Click here for power meter specification or purchase

A Web-enabled Digital Power Meter

Phalguna Devalaraju
Advisor: Dr. Darold Wobschall

Department of Electrical Engineering
University at Buffalo, State University of NY
Sponsor: Esensors, Inc., Amherst, NY

UNIVERSITY AT BUFFALO
State University of New York
School of Engineering and Applied Science
The Electrical Engineering Department

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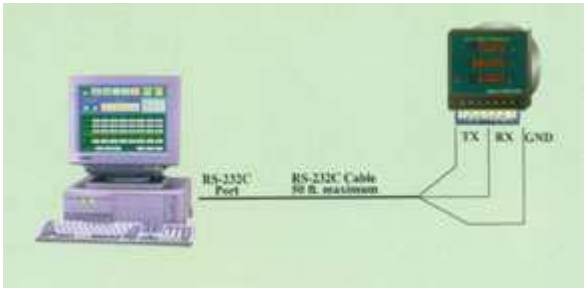
Conventional Power Meters



- Measured data not available remotely
- Most Internet capable DPMs require server computers
- RS232 or RS485 connections required for data transfer
- Expensive to install in large numbers
- Security issues for the data
- Networking with other sensors like HVAC/chemical is not possible with most

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Objectives

- Develop a digital power meter with an IP address
- Facilitate remote monitoring and control of electrical power
- Arrive at an inexpensive solution for effective energy management
- Eliminate the cost of a server computer acting as the interface between sensor nodes
- Maximize the use of off-the-shelf hardware and software
- A power meter that can be a part of a sensor network

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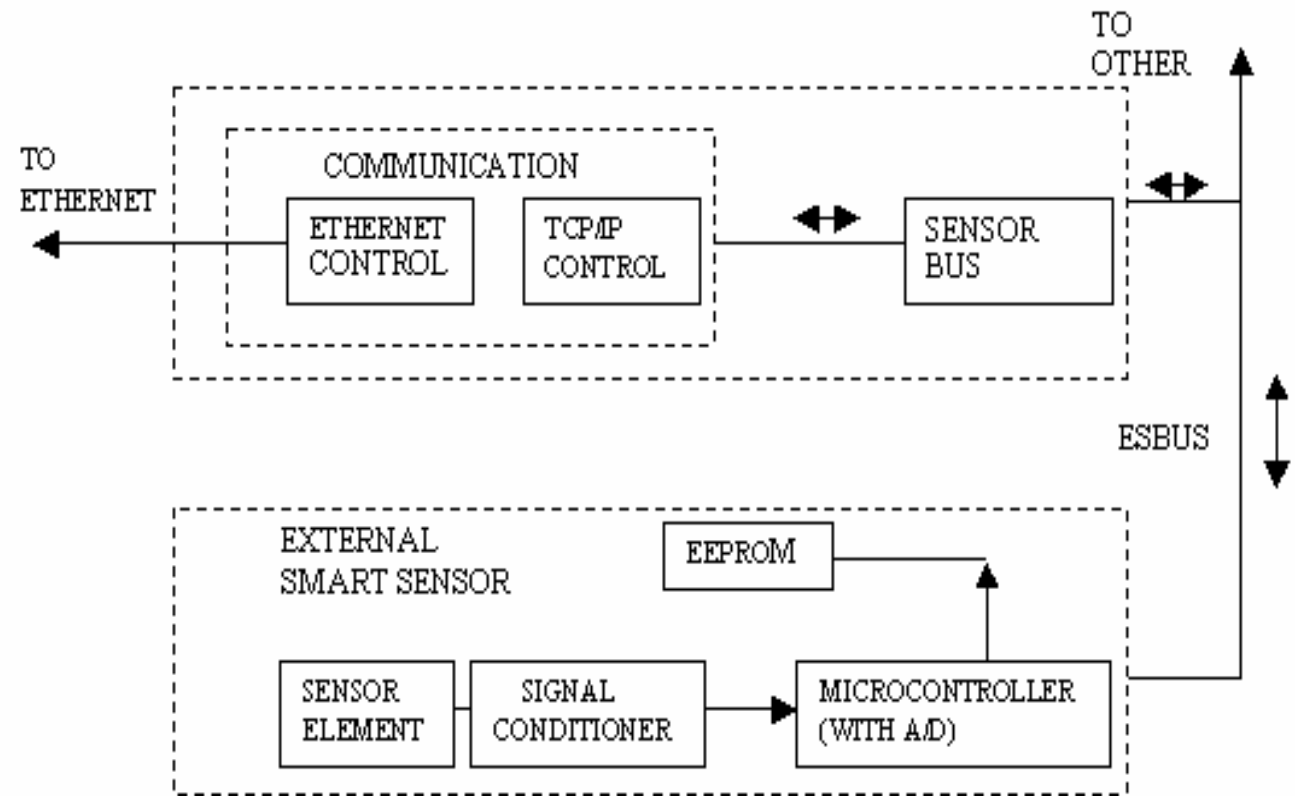
DPM (Digital Power Meter) Features

