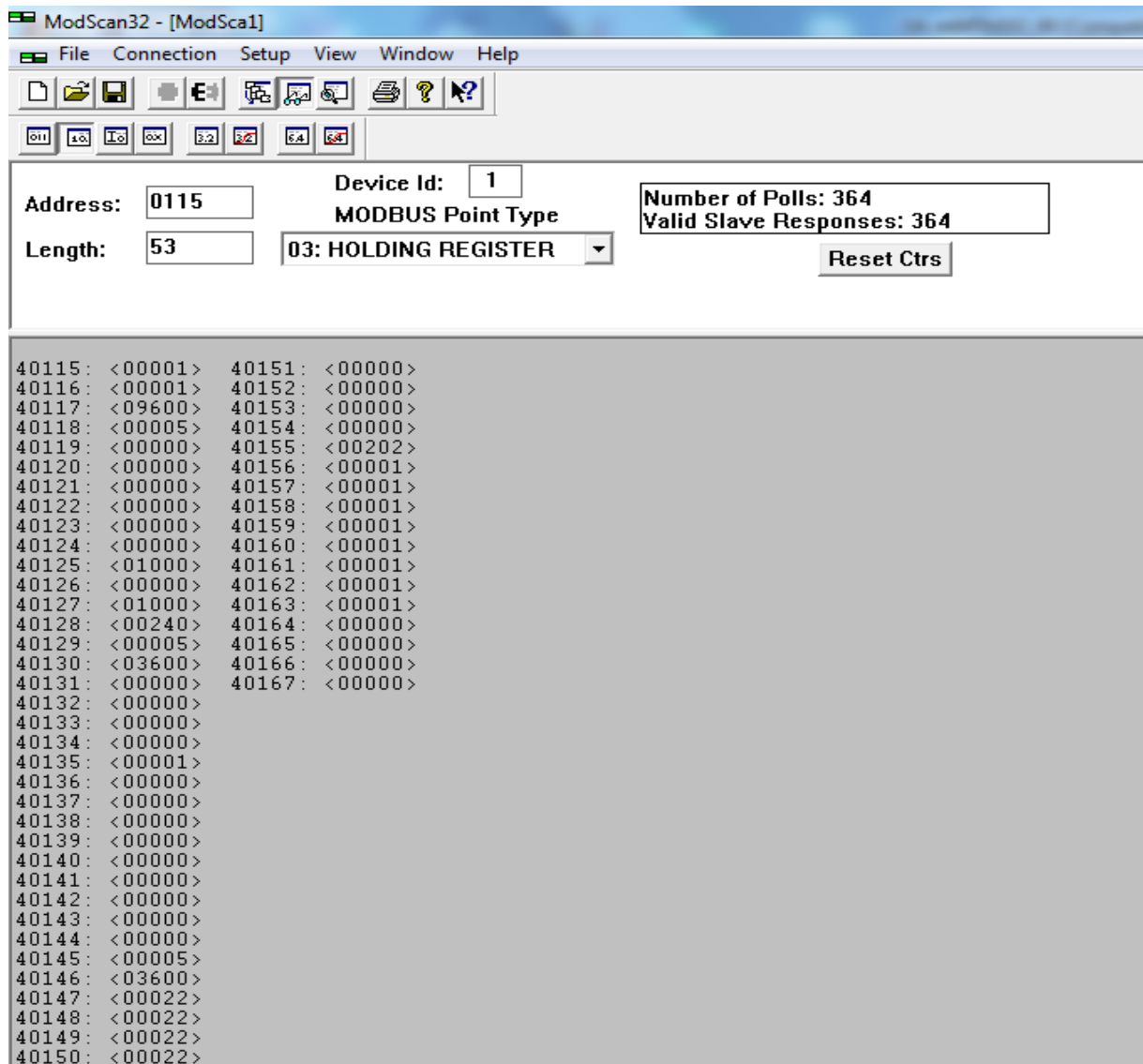
3.8.1   Multifunction meter

Figure 3.14: Modscan32 :   Result

3.8.2   Multifunction Transducer

Chapter 4

Software Design flow

4.1   Query Flow Chart

The software flow chart describes about the programming flow. The flow diagram is shown as below:
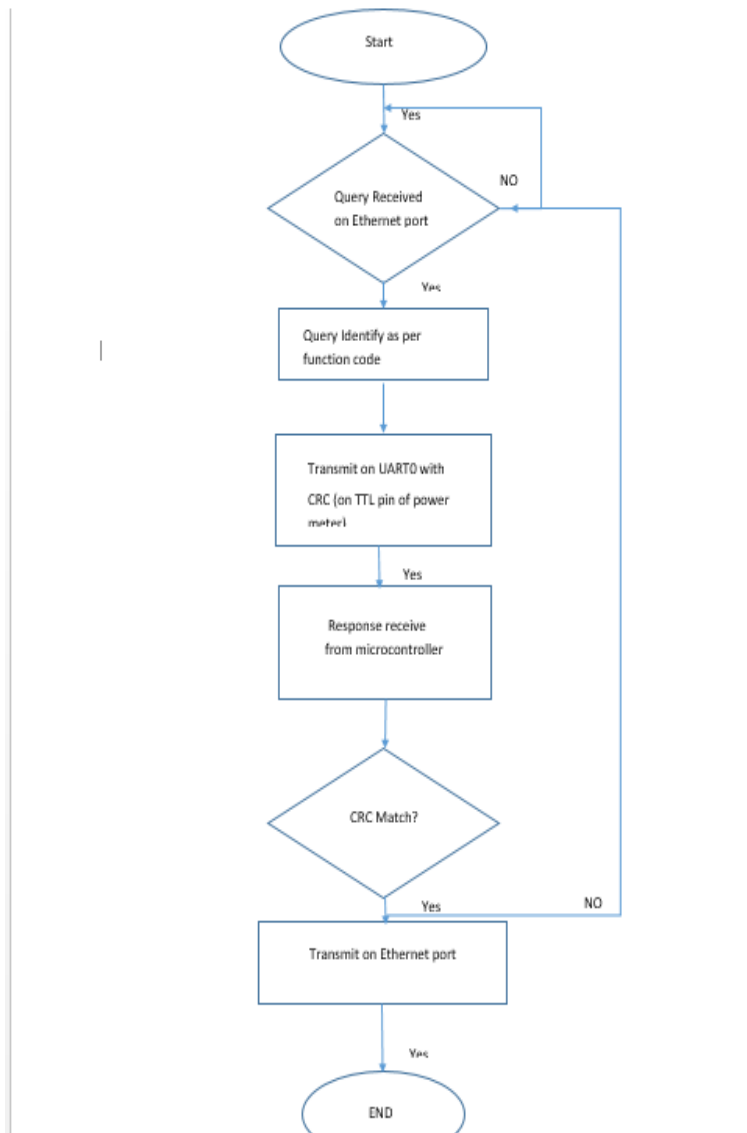
Figure 4.1: Flow diagram

Chapter 5

Work done in Masibus Automation and Instrumentation Pvt. Ltd

5.1 Manual Study

I have studied 3 manuals of local area network.First Manual is concerning Multifunction meter PM2160-A.In that manual I have got summary of PM2160-A.Features of multifunction meter.Wiring with local area network connections.I have additionally studied of PT(Potential Transformers) wiring and CT(Currenrt Transformers).The PTs and CTs should have adequate VA rating to support the burden (loading) on the secondary. you will wish to support the auxiliary provide burden from one in every of the PTs. CT wiring will impose further burden (loading) on the CT.Ethernet interface is provided to remotely communicate with the ability Meter.The RJ-45 connection provided on the rear aspect of meter.Modnet Register Map for 3P4W parameters like on hour,load hour,idle hour,power interruption count.On hour is outlined because the amount that the meter (supply) is ON.load hour indicates the amount the Load is ON and has run. This counter accumulates

as long because the load is bigger than the beginning current (0.1) set.Idle hour indicates the amount of distinction between ON Hour and cargo Hour.PIC shows last Power OFF Power ON time.(Available with RTC choice only)

Then I have studied about Microcontroller of Tiva series.Microcontroller is TM4C1294NCPDT.It is 128 pin-TQFP.Overview of that microcontroller and also features.It is ARM Cortex-M4F Processor core.Hardware details Of MC etc.

