



2010

Development of A Home Energy Management System Using Power line Communication

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Outlines

24/9/53

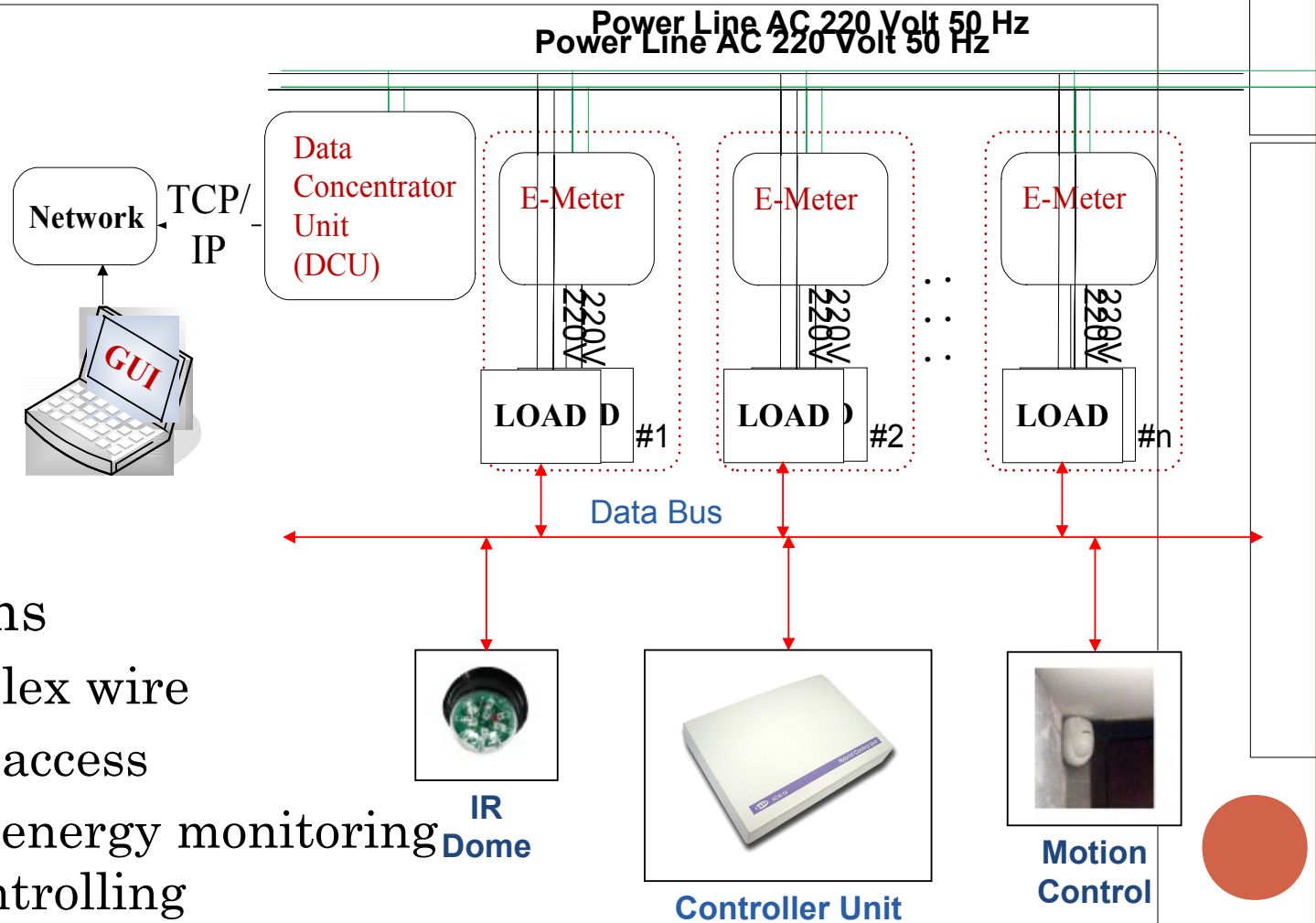
Introduction	Hardware	Objectives	Testing	Conclusion
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INTRODUCTION



Home Automation System



Problems

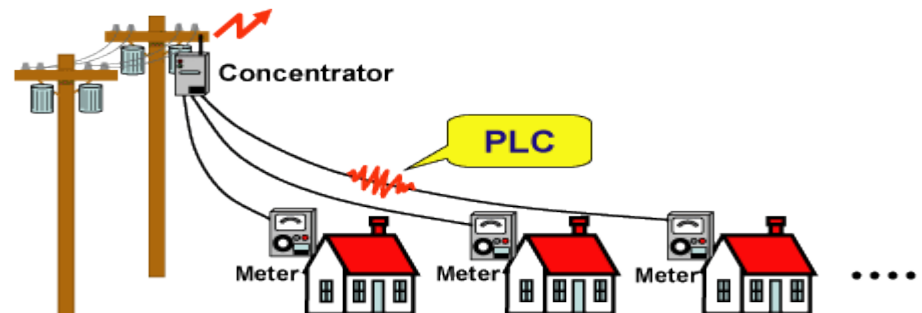
- Complex wire
- Hard access
- Need energy monitoring and controlling

Introduction: Powerline Communication

PLC : Power Line Communication

Power line as Physical media for communications

◆ AMR (Automatic Meter Reading)



◆ Home Network



Introduction

- Residential Demand Control (RDC)



Introduction

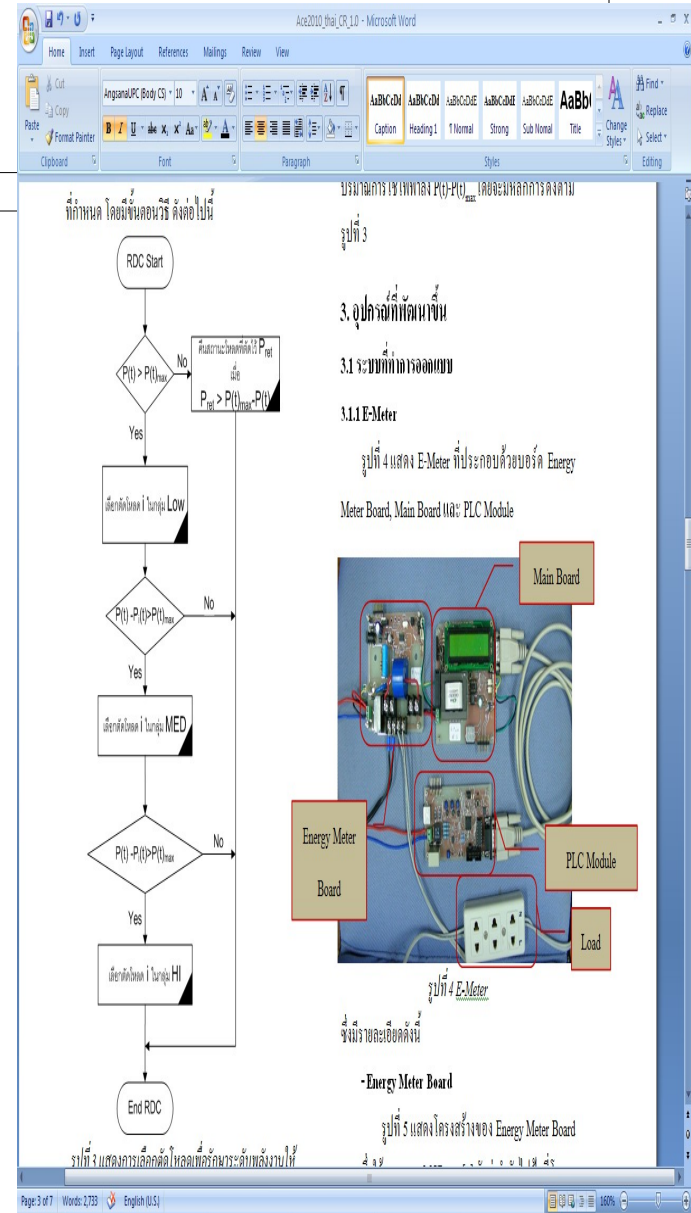
✗ RDC Algorithm

✗ RDC Parameter

- + RDC Maximum Power
- + Total power consumption of all loads
- + Load's power consumption
- + Load Priority