- Two modules: ES02 & EM02
- ES02 measures single-phase electrical parameters: AC voltage (rms), AC current (rms), true power (watts)
- Computes power factor and energy (KWH)
- Nominal input range: 120V (rms) & up to 20A (rms)
- 0.2% accuracy, suitable for metering
- Connects to EM02 through an isolated SPI bus (Esbus)
- Data transmitted over Ethernet using the EM02 module
- Up to 9 power meters can be connected over an Esbus
- Modular sections of the power meter facilitate interchangeability

DPM Features Continued

- Optional on-site LCD display – 2 lines, 16 characters
- IP address configured through a PC using RS232 and ES00r module during installation
- Measured data sent as e-mail or available through Esensors website
- Instant alarm e-mails when the measurements exceed pre-defined limits
- User customizable power meter web page

Smart sensor block diagram using Esbus



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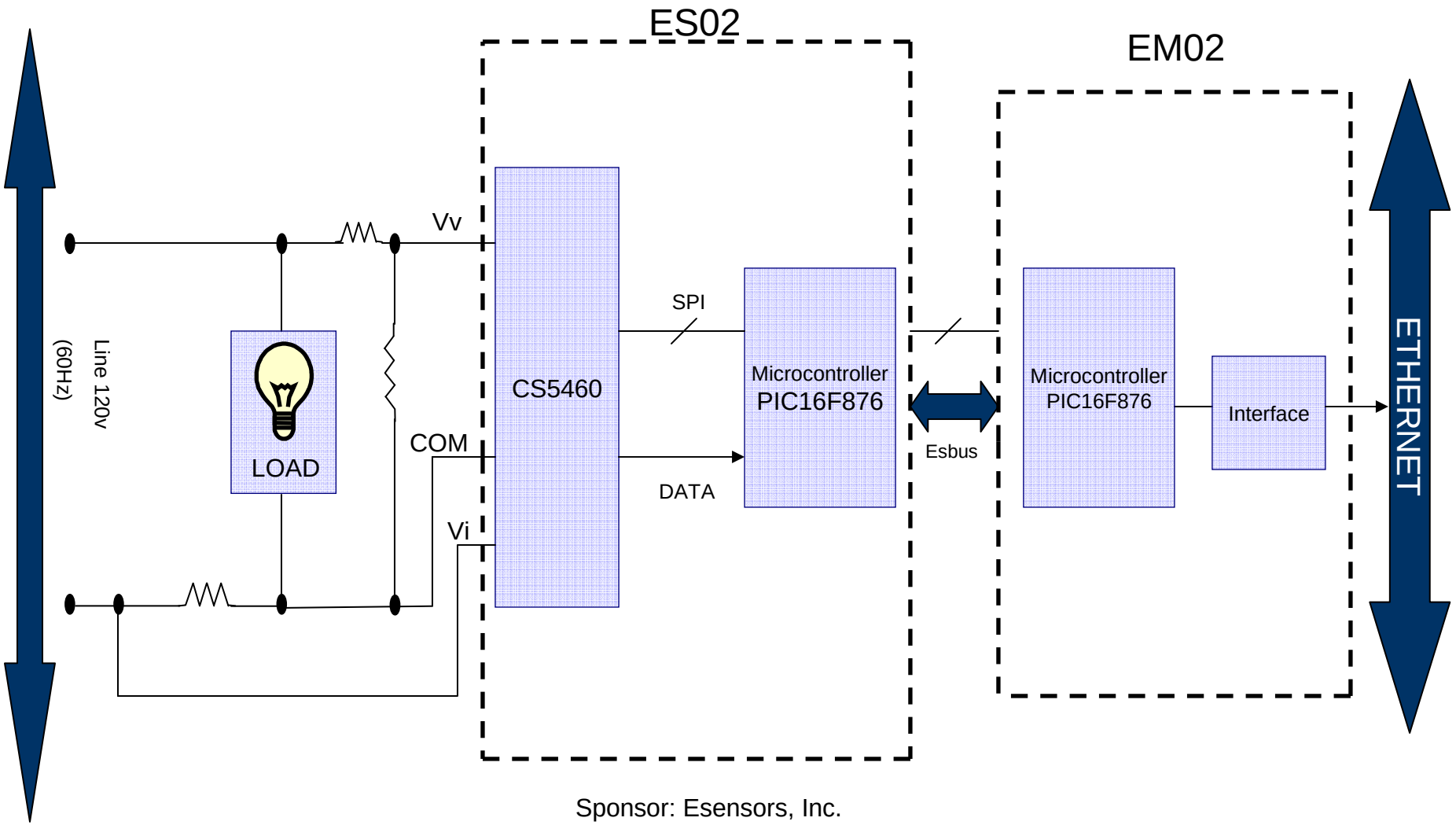
Block Diagram of the Power Meter



