

THAT Home Automation Topology

Final Presentation
Chris Miller • Nick Viera

Advisors

Dr. Irwin
Dr. Malinowski

Bradley University
Electrical and Computer
Engineering Department

Significance

Better Living Through Home Automation

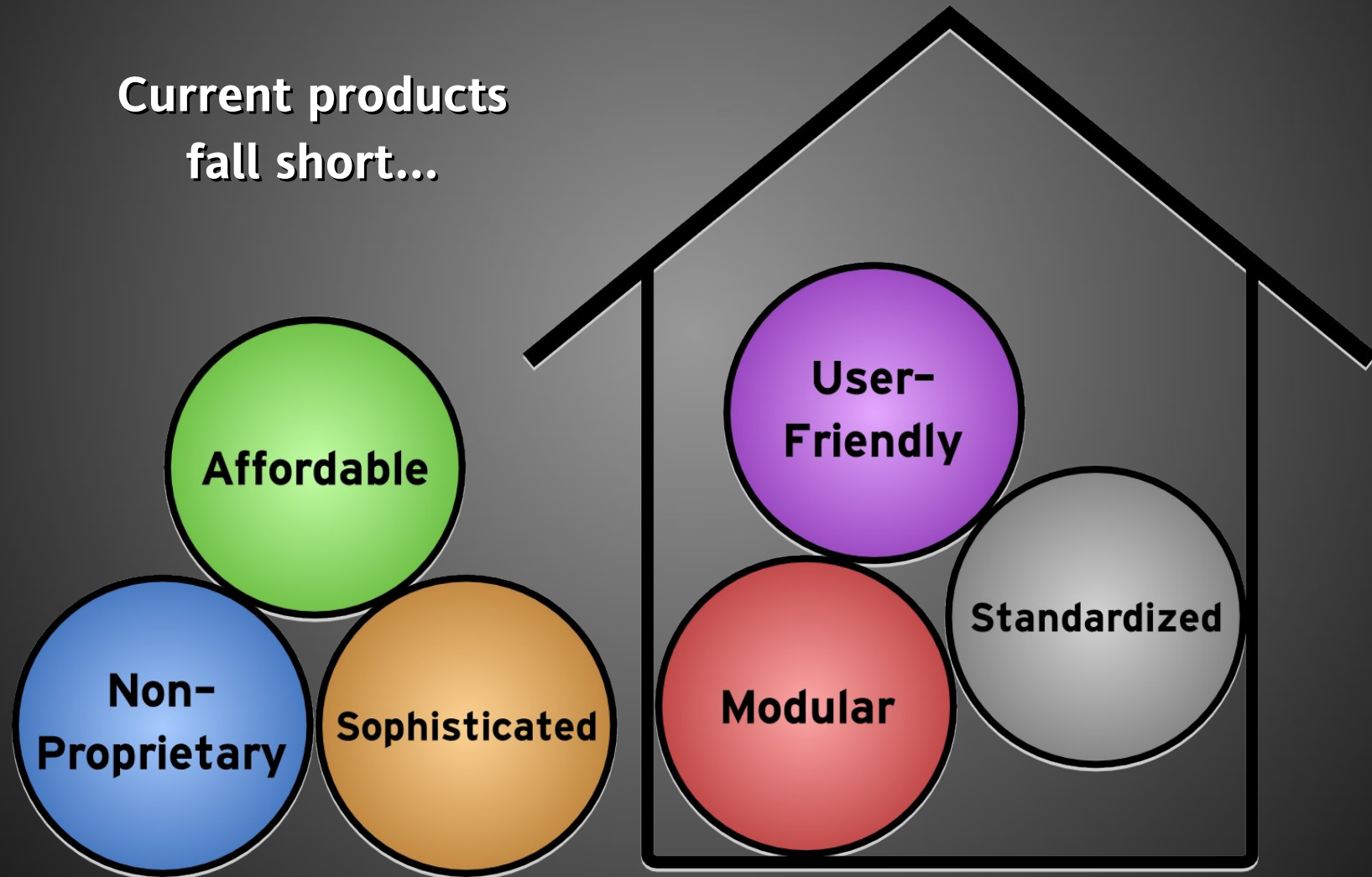
- ▶ Convenience ...
- ▶ Safety ...
- ▶ Savings ...
- ▶ FUN!



Motivation

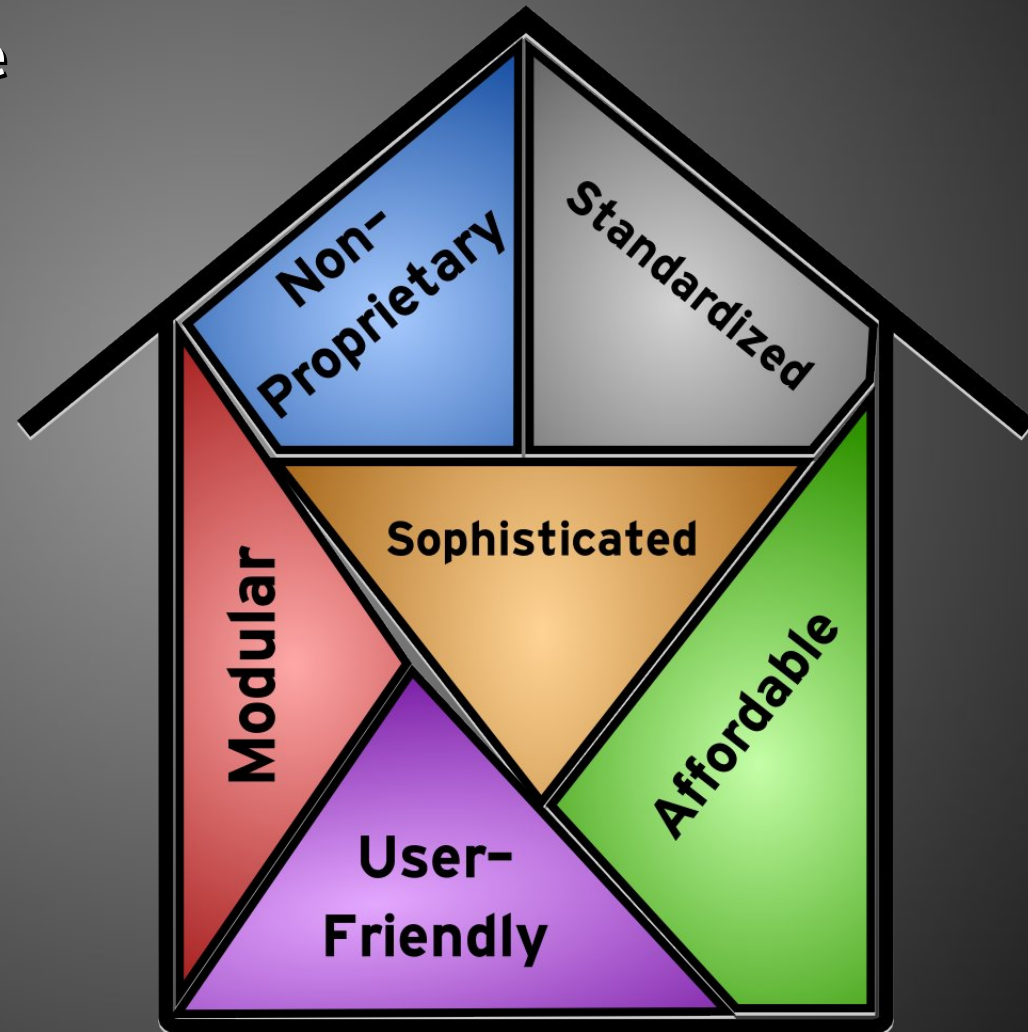
Six Desirable Traits

Current products
fall short...



Motivation

We Intend to achieve
a reasonable balance



The Many Functions of Home Automation

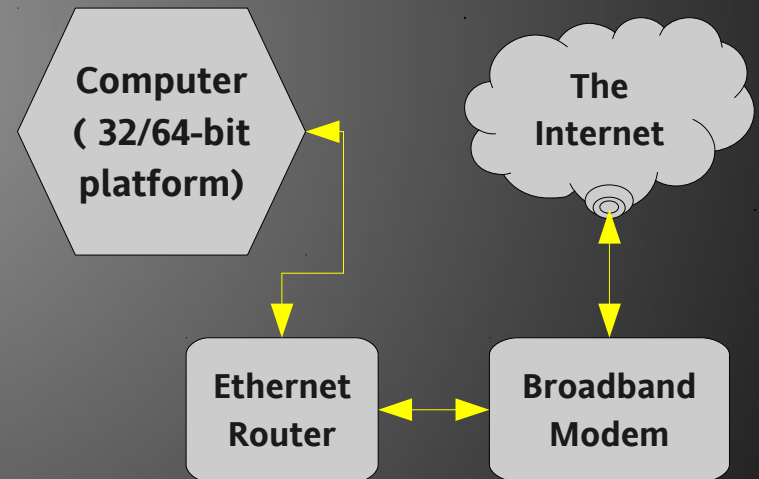
Which to choose?

Annunciator / Siren	●	●		
Digital Thermostat		●	●	●
Electricity / Water / Gas Meter	●		●	●
Electronic Access	●	●	●	●
General Purpose Dimming		●	●	
General Purpose Switching		●	●	
Light / Infrared Sensor				●
Proximity / Motion Sensor	●			●
Smoke / CO / Radon detector	●			●
System Controller (Terminal)		●	●	●
Temperature / Humidity Sensor				●
THAT - IR / Serial Bridge		●	●	
THAT - Wireless Bridge		●	●	●
THAT - X10 - INSTEON Bridge		●	●	●
Water / Rain / Flood Sensor	●			●



Objectives

Given an Existing System:

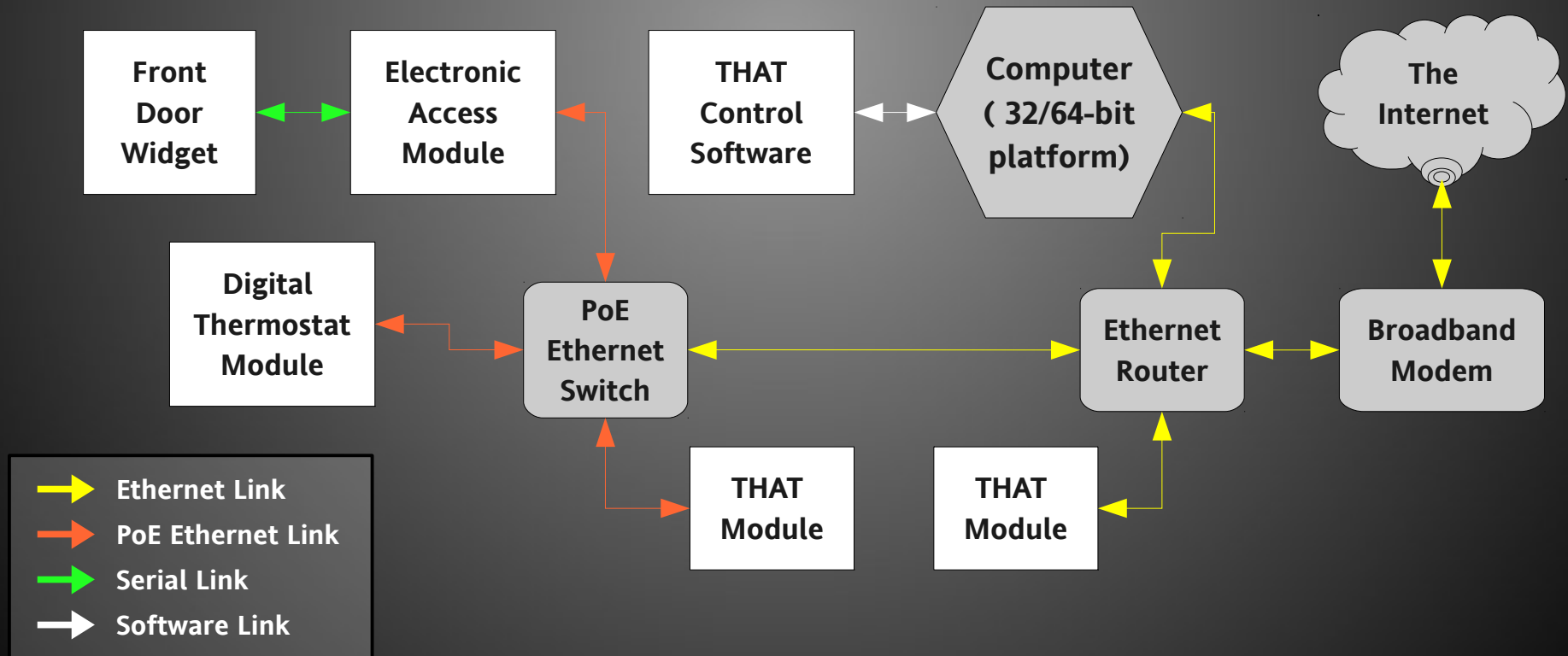


- Ethernet Link
- PoE Ethernet Link
- Serial Link
- Software Link

Objectives

To Design and Implement:

