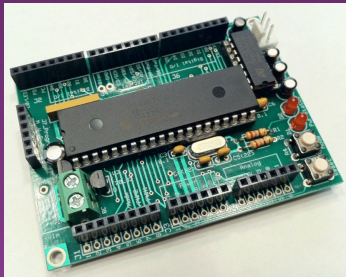


Ham Radio Projects Using The HamStack Platform

NEWS/MidAtlantic VHF Conference

Phil Theis K3TUF



Topics



01

Welcome

10

Quick introduction to microcontrollers

11

Project examples

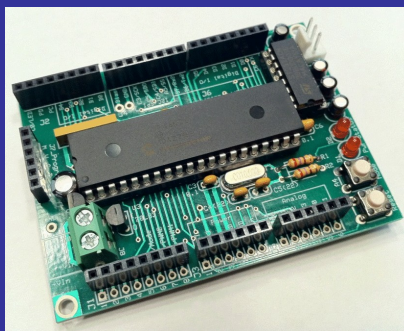
Sierra Radio Systems

Repeater Control Systems



- *High reliability*
- *Up to 8 ports*
- *Modular*
- *Repeater, link, VOIP, remote base*
- *SW configuration*

HamStack Microcontroller Platform



- *Learn to design w/microcontrollers*
- *Option boards*
- *Compilers*
- *Examples*
- *Tutorial*

Station Automation Controllers



- *Radio Router*
- *Station controller*
- *iPhone remote control*
- *Digital compass*

Topics

01

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Quick introduction to microcontrollers

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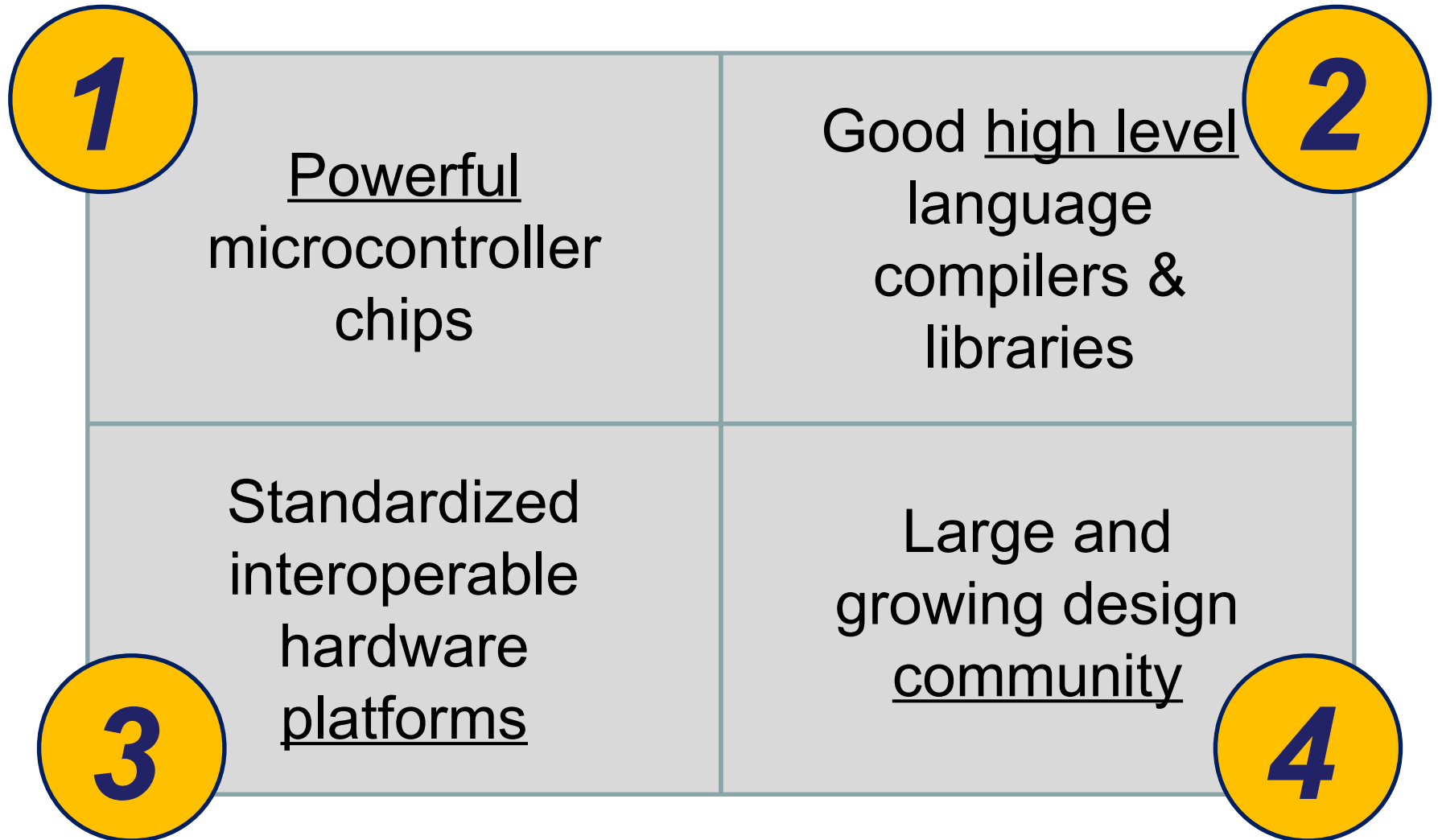
Project examples

What Can You Build With One?

- TR sequencer
- Memory keyer
- CW keyboard
- Station power controller
- Rotor controller
- Tone generator
- Test equipment controller
- Speaker / audio router
- Repeater controller
- Fox hunt tx controller
- Radio control
- Morse code decoder
- APRS encoder
- Frequency counter
- Battery monitor
- Audio meter

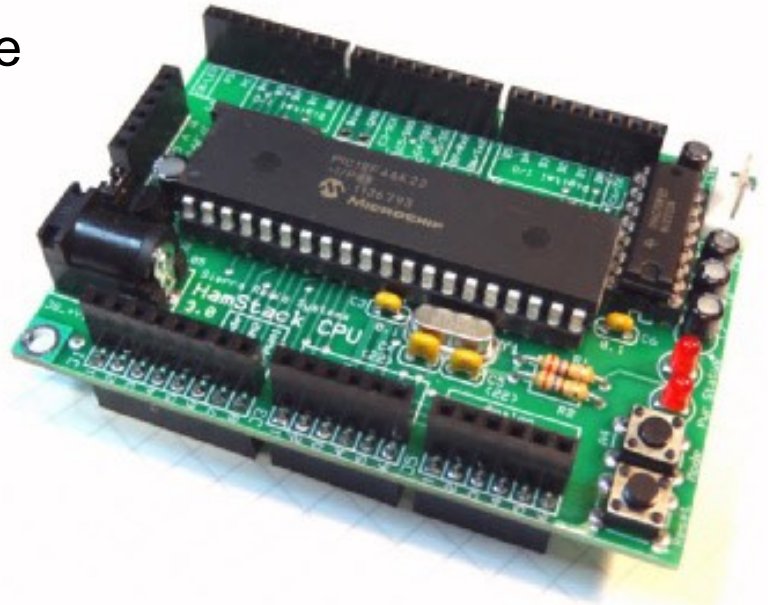


Why Is This A Great Time To Start?



What is a Microcontroller?

- Computer on a single integrated circuit
- Containing...
 - Processor core
 - Flash memory for program storage
 - RAM for variable storage
 - Flash memory for data storage
 - Input/output peripherals
 - Digital input / output
 - A to D converter input
 - Serial UART
 - Serial bus I2C, SPI, etc
 - Pulse width modulator
 - Timers
 - More...



Available From Many Suppliers



Lots of Horsepower

1 MIP

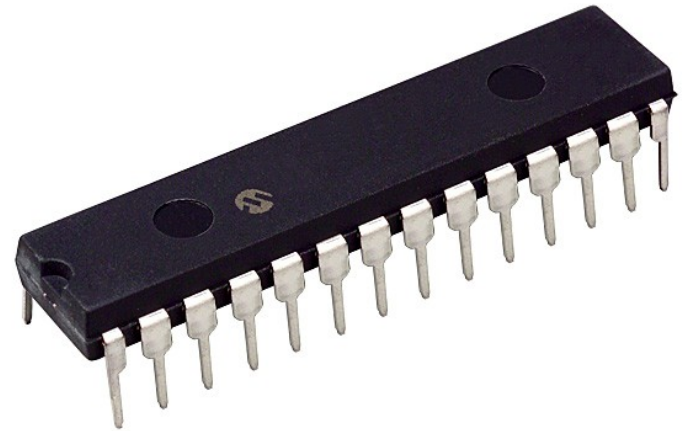


16 MIPs

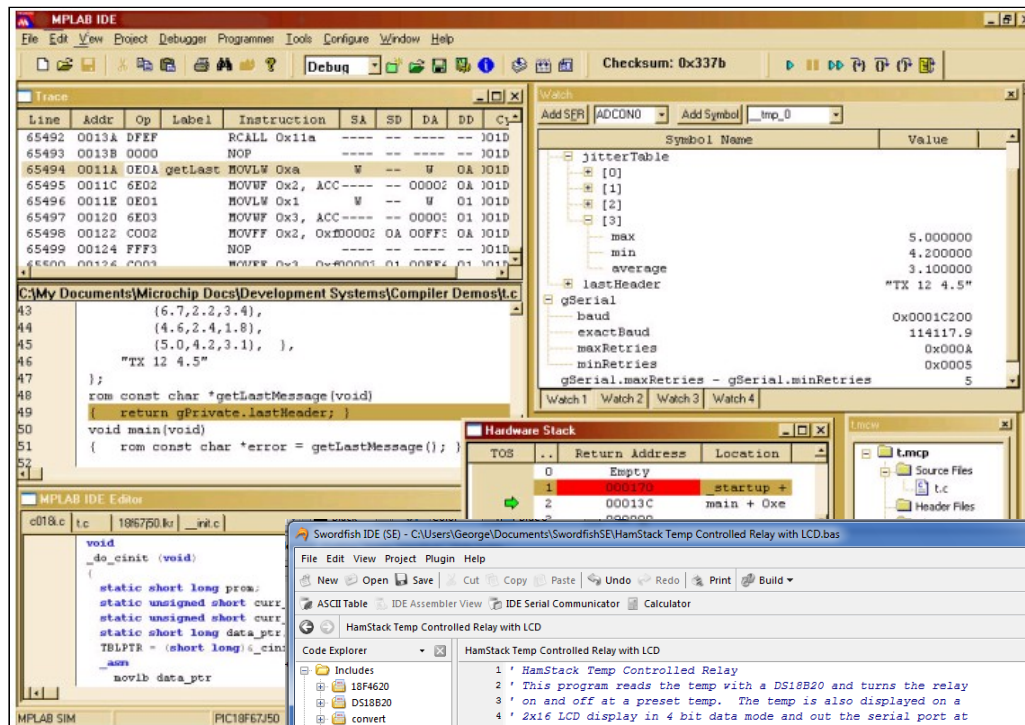
PIC

Microcontroller

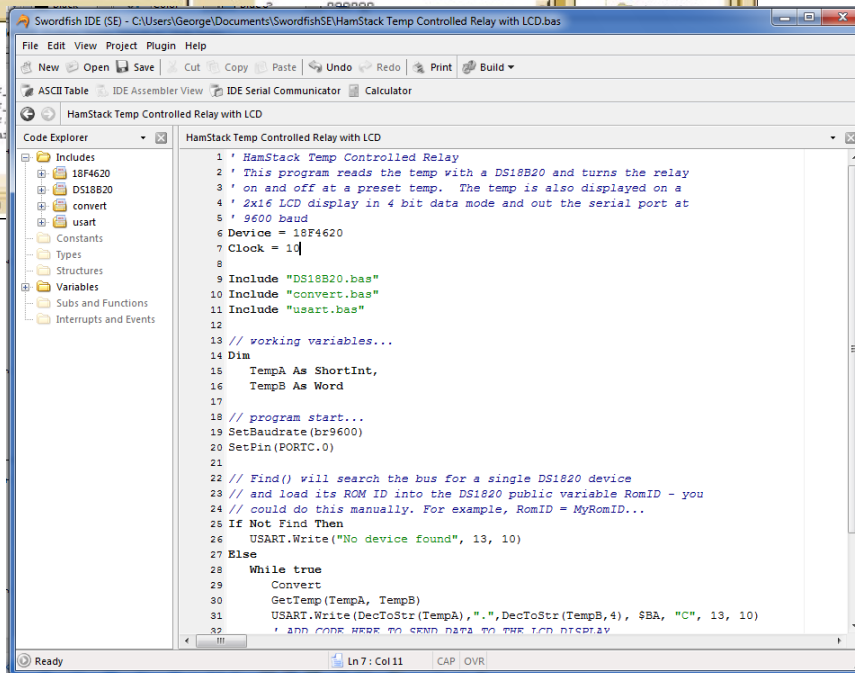
>



High Level Language Compilers



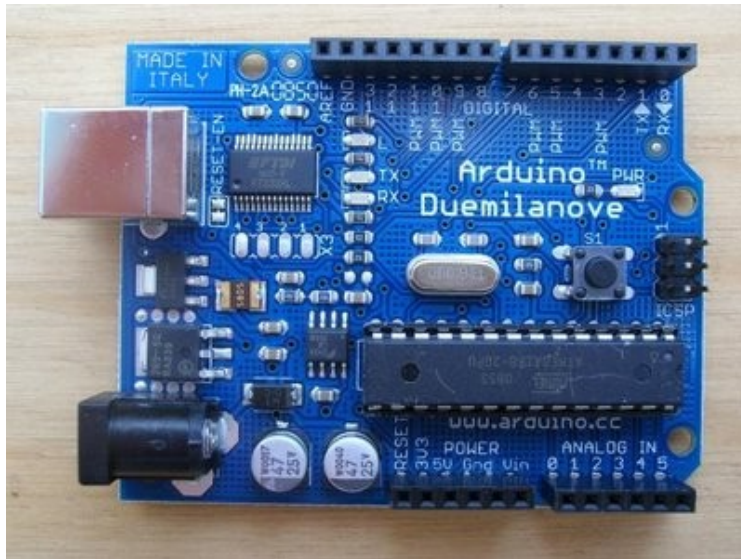
- C Language
- ANSI standard
- Code optimization
- Complete IDE



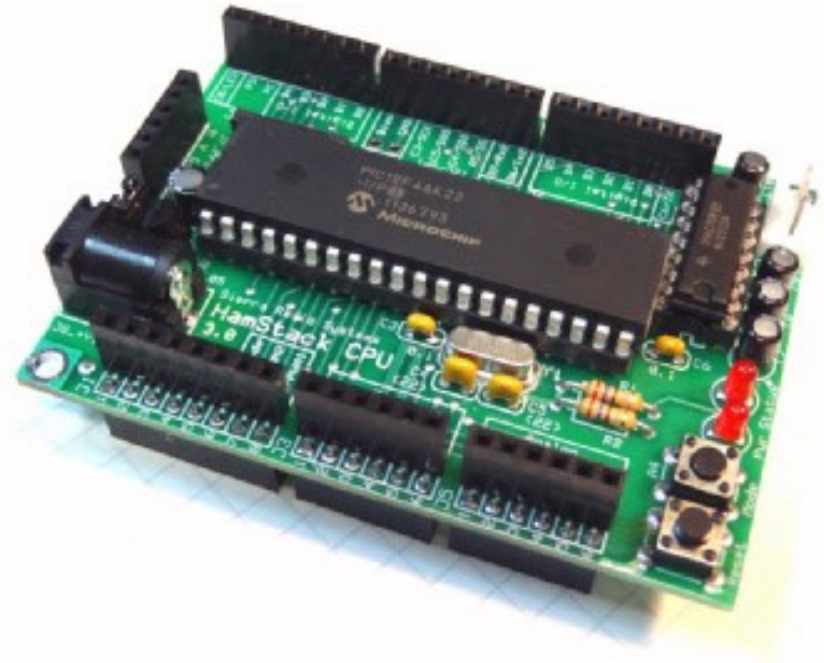
- Structured Basic
- Real compiler
- Full flow control
- Strings, types,
- Subroutines, functions, etc.