Component Placement of the circuit.The components selection for any design is to be done in a way such that the components need not to be changed once placed. Many criteria are present which decides the selection of components. For example, for selecting a microcontroller many different parameters are to be taken care as the operating voltage, current, number of analog to digital output, number of general purpose input-output pins available, timers present in the microcontroller, etc. Once the microcontroller is selected the peripherals of the microcontroller are to be placed in layout according to the requirement. There are many components which are required to be placed very near to the microcontroller. These components generally be the charging discharging capacitors.

The PCB design is fully dependent on the proper components selection. The components placement also plays a major role. The components selection should be done in a proper way. The PCB once designed should not be a source of emittion or reception of any unwanted signal. The routing of PCB reduces the loss from the circuit if done correctly. The connectors if present should be placed in the corner so that while mounting-unmounting the other components are not damaged. The regions are to be created in the PCB for proper grounding of the components. Many circuits have chassis ground which are to be be connected differently from the circuit ground. The proper components placement and component routing is very important for the high efficiency of the whole circuit or system designed.[8]

For Code Composer studio 1st I have got several videos on youtube of code com-

poser studio a way to operate code composer studio.It is associate degree integrated development Environment (IDE) that supports TIs Microcontroller and Embedded Processors portfolio.It contains a collection of tools accustomed develop and right embedded applications. It includes associate degree optimizing C/C++ compiler, ASCII text file editor, project build surroundings, debugger, profiler, and lots of different options.Familiar tools and interfaces permit users to urge started quicker than ever before.

