



# Open HPSDR for On-Site and Remote VHF and Up Operations

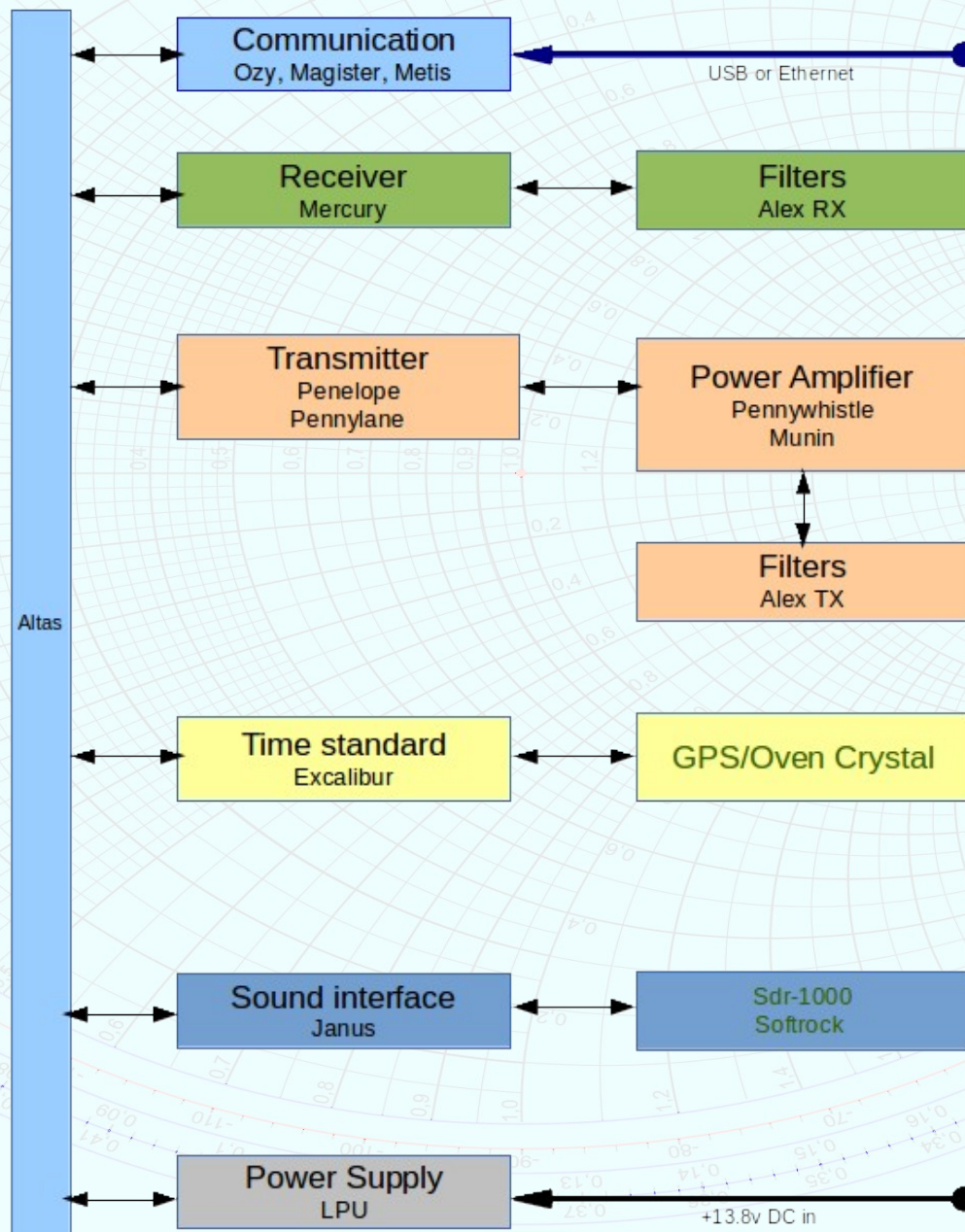
Roger Rehr W3SZ

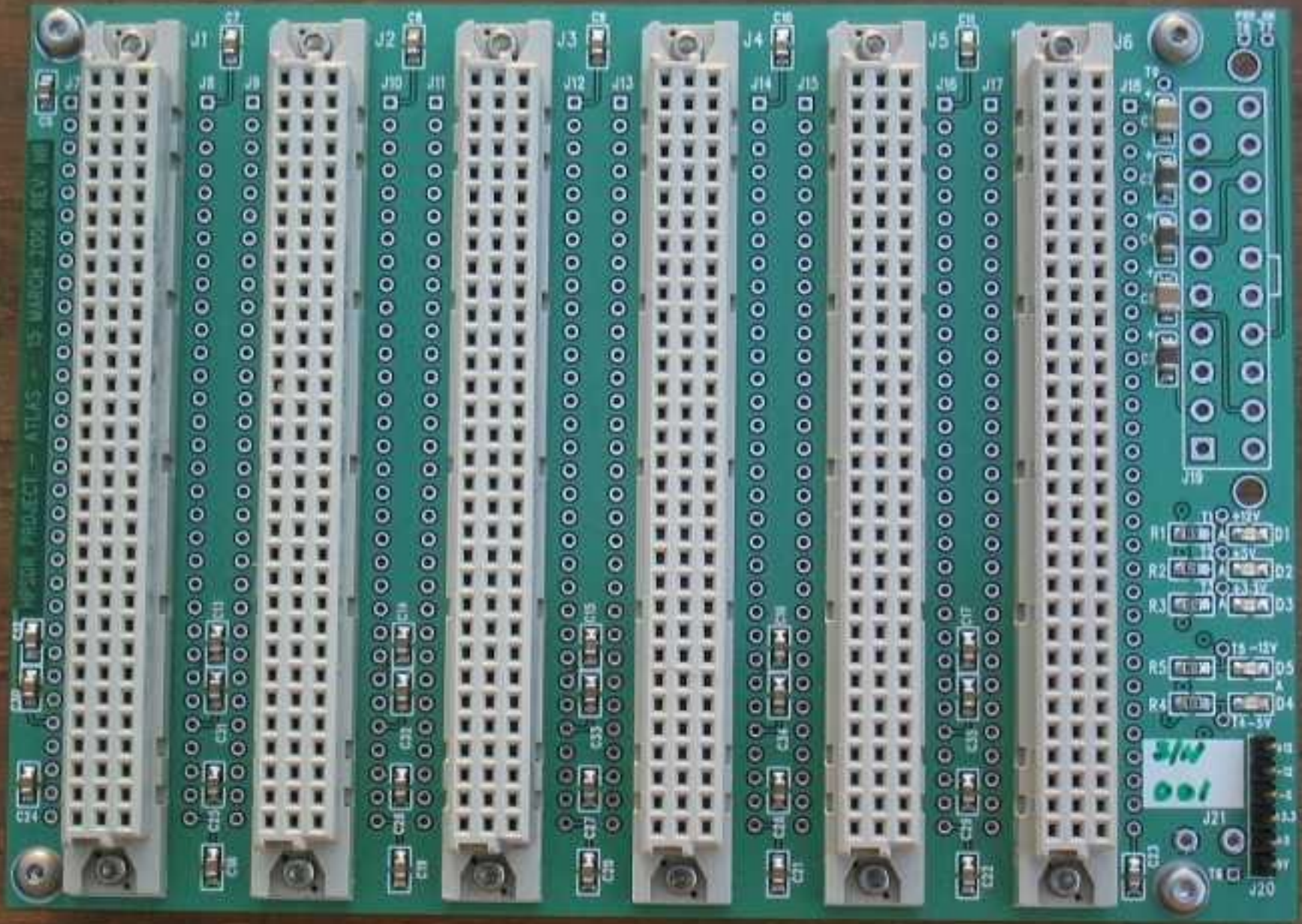
2015 Mid-Atlantic VHF/UHF/Microwave Conference