Standardized Platforms

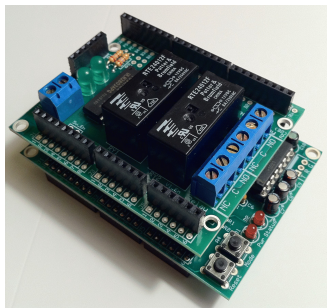
Arduino



HamStack

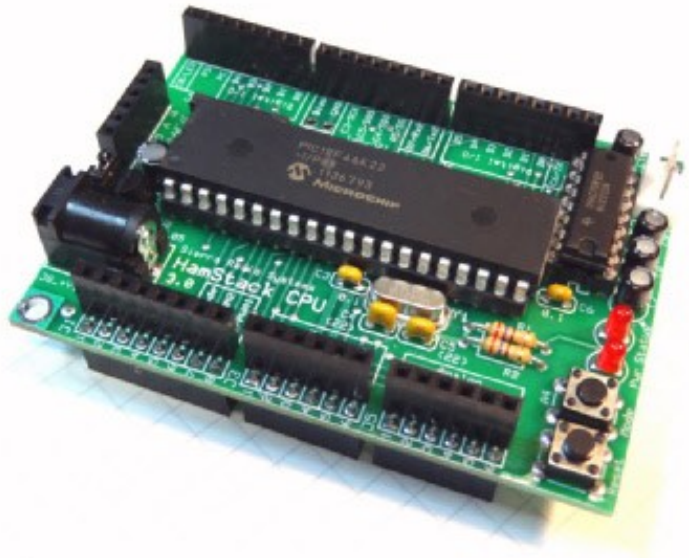


Many Accessory Boards

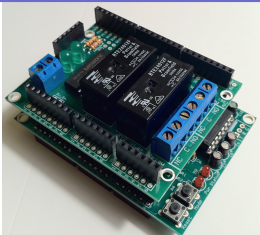


Shameless Plug...

HamStack Microcontroller Platform



- PIC 18F46K22
- 64k Flash program memory
- 4k RAM, 1k Data flash memory
- 64 MHz
- Digital IO, A/D converters, UARTS, SPI, I2C, PWM, timers...
- Programmable in C and Basic
- Lots of options: relays, ethernet, WiFi, keyboard, LCD displays, etc...
- Arduino compatible pinout



Topics

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Project examples

Project examples on hamstack.com

Smart Dummy Load



W1GQ designed this high power dummy load with an embedded HamStack CPU and relay board. A digital sensor monitors the load temperature and controls the two cooling fans and an over-temp alarm. Front panel LCD shows the temperature.

[More info](#) >>

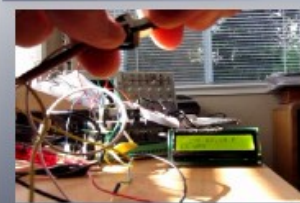
DTMF Decoder



This project uses the 8870 DTMF decoder chip circuit built on a HamStack prototype board. As tones are decoded, the ASCII character is sent to the serial port. The firmware is written in Swordfish Basic.

[More info](#) >>

CW Keyer Prototype



John, KJ6K, is designing an open source keyer project written in Microchip C18 C language compiler for the HamStack. The video shows some basics of the multi-tasking capability of the HamStack software stack.

[More info](#) >>

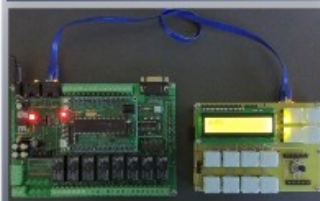
GPS-Based Clock



John has been working on a GPS satellite-based clock synchronization project. The HamStack reads the time from the GPS receiver and displays the time.

[More](#) >>

Antenna Controller



This project uses the 8 relay GPIO board and a new prototype control head. The Control head lets you select any one of 8 antennas with the push of a button. Status is displayed on the LCD.

[More info](#) >>

Rotary Encoder



This mini-project shows how to use a mechanical rotary quadrature encoder as an input device to indicate left or right knob rotation. The example is written in Swordfish Basic.

[More info](#) >>

Digital Compass



Today's digital electronic compass' can be interfaced to a HamStack CPU board and used for a variety of ham radio projects including accurate antenna direction measurements.

[More info](#) >>

KJ6HFR's Breadboards



Robert, KJ6HFR, made some very nice prototype breadboards based on the HamStack CPU. Check out these cool YouTube videos !

[Breadboard video #1](#)

[Breadboard video #2](#)

18F4620 CookBook



Robert, KJ6HFR, has written up a great reference document based on his experience with the PIC 18F4620 CPU used on the HamStack CPU board. Download the PDF and check it out. See the [YouTube video](#).

[Download](#) >>

N6YP's Temp Control



Frank, N6YP, developed a great repeater site temperature monitoring system using our GPIO board and digital temperature sensors. The system keeps track of 3 repeaters and displays the status on a 4 line LCD.

[More info](#) >>

CW/PSK K3 Keyboard



This CW/PSK keyboard project is featured in the June 2012 issue of CQ magazine. The HamStack project uses a PS2 keyboard to send CW & PSK to an Elecraft K3 or KX3 radio and provides rig control through the serial port.

[More info](#) >>

W1GQ Yagi Switching



This article by Bruce, W1GQ, shows how he used a HamStack and GPIO board to remotely switch stacked Yagi antennas for his contest station.

[Download the article here.](#)

[Download](#) >>

Projects

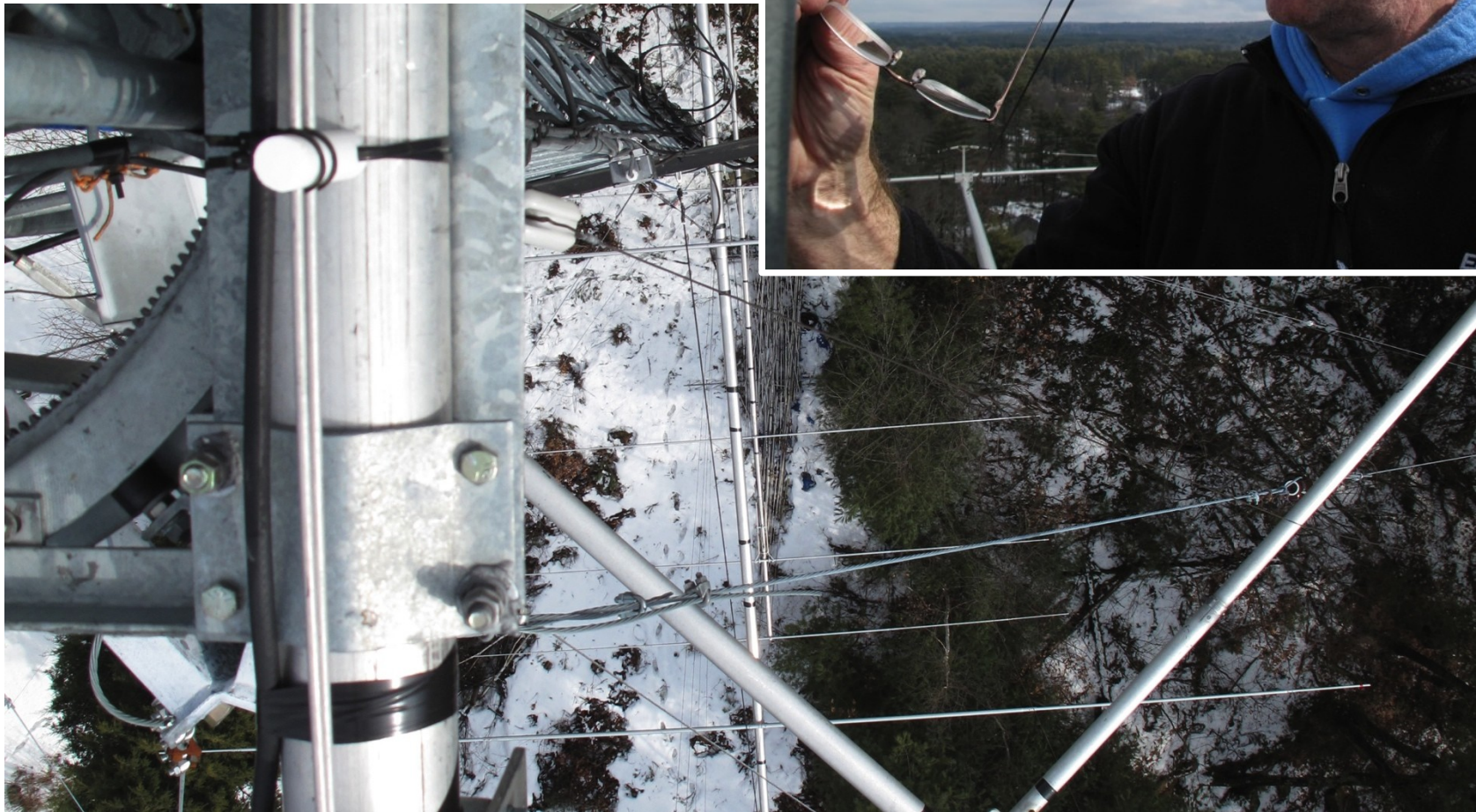
1. **Remote antenna control box**
2. CW keyboard
3. Audio mixer and SO2R controller
4. iPhone app for control and monitoring
5. Digital compass
6. Electronic keyer