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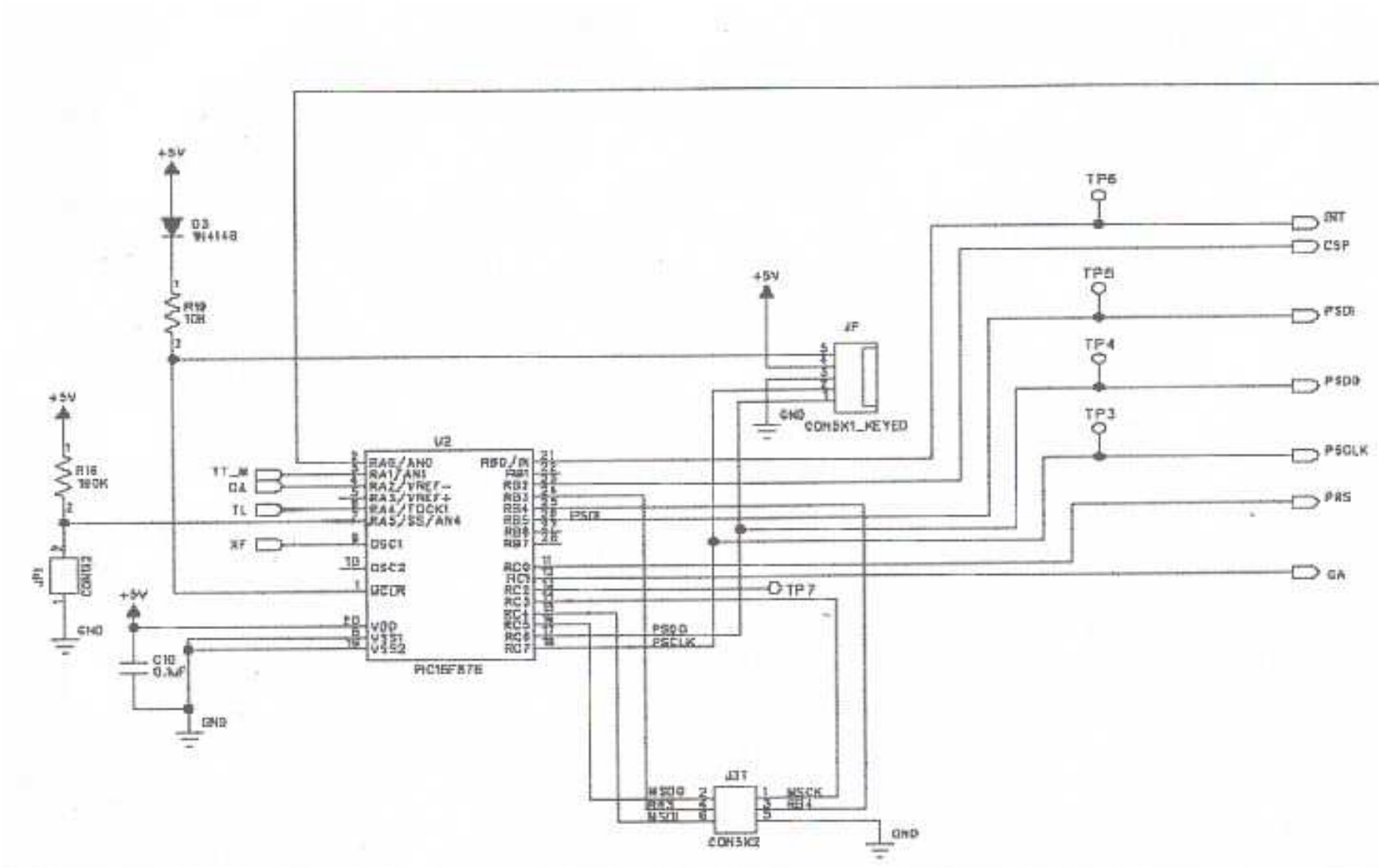
ES02 Details