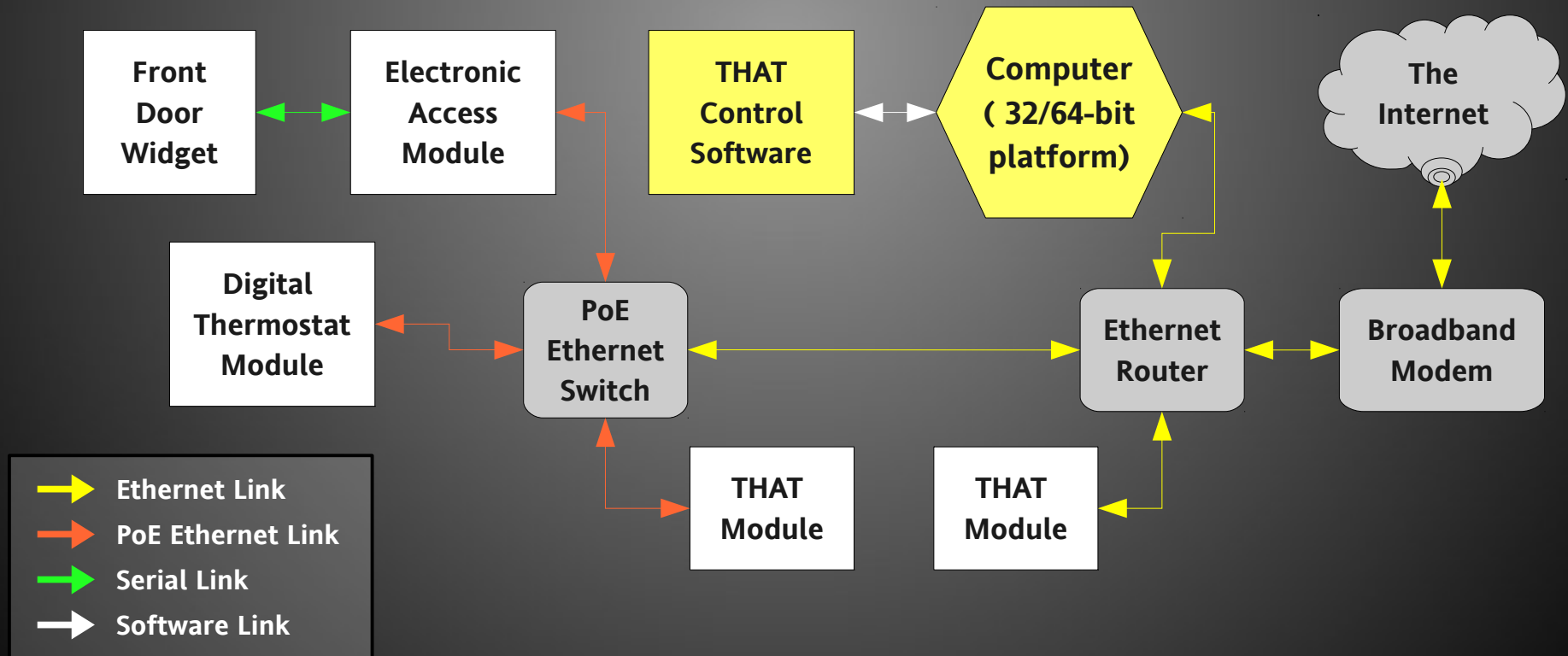
- THAT topology and protocol (Nick and Chris)



Objectives

To Design and Implement:

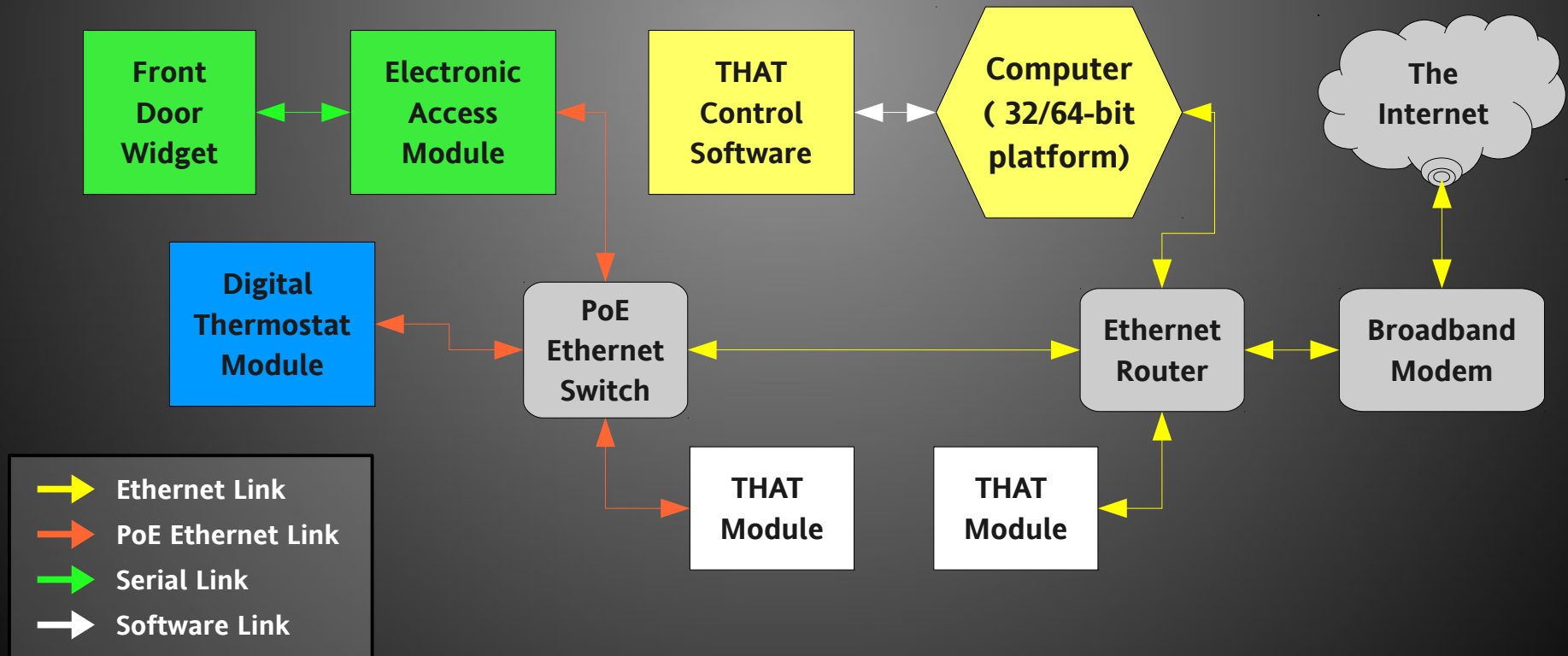
- THAT topology and protocol (Nick and Chris)
- THAT Control Software (Nick and Chris)



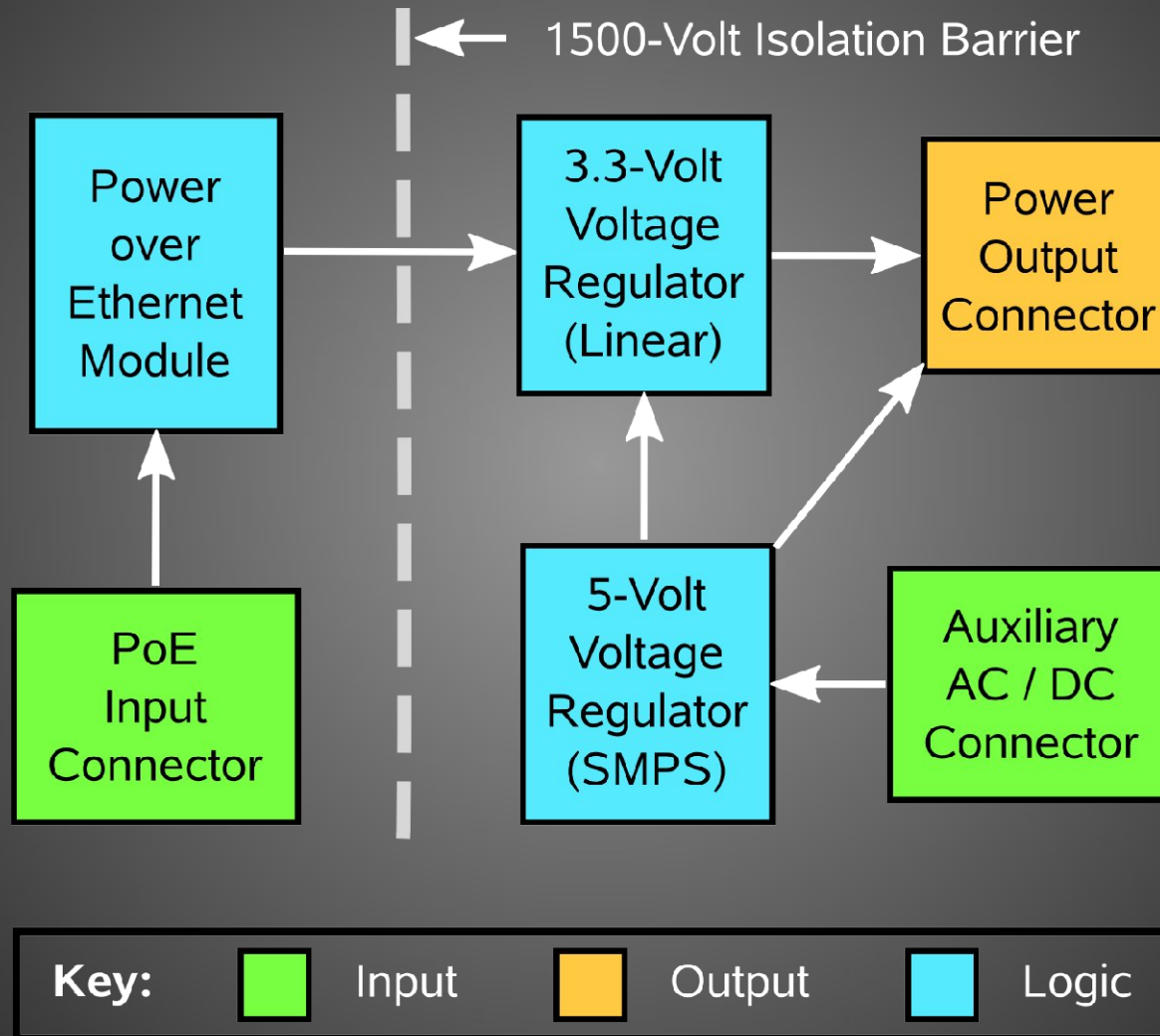
Objectives

To Design and Implement:

- THAT topology and protocol (Nick and Chris)
- THAT Control Software (Nick and Chris)
- Digital Thermostat Module (Nick)
- Electronic Access Module (Chris)



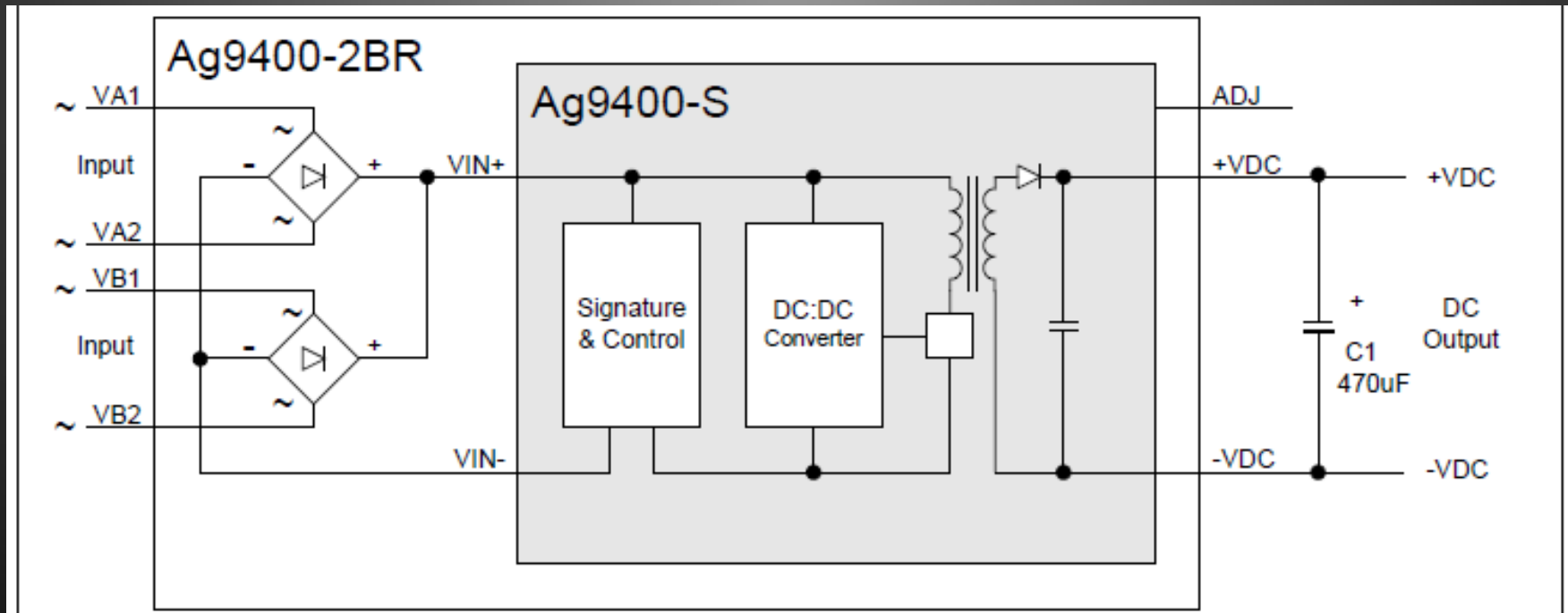
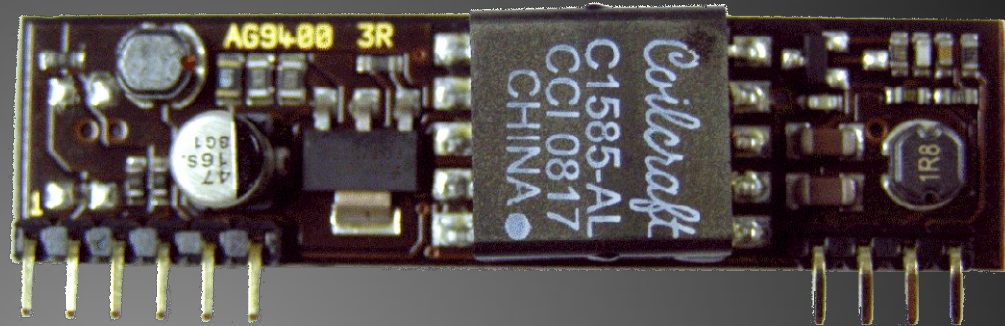
Block Diagram