Station Automation @ W1GQ

Remote Antenna Switching

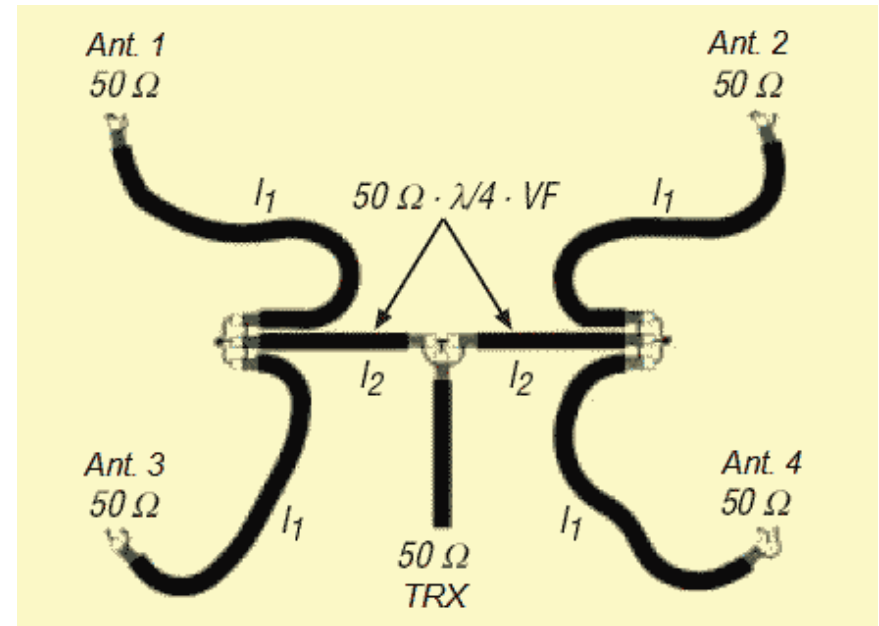


Bruce, W1GQ,
on the tower at his
contest station

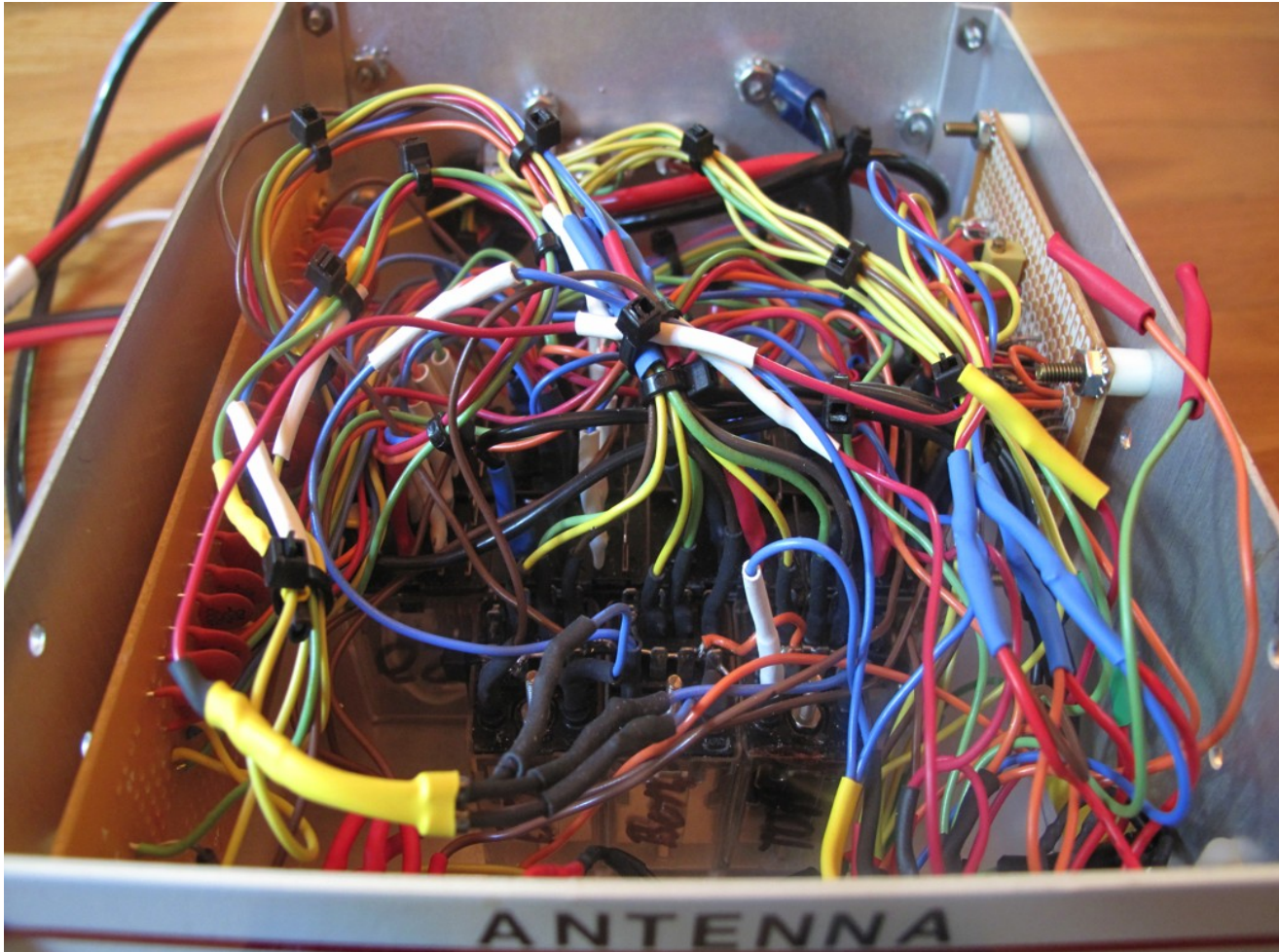


Feeding Stacks

- Coaxial matching
- Vacuum relays for insertion loss & reliability
- Plenty of coax and control cable
- Many things to go wrong given environment, power and operator error



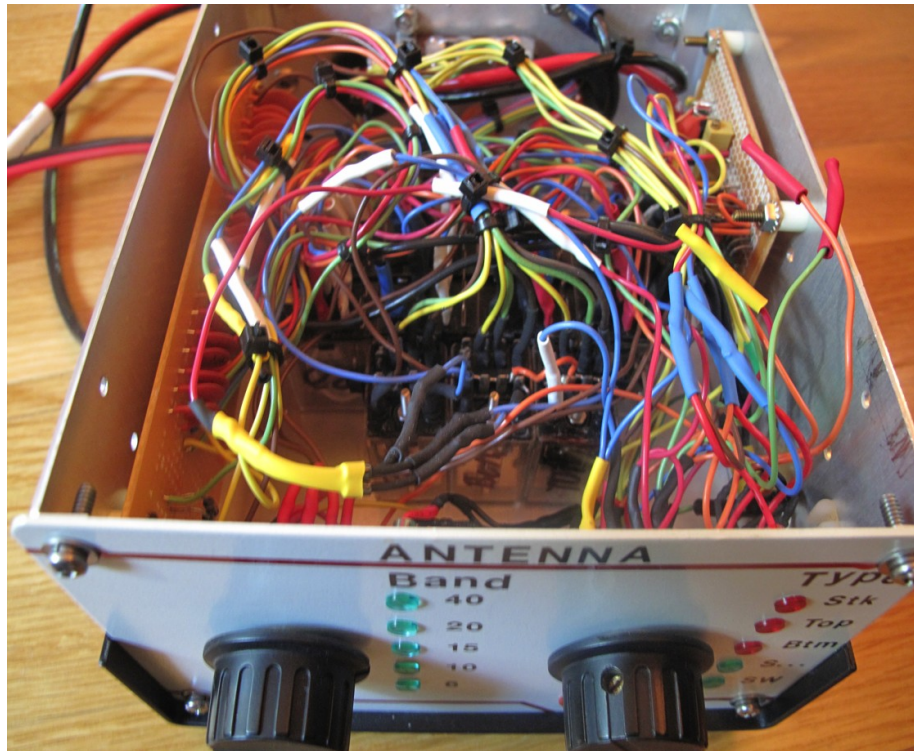
Problem with Antenna Stacking is...
Controlling the Stack !



Solution: Hamstack

New

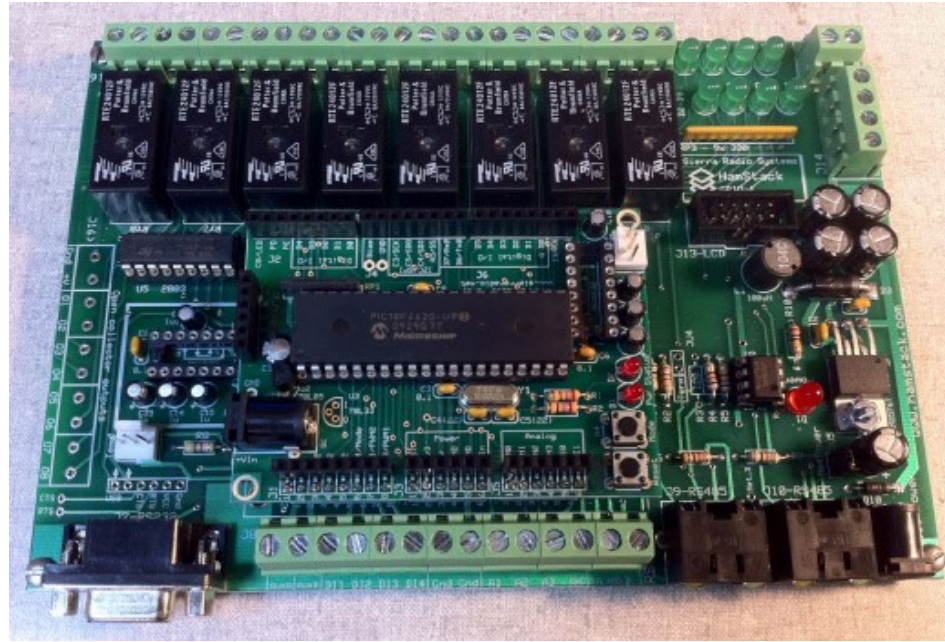
Old



System Components



- Control Head
- 12 backlit push buttons
- Green / Red / Yellow / Off
- 2x16 backlit character LCD
- Rotary encoder with button

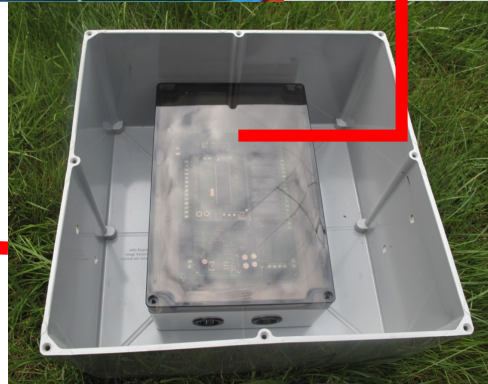


- 8 SPDT relays
- 4 Digital inputs
- 4 Analog DC voltage inputs
- Power supply

Shack Installation



**CAT5 Cable
Data & Power**



Tower Installation



Hardwired to Networked to Wireless

Control Point

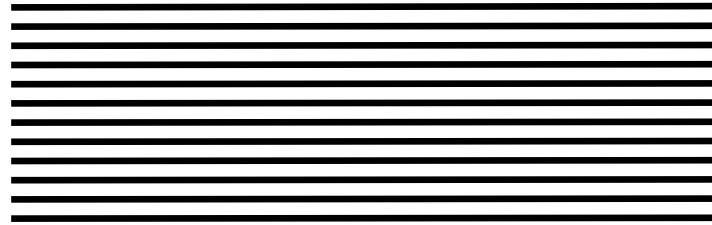
Communication Channel

Remote Device

*Hard wired
point to point*



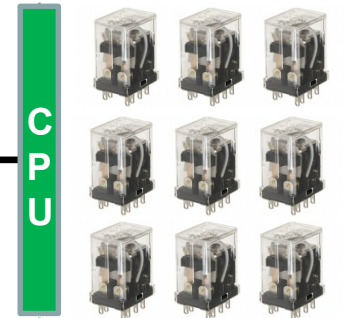
Many individual wires



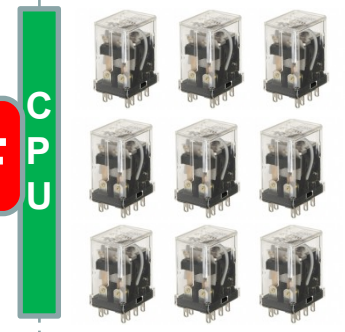
*CAT5
Network
cable*



CAT5 Cable



*Wireless
Network*



Projects

1. Remote antenna control box
2. **CW keyboard**
3. Audio mixer and SO2R controller
4. iPhone app for control and monitoring
5. Digital compass
6. Electronic keyer

HamStack CW/PSK Keyboard Project

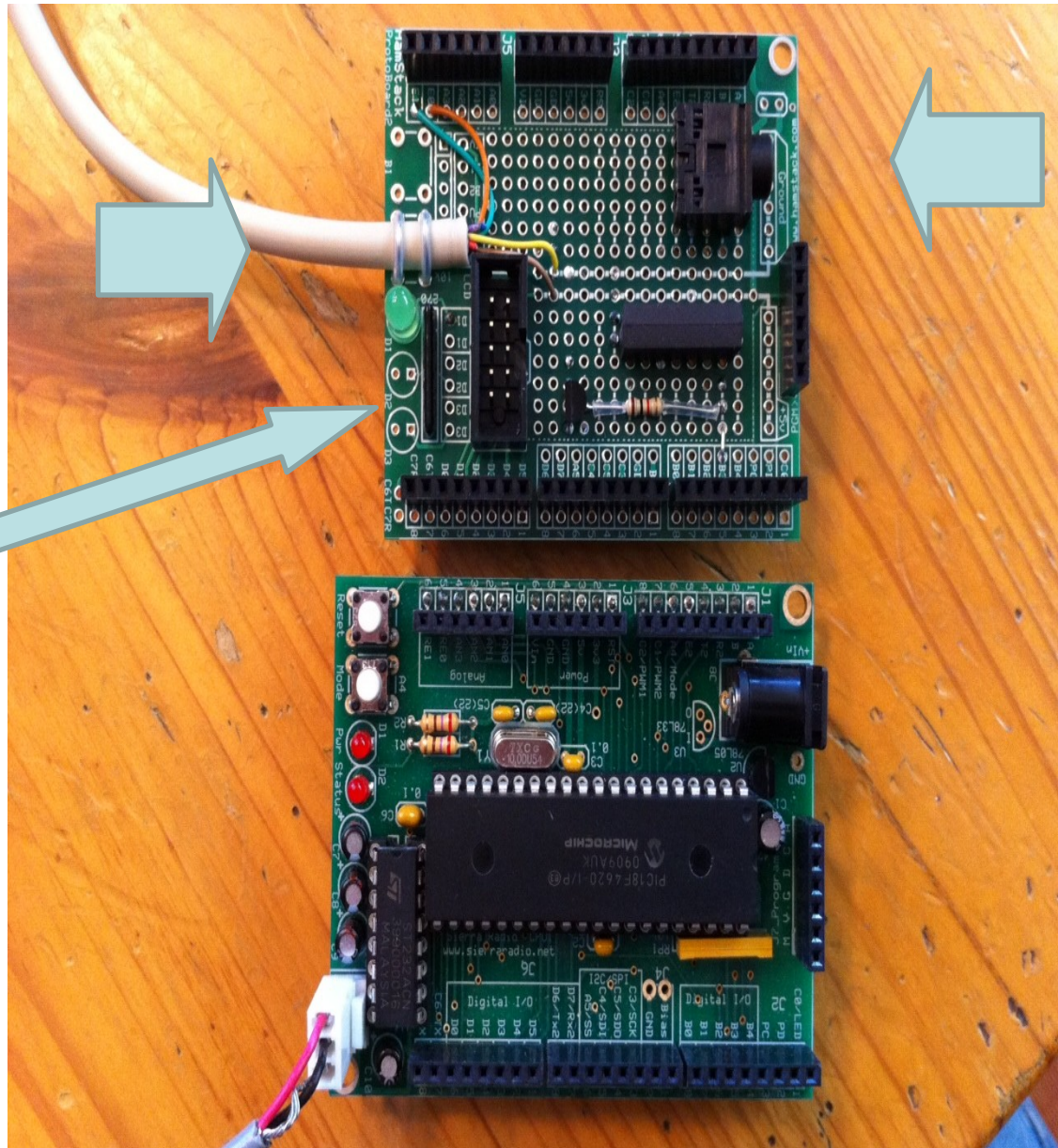
Goals

- Operate an Elecraft KX3 radio in the field on PSK and CW without a computer or CW paddle