✗ RDC Algorithm

- + If total power consumption > RDC Maximum Power
- + Define load(s) to off
- + Off load(s)



OBJECTIVES



Objectives

- Hardware
 - PLC E-Meter
 - Data Concentrator
- Software
 - Energy Control; GUI Programming



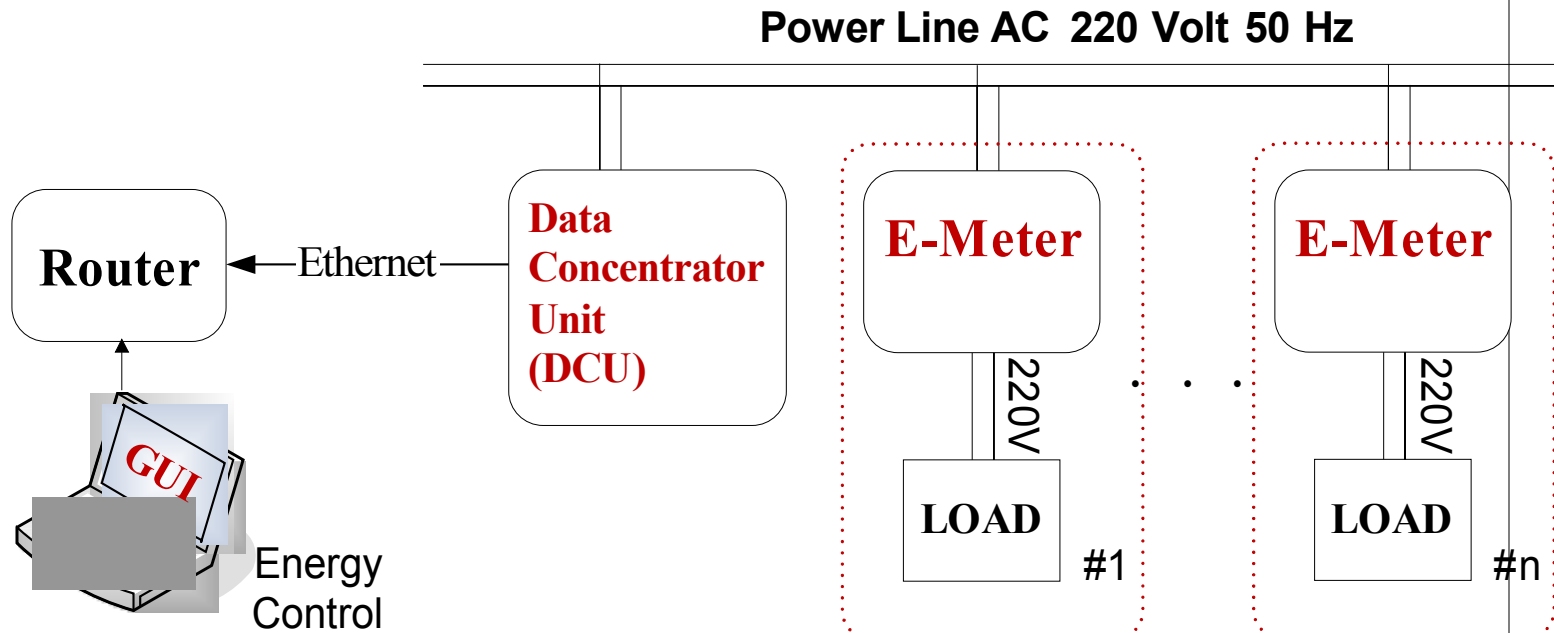
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HARDWARE