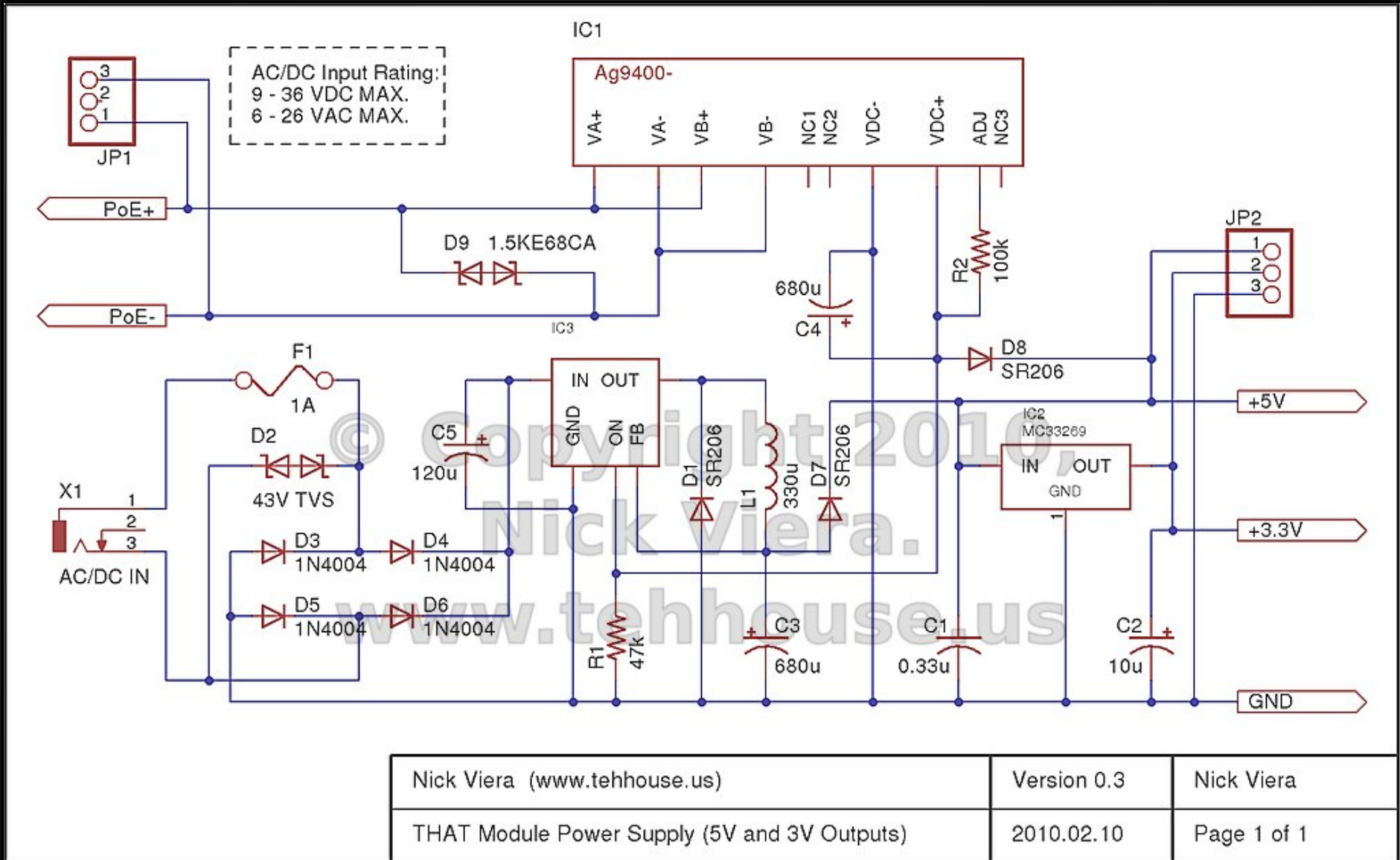
Important Components

PoE Controller

Ag9405 Power over Ethernet (PoE) module by Silvertel implements IEEE 802.3af



Schematic



Nick Viera (www.tehhouse.us)

Version 0.3

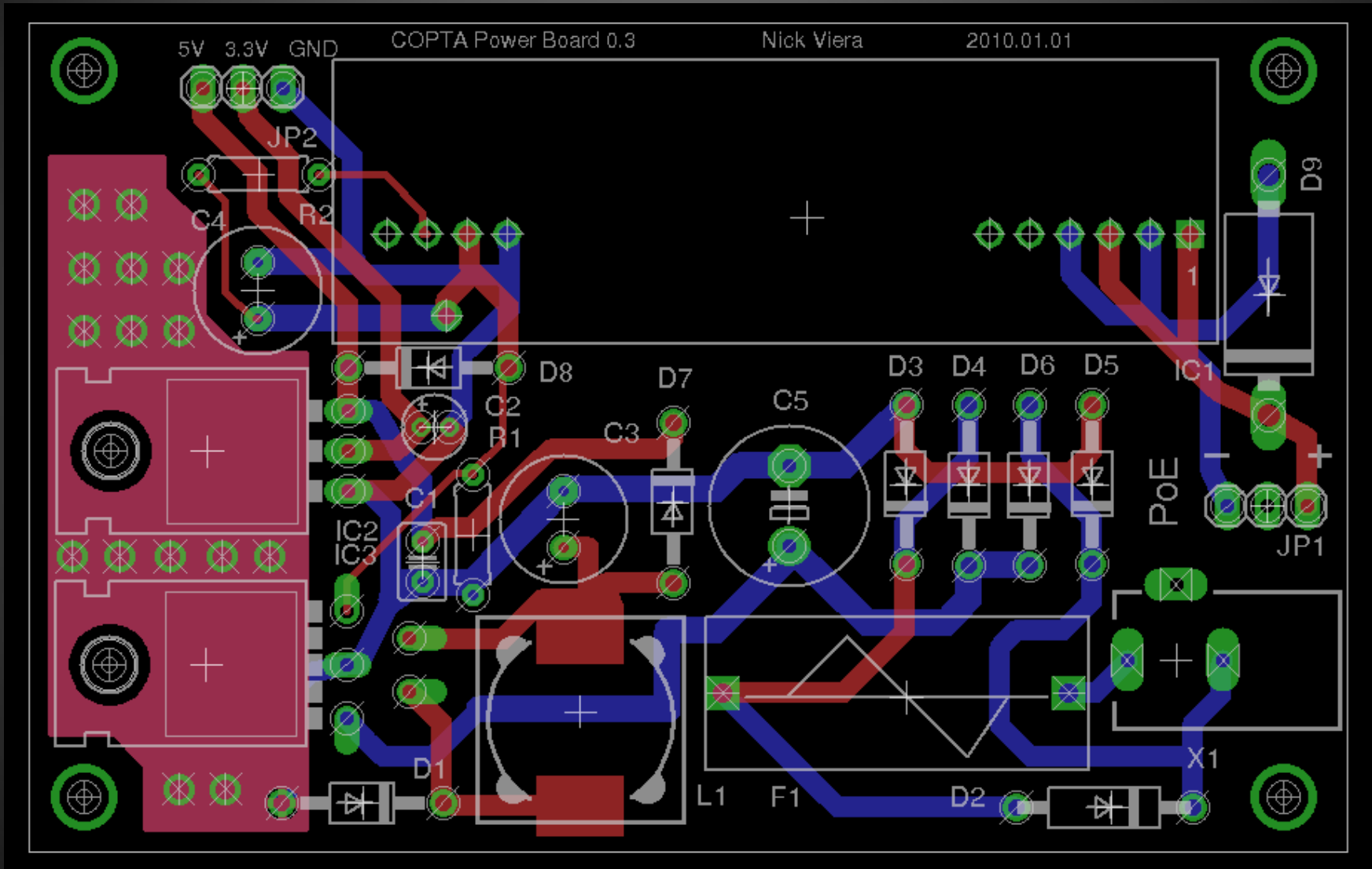
Nick Viera

THAT Module Power Supply (5V and 3V Outputs)

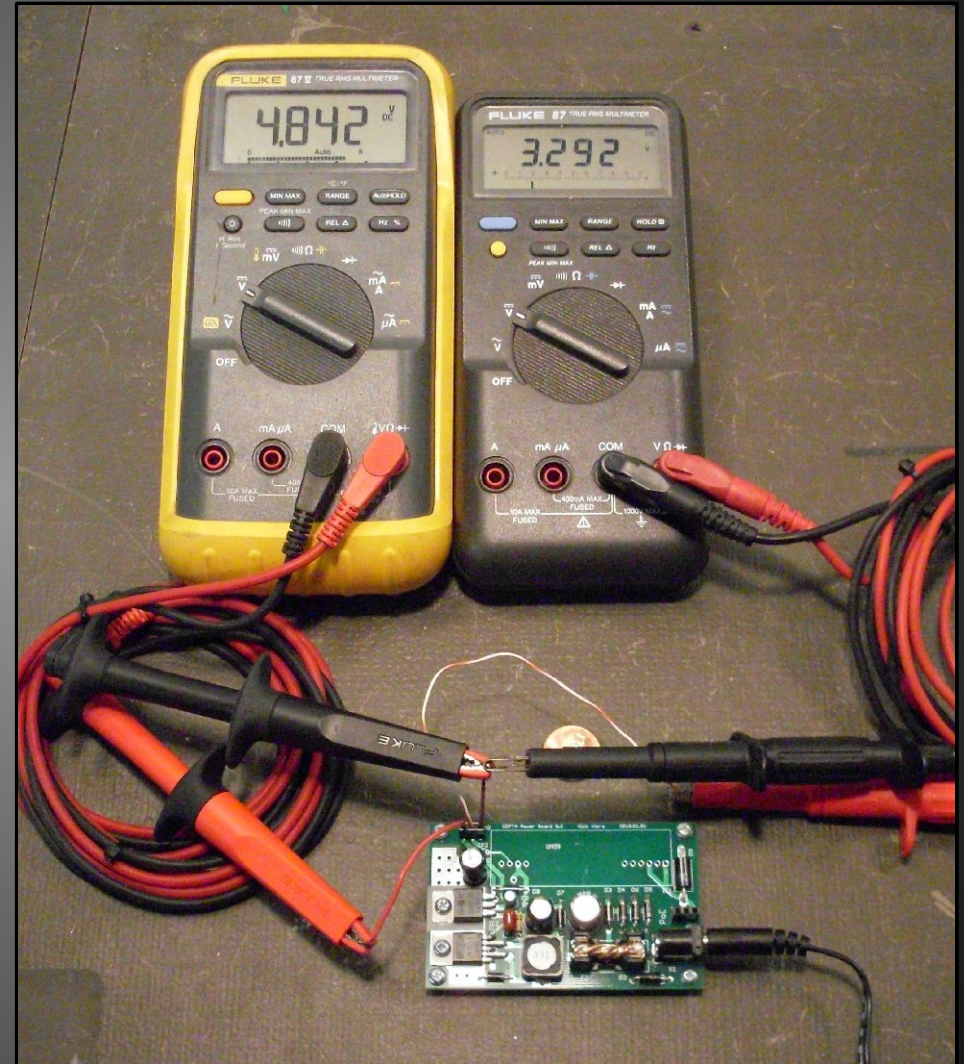
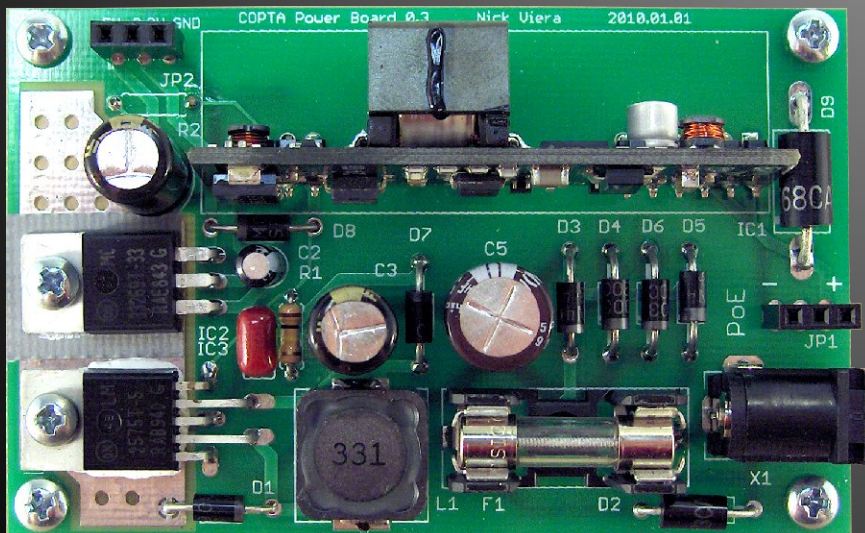
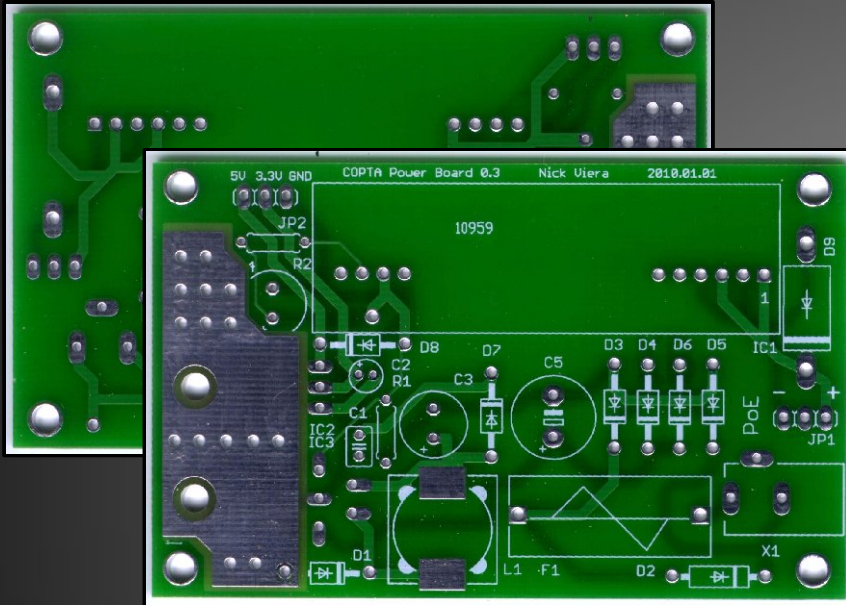
2010.02.10