Approach

- Build an interface
 - PS2 keyboard input
 - Serial data output to radio
 - Straight key output to radio
 - LCD status display
- Write some firmware
 - Convert keyboard input to CW or PSK commands
 - Keyboard macros (brag tapes AND radio control commands)
 - Sending speed up/down

Interface Prototype and CPU Boards



PS2 keyboard
cable
Connections:
clock, data, +5v,
gnd

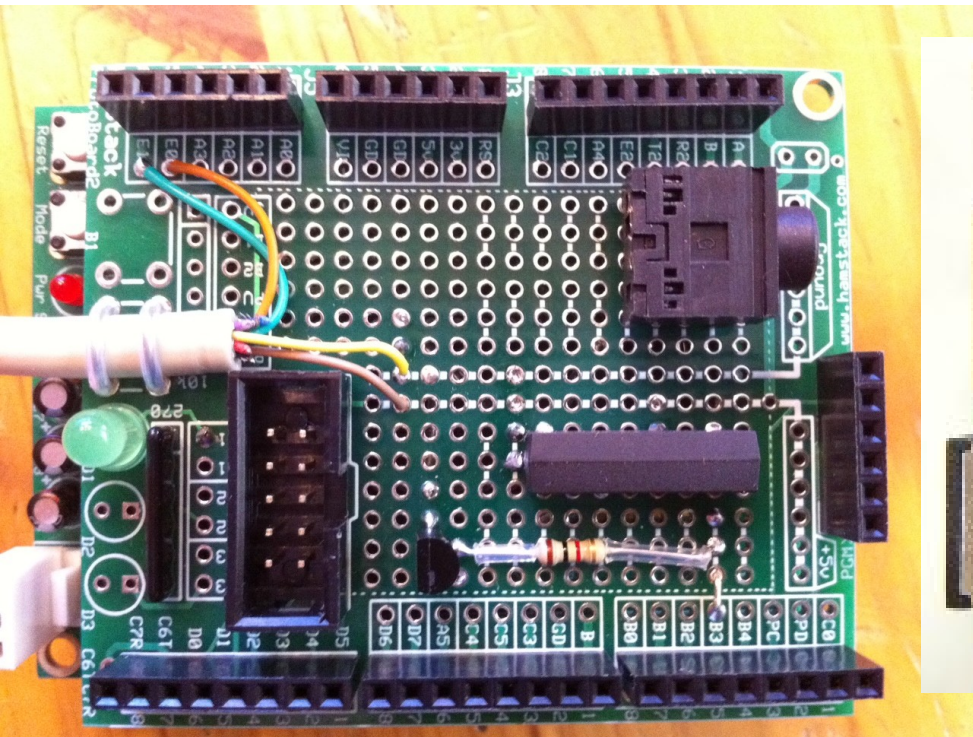
LCD jack

Keyed
output

Code practice
oscillator used
as a virtual
transmitter for
testing the CW
keyboard



From Prototype to Production PCB



Status



- Article by David Witkowski W6DTW
- June 2012 CQ Magazine
- Multi-IO PCB Kit available
 - PS2 keyboard input
 - 10 pin LCD connector
 - SPST reed relay
 - 3.5mm key out jack
 - DB9 for RS232
- Open source software download



Projects

1. Remote antenna control box
2. CW keyboard
3. **Audio mixer and SO2R controller**
4. iPhone app for control and monitoring
5. Digital compass
6. Electronic keyer

Problem



Solution



Well, Not Really



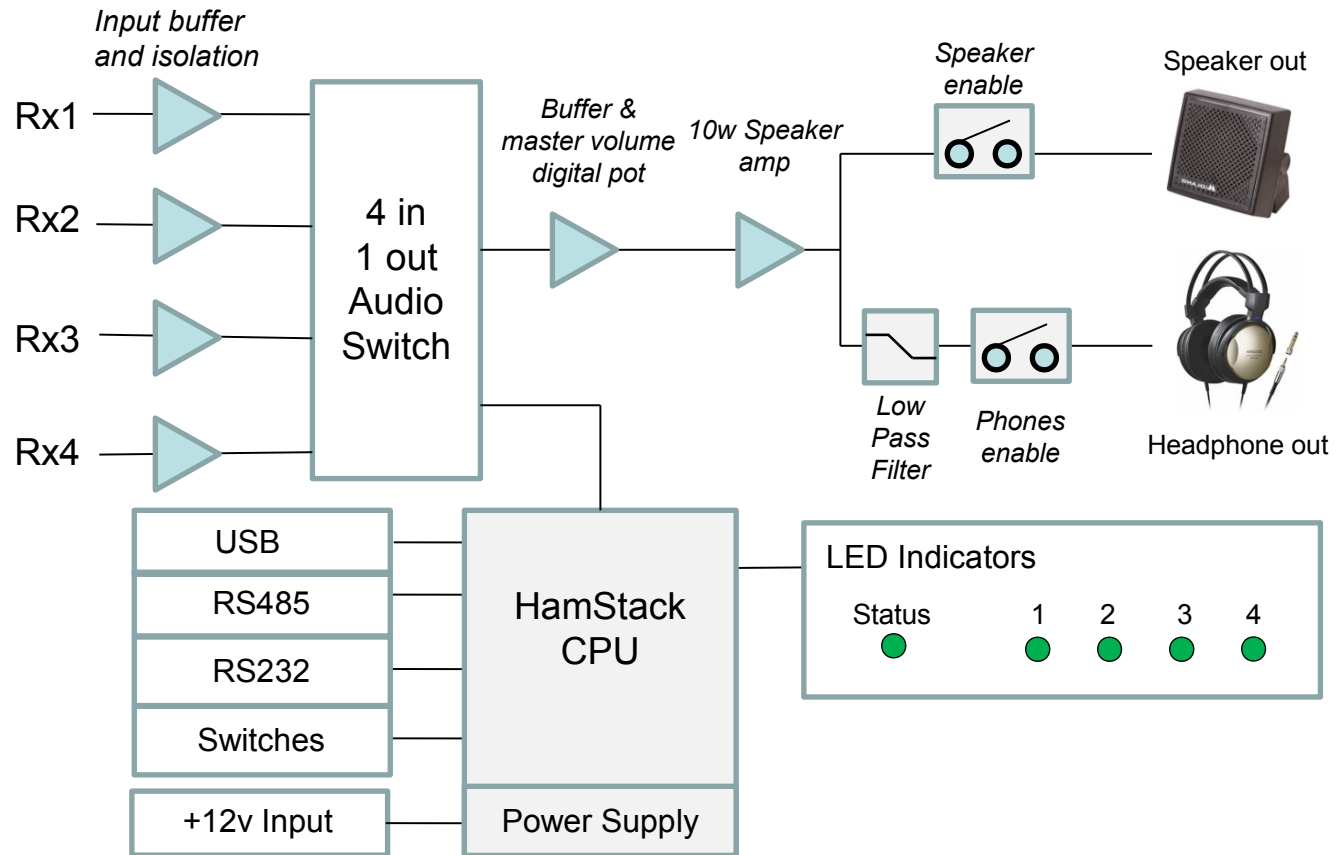
I got it !



I need a box with...

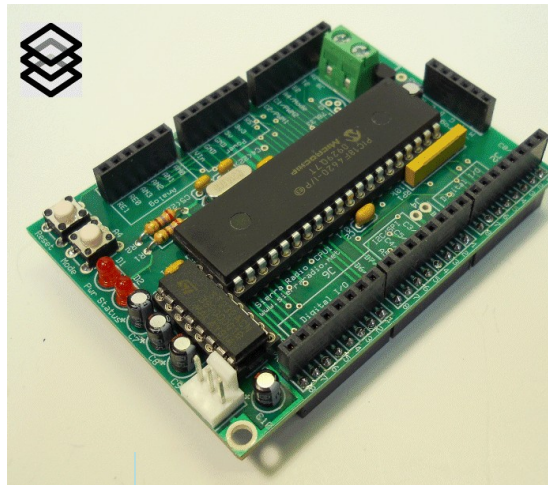
- Speaker level input
- DC isolation to avoid ground loops
- Enable each channel individually
- Active audio mixing to a single output channel
- Master volume setting
- Single audio amplifier output to ordinary speaker
- Headphone output with out hiss !
- Hardware or software control

RadioRouter Block Diagram



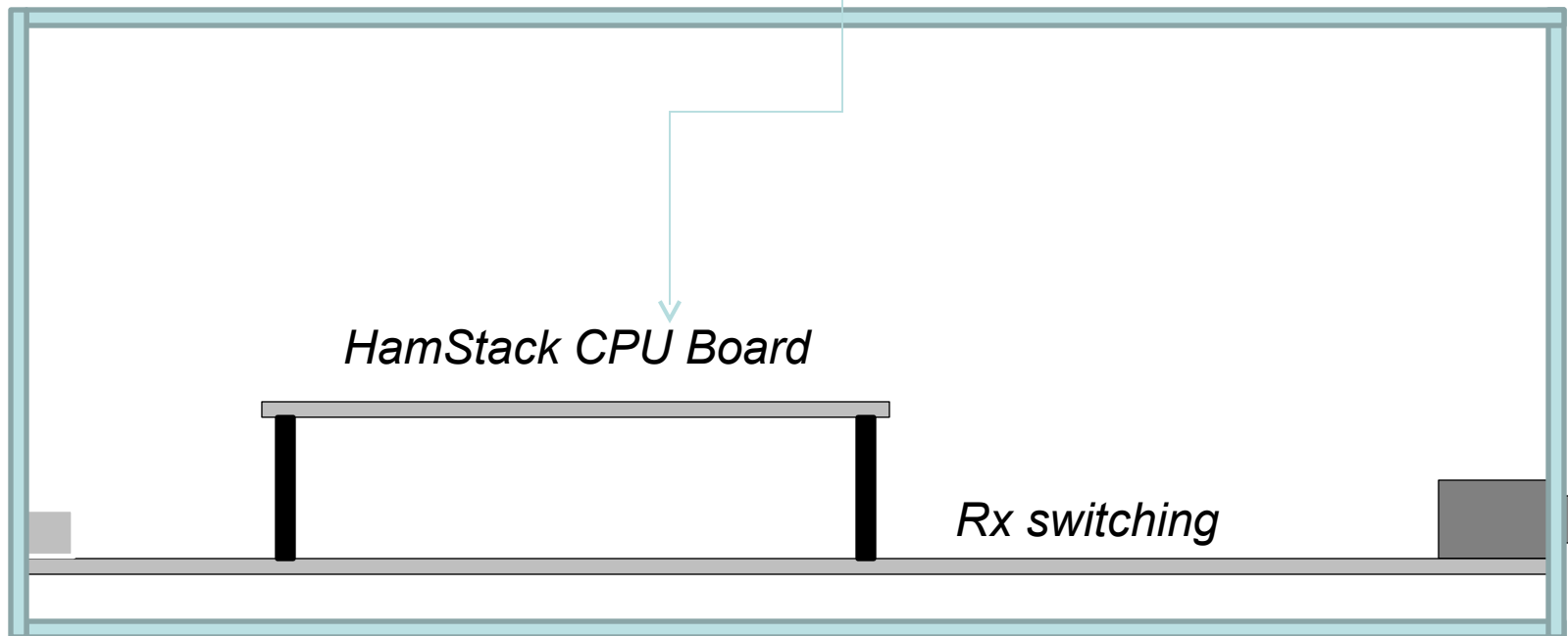


Radio Router



Front *side view*

Back



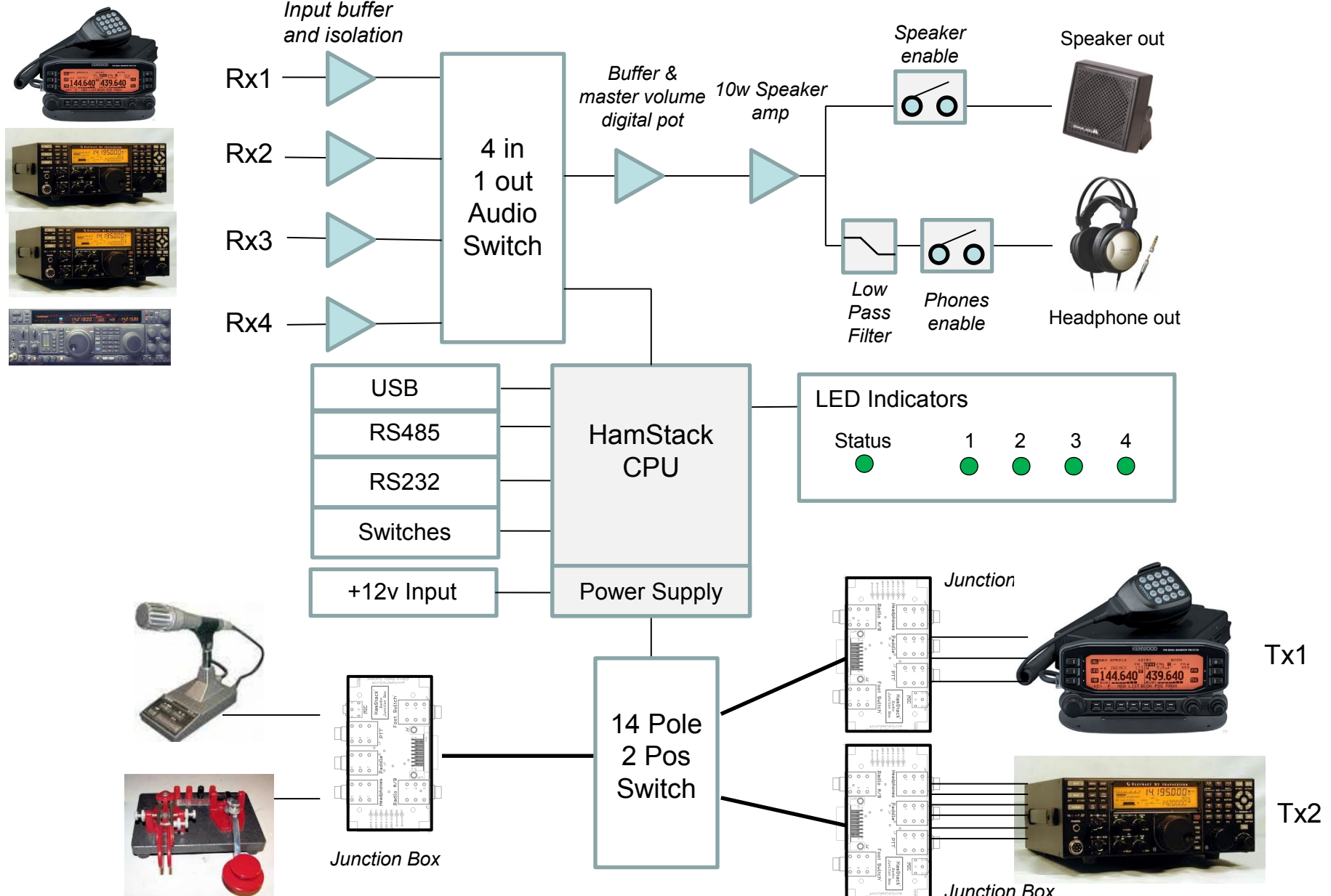
What about transmit !???!