- Cirrus Logic's CS5460 Power/Energy IC used for A/D conversion
- Current and voltage channel inputs are 250mV (RMS) full-scale
- Current shunt and resistive divider are used for measuring current and voltage respectively
- The microcontroller, PIC16F876, collects data from the power IC in 24-bit words, converts it into ASCII format and transmits over the Esbus
- Can take upto 80A with an analog switch and upto 30A without the switch
- Can operate at a maximum voltage of 180V without damage to the module

Schematic of ES02 – 1



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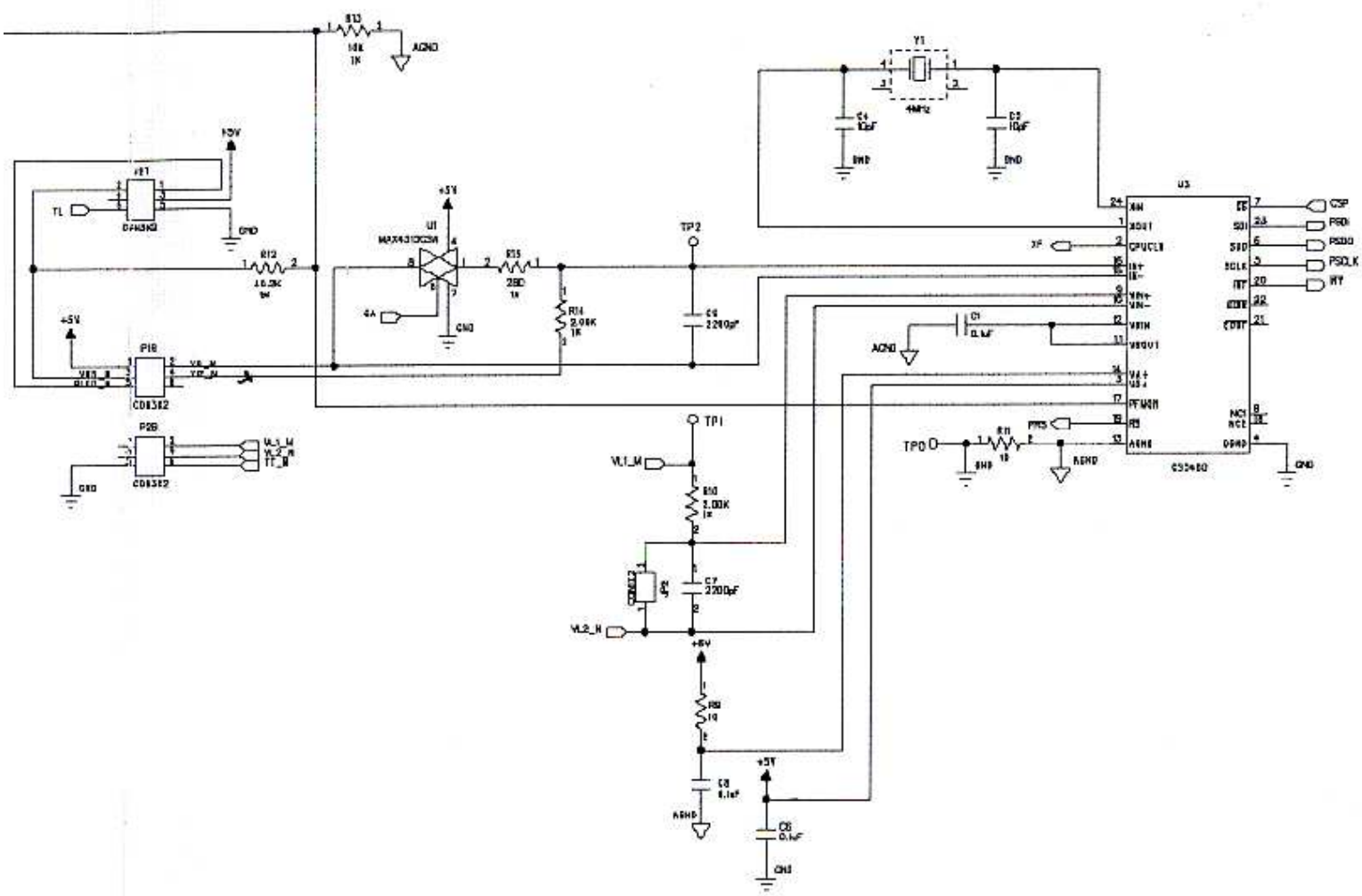
Schematic of ES02 – 2