Page 1 of 1

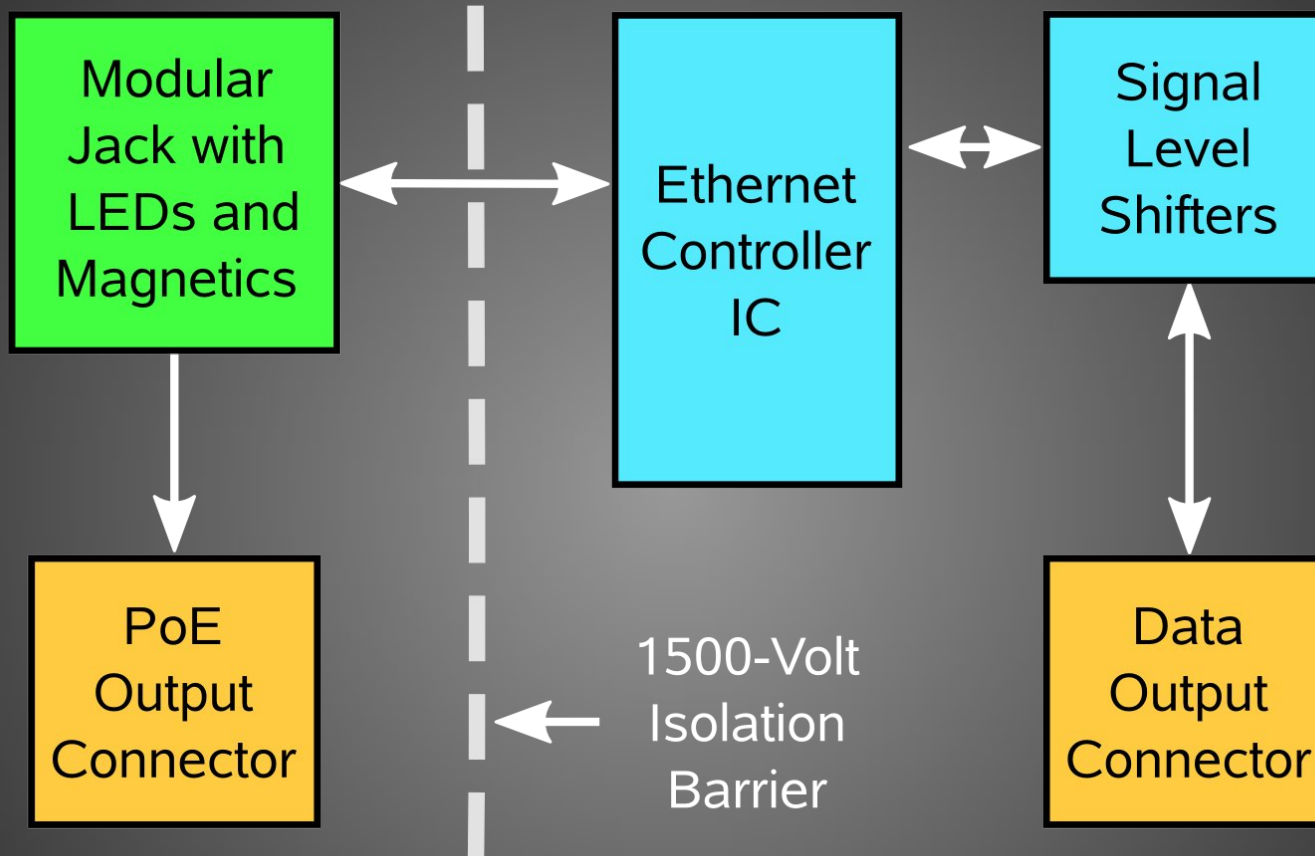
PCB Layout



Completed Power Supply

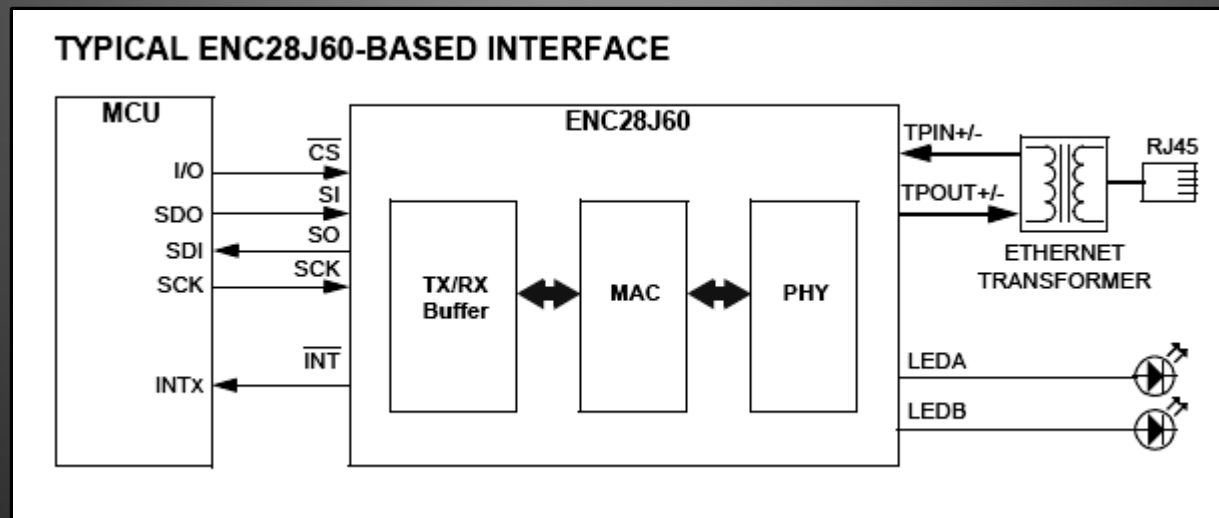
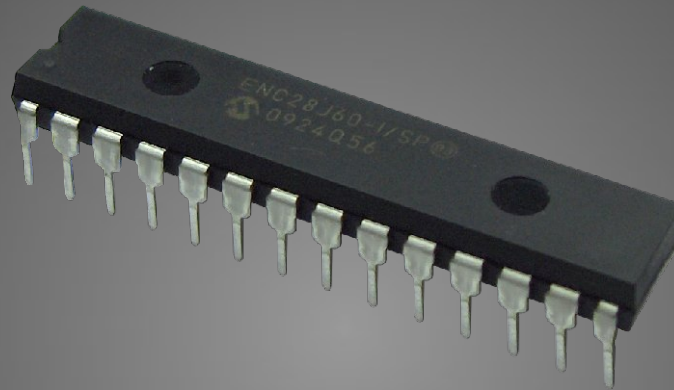


Block Diagram

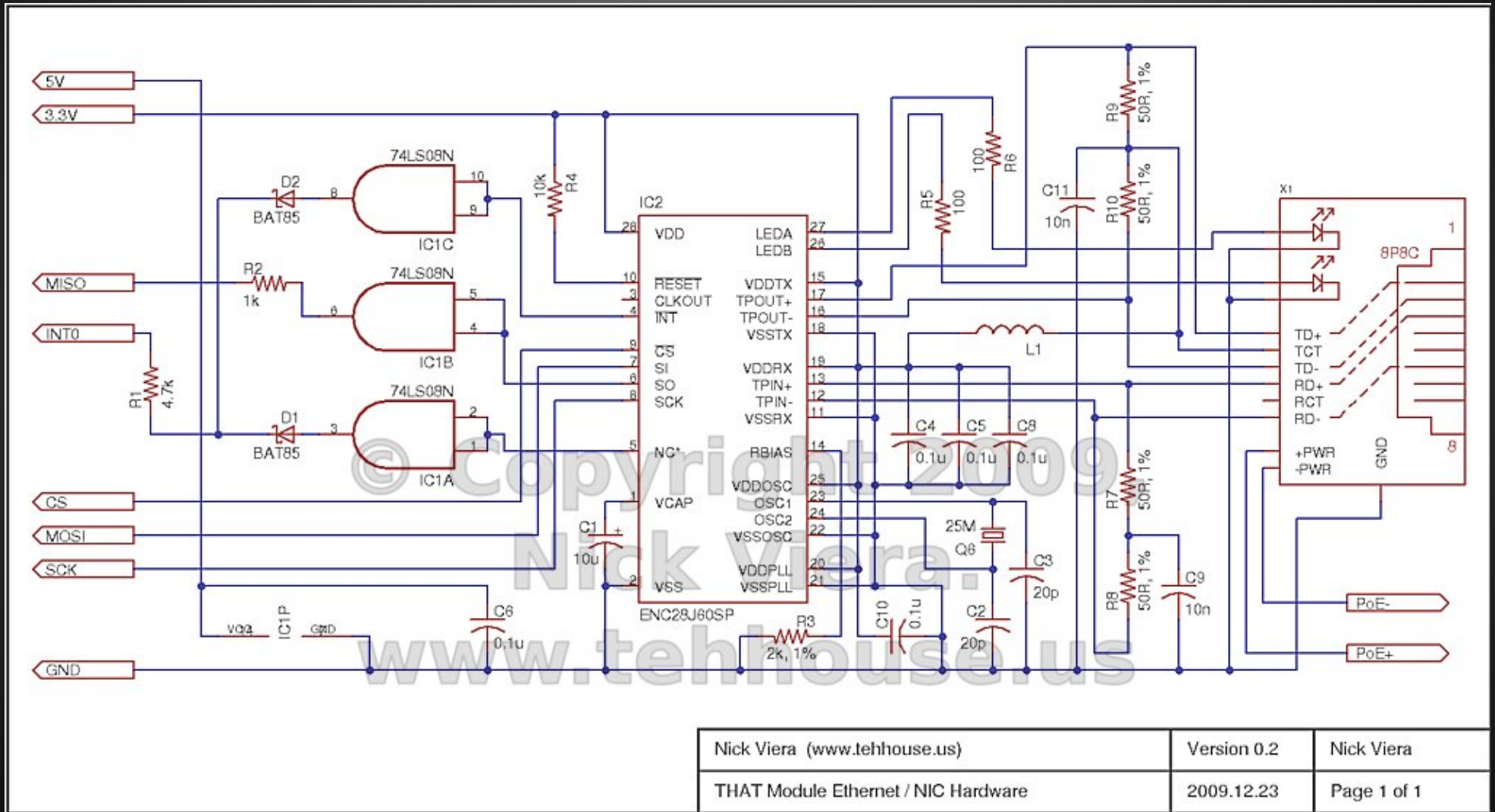


Ethernet Controller

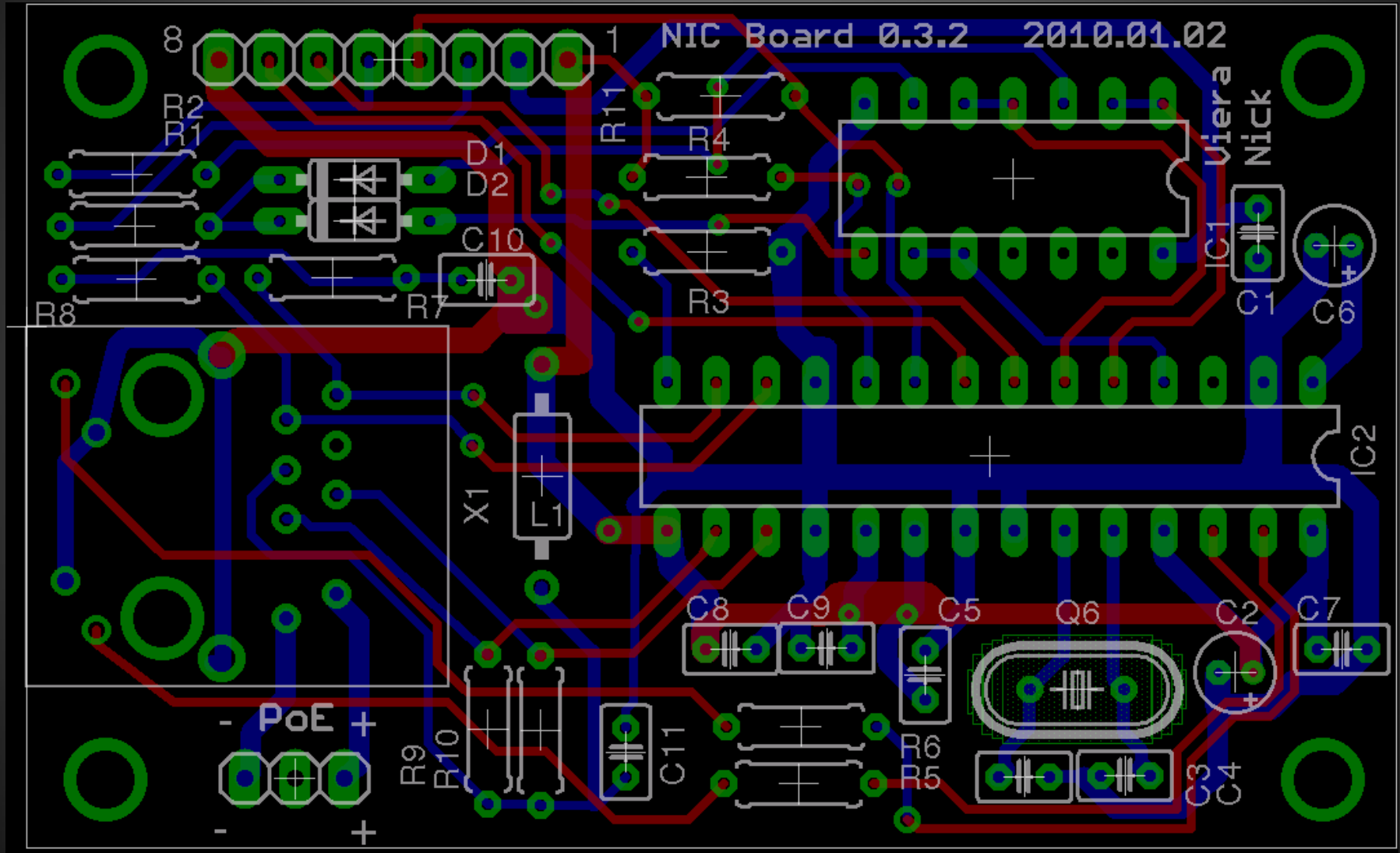
ENC28J60 IC by Microchip implements IEEE 802.3