I need a box with...

- Dry contact switching between two transmitters
- Routing mic audio, PTT, paddle input, and whatever else...
- Amp relay keying, ALC, data, etc.
- Convenient jack placement for mic & key
- Software control for SO2R



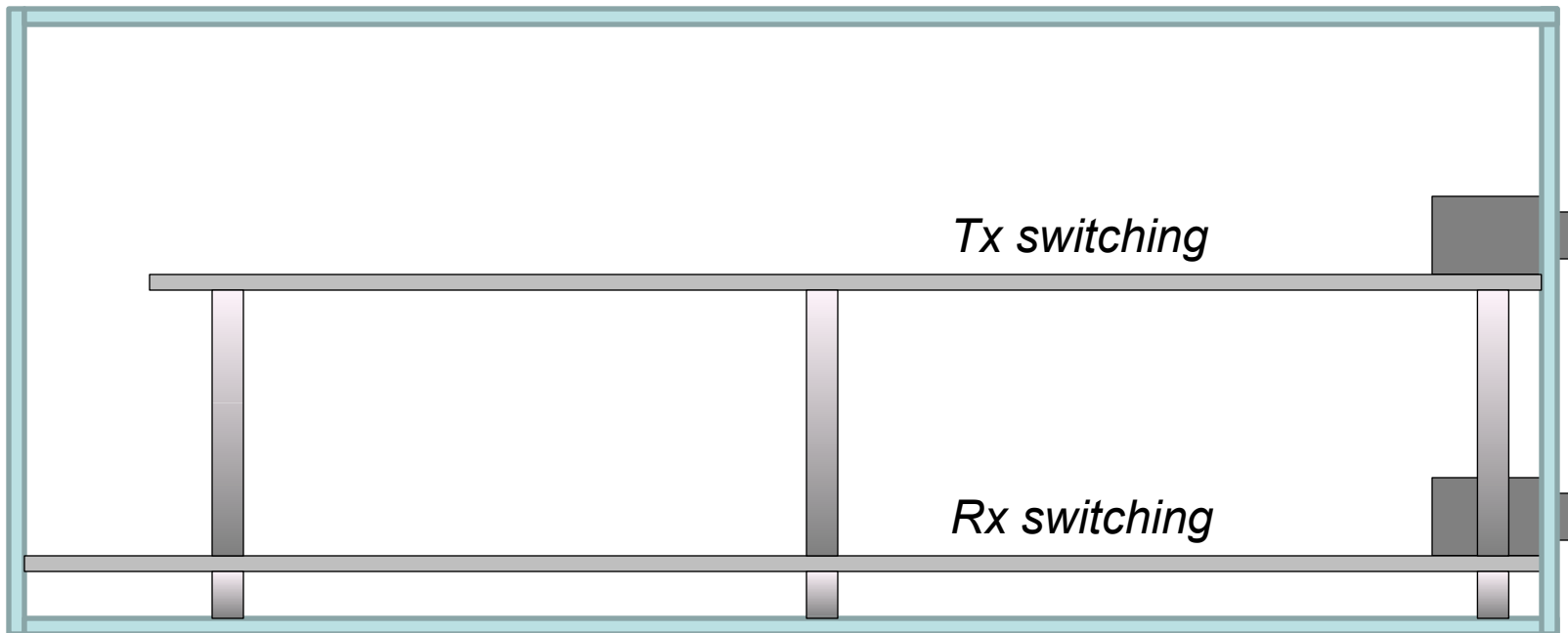
RadioRouter Block Diagram



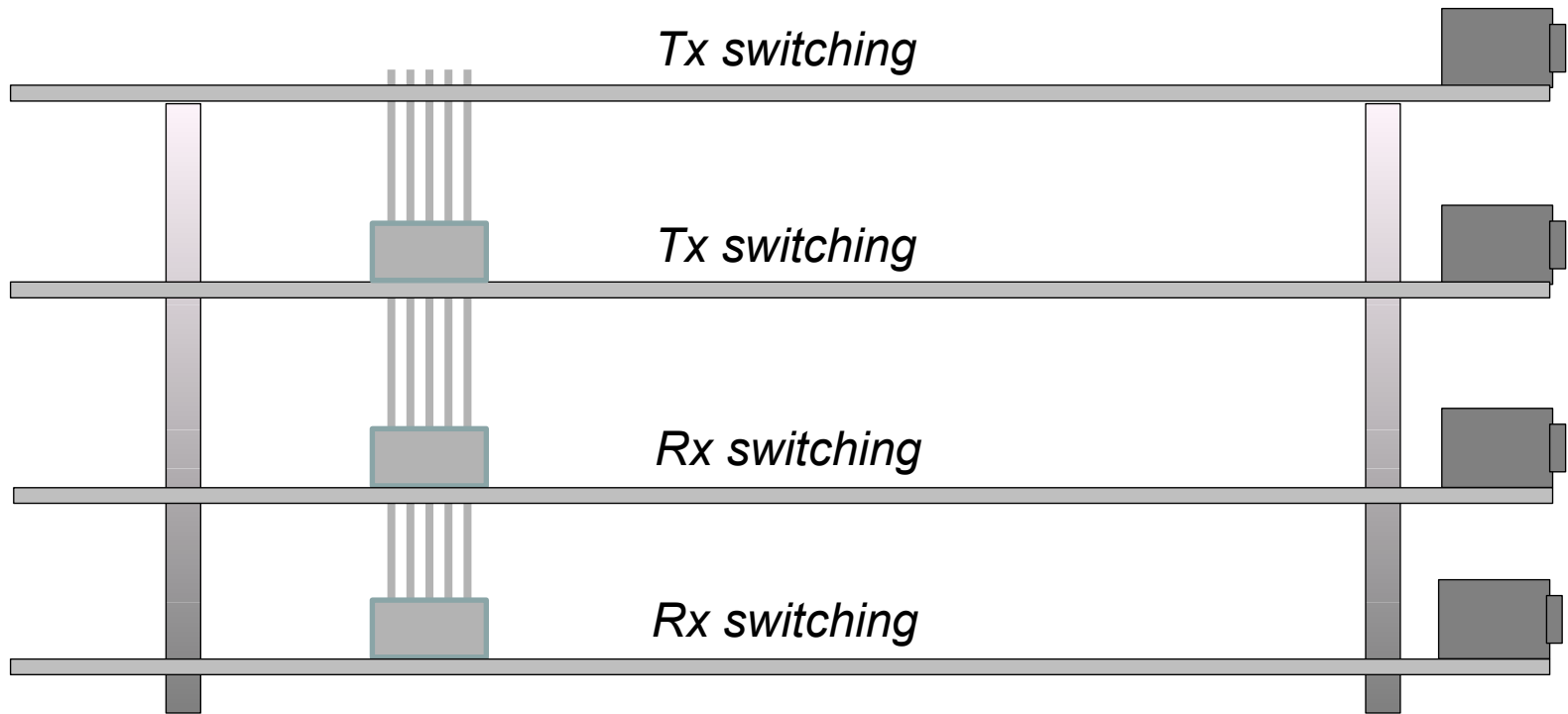
Radio Router

Front

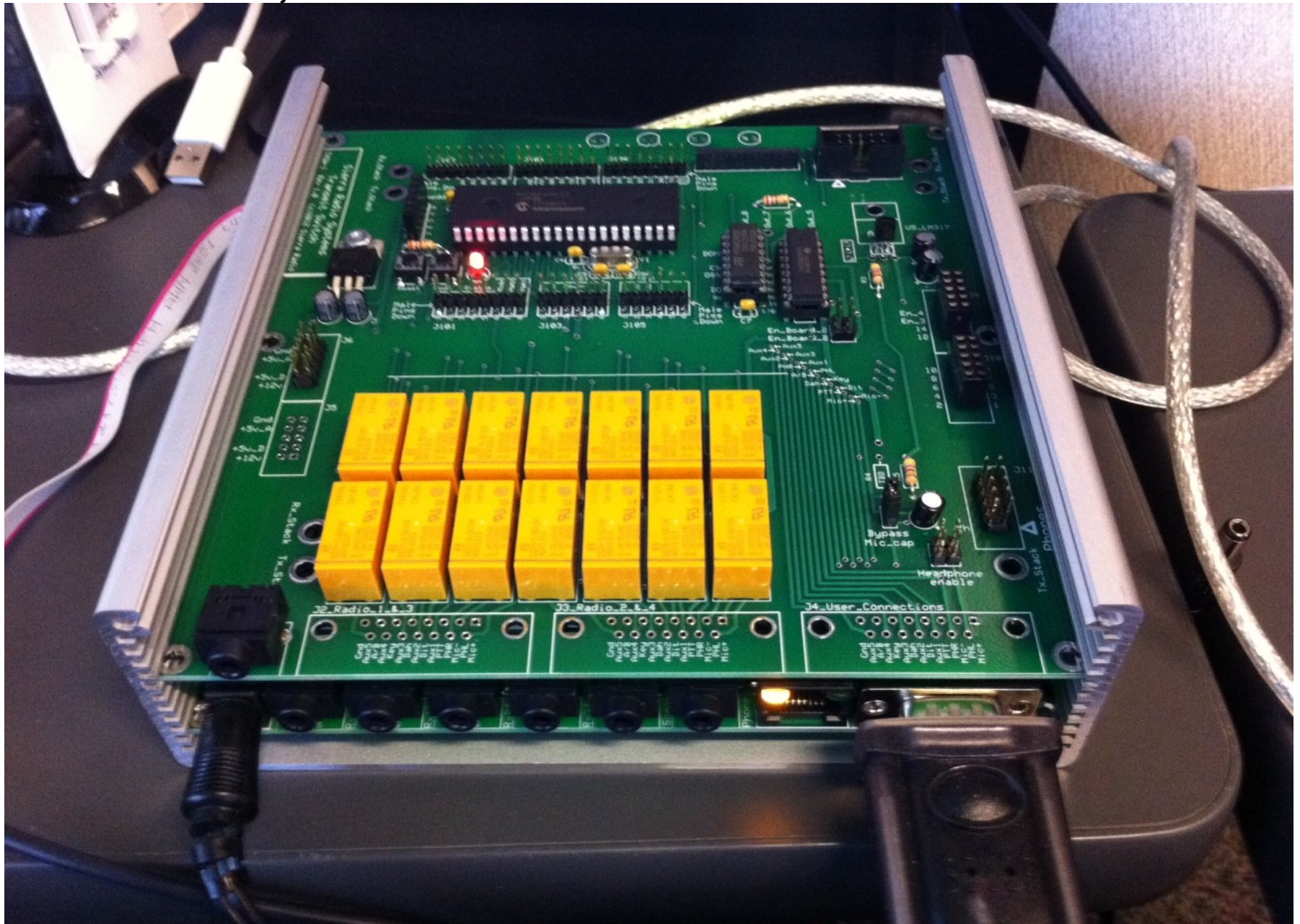
Back



Expanding to 8 Receivers AND 4 Transmitters !



“14 Pole, 2 Position Switch”

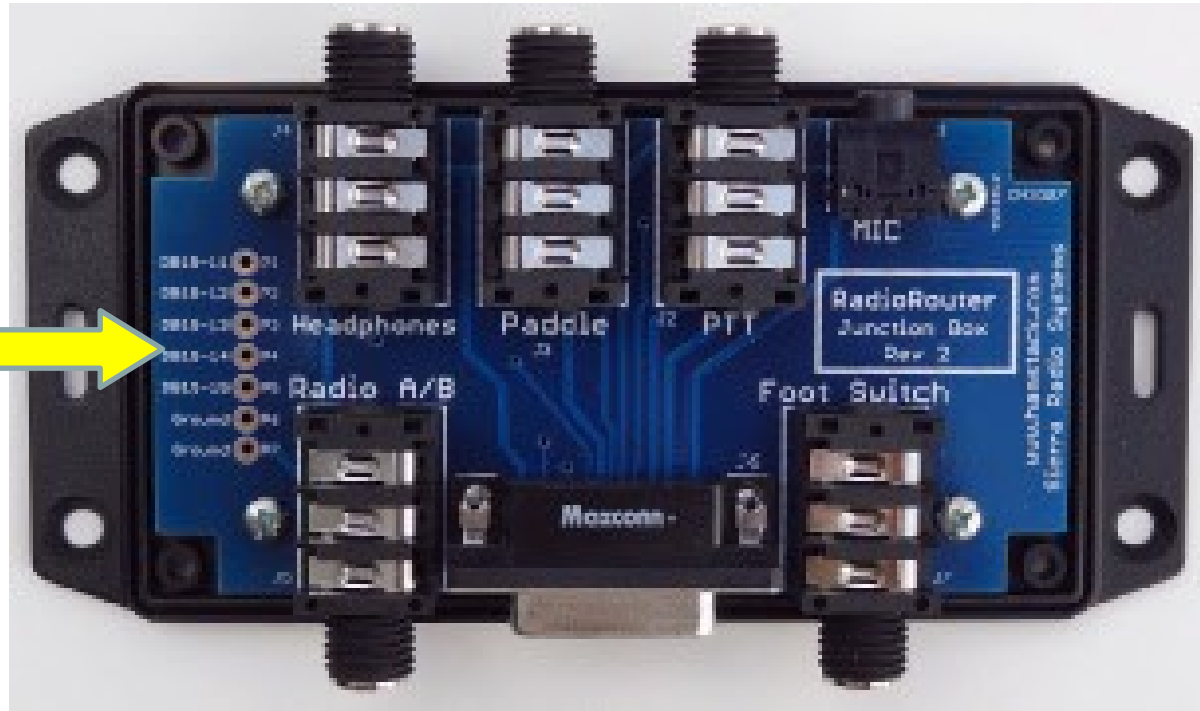


HamStack CPU Control



Tx Junction Box

Headphones Paddle PTT MIC



Radio A/B Main Cable Foot Switch

RadioRouter



User Interface Options

Masters

Mechanical
Switches

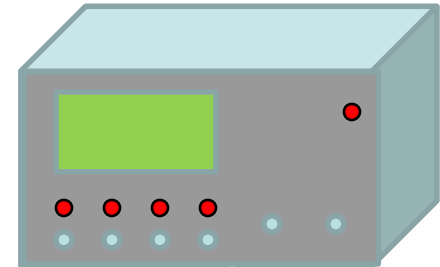


Software
“Station Control Panel”