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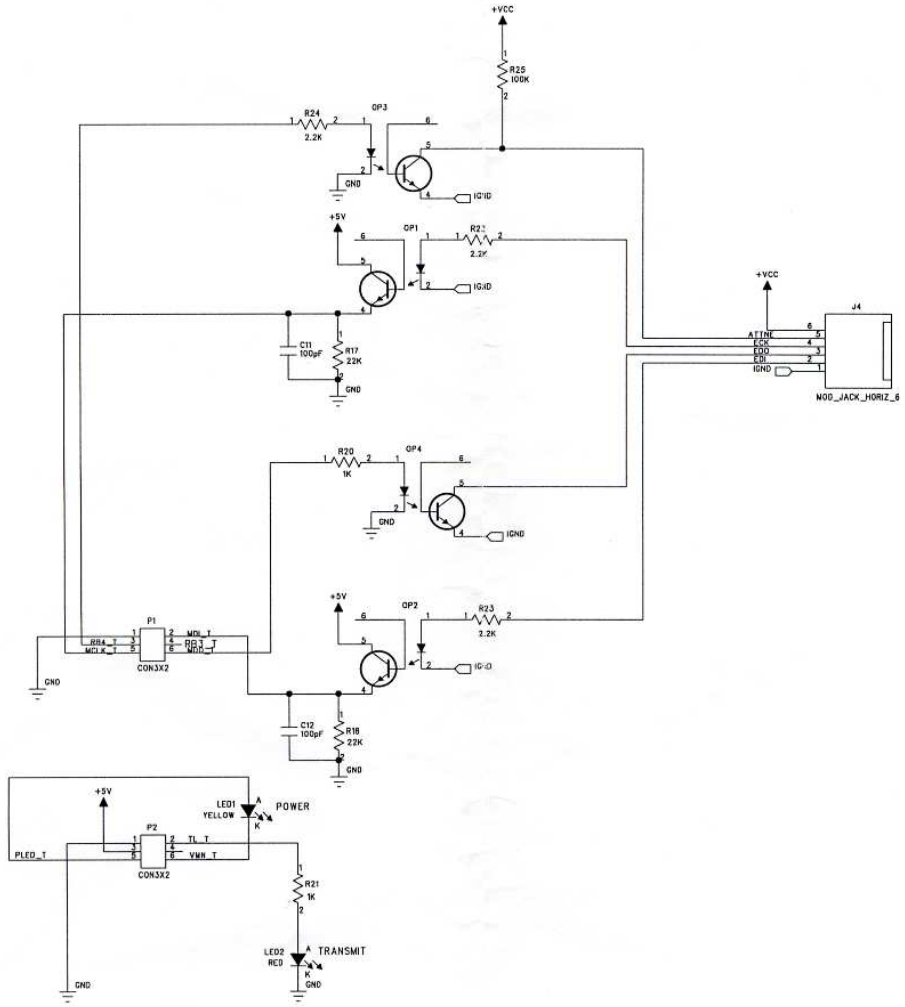
Schematic of ES02 – 3