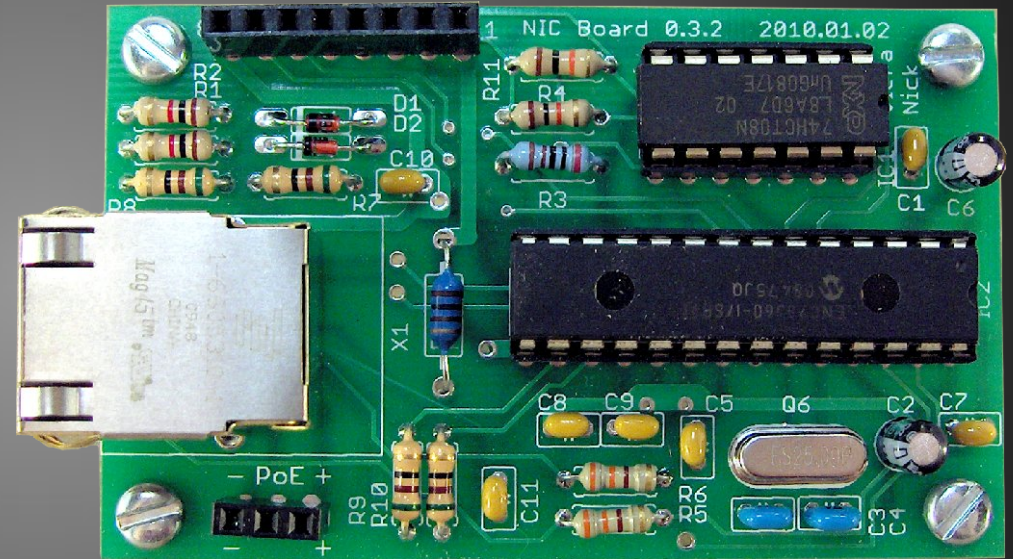
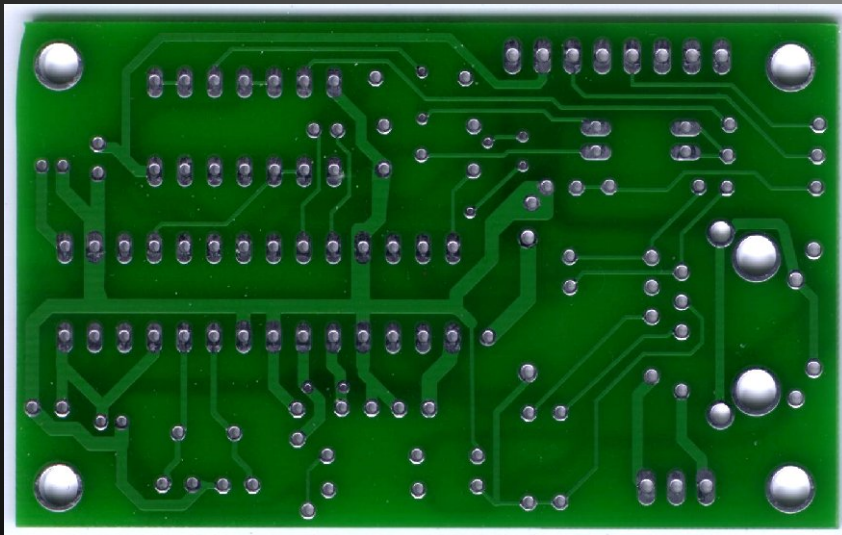
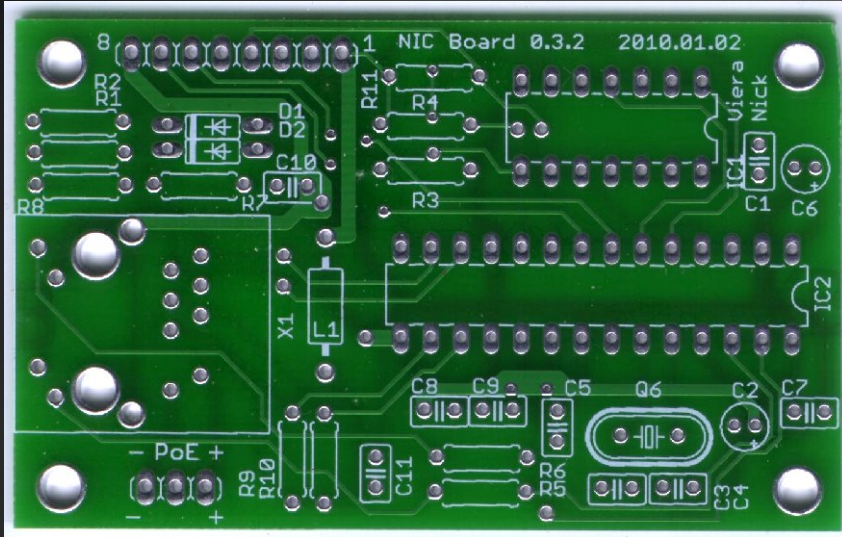
Schematic



PCB Layout



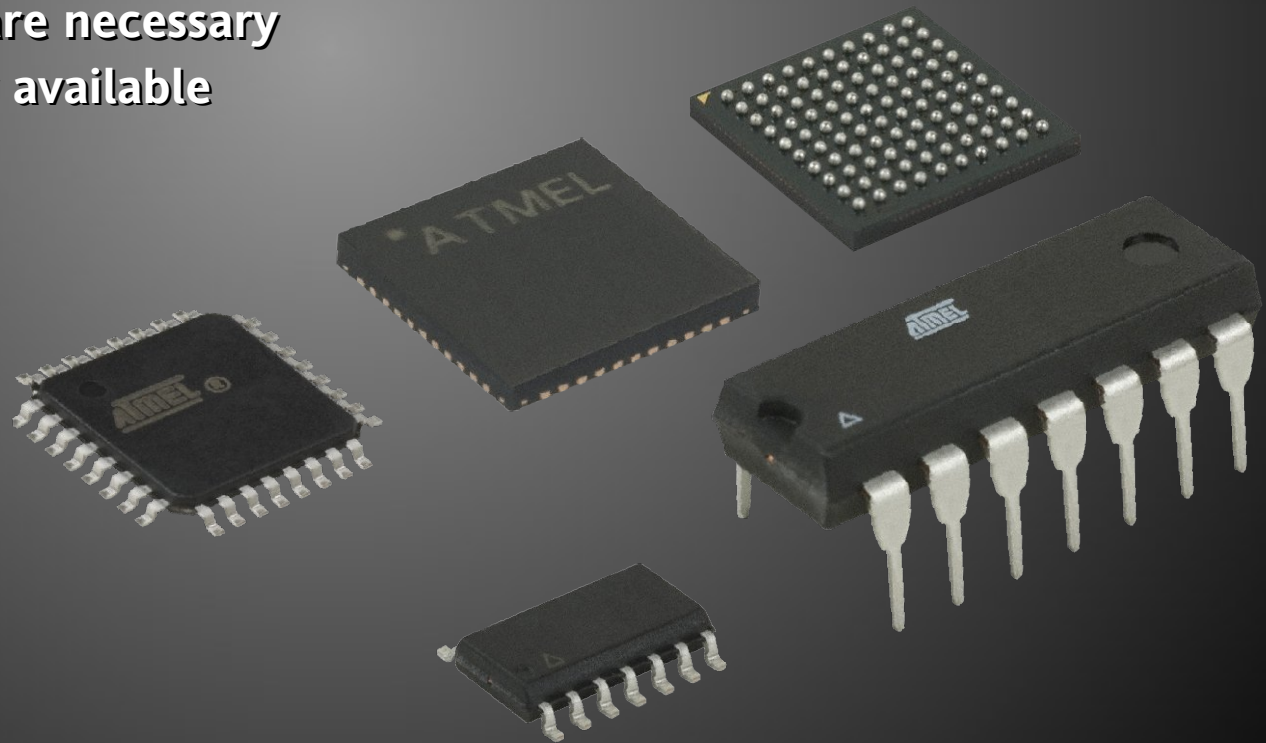
Completed NIC



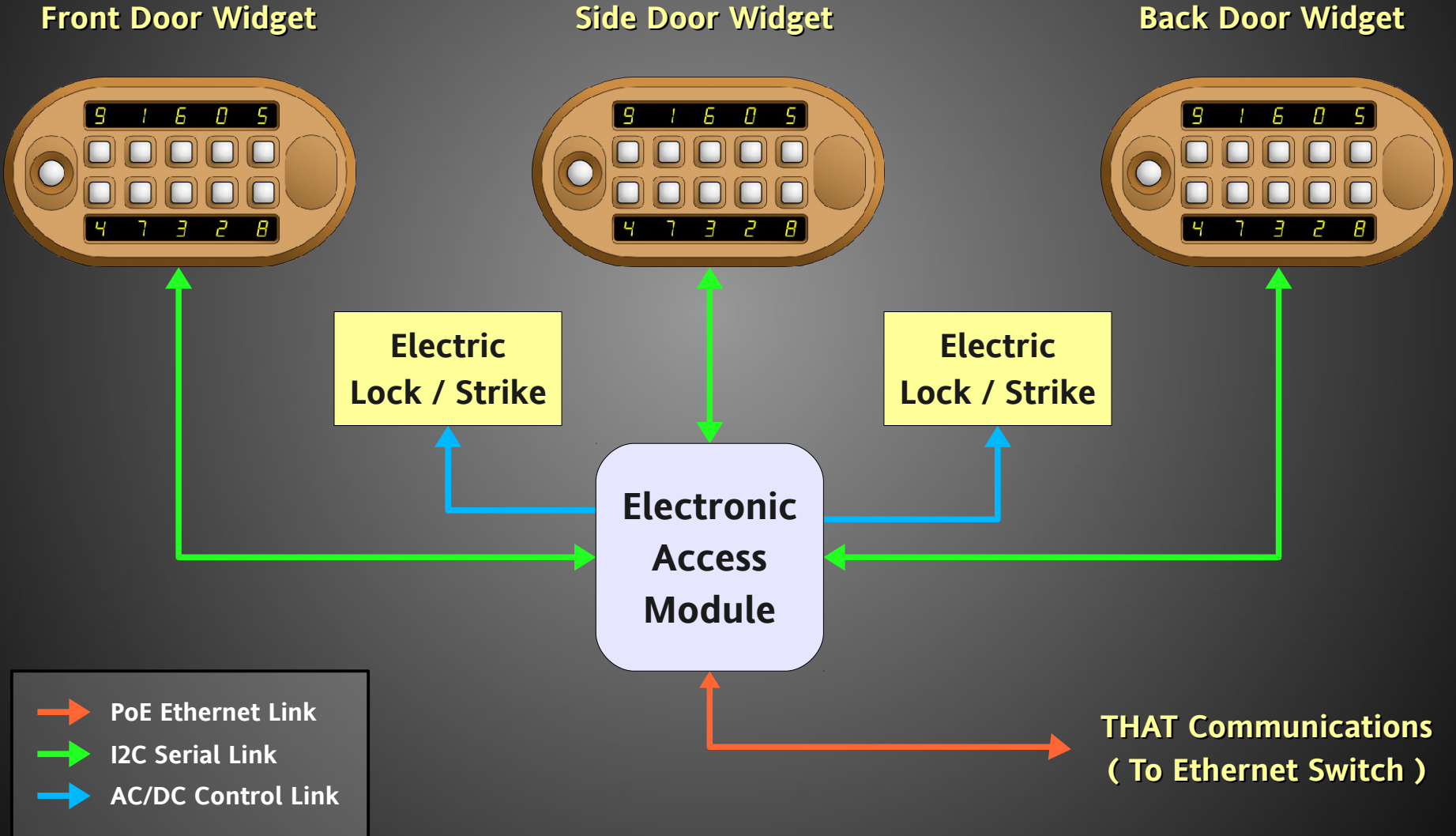
Microcontroller Platform

Atmel AVR Series

- ▶ 8-bit RISC architecture
- ▶ In System Programming
- ▶ Many peripherals (ADC, comparators, serial UART, I²C, SPI)
- ▶ Many through-hole and SMT package options
- ▶ Assembly and C languages
- ▶ No proprietary software necessary
- ▶ Cost-effective, readily available