# openHPSDR

- Started in 2005
- Includes interested hams world-wide
- Primary motivator: Phil Harman VK6PH
- Hardware and Software
- TAPR has provided seed money, storefront
- Apache Labs
- Each unit covers 10 kHz through 55 MHz
  - Perfect for IF radio for VHF/UHF/Microwave work

# openHPSDR Hardware



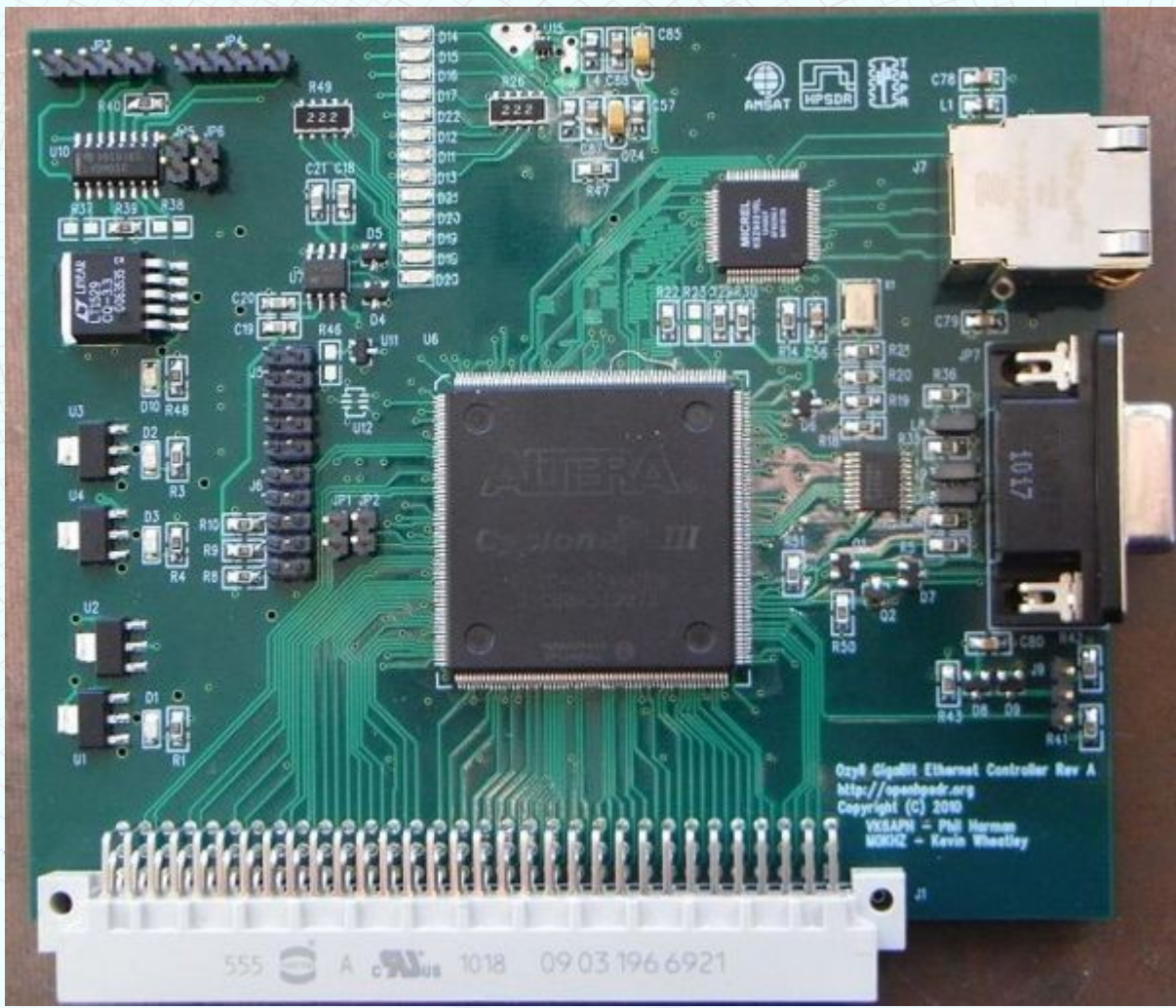


# Mercury Direct Down Conversion (DDC) Receiver

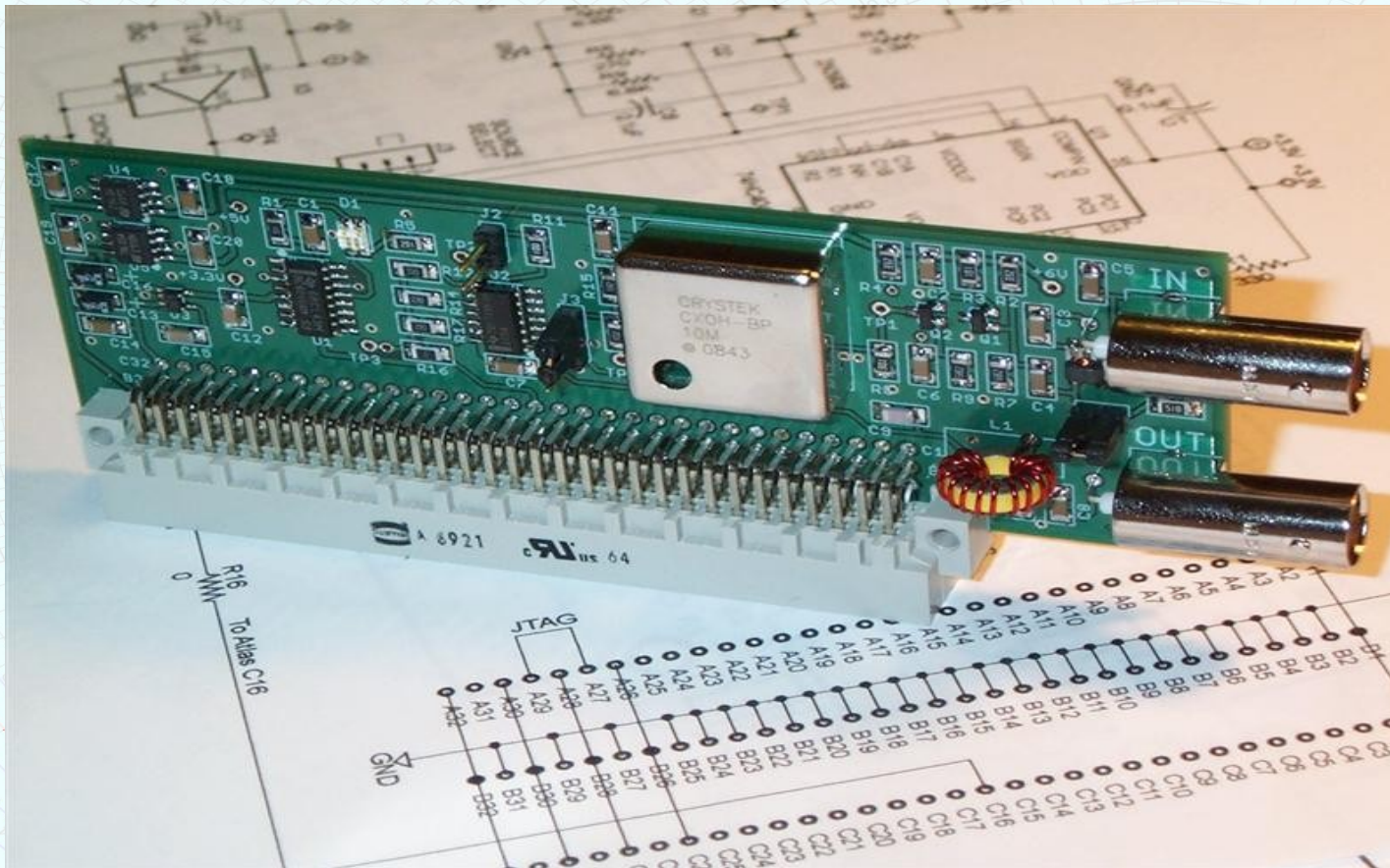




# Metis Ethernet Interface



# Excalibur 10 MHz Frequency Reference





# Pandora ( cover removed)



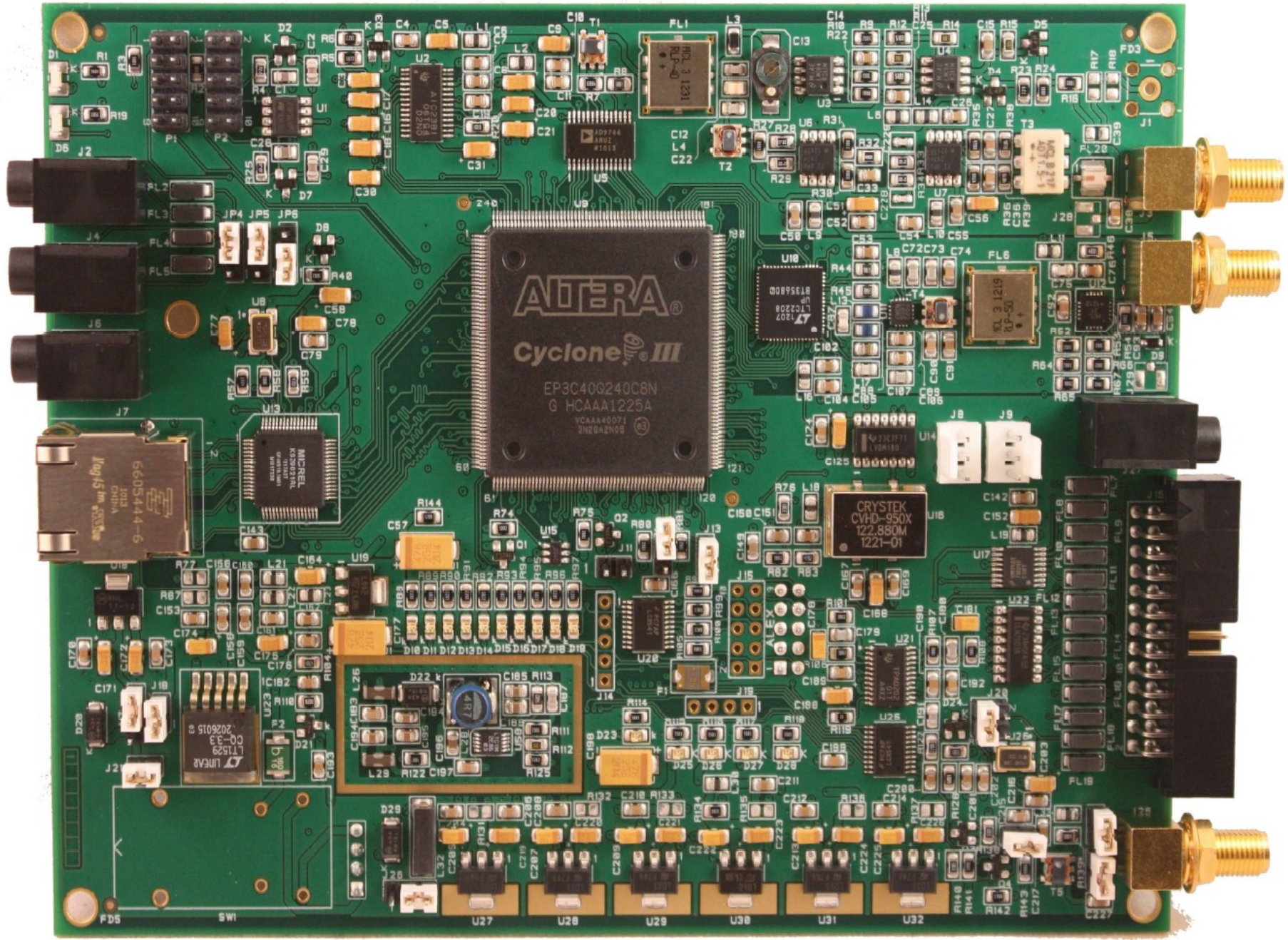
# OpenHPSDR specifications

- Blocking Dynamic Range: no detectable gain compression below ADC overload
- Dynamic Range 125 dB
- Image Rejection > 110 dB
- Full Duplex
- Transmitter two-tone 3rd order IMD -50 dBc @ 400 mW output
- 500 mW RF output on 160 – 10 m amateur bands, 350 mW on 6 m
- Noise Floor -135 dBm in 500 Hz

# Specifications Continued

- Seven user-configurable open collector outputs
- Separate open collector PTT connection
- Stereo outputs at line level and headphone level
- Low phase noise master clock (-140 dBc/Hz @ 1 kHz at 14 MHz)