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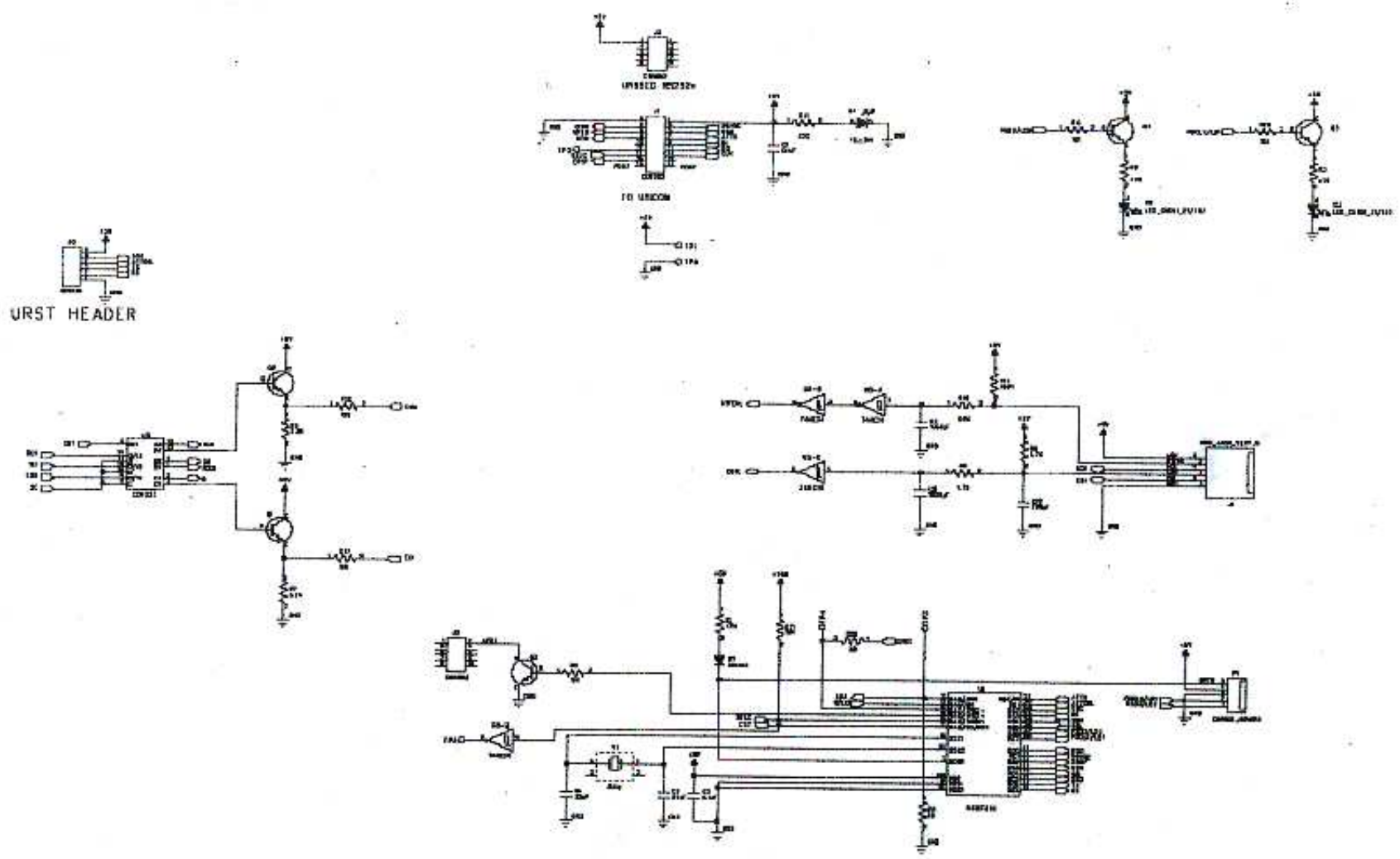
EM02 Details

- This module is the interface between Ethernet and Esbus
- Acts as the master module and provides the clock for Esbus communications
- Network side of this module handles TCP/IP protocol
- Network communications based on the Ubicom SX stack
- Uses a modified version of the Ubicom evaluation board
- EM02 receives/sends e-mails/HTTP data through a standard Ethernet interface (8-pin modular connector, 10Mbps)
- A newer version of this module is being built that conforms to the IEEE 1451 NCAP hardware standards