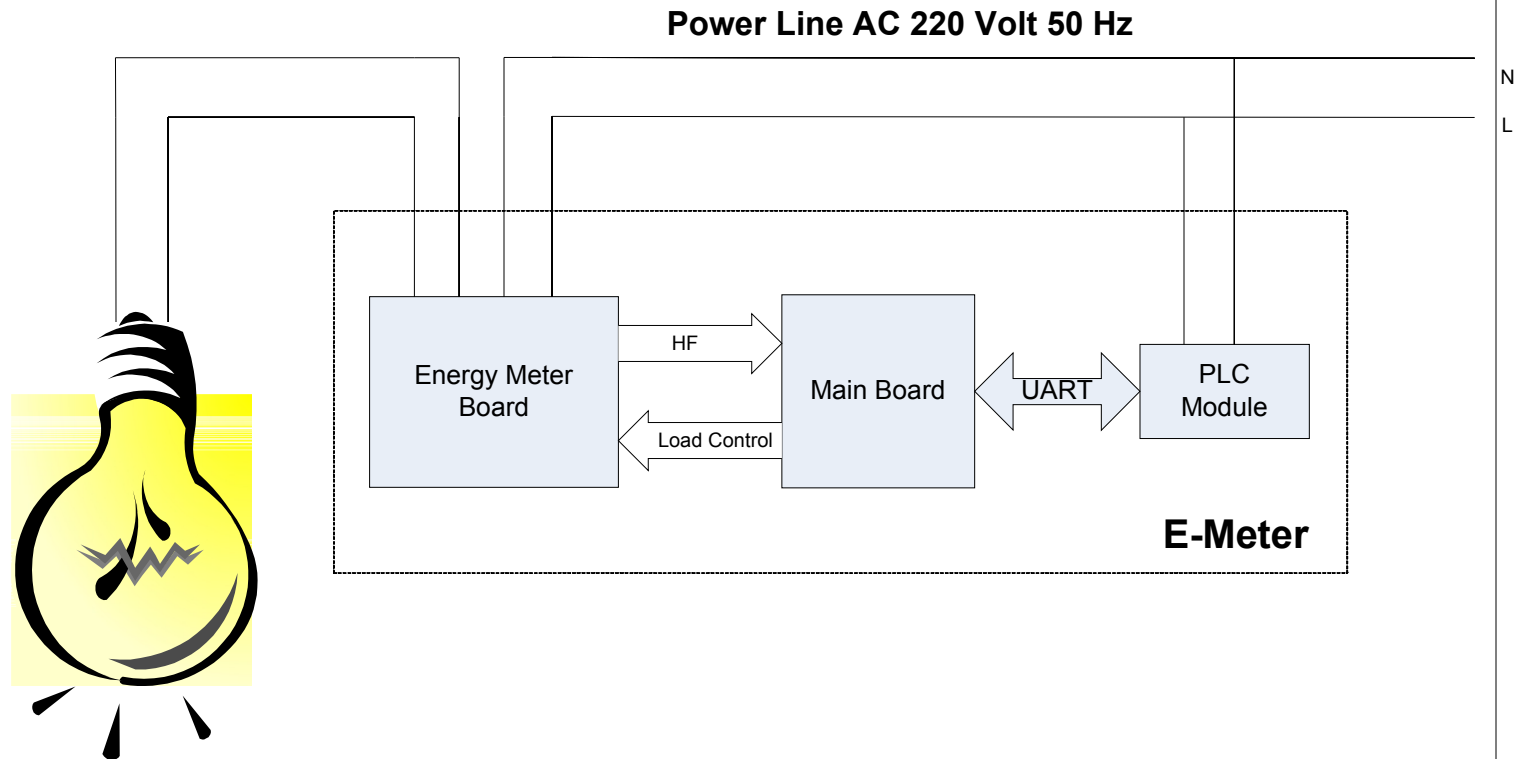
System Implementation

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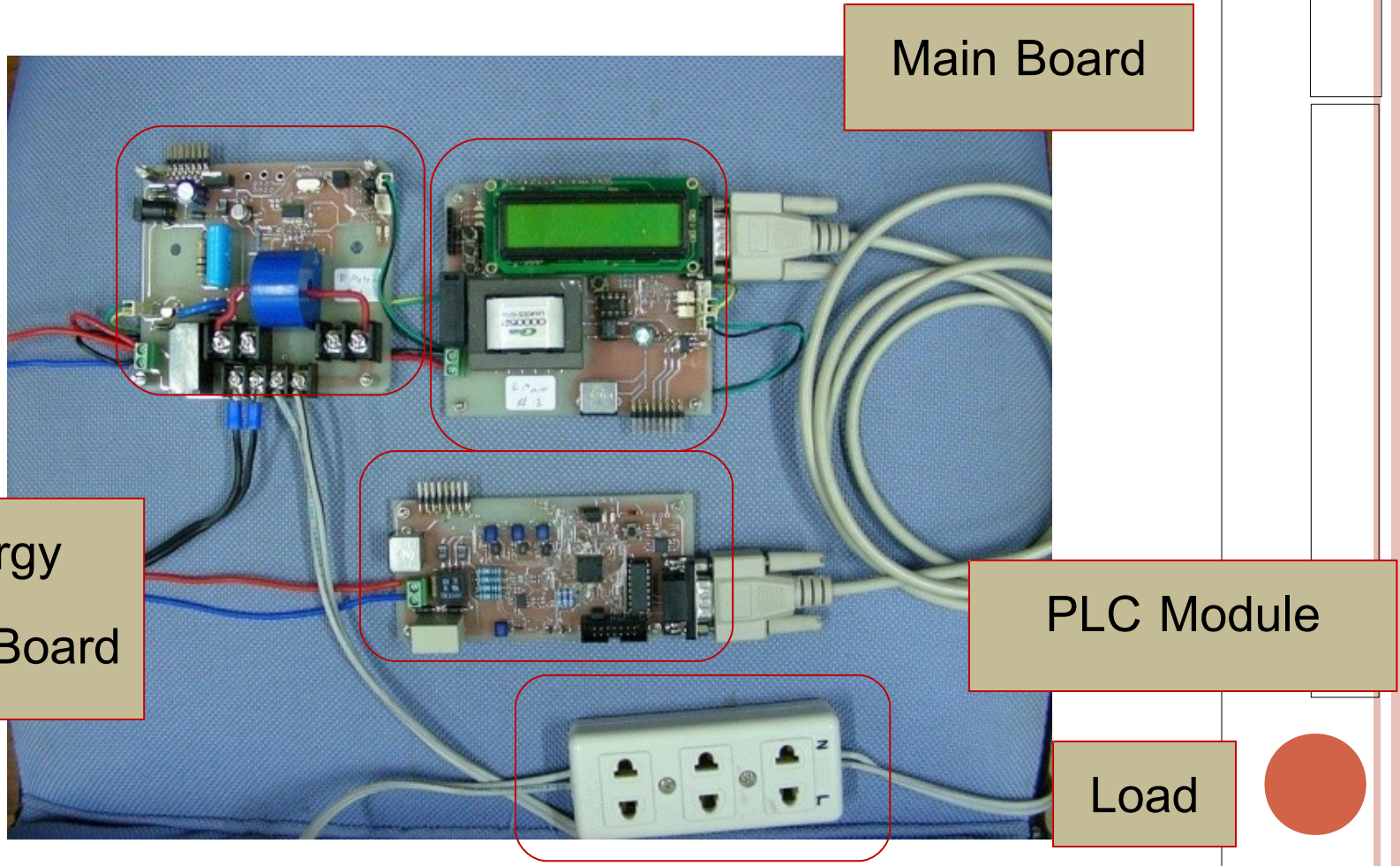