ALTERA  
Cyclone III

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VCAAAA0071  
3N28AZN9S

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K30931RL  
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CRYSTEK  
CVHD-950X  
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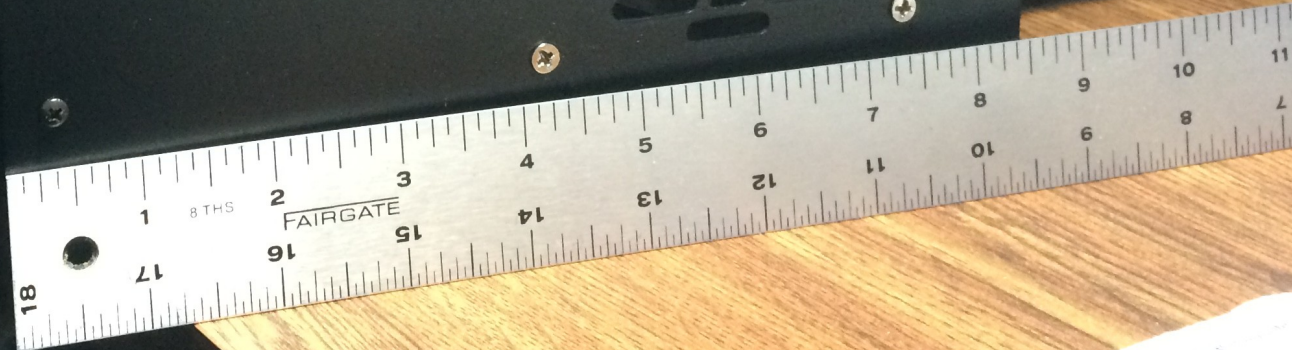
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APACHE LABS  
www.apache-labs.com