Module Sub-Topology



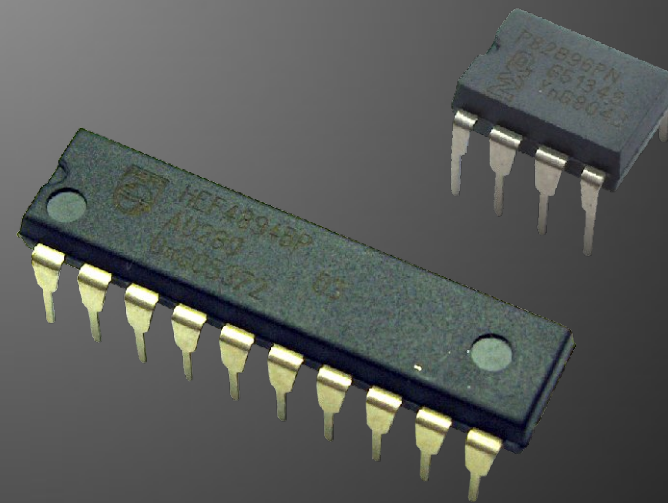
Module Overview

Hardware

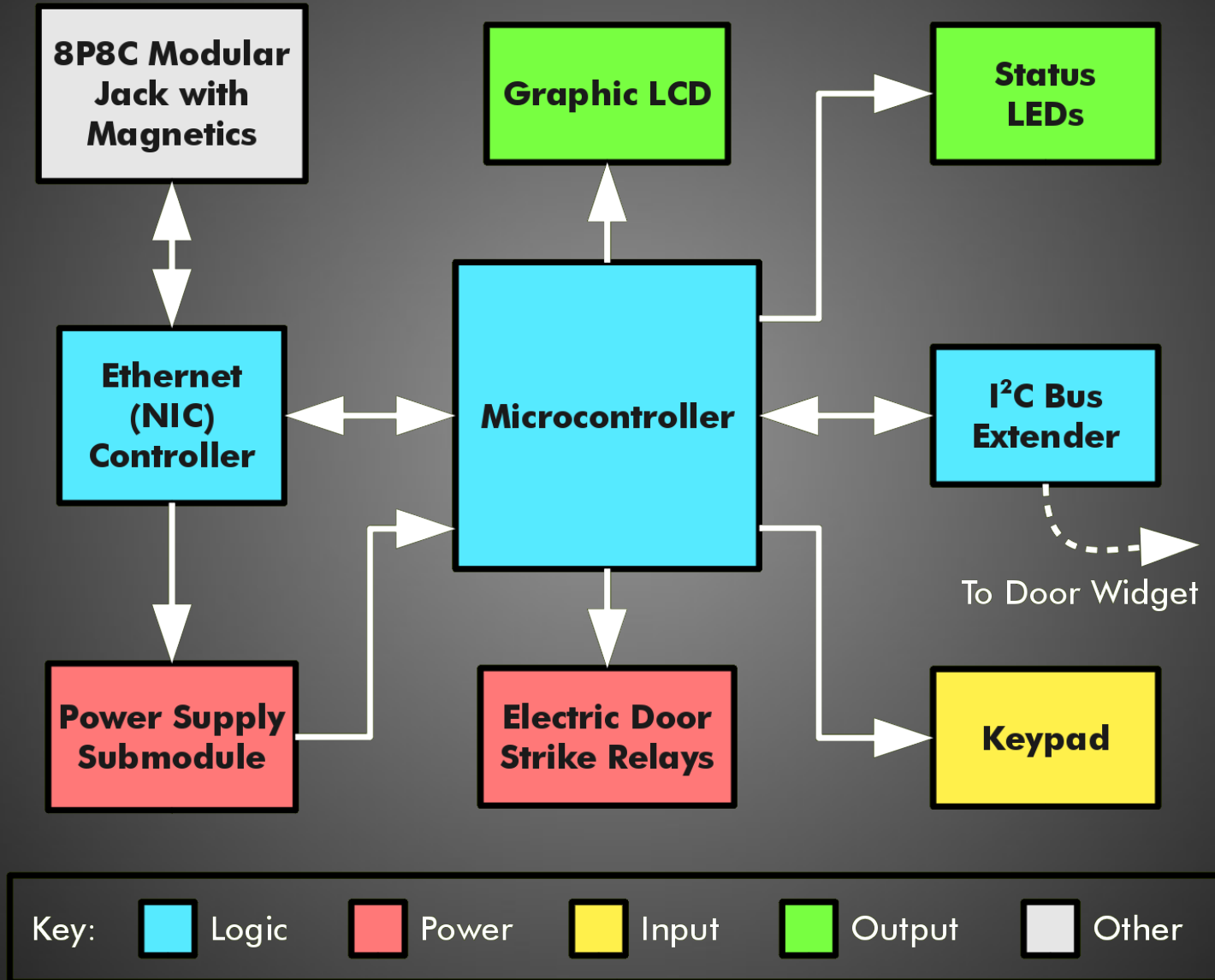
- ▶ Graphical LCD
- ▶ Integrated relays
- ▶ Piezo buzzer
- ▶ Seven-segment LEDs
- ▶ Pushbutton switches

Firmware

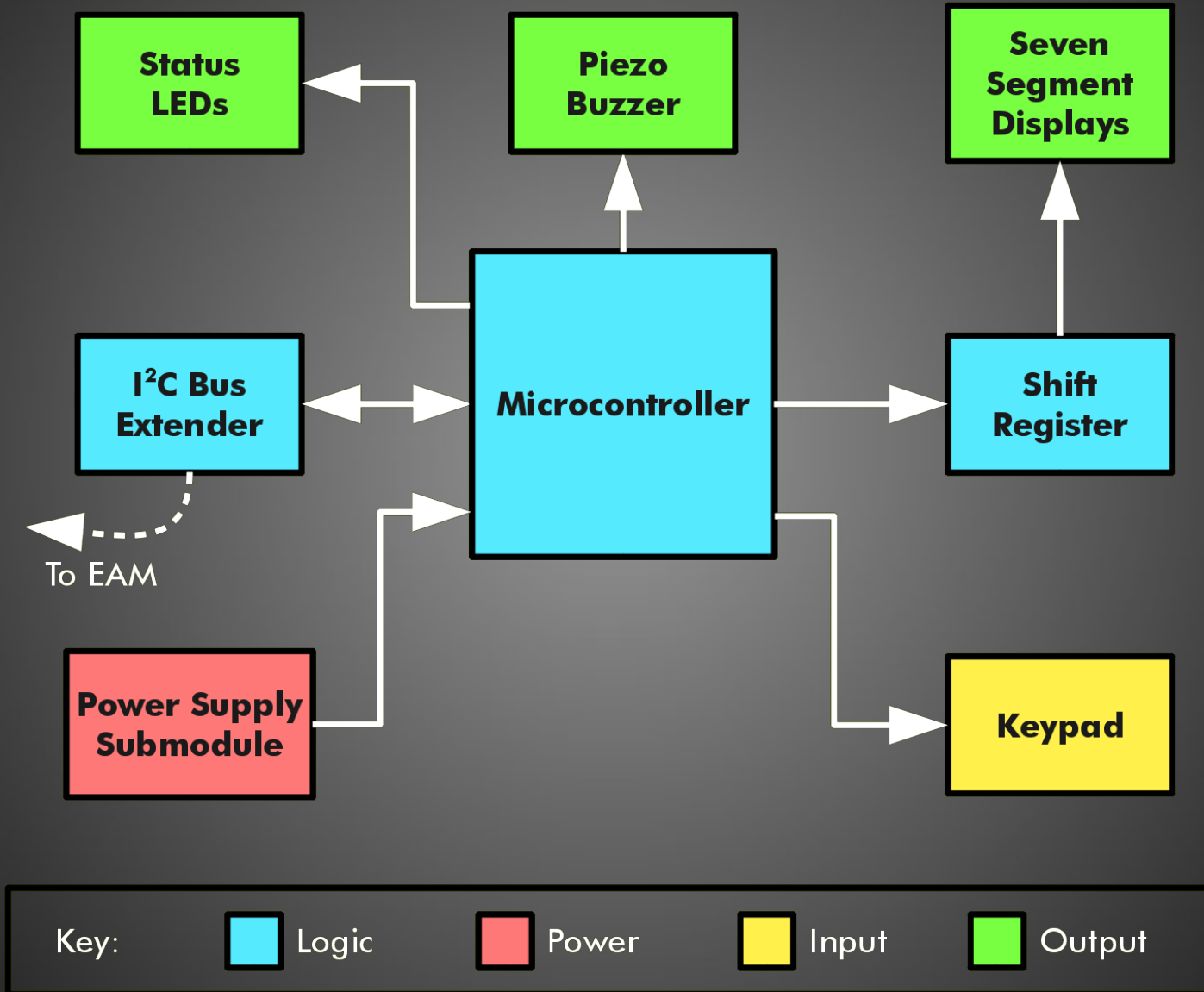
- ▶ Open-source
- ▶ Programmable functionality
- ▶ Multi-user support



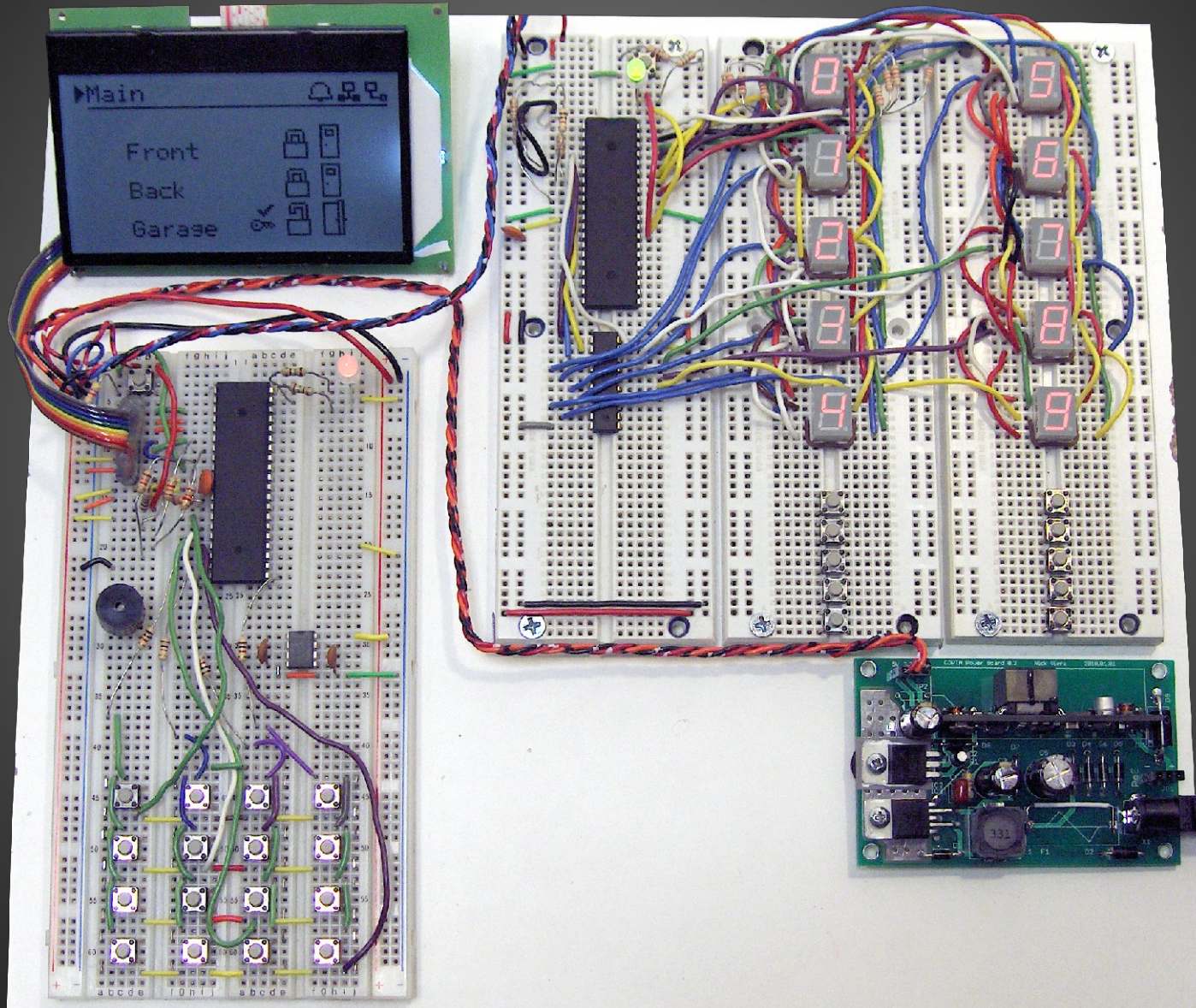
EAM Block Diagram



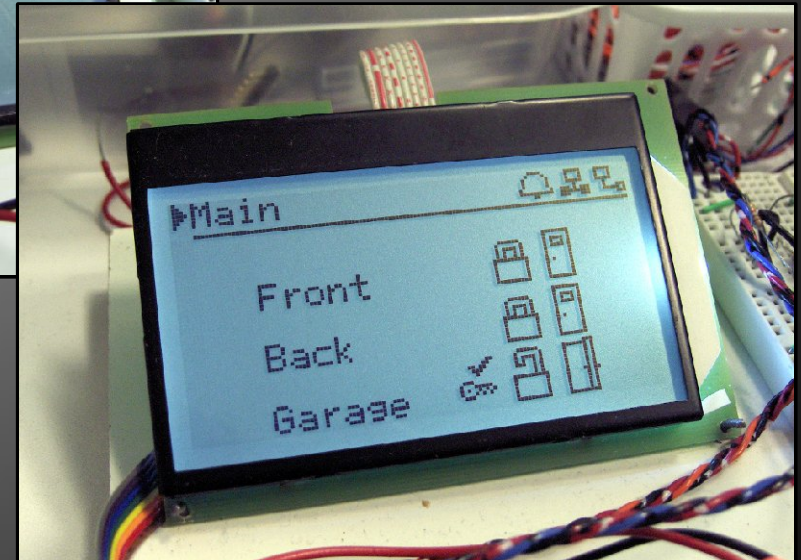
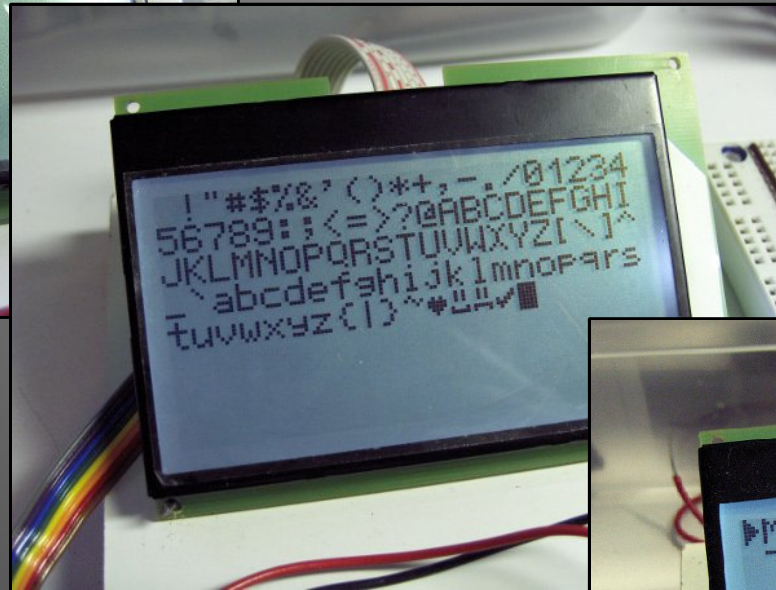
Door Widget Block Diagram