Hardware : E-Meter

○ Diagram



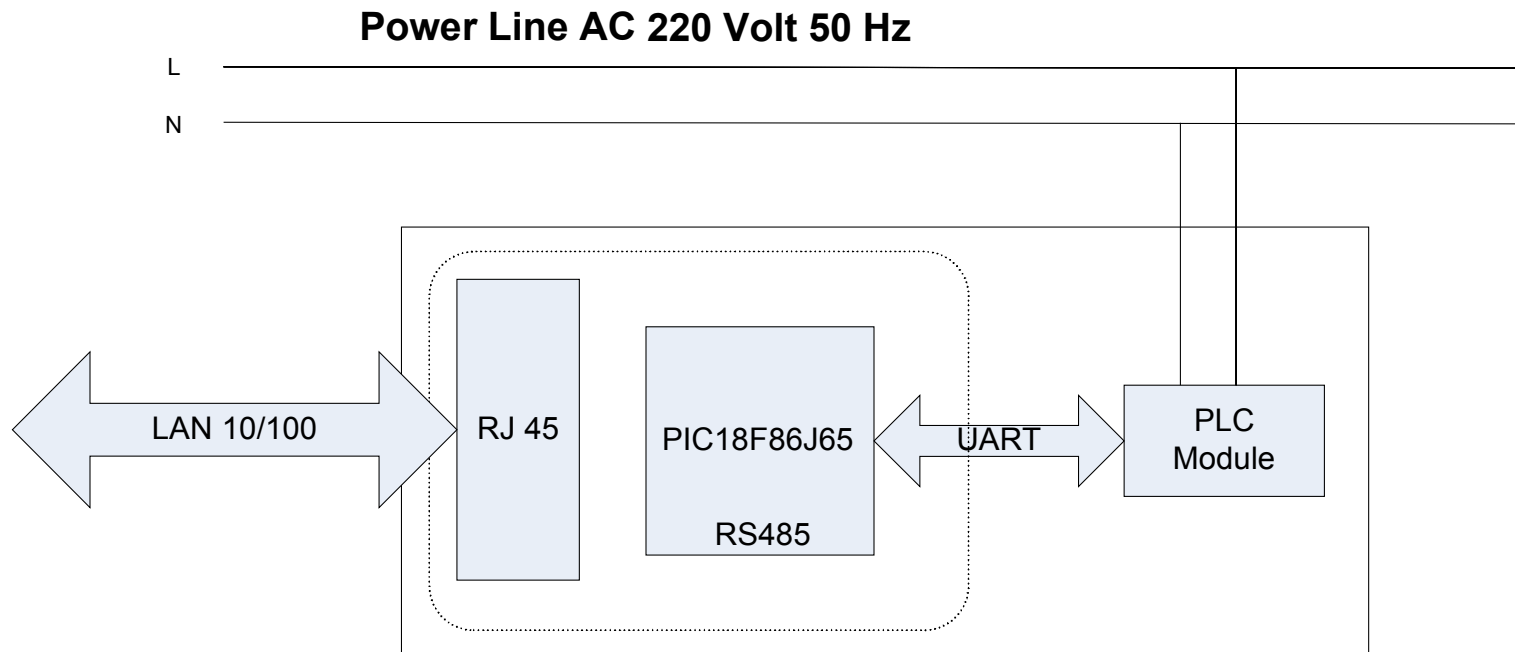
Hardware : E-Meter



Hardware : Data Concentrator Unit

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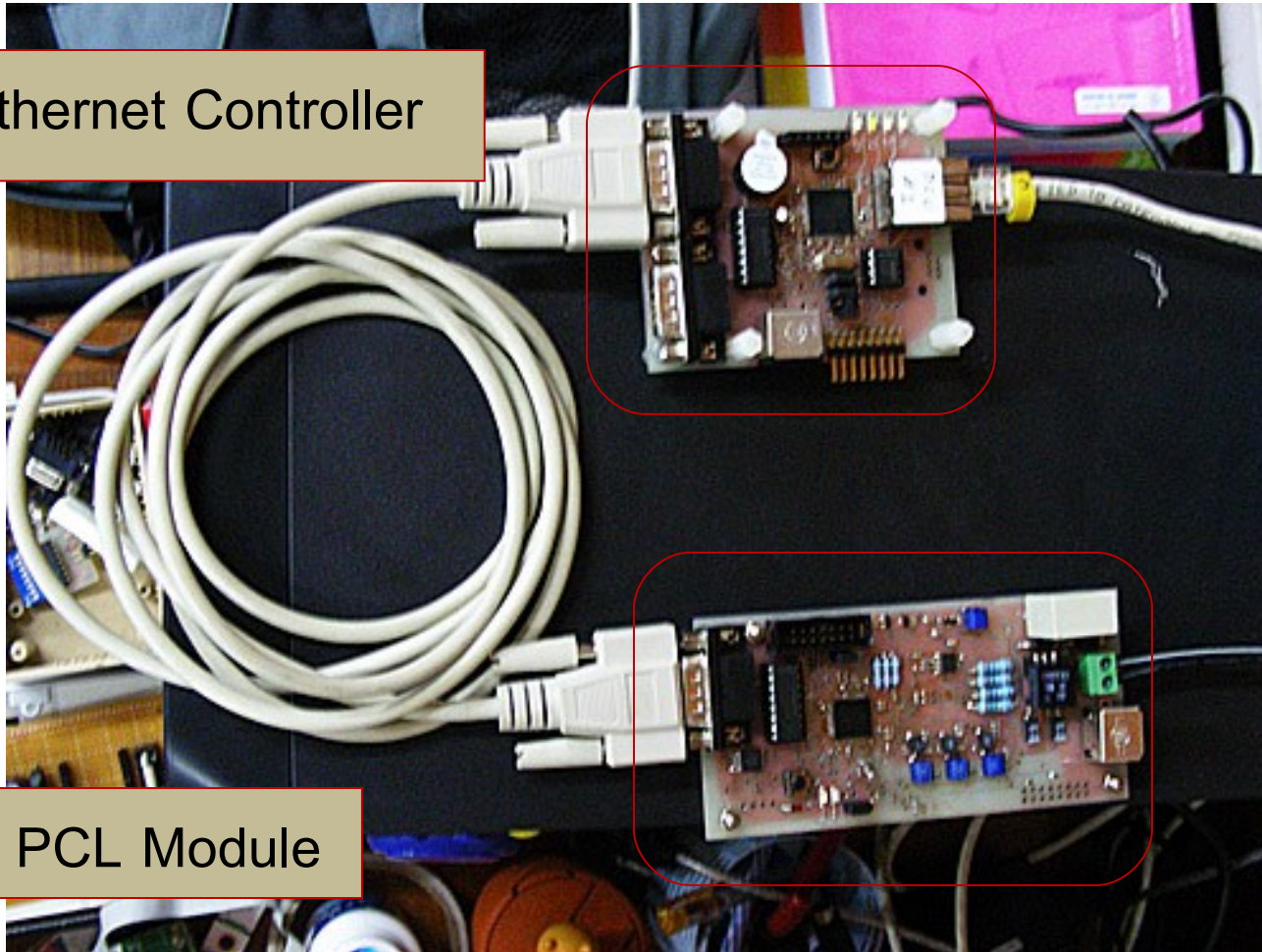
○ Diagram



Hardware : Data Concentrator Unit

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Ethernet Controller



PCL Module



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TESTING



Testing : PLC Module

○ Conditional

- No Load
- Load Line



Testing : E-Meter

- Power Meter Testing



Testing : E-Meter

○ Power Test Result

$$error = \frac{W_{meter} - W_{ref}}{W_{ref}} \times 100\%$$

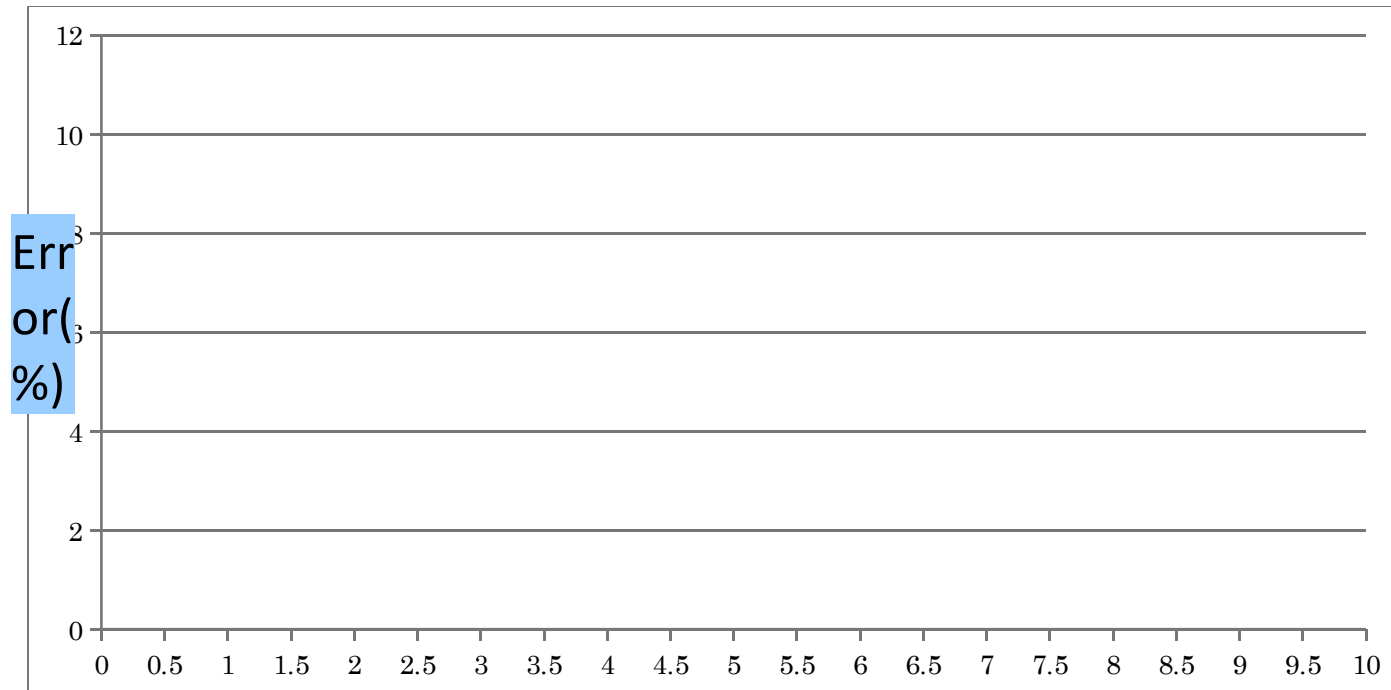
Current(A)	Wref	W E-Meter	Error(%)
0.15	32.9	32.95026	-0.15277
0.25	54.94	54.91773	0.040535
0.5	109.9	109.8355	0.058726
0.75	164.97	164.7541	0.130851
1	219.98	219.6719	0.140074
1.5	329.35	329.5092	-0.04834
3	659.51	659.0184	0.074536
5	1099.5	1098.715	0.071428
10	2199.5	2200.389	-0.04042



Testing : E-Meter

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○ Power Test Result

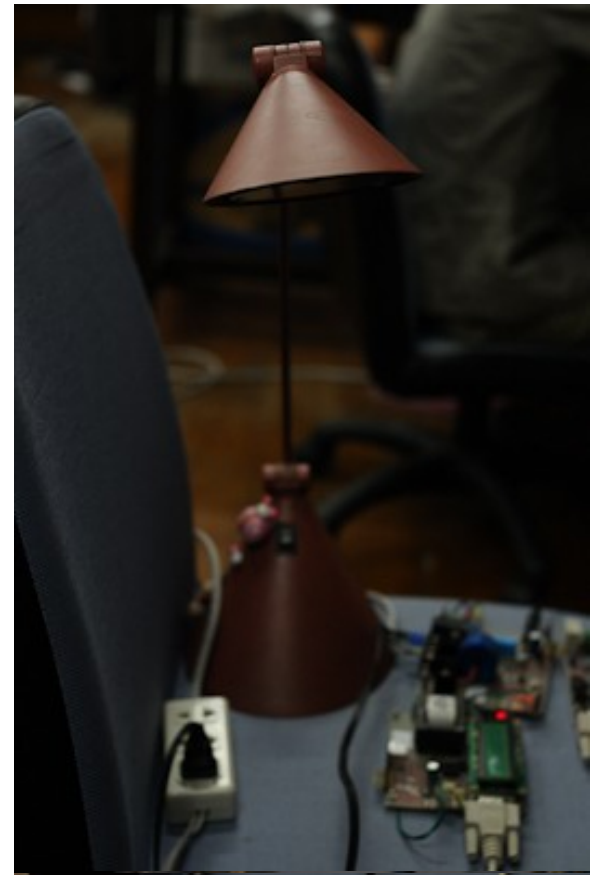


Current(A)