ANAN-10  
HF + 6M SDR Transceiver

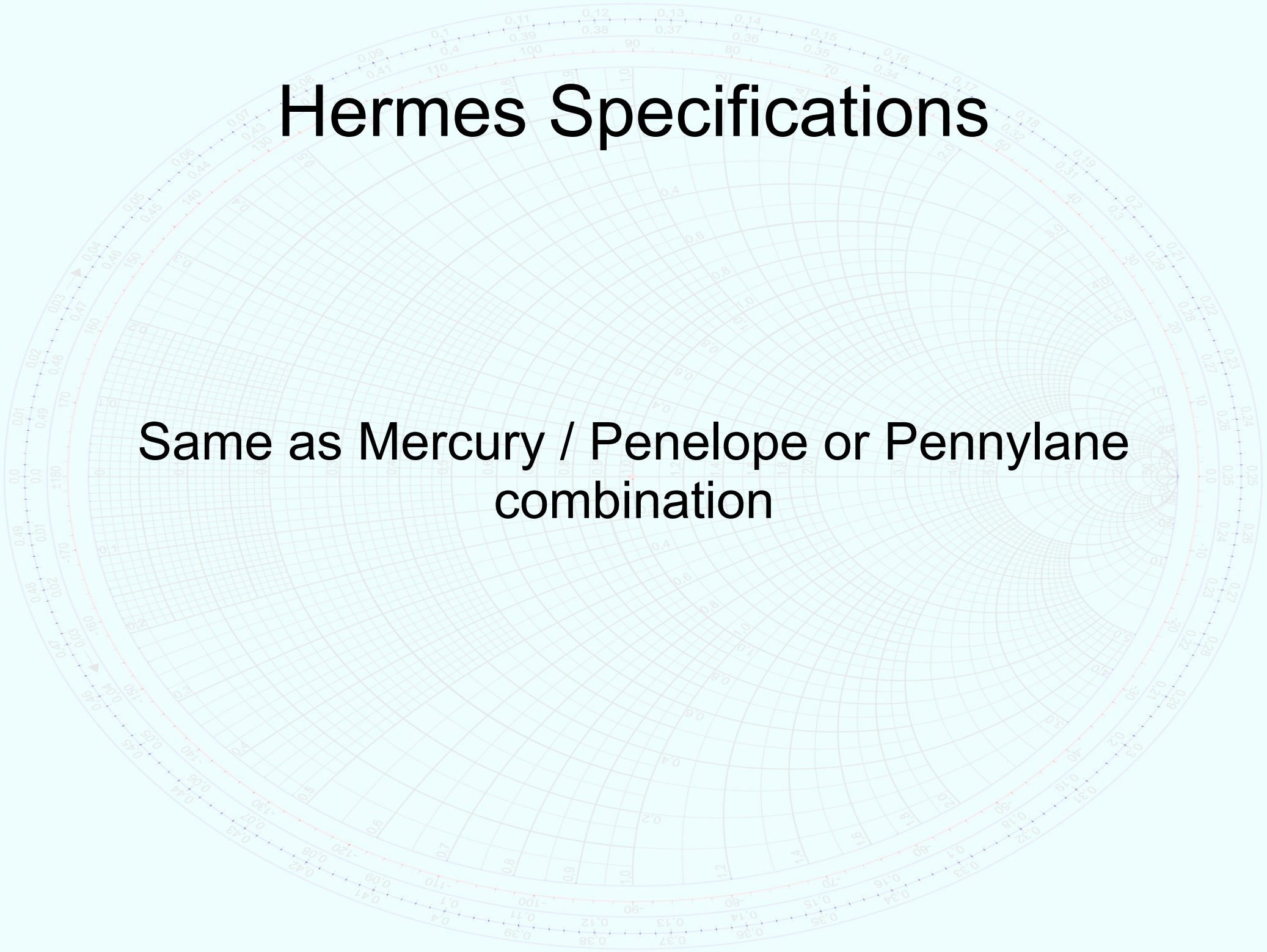
MIC HEADPHONE KEY

LAN



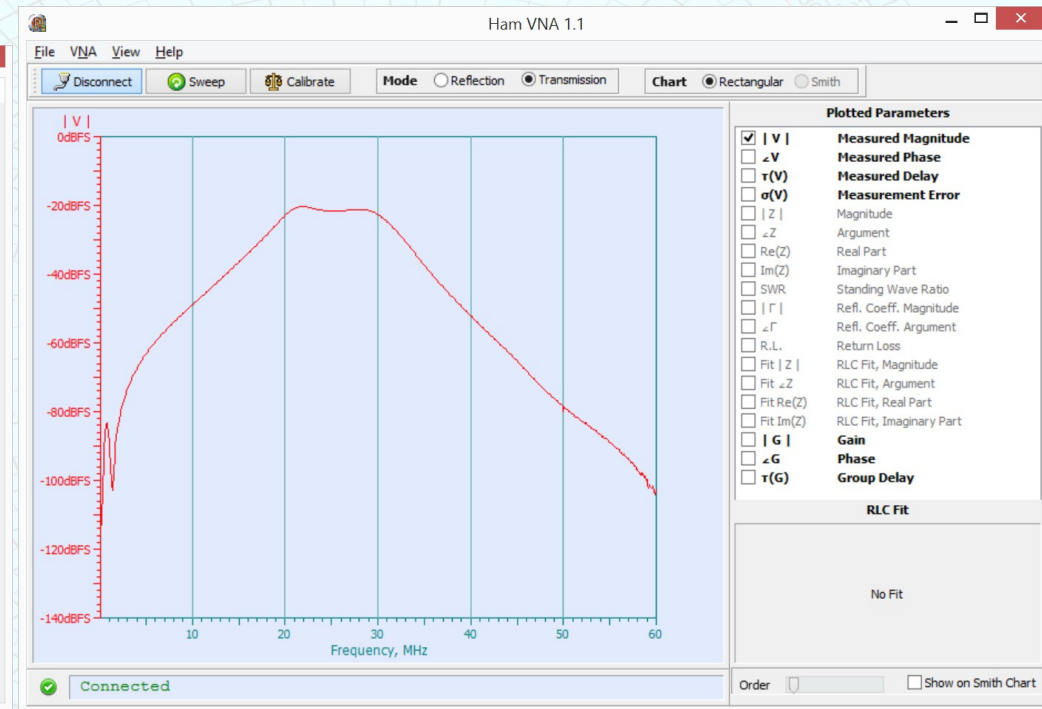
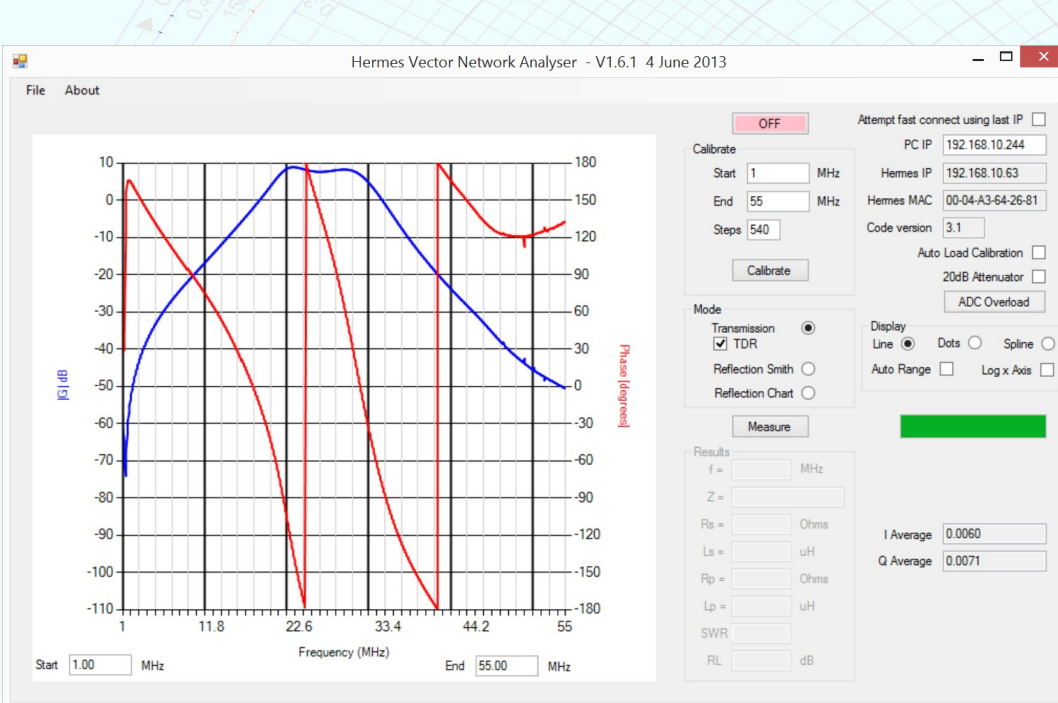
# Hermes Specifications