5.2 Tools

Different tools are used for different purpose. The tools can be explained in details as follows:

5.2.1 Orcad 16.6

Every electronic system features a routed board on that the elements are mounted. That board is termed as Printed circuit Board(PCB).Orcad 16.6 delivers electronic style tools to assist electronic engineers round the world.OrCAD PCB style solutions provide absolutely integrated front-end style, analog/mixed signal simulation, signal integrity analysis, and place-and-route technologies that boost productivity.It is a PCB planning tool.Totally different steps learnt in Orcad 16.6 are mentioned as below:[9]

a. Symbol development

b. Schematic design

c. PCB symbols

d. PCB development

e. Gerber files creation

f. Outjob files

g. CAM file

h. Generating PCB from CAM file

Schematic Symbols: The symbols which represent electrical and electronics components.

Schematic Design: It is a representation of connection of elements of the system using abstract and graphics.

PCB Footprints: A footprint is the arrangement of pads(in surface-mount technology) or through-holes (in through-hole technology) accustomed physically attach and electrically connect a part to a Printed circuit board.

PCB Designing: PCB connects electronic components using tracks, pads and copper region.
- It can be in single layer or multi-layered.

Outjob Files: Outjob contains all manufacturing files such as gerber, drill drawings, art files, fabrication files and mechanical specifications.

5.2.2   GerberLogix

GerberLogix is the Gerber viewer for printed circuit board. All the Camtastic files and the Gerber files can be viewed and compared in this software. It is easy to compare more than one gerber files by placing each PCB on top of each other and find out the difference.[10]

5.2.3   Code composer Studio

Code composer Studio is associate integrated development environment (IDE) that supports TIs Microcontroller and Embedded Processors portfolio. Code Composer Studio contains a set of tools accustomed develop and correct embedded applications. It includes associate optimizing C/C++ compiler, ASCII text file editor, project build atmosphere, debugger, profiler, and lots of different options.[11]
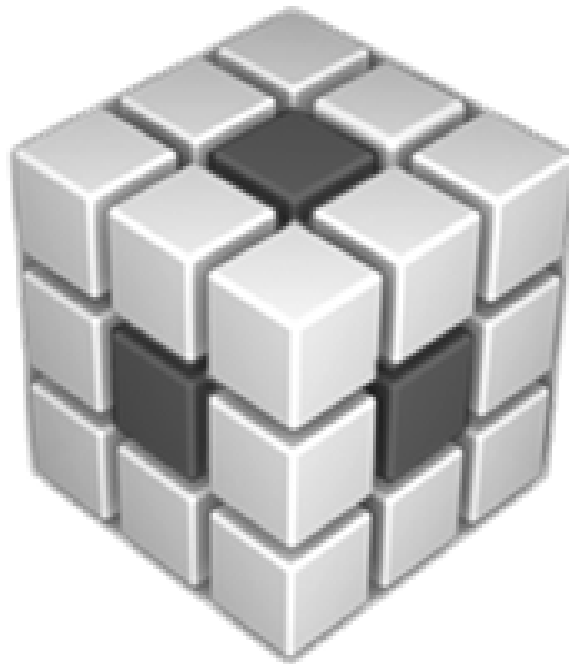
Figure 5.1: Code Composer Studio

5.2.4   Modscan32

Modscan32 may be a 32-bit Windows application that is a Modbus master device for protocol testing and playing Modbus serial and TCP/IP knowledge assortment by polling at user-defined intervals all the way down to milliseconds. It will acquire knowledge in number, unsigned decimal, and floating purpose formats. It conjointly supports register writes. The slave interval and delay between polls are user selectable.

Chapter 6

Conclusion

6.1 Conclusion

After extensive study,research and analysis,and feasibility of options for power quality monitoring and analysis an attempt has been made to design an ethernet based smart energy meter. By developing this device,Ethernet based meter basically used in LAN network and its access any where from the LAN network or establish any wireless server Also the speed of ethernet communication is faster than Modbus.

In this project, schematic as well as PCB are developed and tested. Software testing product have done. After validation and verification the product will release.The methodology developed can be easily used into any smart meter architecture without use of additional hardware.Future research cab be done in the data analysis,communication technology,and in improving power factor correction Techniques.With a wide range of analog, digital output and communication options Multi Function Transducers can be used in many applications from a simple analog transducer to an Ethernet transducer.

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