Testing : On-Off Load

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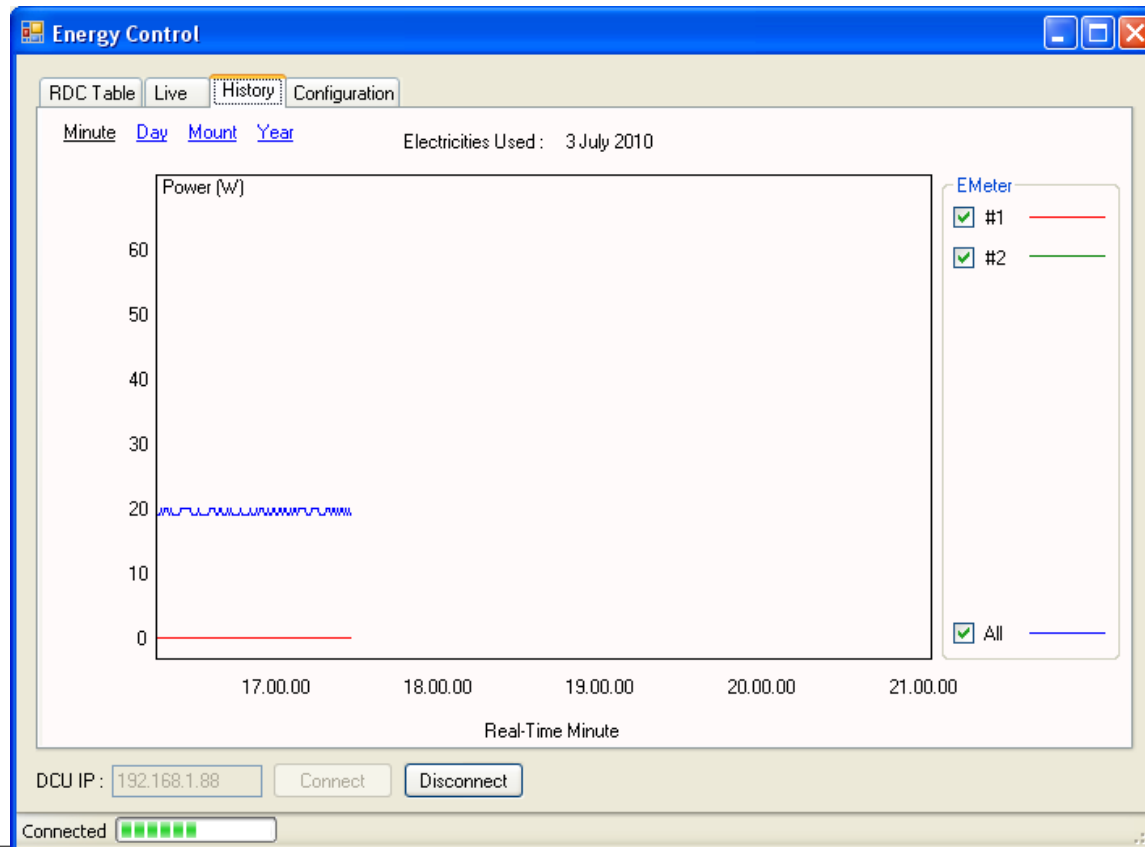
Testing : Energy Monitoring

- System setup
 - A lamp1 10W is installed with E-Meter#1
 - A lamp2 20W is installed with E-Meter#2



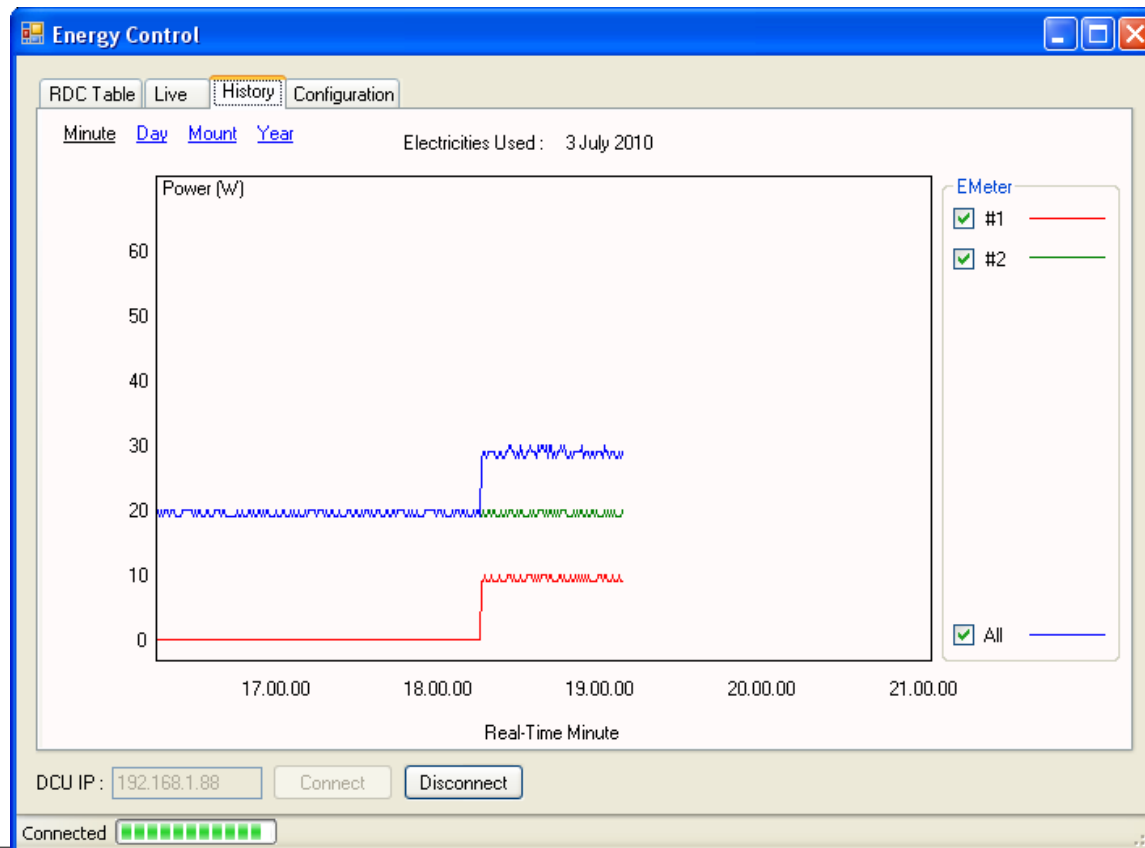
Testing : Energy Monitoring

- Lamb1 is turned off.
- Lamb2 is turned on.