Same as Mercury / Penelope or PennyLane combination



# Hermes VNA

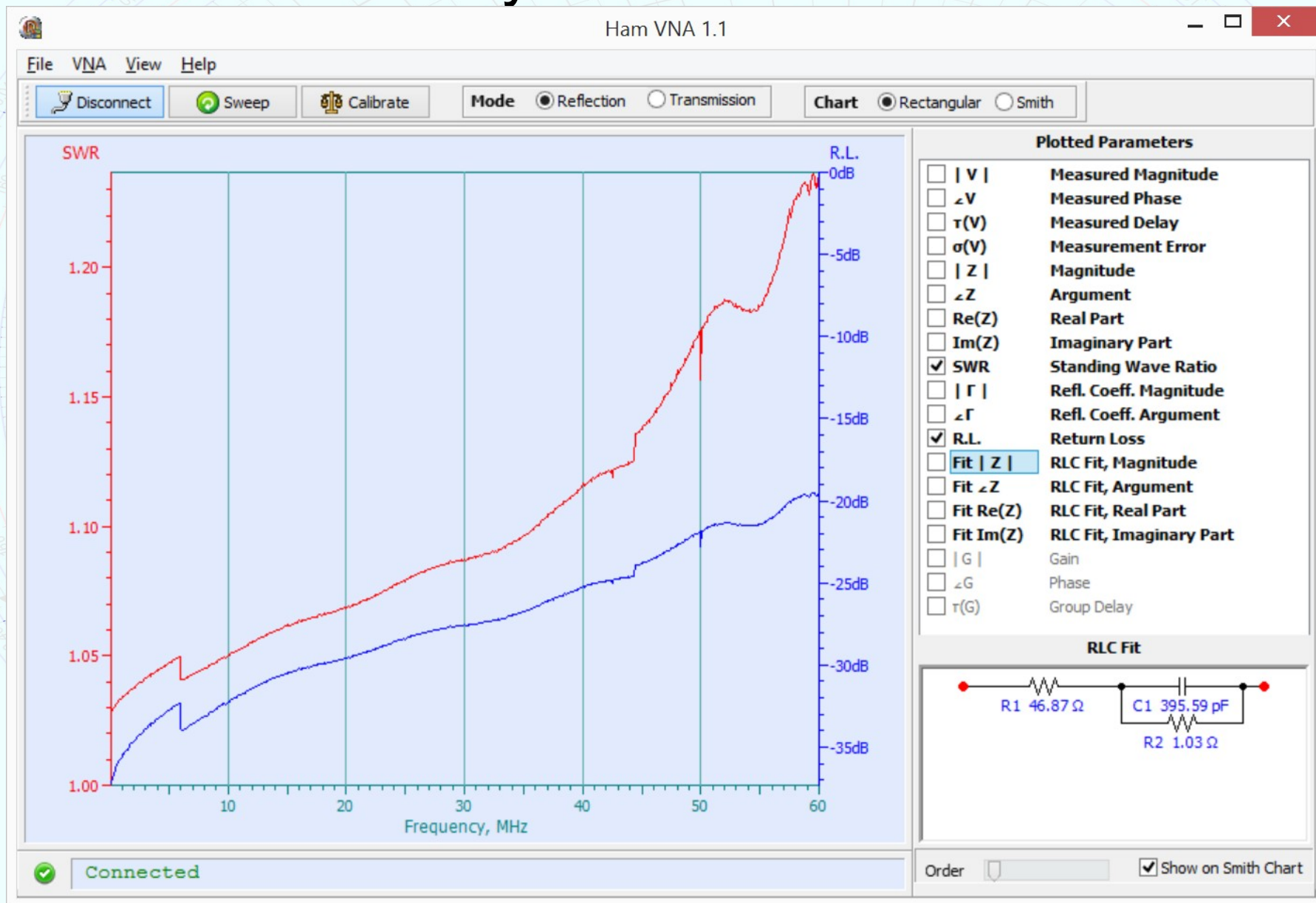
## 0-55+ MHz





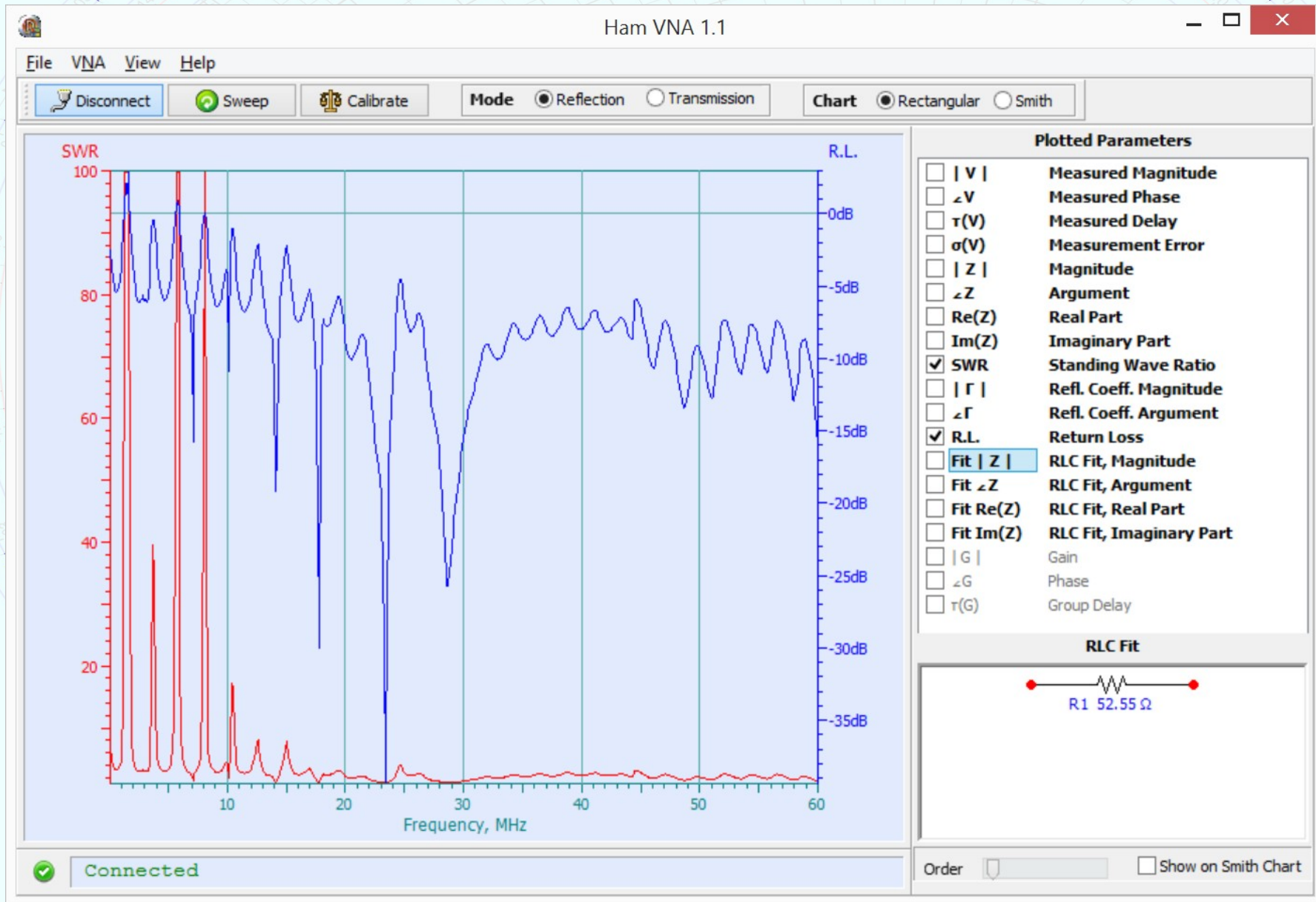
# Hermes VNA

## Dummy Load SWR / RL

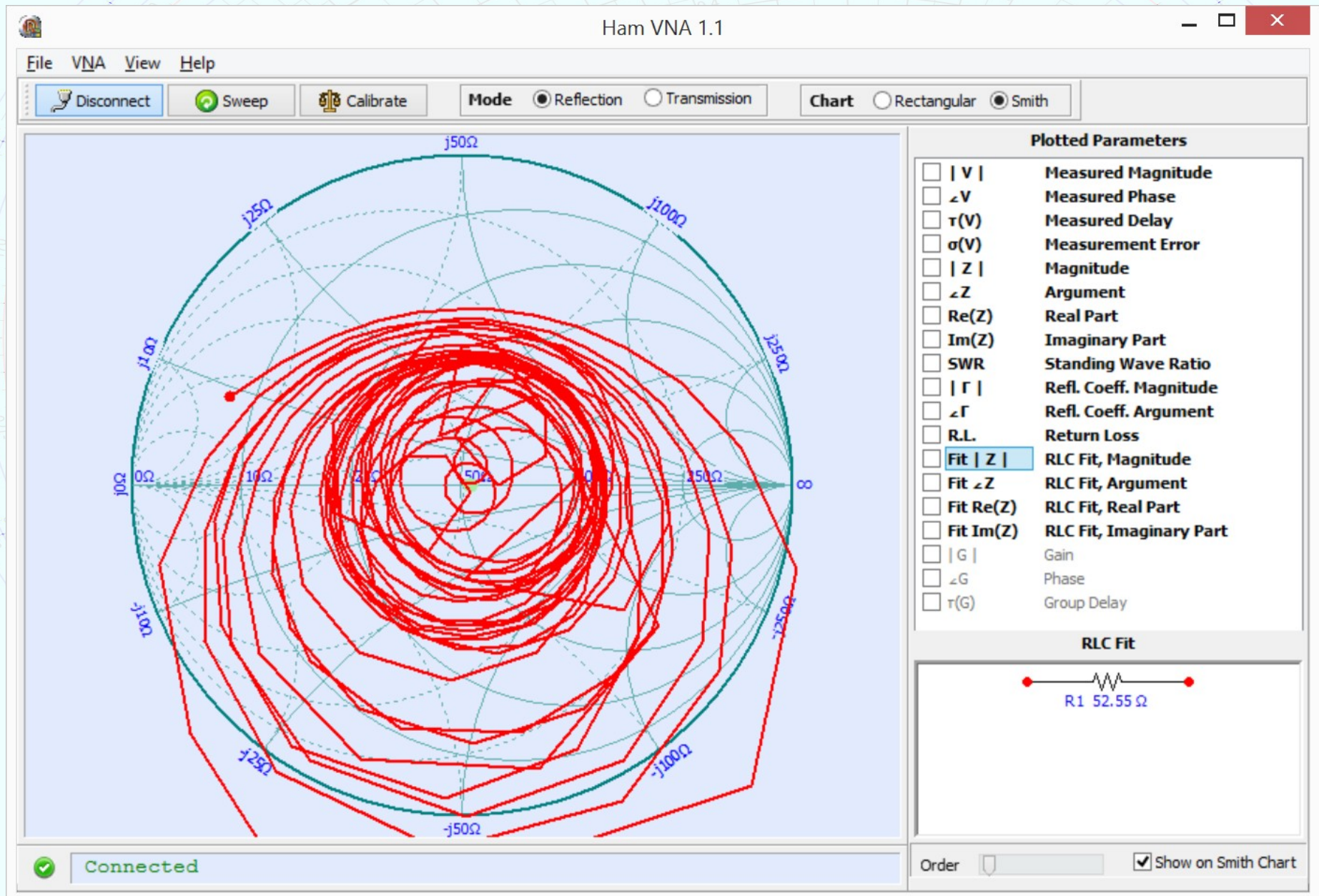


# Hermes VNA

## 23 year old 14 AVQ SWR / RL



# Hermes VNA 14AVQ Smith Chart



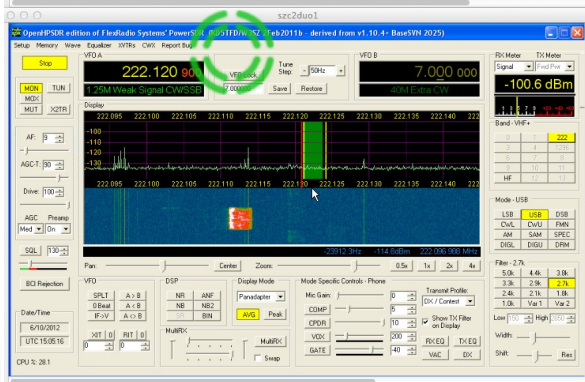
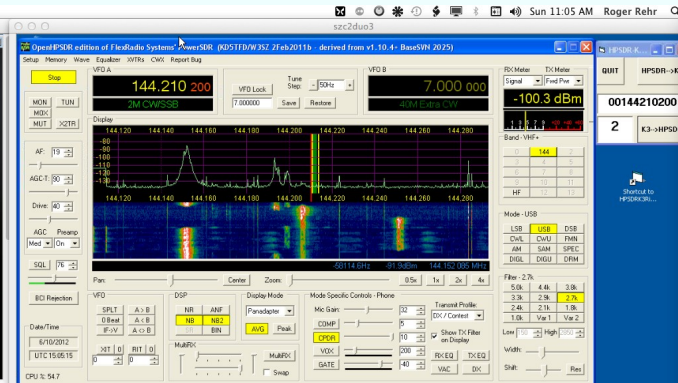
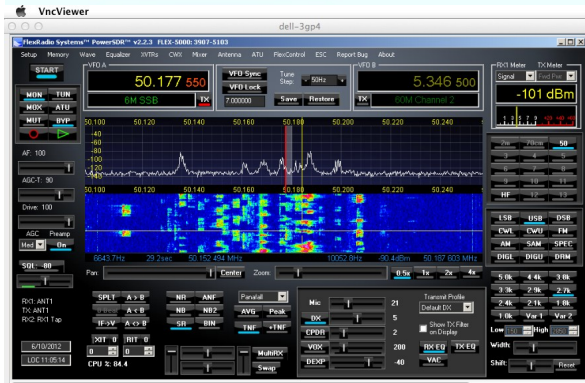