Electronic Access Module Prototyping



Electronic Access Module Prototyping



Module Overview

Hardware

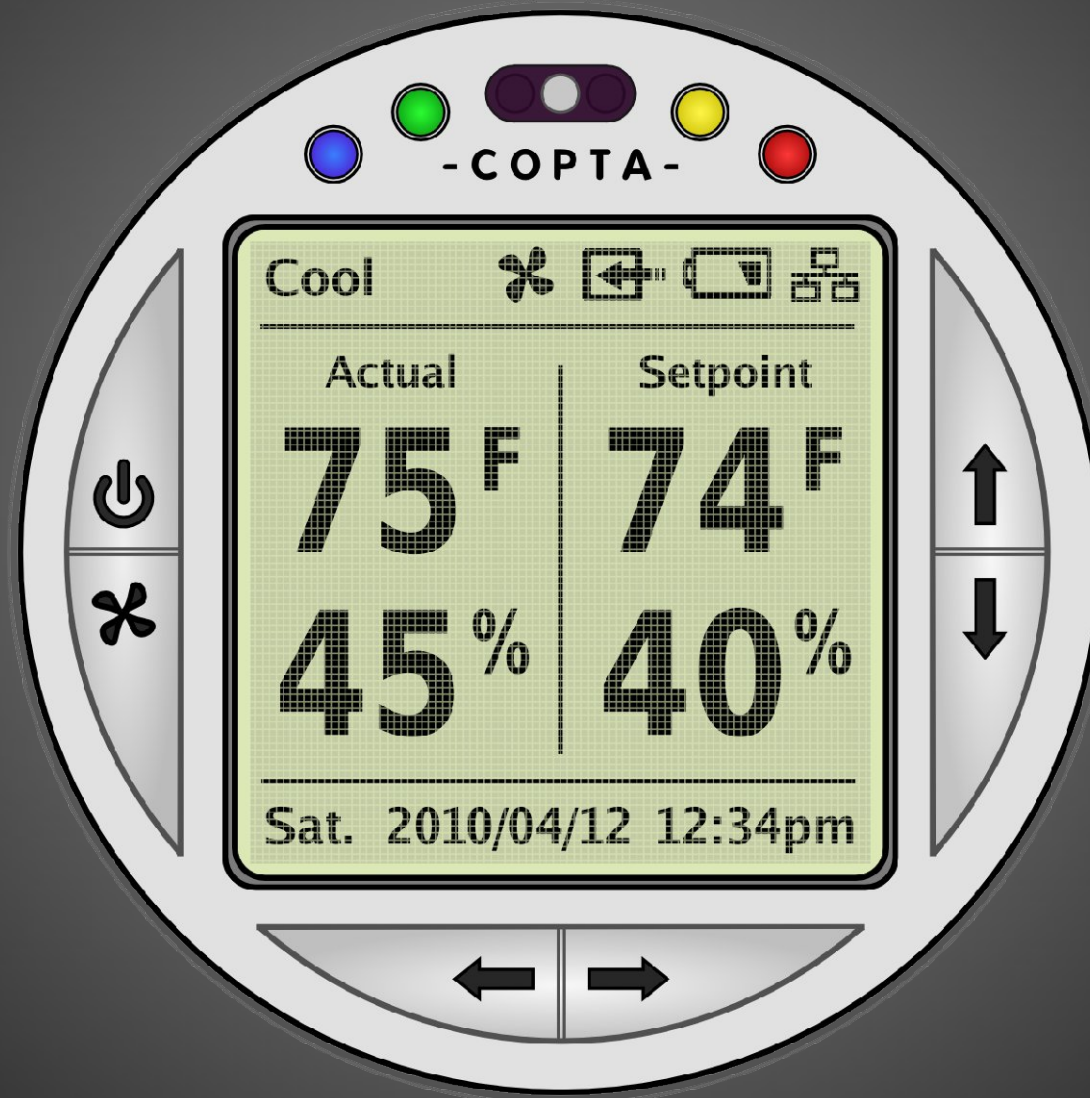
- ▶ Graphical LCD screen
- ▶ 6 switches and 5 LEDs
- ▶ 4 relays
- ▶ Thermostat: -20 to 70°C with $\pm 2^\circ$ accuracy
- ▶ Humidistat: 10 to 95% with $\pm 2\%$ accuracy

Software

- ▶ End-user configurable
- ▶ Weekly scheduling
- ▶ Heat, Cool, Auto, Fan, and Circulation modes
- ▶ Short-cycle prevention
- ▶ Settings stored to non-volatile memory
- ▶ Passcodes for restricted access