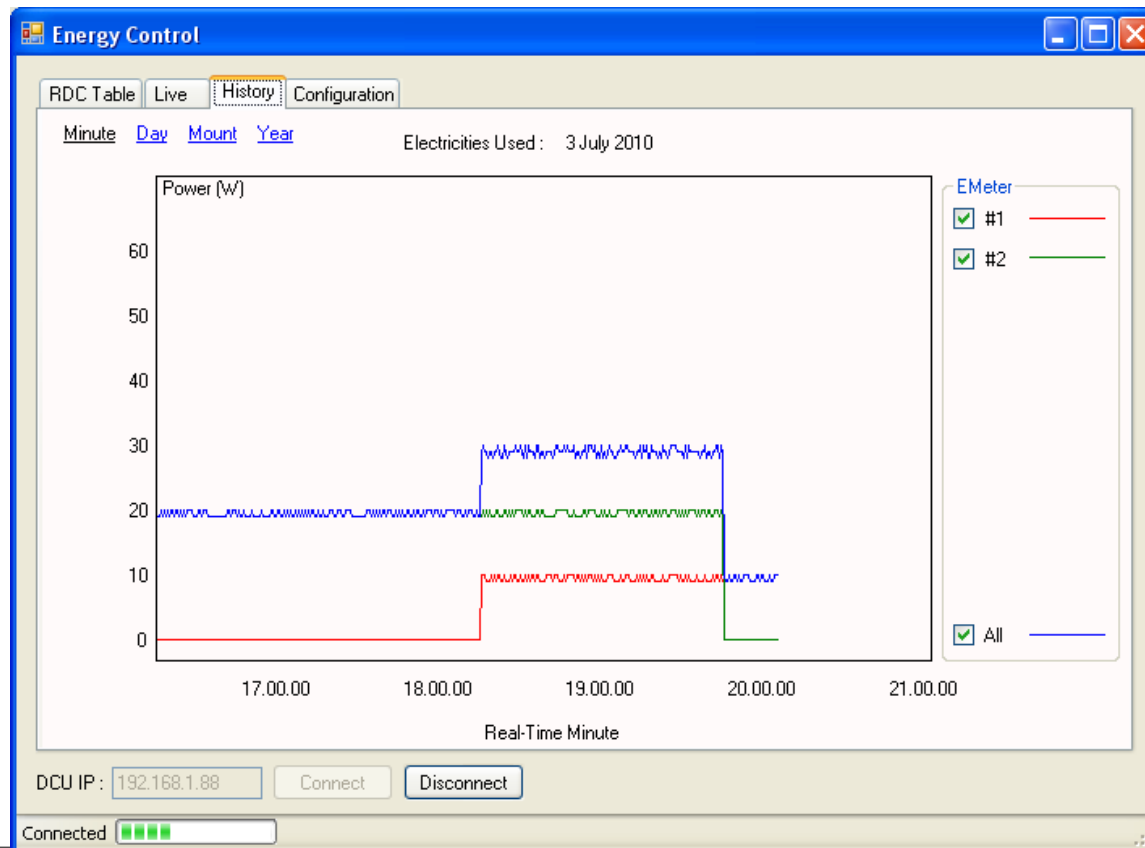
Testing : Energy Monitoring

- Lamb1 is turned on.
- Lamb2 is turned on.



Testing : Energy Monitoring

- Lamb1 is turned on.
- Lamb2 is turned off.



CONCLUSION



Conclusion

- E-Meter
 - Monitor energy and send data over Powerline.
 - On-off load
- Data Concentrator
- Energy Control GUI
 - Turn on-off loads which are installed in PLC network.
 - Monitor energy and show
- Future work
 - Implement RDC.



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Q & A ...



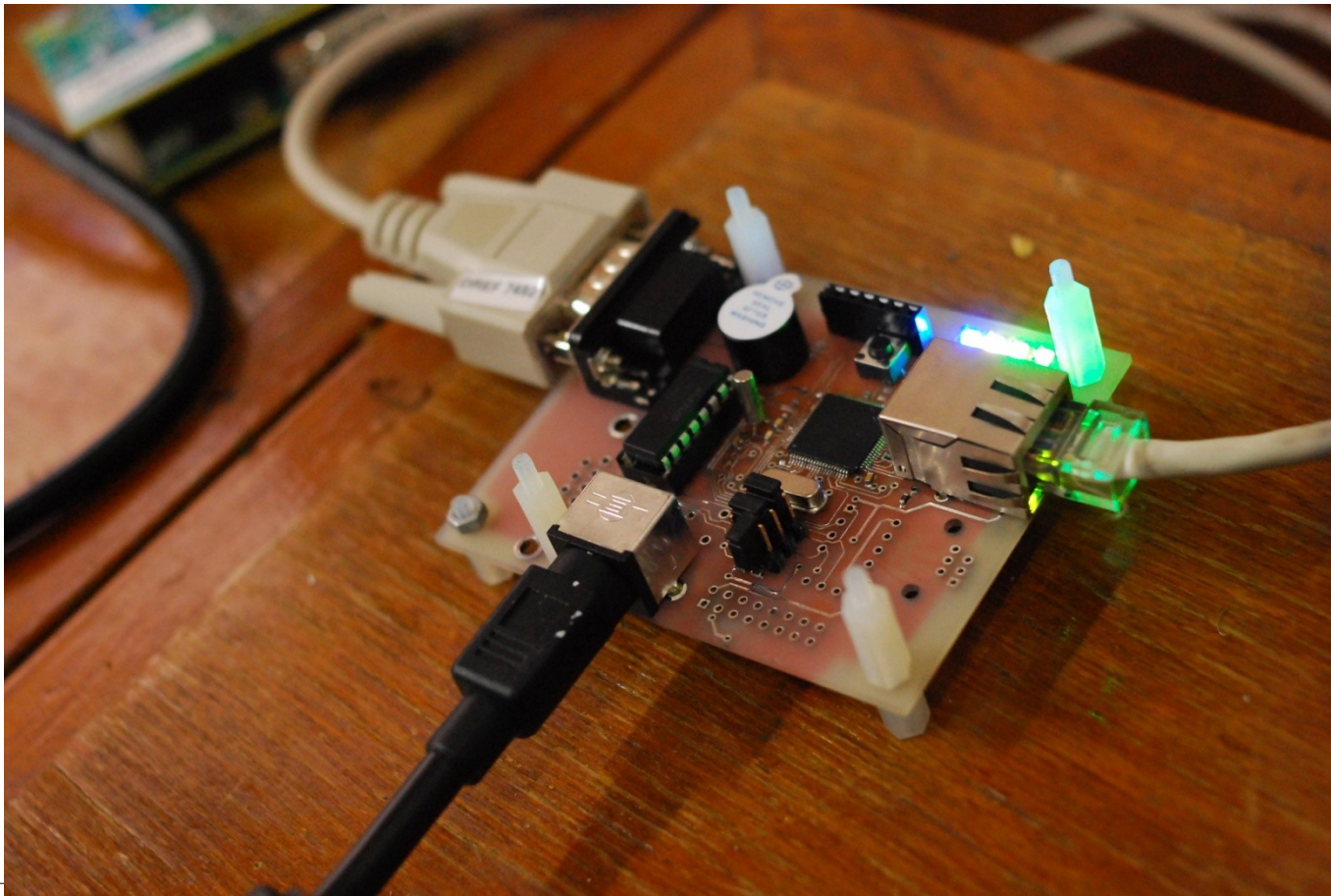
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THANK YOU