# Apache Labs

apache-labs.com

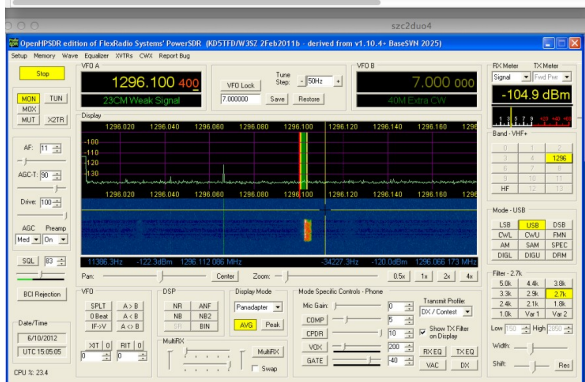
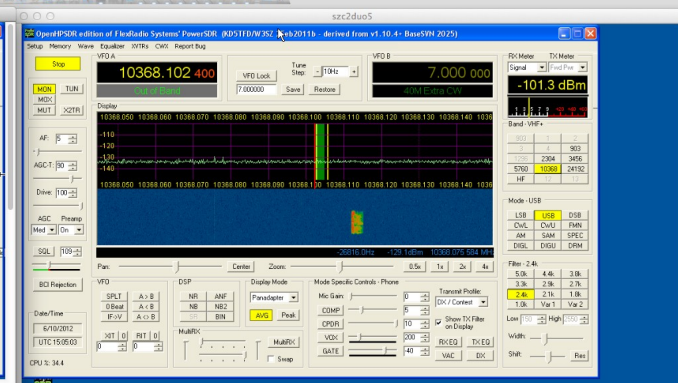
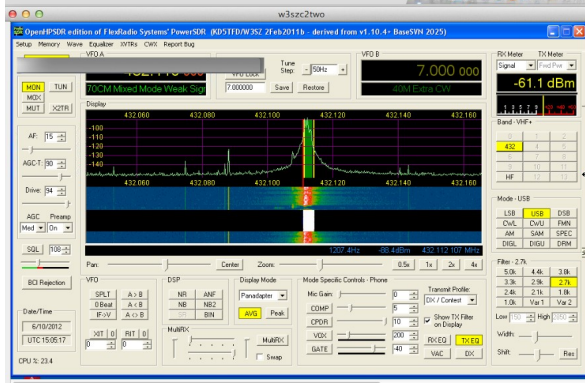
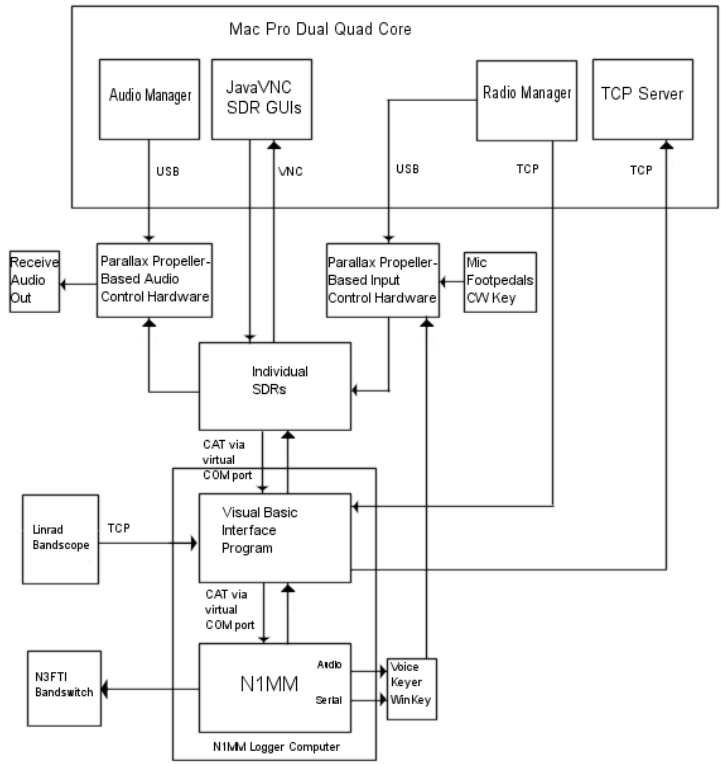
- “Abhi”, Abhishek Arunoday Prakash
  - Did the PCB Design for Hermes
- Based in India
- Extremely good customer support
- Product line includes
  - Hermes \$895
  - ANAN Series \$995 to \$4289
  - Angelia \$1495
  - PCBs for Hermes, Angelia, Enclosures