USB
RS232

Hardware
Control Head



USB
RS232
RS485

Slave Devices



Radio Router

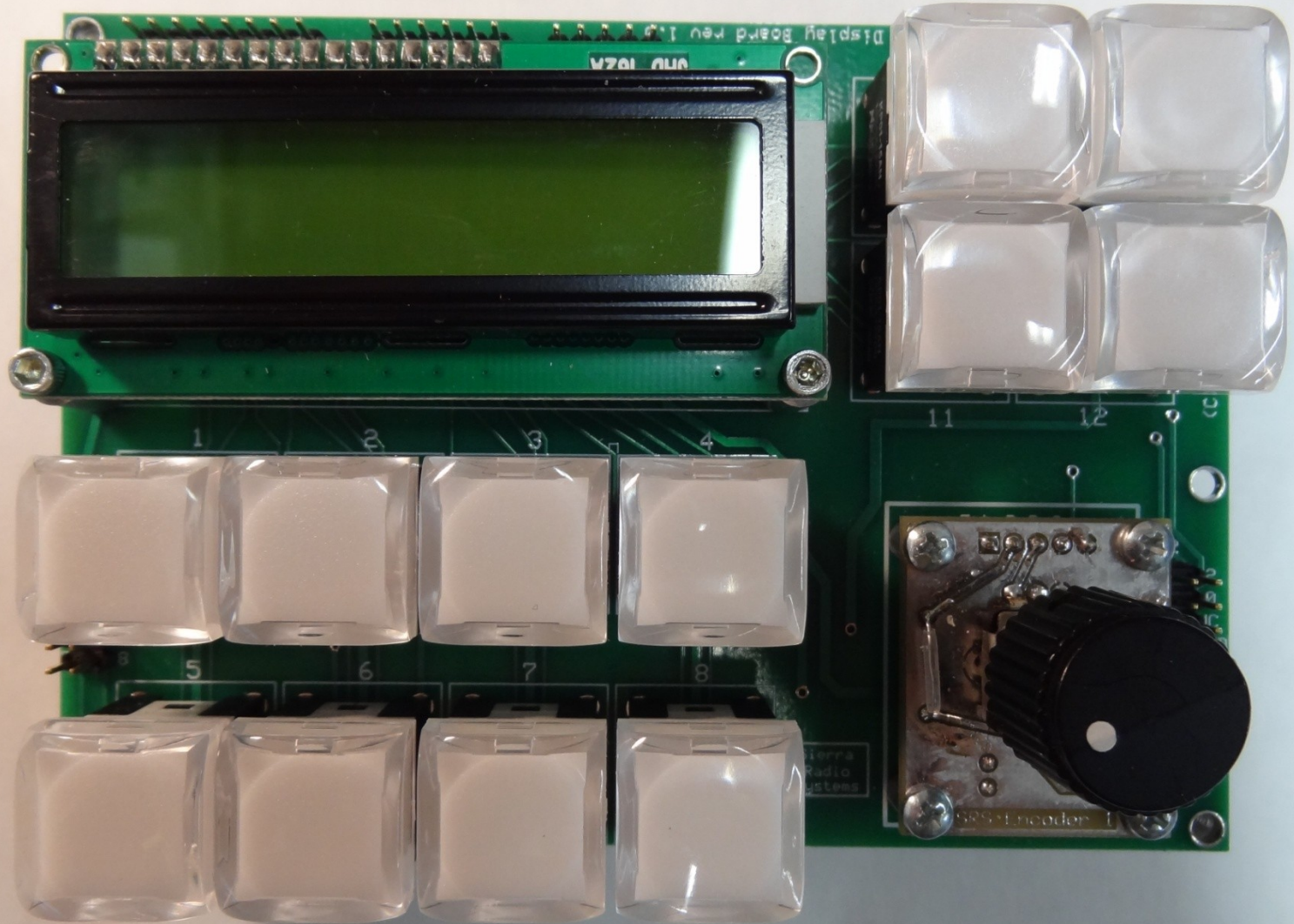


Radio Router



Radio Router

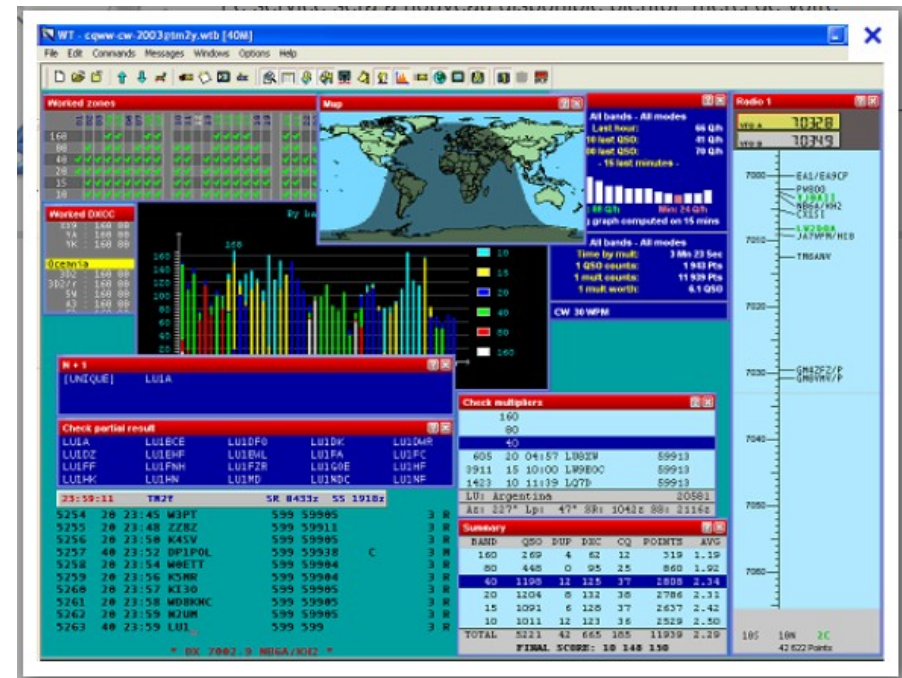
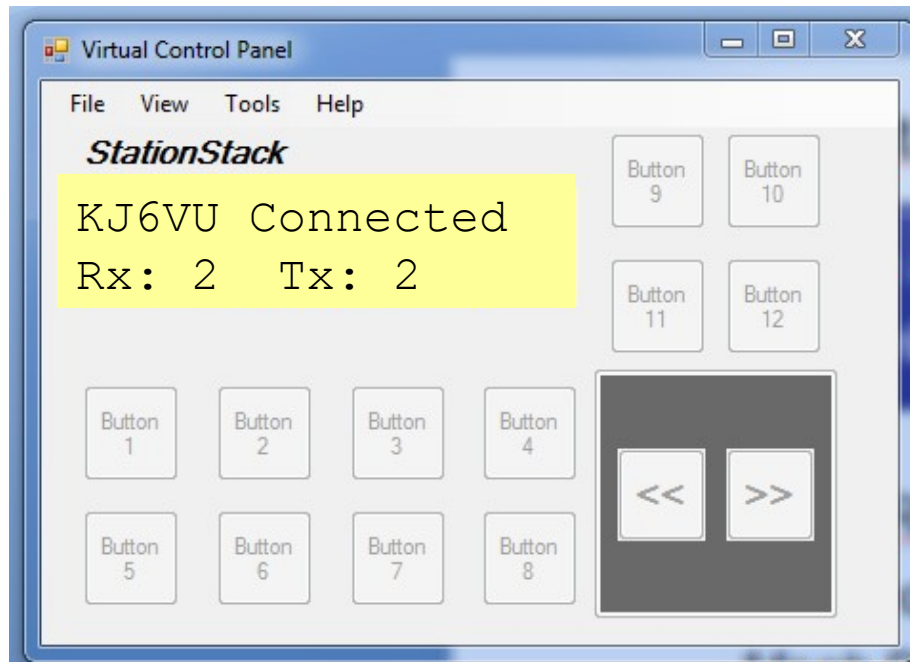
Hardware Control Head



Control By Software

Sierra Radio Control Program

Contesting Programs



Supports OTRSP
Open Two Radio Serial Protocol

Software Control

Standard commands

- MIX,11010010
- VOL,95
- PING
- SETADDR
- HELP
- STATUS

Addressing

- Direct //PING
- Network addressed
/A01:PING:83

SO2R commands

Receiver select

- RX1, RX2, RX3, RX4
- RX1S, RX1R, RX2S, RX2R

Transmitter select

- TX1, TX2, TX3, TX4

Query

- ?RX, ?TX, ?FW

Works with popular logging programs
that support OTRSP protocol
WinTest, N1MM, WriteLog, etc

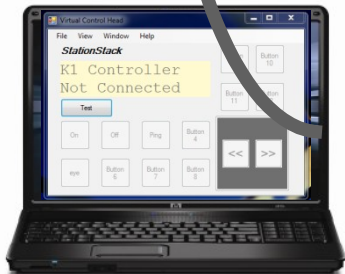
Projects

1. Remote antenna control box
2. CW keyboard
3. Audio mixer and SO2R controller
4. **iPhone app for control and monitoring**
5. Digital compass
6. Electronic keyer