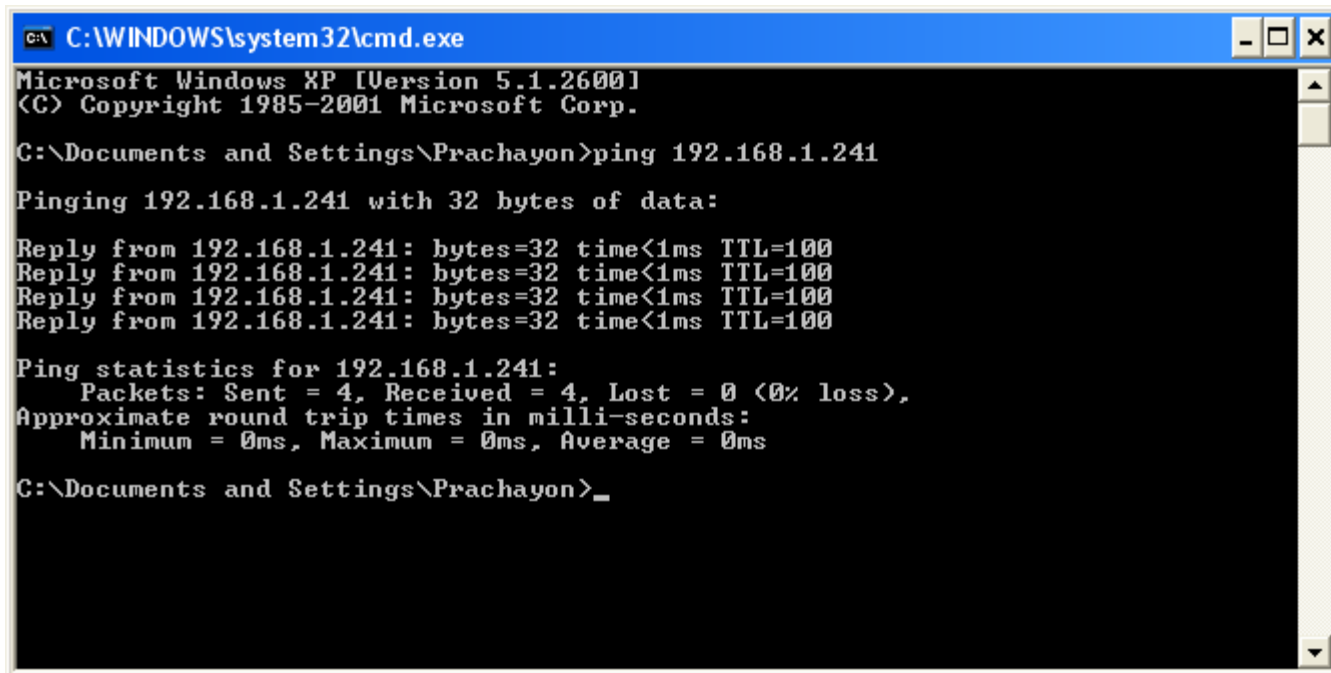
Testing : DCU

○ Data Concentrator Unit



Testing : DCU

○ Ping Testing



```
C:\ C:\WINDOWS\system32\cmd.exe
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\Documents and Settings\Prachayon>ping 192.168.1.241

Pinging 192.168.1.241 with 32 bytes of data:

Reply from 192.168.1.241: bytes=32 time<1ms TTL=100
Reply from 192.168.1.241: bytes=32 time<1ms TTL=100
Reply from 192.168.1.241: bytes=32 time<1ms TTL=100
Reply from 192.168.1.241: bytes=32 time<1ms TTL=100

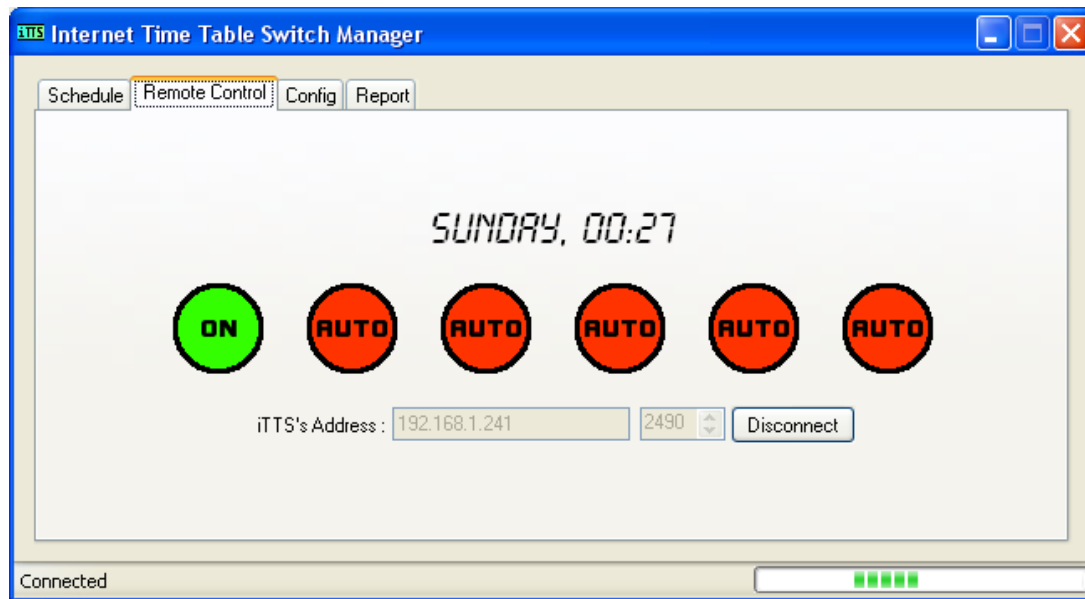
Ping statistics for 192.168.1.241:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\Documents and Settings\Prachayon>_
```



Testing : DCU

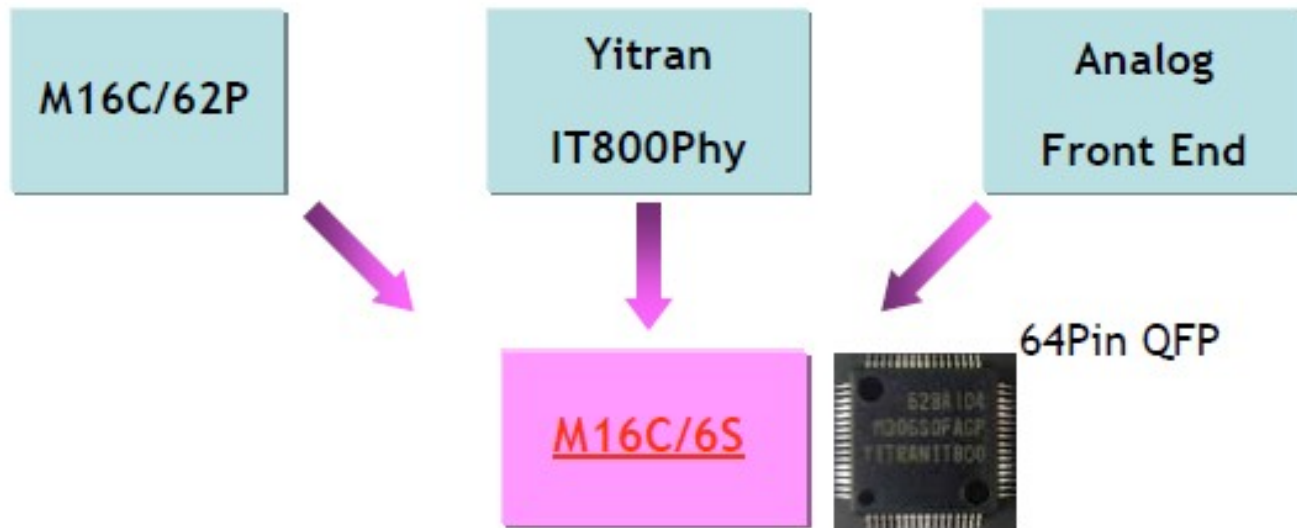
- Ethernet Program



Introduction: PLC micro-controller, M16C/6S

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- **PLC micro-controller, M16C/6S**
 - 1 chip combining MCU, communication IP, and analog front end