EM02 Schematic



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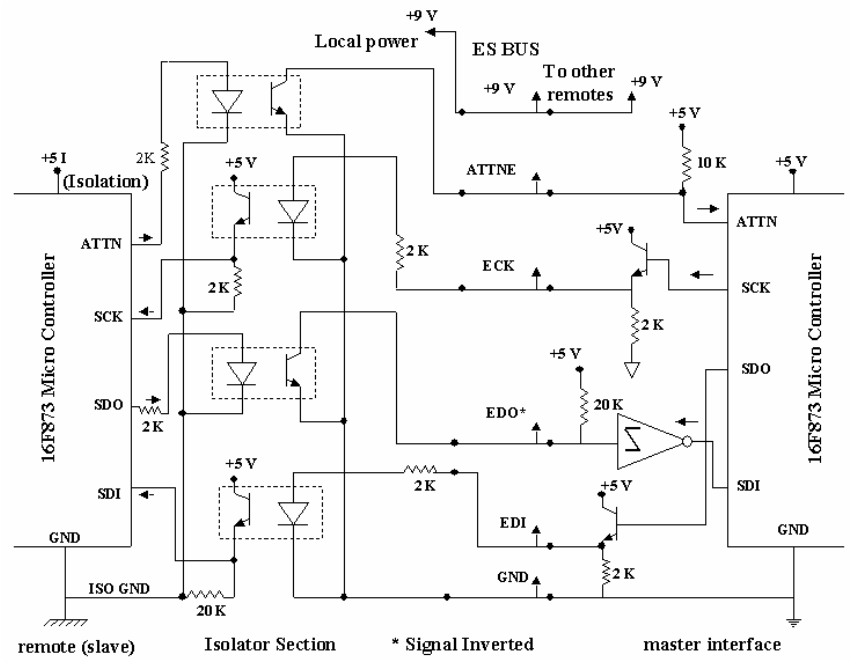
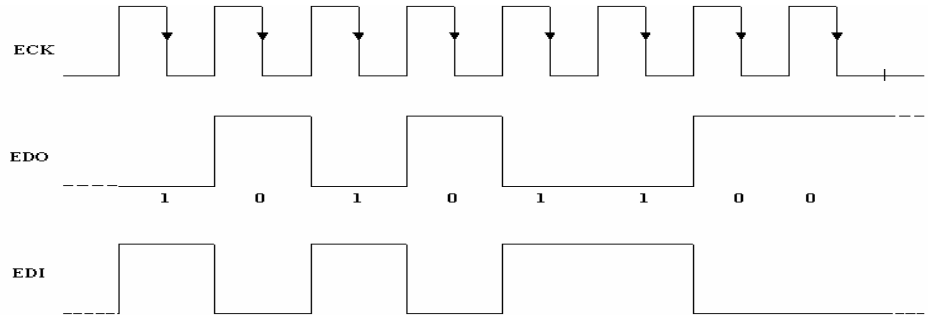
Esbus Overview





- 6 - wire full - duplex modified SPI
- Each byte of data uses an 8 – clock cycle
- Data rate – 10KHz
- ATTN line – Generate Alerts
- Two handshaking signals used to control data transfer
- Optical Isolators – Noise Reduction and Safety
- Multiple sensors can be connected to the EDO line

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Command Format

Command from the user's browser

ecfybbbb

e – Header character

c – Channel/Sensor # (1-9)

f – Data format code

y – Command byte

bbbb – Command data if any

Ex: e1120000

Sent by the user through the Esensors website

www.eesensors.com\e1120000

- Each EM02 has its own IP address
- Command in HTTP format received by EM02
- EM02 transmits the command in Esbus format to ES02
- 'c' can specify different types of sensors
- 'y' and command data 'bbbb' can calibrate the device

Data Format

Data from the power meter

Header: Eiiiicfw

E – Header character

iiii – Sensor ID

c – Channel/Sensor # (1-9)

f – Data format code

w – Status/Command byte

Ex: ES02a110

Data: ssddd.dd

Ex: Va120.00; Pf0.9995;Pa1500.0

Sent by the power meter through Ethernet in HTTP format

- 32 bytes sent back in Esbus format
- 8 – byte header and 24 bytes data
- Sensor ID specifies type of sensor
- ‘w’ used to alert the user
- Data is converted to HTTP format by embedded Ethernet module in EM02