Station Controller

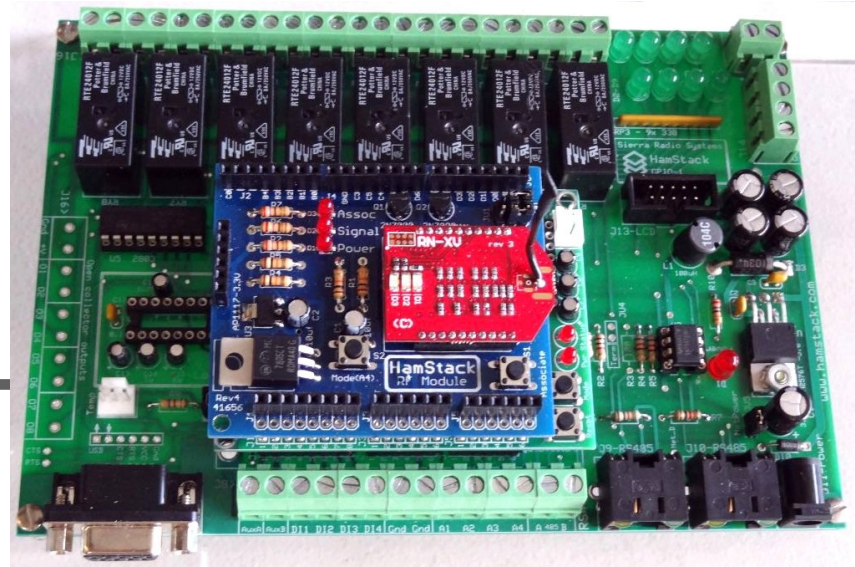


HamLog
iPhone App



PC Program

AdHoc or
Internet

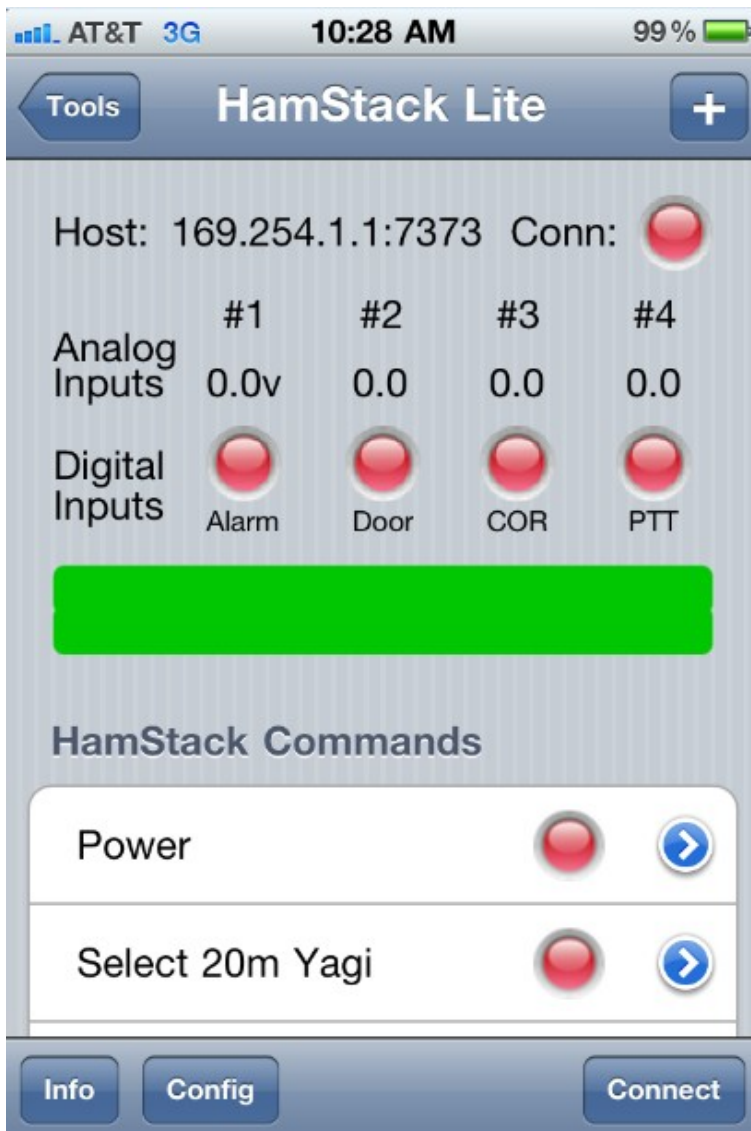


Ethernet
or WiFi
Board

GPIO Board
w/ Station Control Firmware

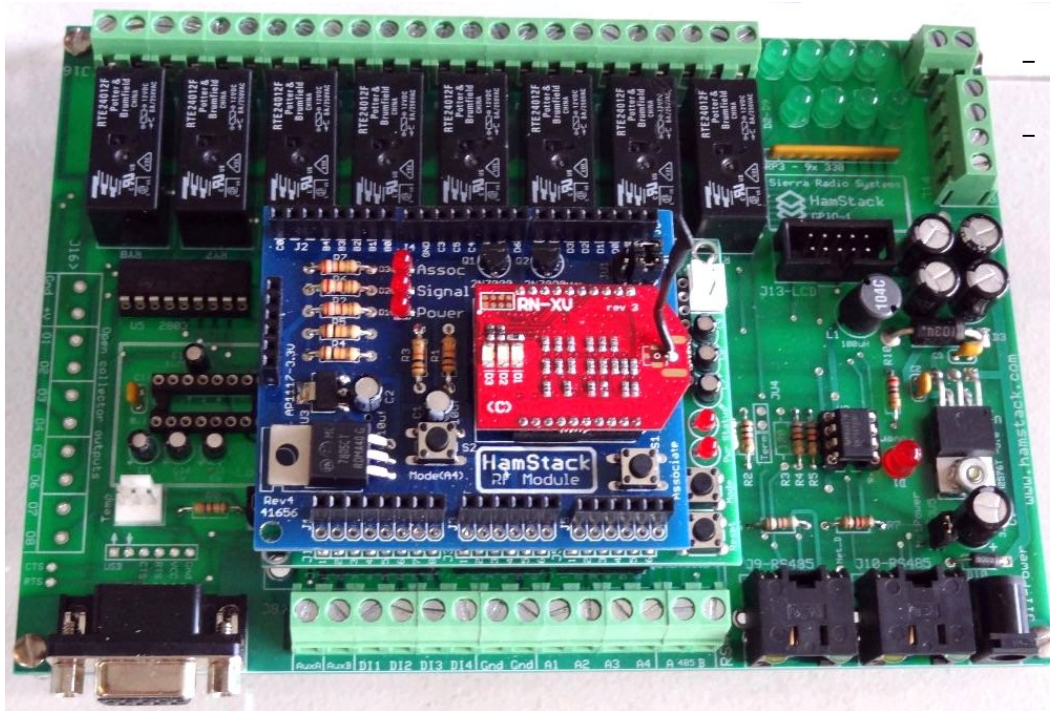
- *Station power*
- *Antenna selection*
- *Power supply voltage*
- *Rotor control*
- *Etc...*

HamStack Lite iPhone Station Controller App



- Feature of HamLog by N3WG
- Available now
- Displays GPIO board status
 - 4 Analog voltage inputs
 - 4 Digital logic inputs
 - 2 Line status text field
 - 8 Command string buttons
 - Optional LED status for pushbuttons

Station Controller Pack

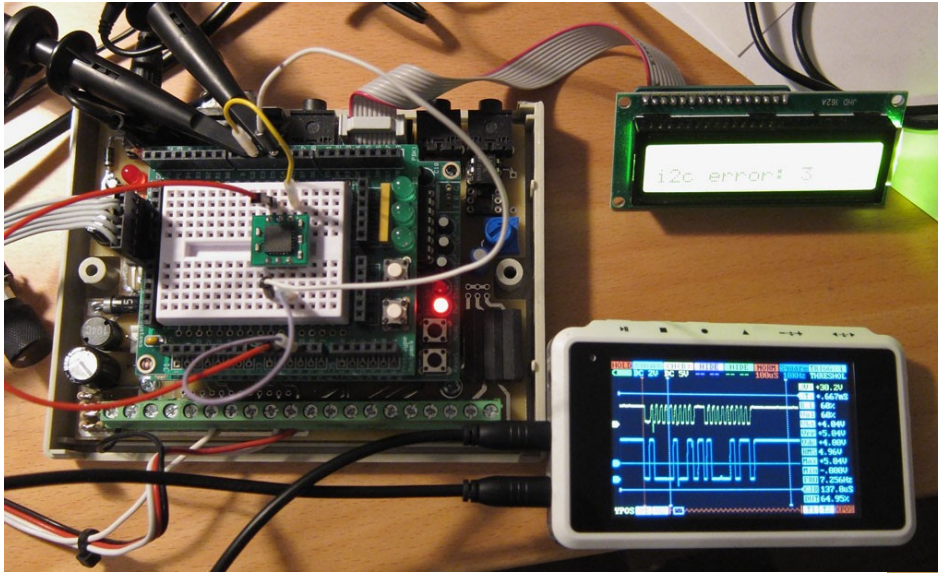


- WiFi radio module
- CPU board
- GPIO board
 - 8 SPDT relays
 - Up to 8 amps
 - LED indicators
 - 4 Digital inputs
 - 4 Analog DC voltage inputs
 - Serial control RS232 or RS485
 - LCD display
 - 5v DC switching power supply
 - Runs cool and quiet

Projects

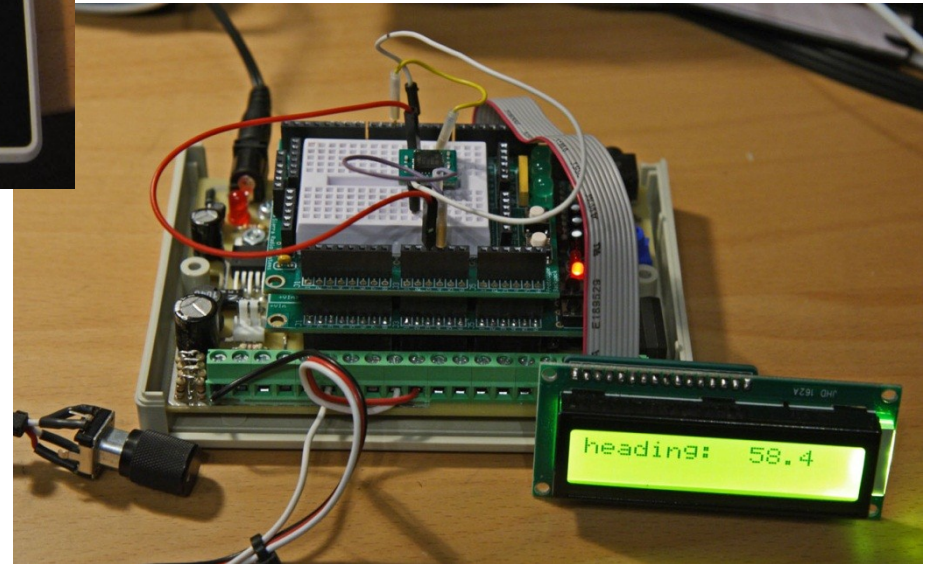
1. Remote antenna control box
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5. **Digital compass**
6. Electronic keyer

Digital Compass on the Bench

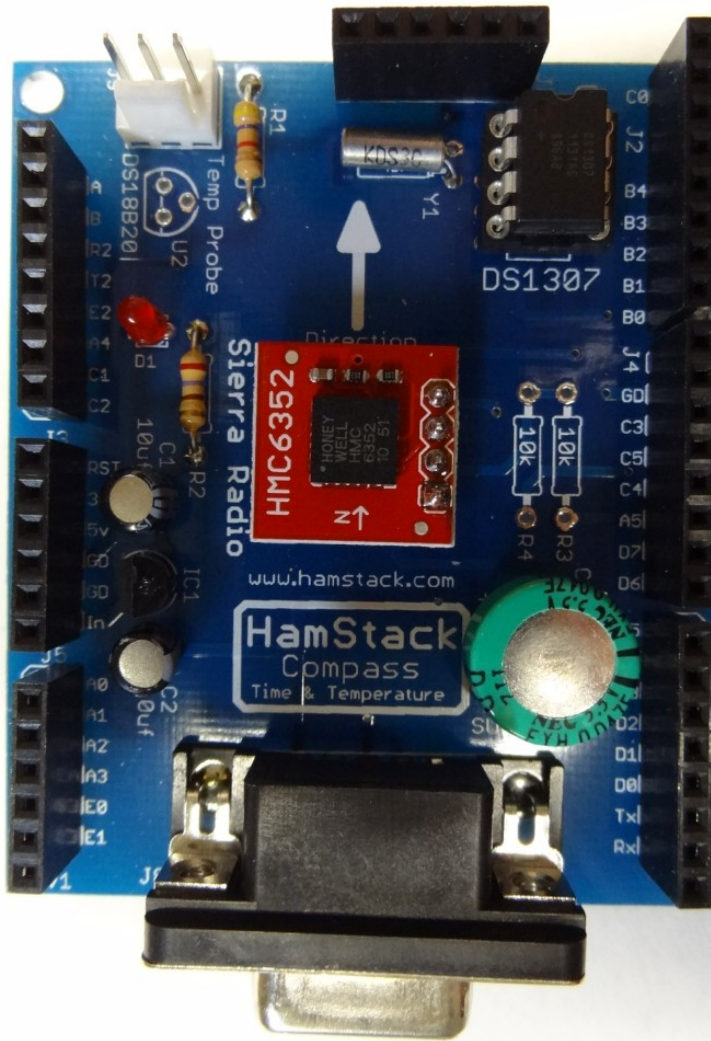


Testing the I2C serial interface

Working compass shows direction of the magnetometer chip



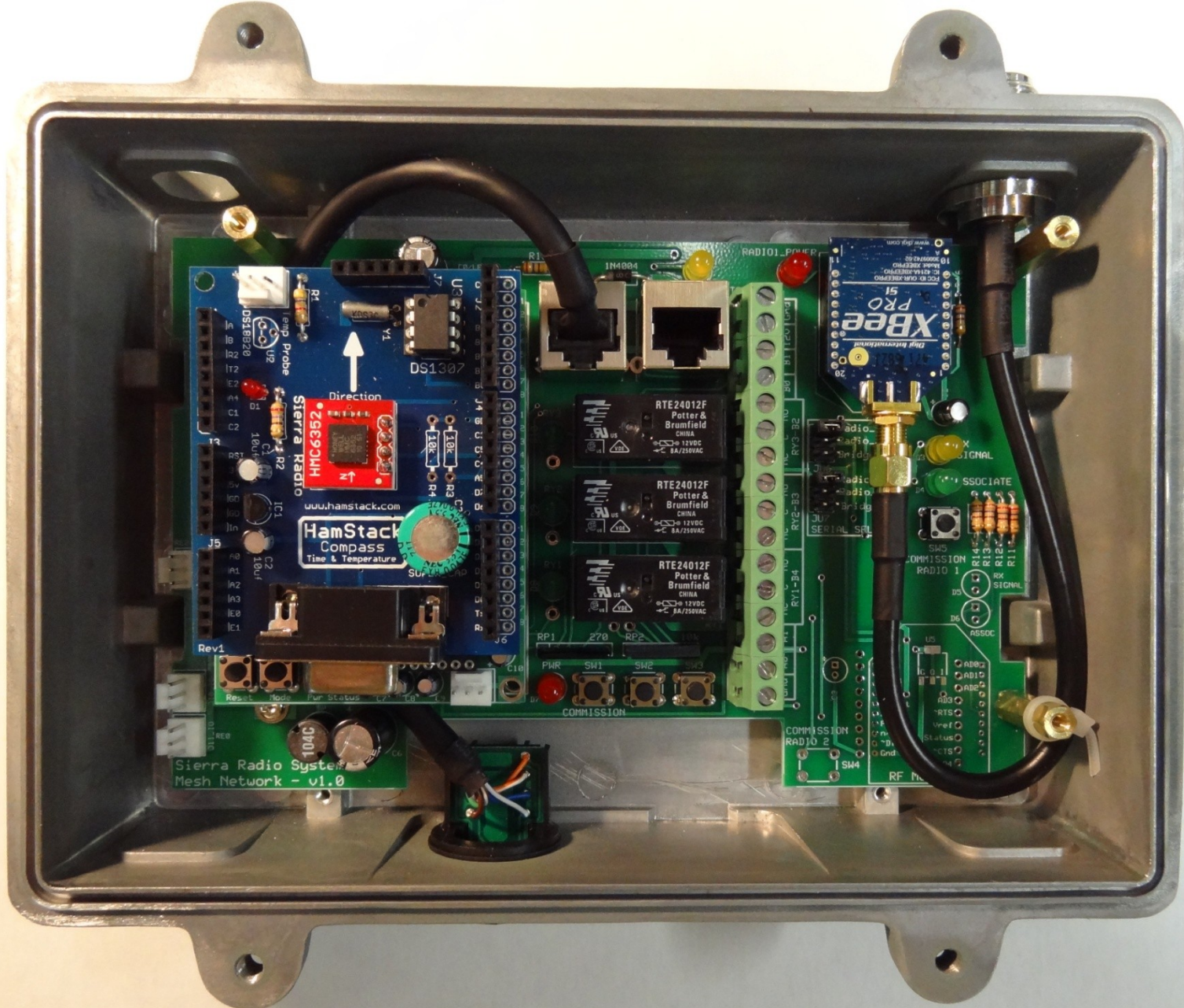
2 Axis Magnetometer - *AKA*: Digital Compass