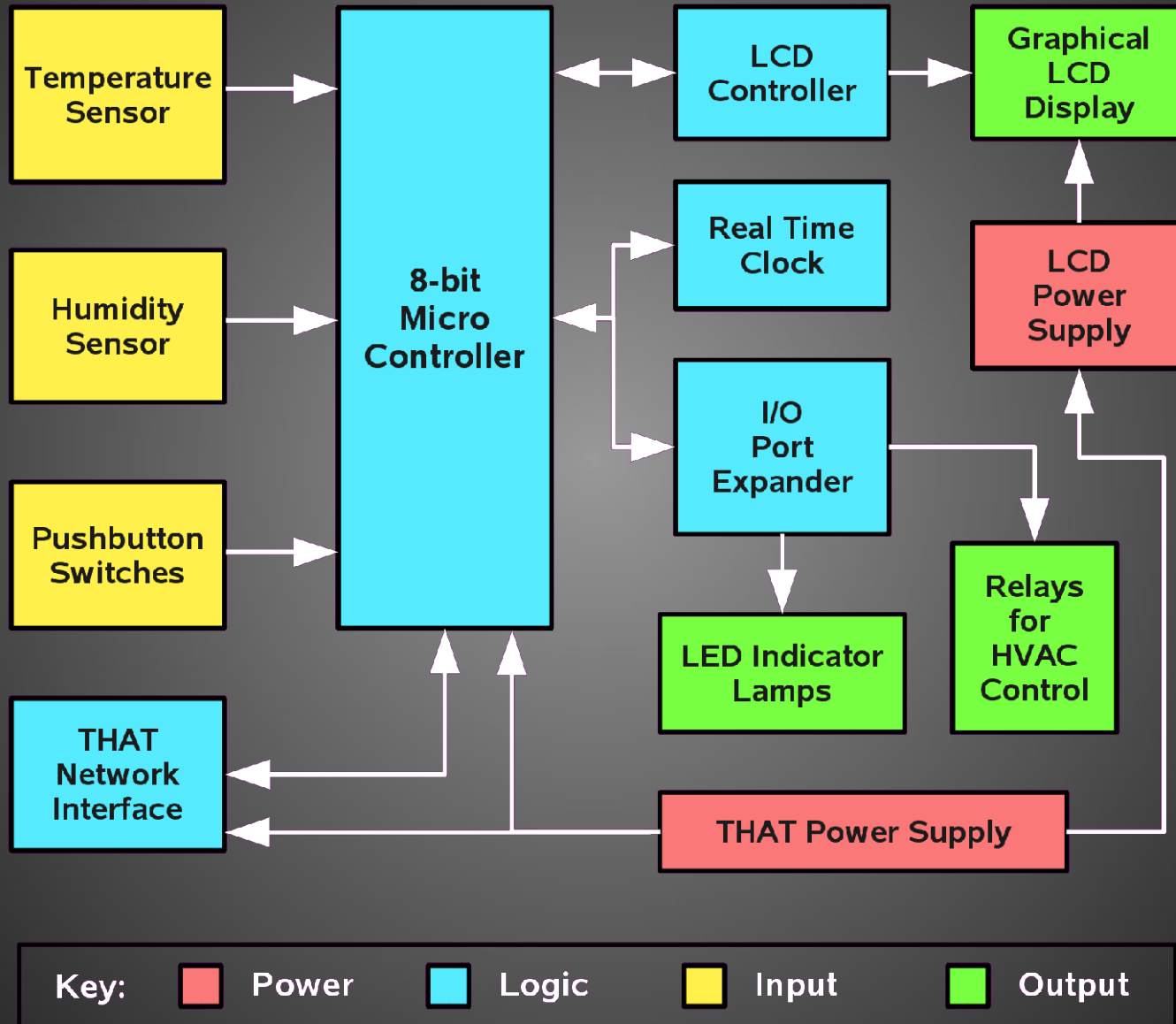


Physical Design Concept



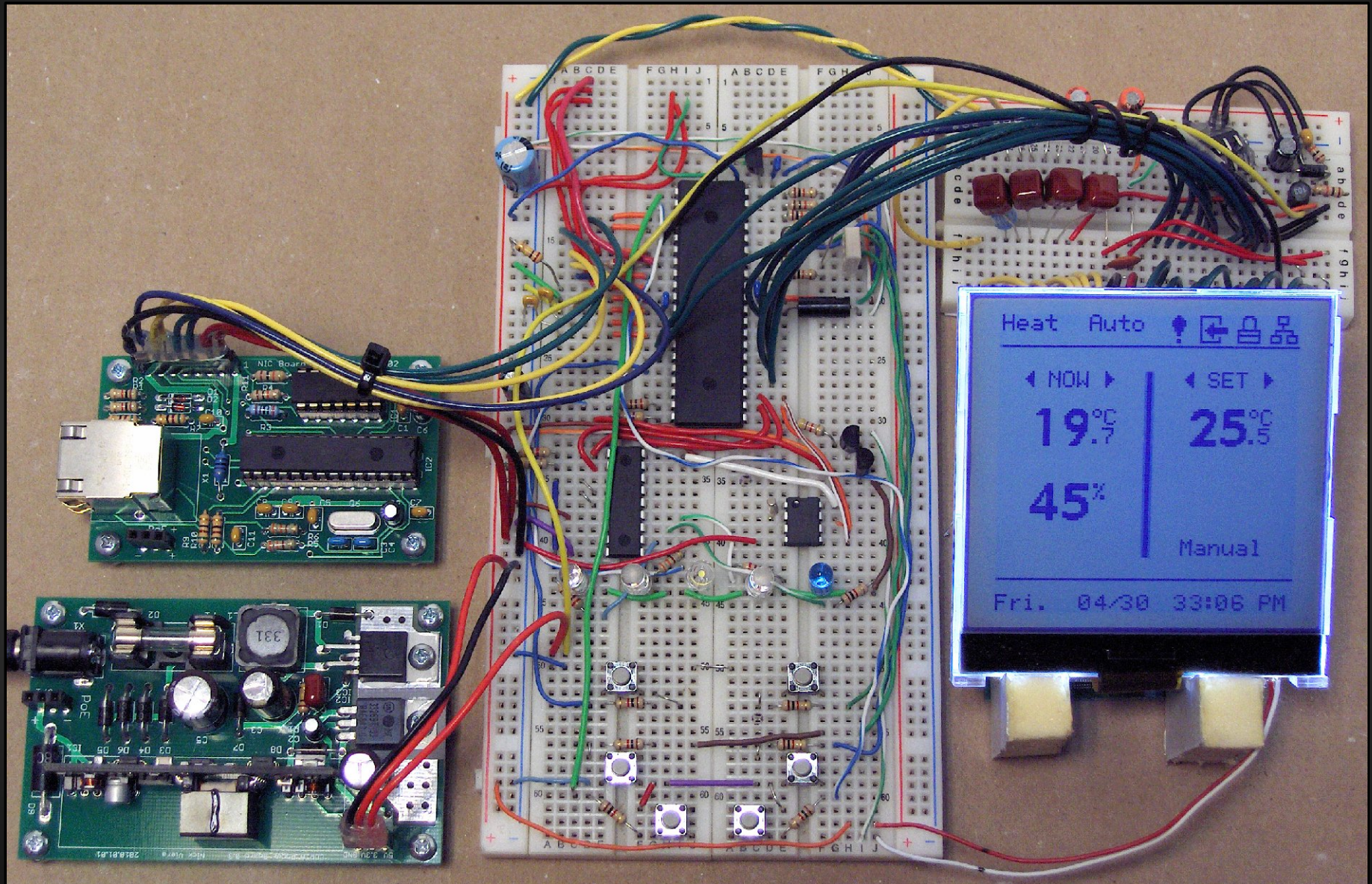
Digital Thermostat Module

Block Diagram

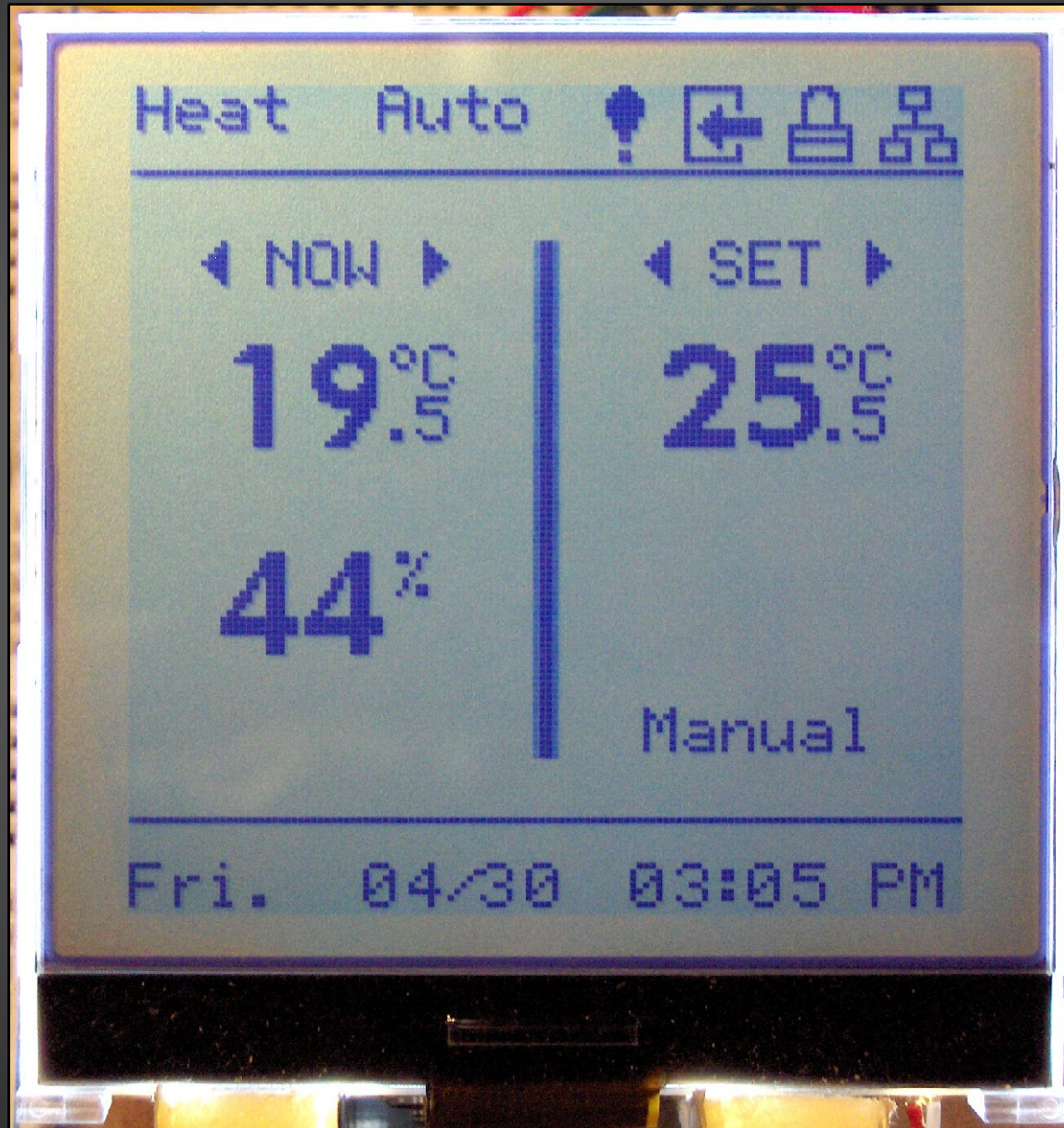


Digital Thermostat Module

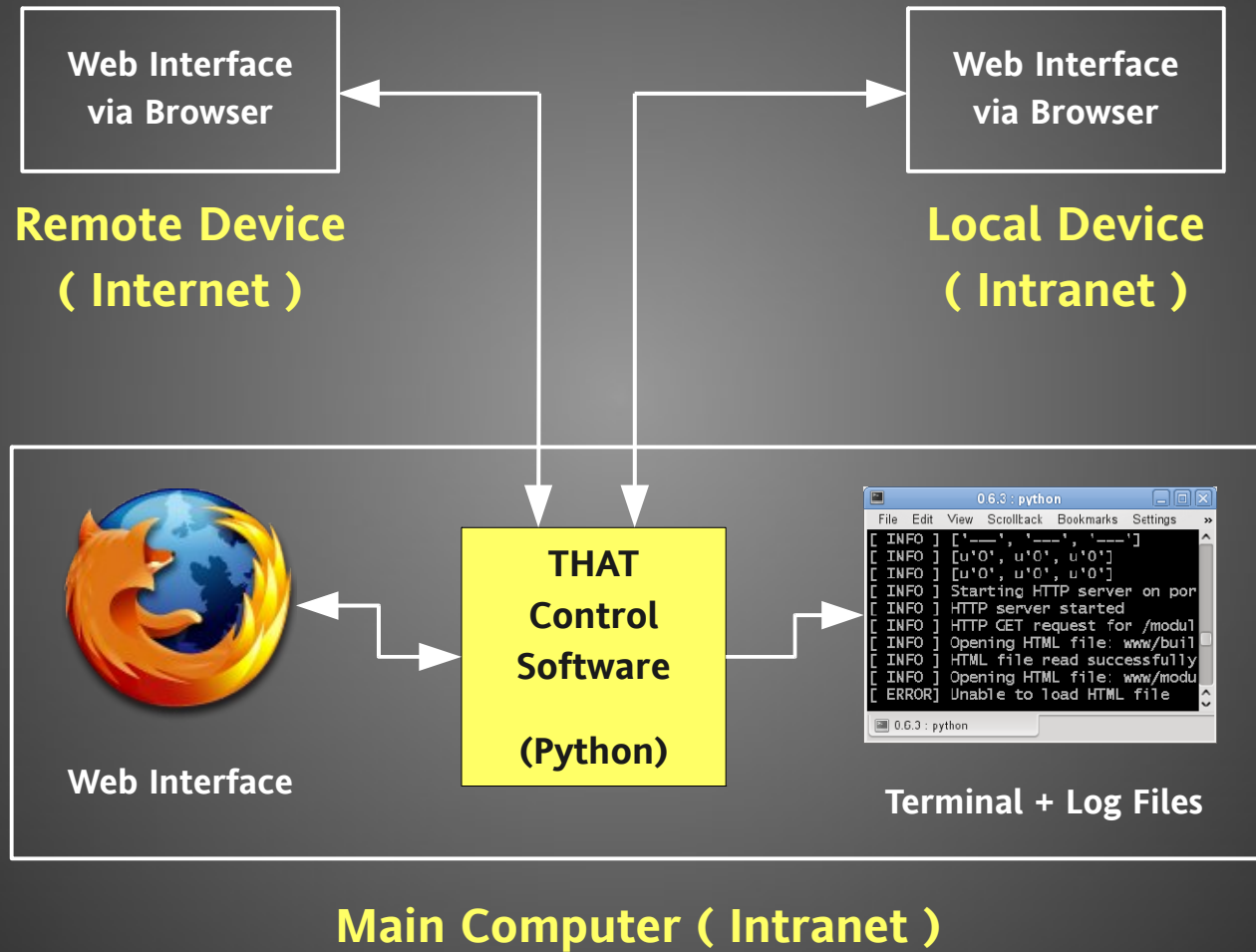
Prototype Device



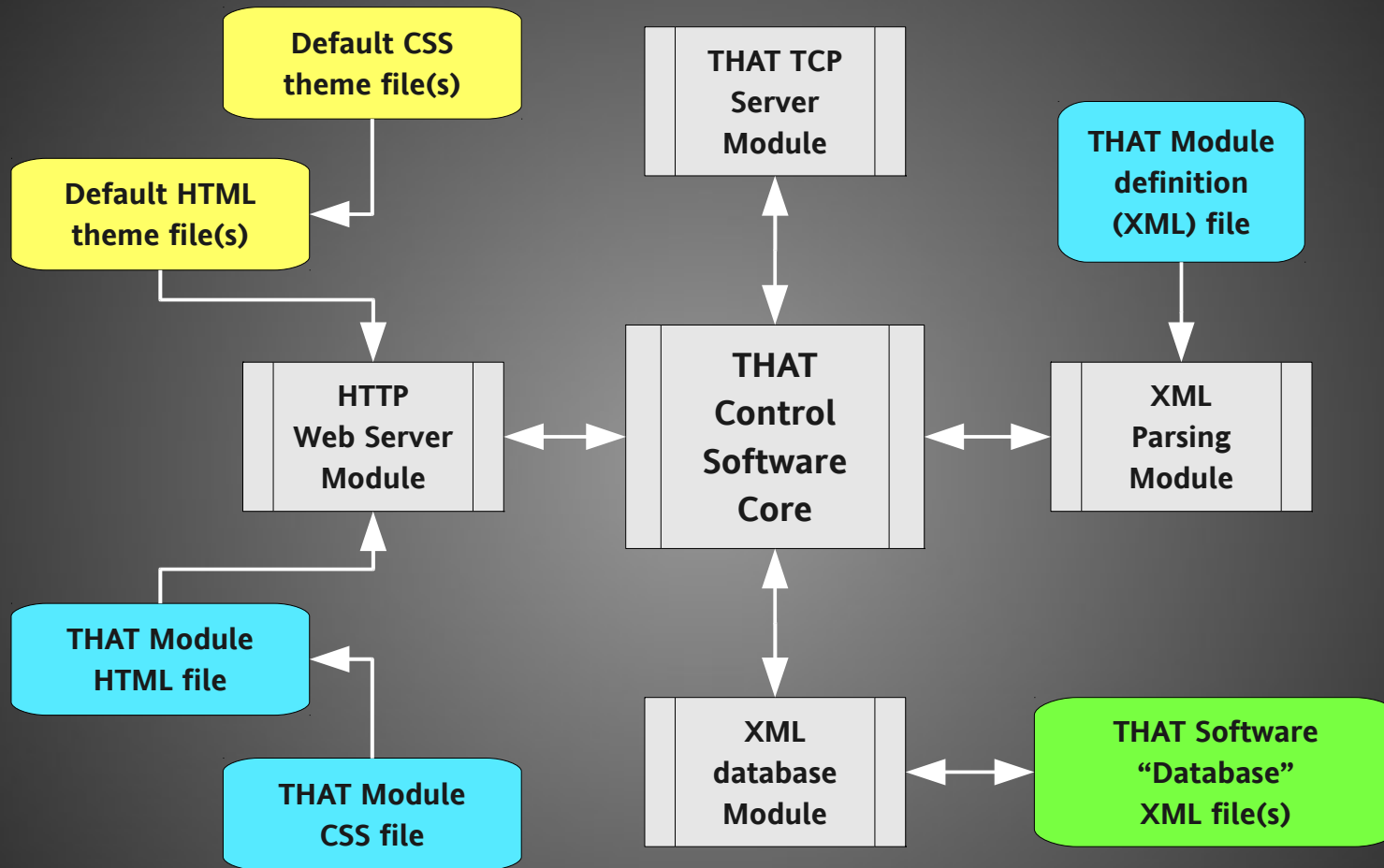
Prototype LCD Readout



Example Usage



Block Diagram



- Provided by the module manufacturer
- Provided with THAT Control Software
- Dynamically generated by THAT Control Software

A Module's XML File

```

1  <?xml version="1.0"?>
2  <module name="copta">
3
4  <identification id="1234-abcd">
5      <fullname>    Digital Thermostat Module    </fullname>
6      <class>      Complex I/O Module           </class>
7      <description> A programmable digital thermostat. </description>
8      <version>    0.1                          </version>
9  </identification>
10
11 <controls>
12 <controls-item name="System Mode">
13     <register> 100          </register>
14     <type>    read-write  </type>
15     <states default="Off">
16         <states-item name="Off">
17             <value> 0 </value>
18         </states-item>
19         <states-item name="Heat">
20             <value> 1 </value>
21         </states-item>
22         <states-item name="Cool">
23             <value> 2 </value>
24         </states-item>
25         <states-item name="Auto">
26             <value> 3 </value>
27         </states-item>
28     </states>
29 </controls-item>

```

Model
Identification
section

Controls
Declaration
section

Conclusion

Completed Work

- ▶ Basic communication scheme
- ▶ TCP communications software
- ▶ THAT Power Supply
- ▶ THAT Network Interface

In Progress

- ▶ Digital Thermostat Module
- ▶ Electronic Access Module
- ▶ THAT Control Software

► Questions? ◀

References:

[1] D. Dwelley & J. Herbold, “Banish Those Wall Warts With Power Over Ethernet,” *electronic design*, Oct. 2003. [Online]. Available: <http://electronicdesign.com/article/power/page/page/1/banish-those-wall-warts-with-power-over-ethernet59.aspx>

[2] D. Sherman, “AN452 One mile long I²C communication using the P82B715.” Datasheet & Application Note Database, May 2010. [Online]. Available: <http://www.datasheetarchive.com/pdf/Datasheet-054/DSA004594.pdf>

[3] G. Socher, “An AVR microcontroller based Ethernet device,” June 2006. [Online]. Available: <http://www.tuxgraphics.org/electronics/200606/article06061.shtml>

[4] G. Socher, “HTTP/TCP with an atmega88 microcontroller,” Nov. 2006. [Online]. Available: <http://www.tuxgraphics.org/electronics/200611/embedded-webserver.shtml>