Results

Va (V_{rms})		Ia (A_{rms})		Power Factor		True Power (watts)	
Enetics*	ES02	Enetics	ES02	Enetics	ES02	Enetics	ES02
20	20	1	1	0.95	.9472	19	0019.0
120	120	1	1	0.97	.9683	116.4	0116.2
120	120	5	4.99	0.99	.9908	594	0593.3
120	120	20	20	0.99	.9897	2376	2375.3

* ***Enetics*** LMS-5750 PowerScape

Module	Dimensions (in)	Weight (oz)
ES02	3.125x2.125x1.5	6.0
EM02	3.6x2.6x1.1	4.5

Temperature Range: -45C to +125C
Operating Humidity: 0 to 100% (non – condensing)

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Current Work

- The single – phase power meter is in the final stages of testing
- Networking the power meter with other sensors like HVAC
- Design of a wireless communication link for the single phase power meter data transfer
- Design and development of a three-phase, web-enabled digital power meter specifically for industrial use
- Inclusion of low data rate wireless networking capability

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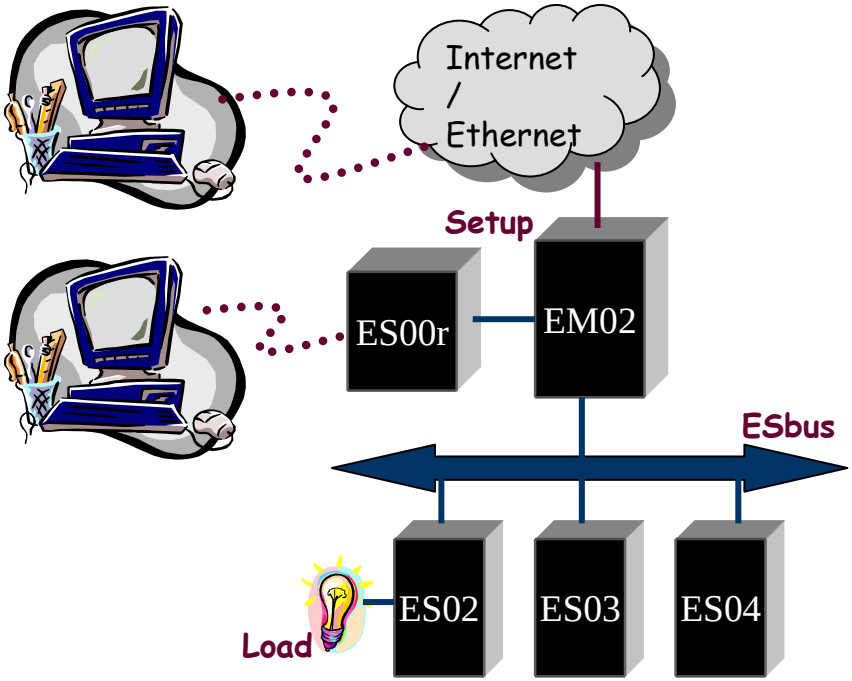
Summary

ES02

EM02



Networked sensors

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Thank You !!

Phalguna Devalaraju
pd6@buffalo.edu

UNIVERSITY AT BUFFALO
State University of New York
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- No CTs, PTs or other auxiliary devices required.
- Easy installation
- Humidity, temp, surge, housing material, overlaod capacity
- Option of on-the-spot LCD display.
- Many power measuring devices use RS232 or 485 to connect to a computer.
- Calibration from computer, dim of the cases.
- Maximum data logging capacity of the website, min current and voltage msmnt, any website graphs, sleep mode power cnsmp, normal mode cnsmp, weight, possible sets of msamnts,
- Esbus small block diagram, wiring and data transfer details.
- Mention about UBicom embedded internet board.
- Explain off the shelf software, cost of electricity, any changes or control that can be effected from the website or by the remote user.
- Diagrams of fluke etc multimeters handheld, rs232 meters with computer, ION or similar internet enabled power meters with block diagrams..
- Fully Customizable Web Page Development
- Multiple Meter Hosting On One Page
- Read Direct From Meters (No Server Software Needed)
- No Active X Controls Or Java Downloads
- IT Dept. Friendly (Works Through Firewalls)
- Instant Alarm Emails – Direct From The Meter
- Talk about other sensors available with same concept(internet).. Say that research is going on.. In this field..
- On-site data logging not included– needs real time clock which increases time and cost