Hardware : E-Meter

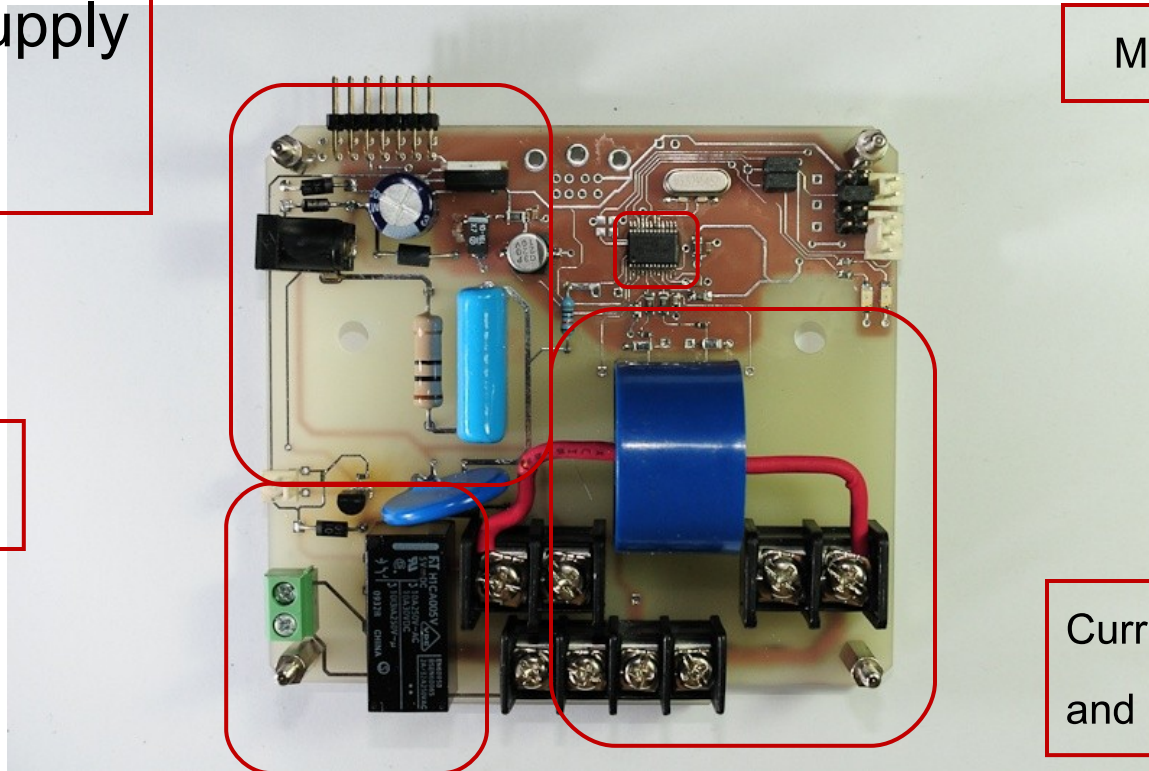
- Energy Meter Board

Power Supply
Unit

Relay Circuit

MCP3906

Current Transformer
and Voltage Divider



Hardware : E-Meter

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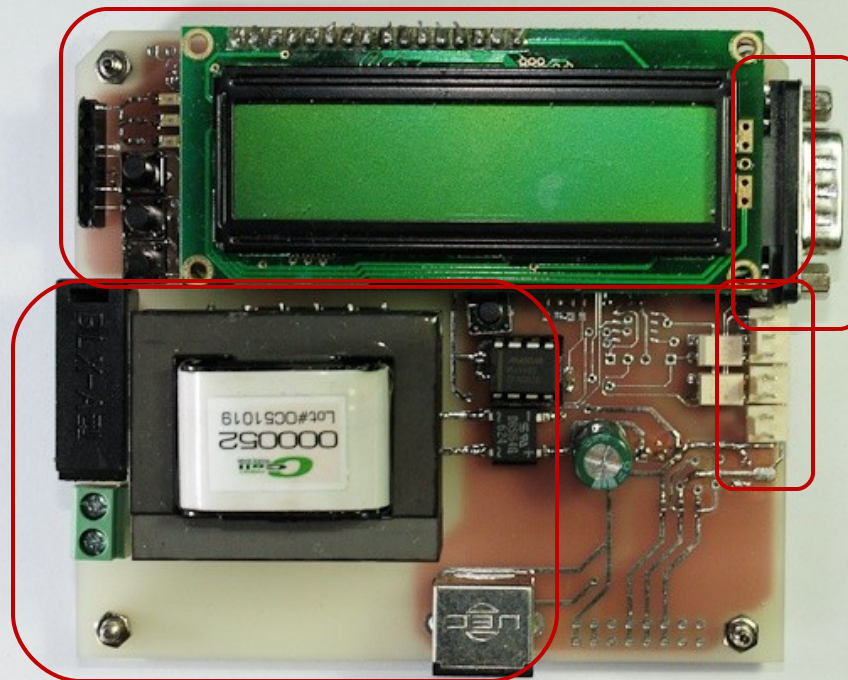
○ Main Board

PIC18F45J10,
LCD and
Interface

Serial Port

Meter Interface

Power Supply
Unit



Hardware : Data concentrator UNIT

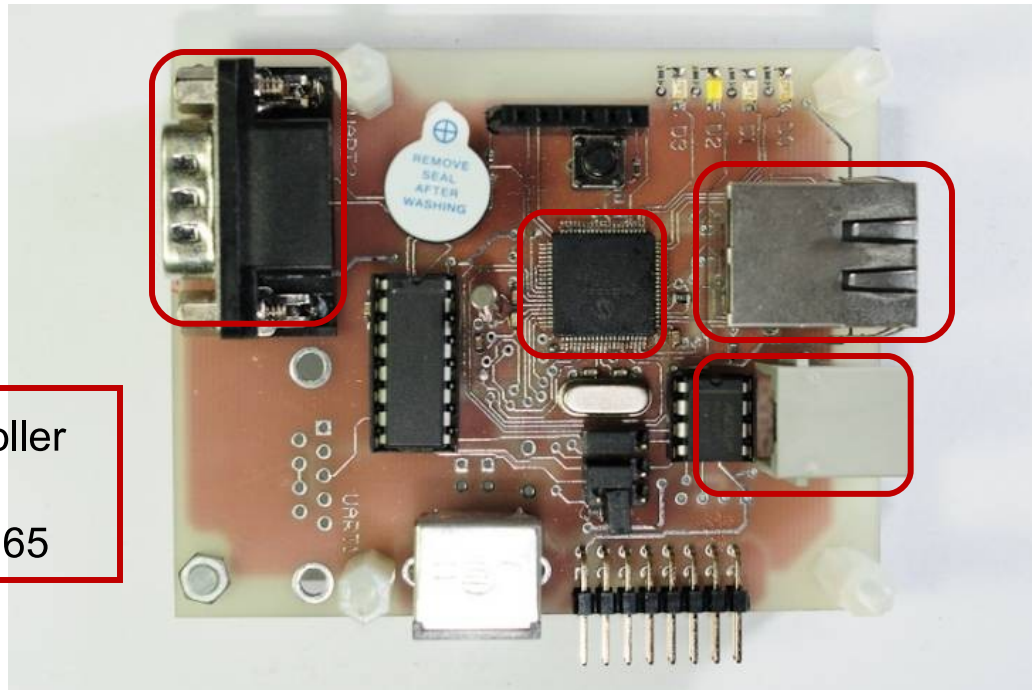
○ Ethernet Controller

Serial Port

Ethernet
Port

Microcontroller

PIC18f86J65



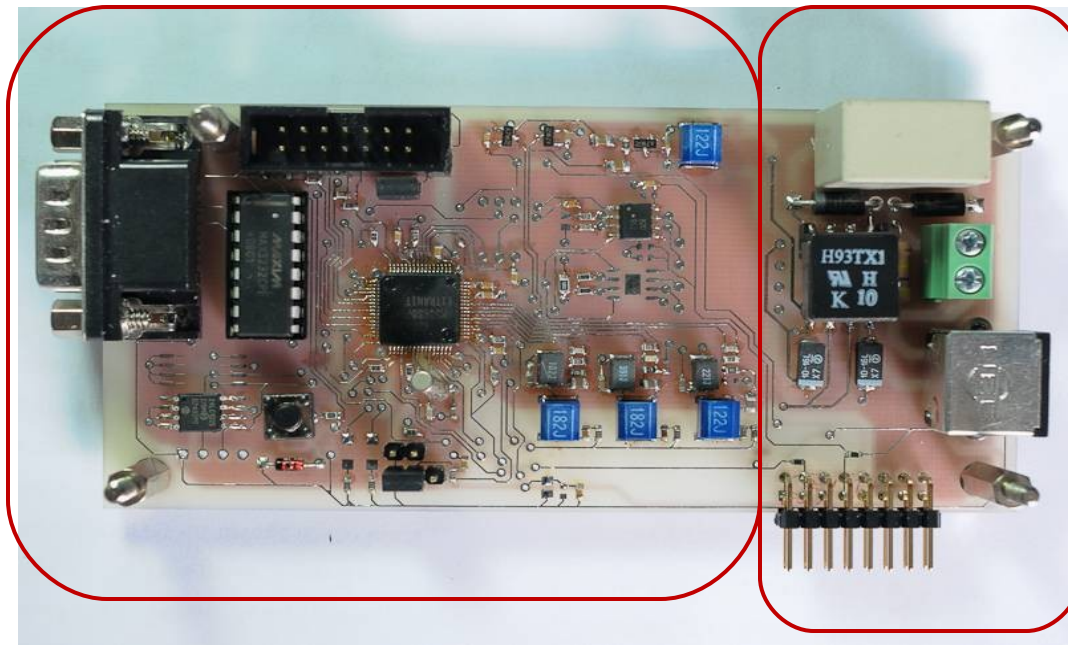
Hybrid Bus
Port



Hardware : PLC Module

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EVB08



Power
Supply
And
Powerline
Filter



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SOFTWARE



Software : E-Meter

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- Structure



Software : Energy Control

- GUI
- Database

Developing