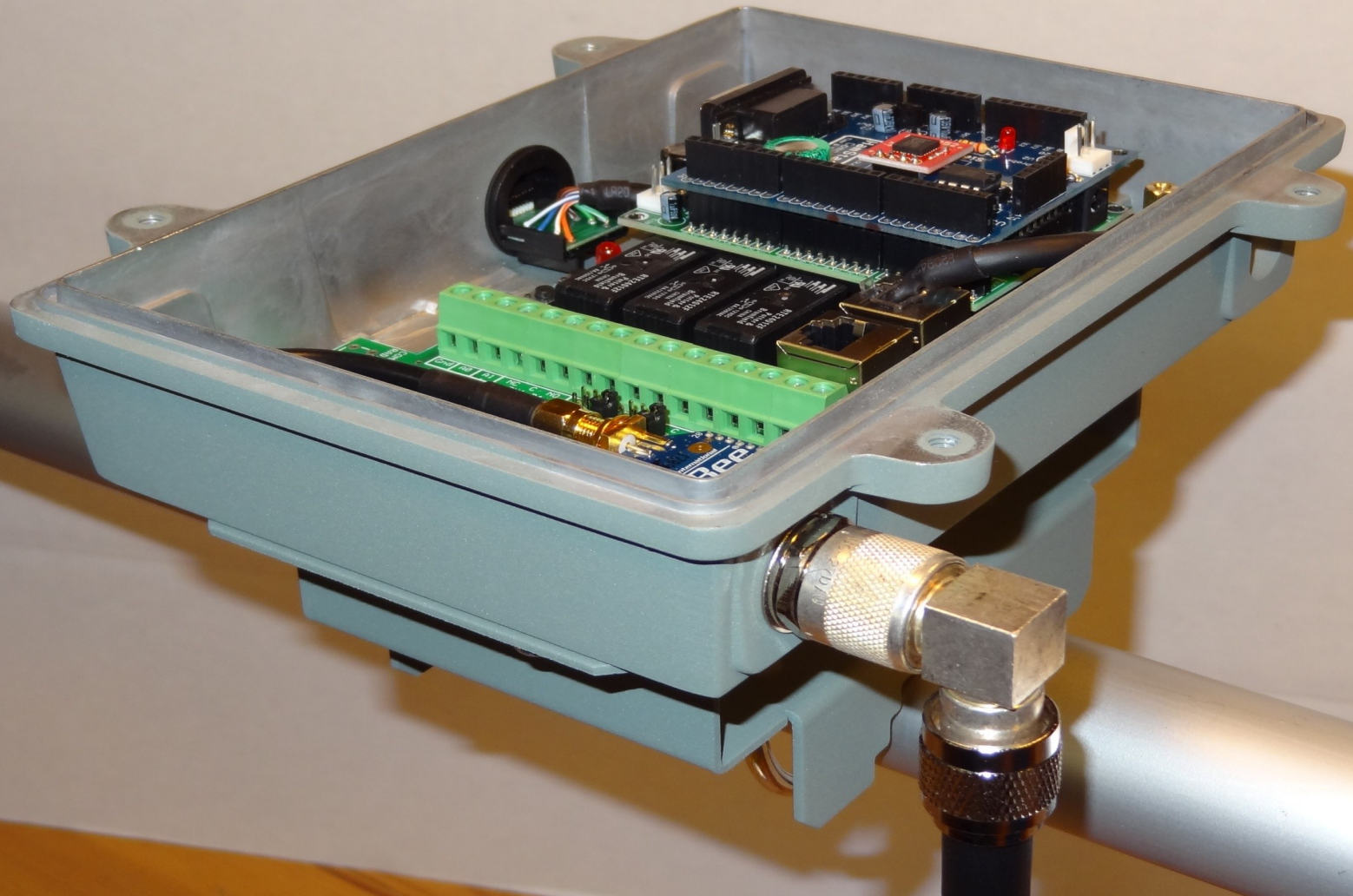
- Accurate to 2 degrees
- Built-in CPU
generates compass heading
- Communicates with HamStack
via I2C interface
- Optional DB9 for RS232
- Real time clock / calendar chip
- DS18B20 temperature chip
- 3 pin temperature probe jack

Rugged Outdoor Network Chassis

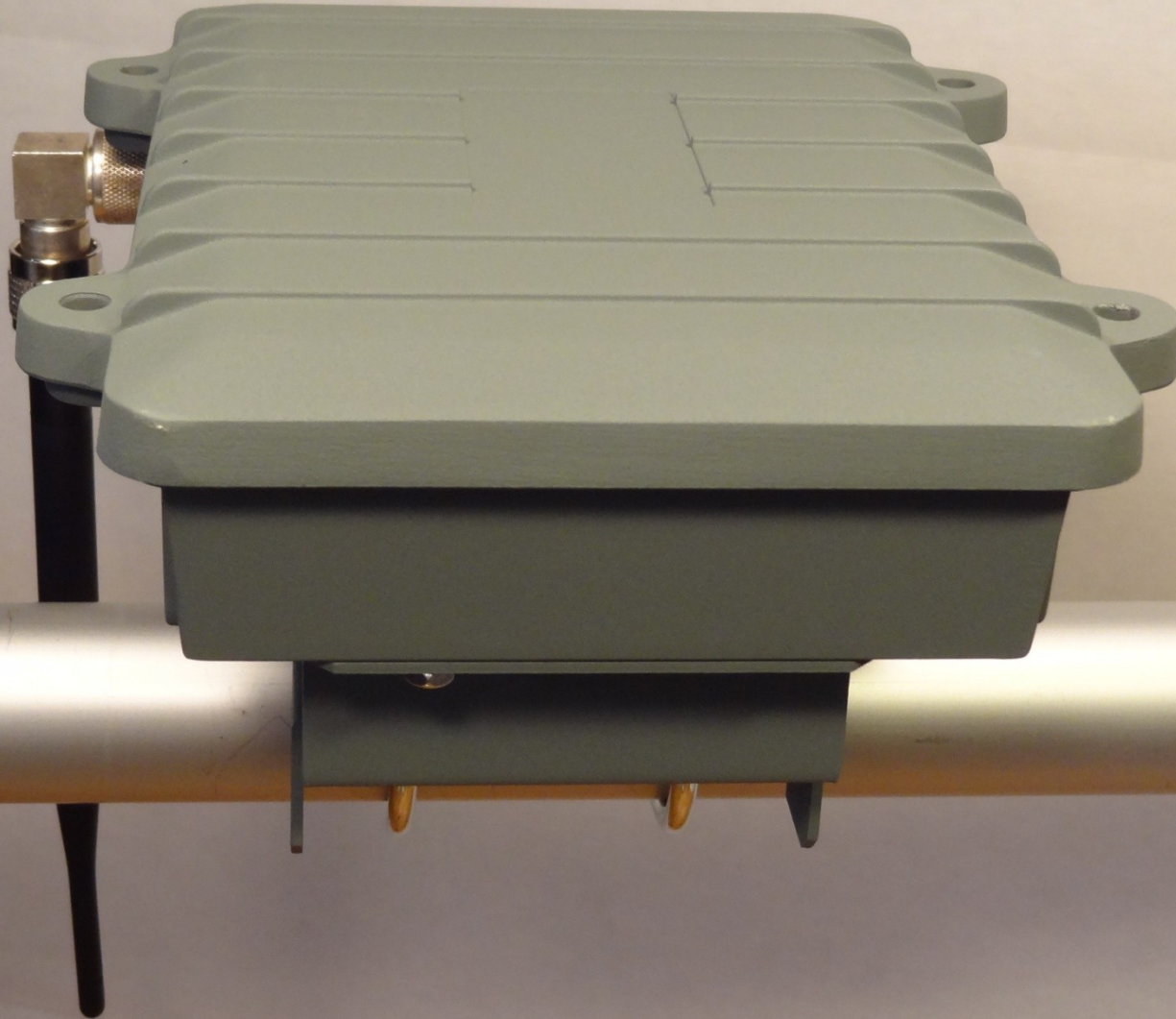




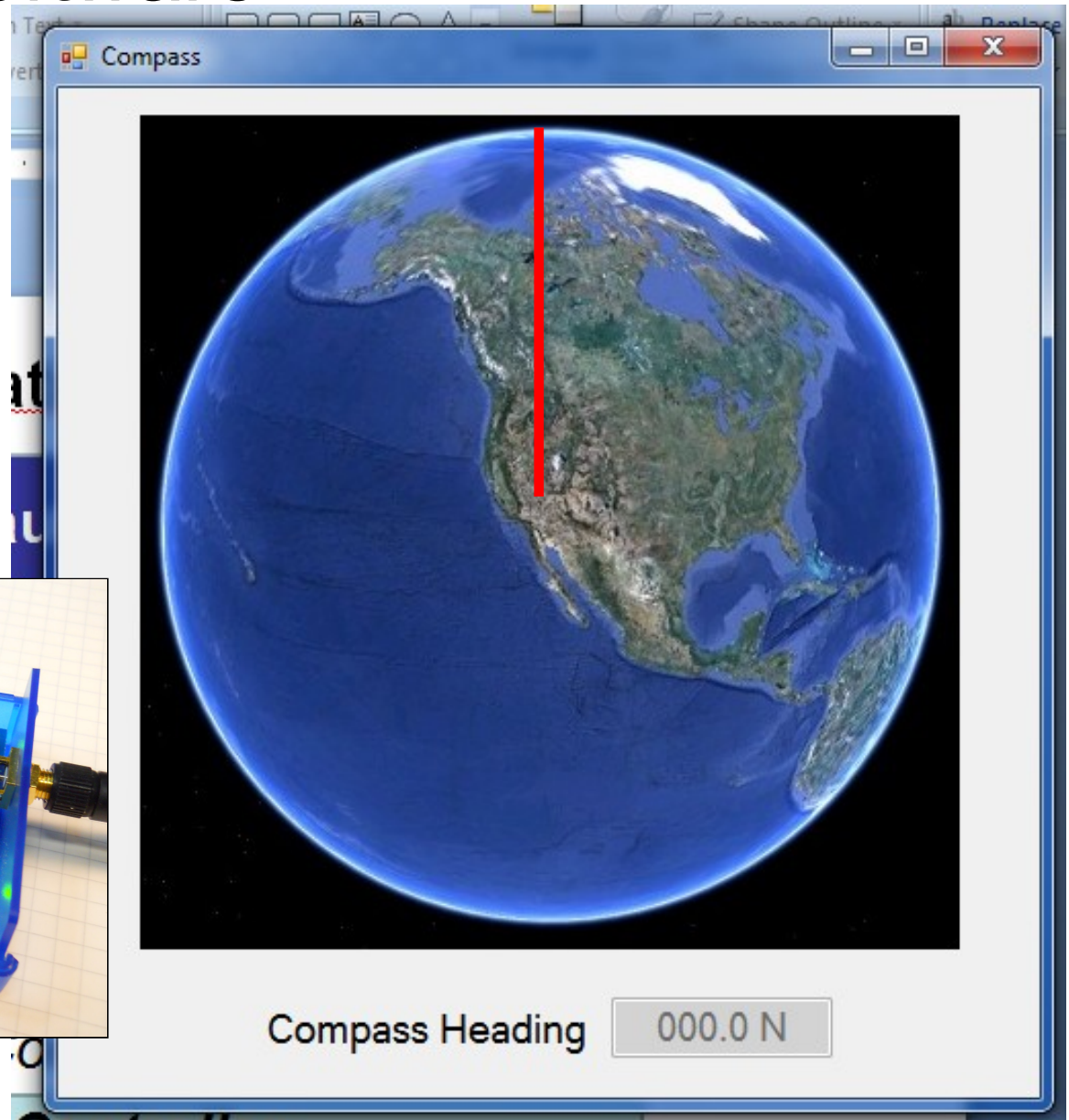
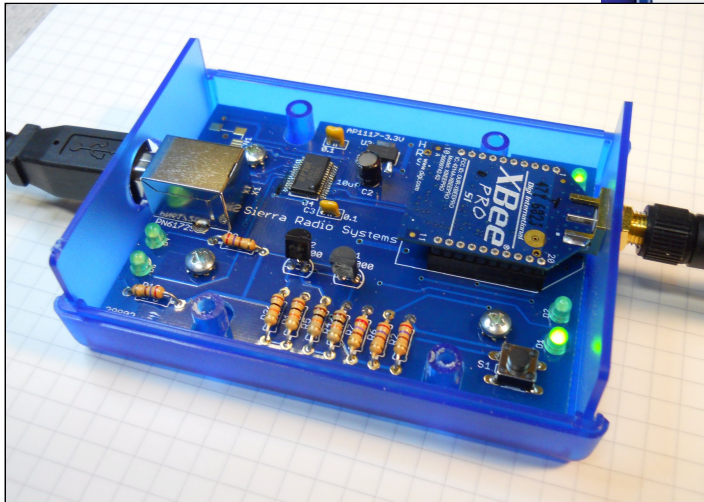
Boom Mounted Digital Compass



Boom Mounted Digital Compass



Compass Software



Projects

1. Remote antenna control box
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5. Digital compass
6. **Electronic keyer**

Implementing a CW Keyer Using the HamStack

John Best, KJ6K



Goal: Demonstrate the Advanced Programming Techniques for a common ham radio application

Features

- Tone output to speaker
- Opto-isolated output to key modern or boat-anchor tube radio
- LCD display of code speed with instant control
- Single encoder control to set keyer mode, left/right handed, weight, tone frequency
- Remembers last state after power off



Packaging



Front panel

- 2 line x 16 character LCD
- Backlit
- Rotary encoder
- With push button



Rear view

- RCA key out – opto-isolated
- Tone / speaker out
- Paddle input
- DB9 for RS232
- Power 6-14 VDC

HamStack C Library

Interrupt driven functions

Timers

- Seconds since startup
- Millisecond, 0.1 second, second countdown timers
- User written 1 ms interval function

Tone generation

Up to 4 sine or square wave tones

CW generation

DTMF string generation

Serial port transmit and receive

Shaft encoder

Non-Interrupt functions

Read / write EEPROM data memory

2C interface

- External serial EEPROM read/write
- Honeywell magnetic compass

One-wire interface

- Digital temperature sensors

On-chip A/D converter

PWM voltage output

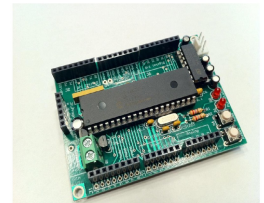
Shift register i/o

LCD display

Sierra Radio Systems



Getting Started with the
HamStack
C Library



Summary

- Very powerful resource for your DIY tool kit
- Its easier than you think
- Attend ARRL DIY tutorials
Using Microcontrollers in Ham Radio Projects
- Check out projects at
www.hamstack.com

Thank You !