# OpenHPSDR at W3SZ





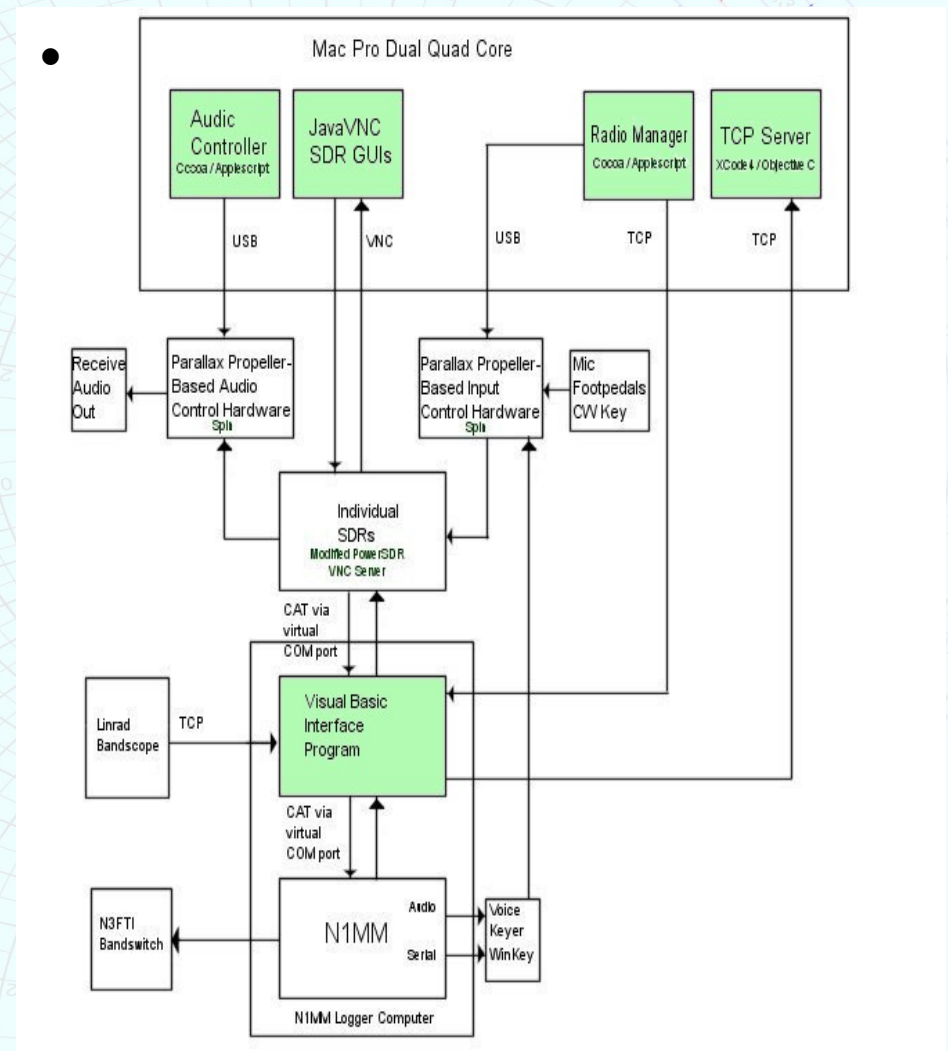
Terminal window showing a netcat listener on port 2000. It receives a connection from 192.168.1.111. The audio controller interface shows various settings for audio input and output.



WriteLog interface showing a list of frequencies. The selected frequency is 0281194566. The interface includes various controls for logging and playback.

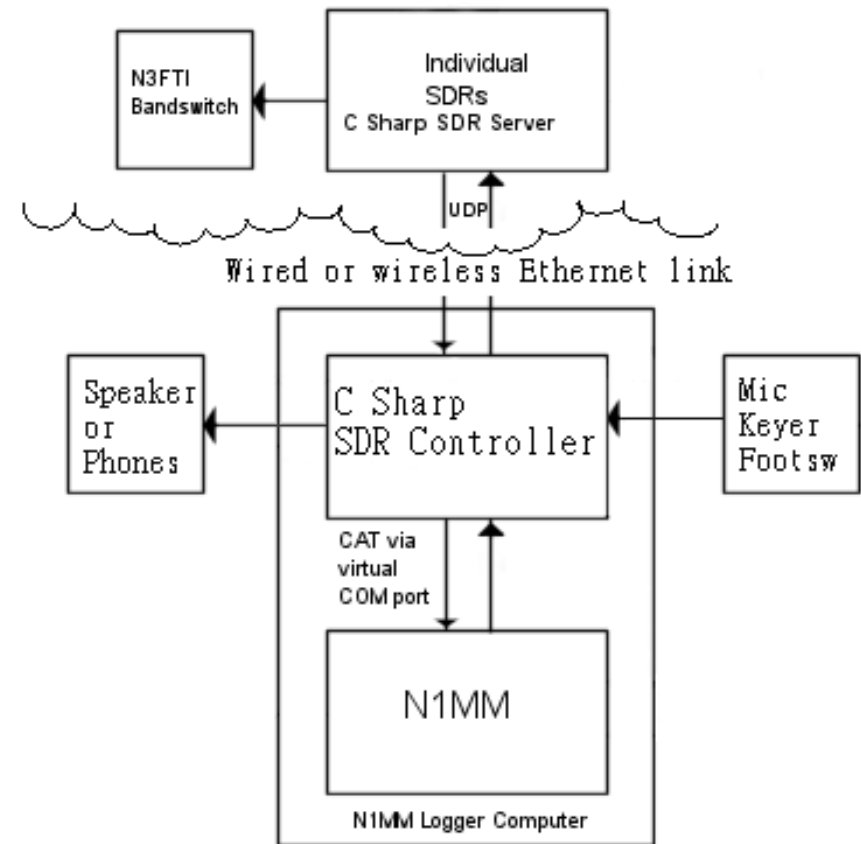
# W3SZ SDR Controller

- First version used 6 instances of VNC – Large Ethernet bandwidth
  - Needed Dual Quadcore Mac Pro with Gigabit NIC
- Controller consisted of multiple homebrew software pieces on 2 computers
- Needed homebuilt hardware controller



# W3SZ SDR Controller 2.0

- Goals
  - Reduce Ethernet Bandwidth
  - One program on one computer
  - Maintain all features of original version
  - Provide for remote operation
  - Eliminate need for hardware controller





# W3SZ SDR Controller 2.0

- Separate Full-time Bandscopes for
  - 50 MHz
  - 144 MHz
  - 222 MHz
  - 432 MHz
  - 903 MHz
  - 1296 MHz
  - 2,3,5,10,24 GHz
  - HF
- Full integration with N1MM Plus
- Automatic Switching of:
  - Microphone
  - CW Key / Keyer
  - Footswitch
  - Receive Audio channels for 2 radios
  - 2,3,5,10,24 GHz transverters to microwave IF radio
- Remote Operation

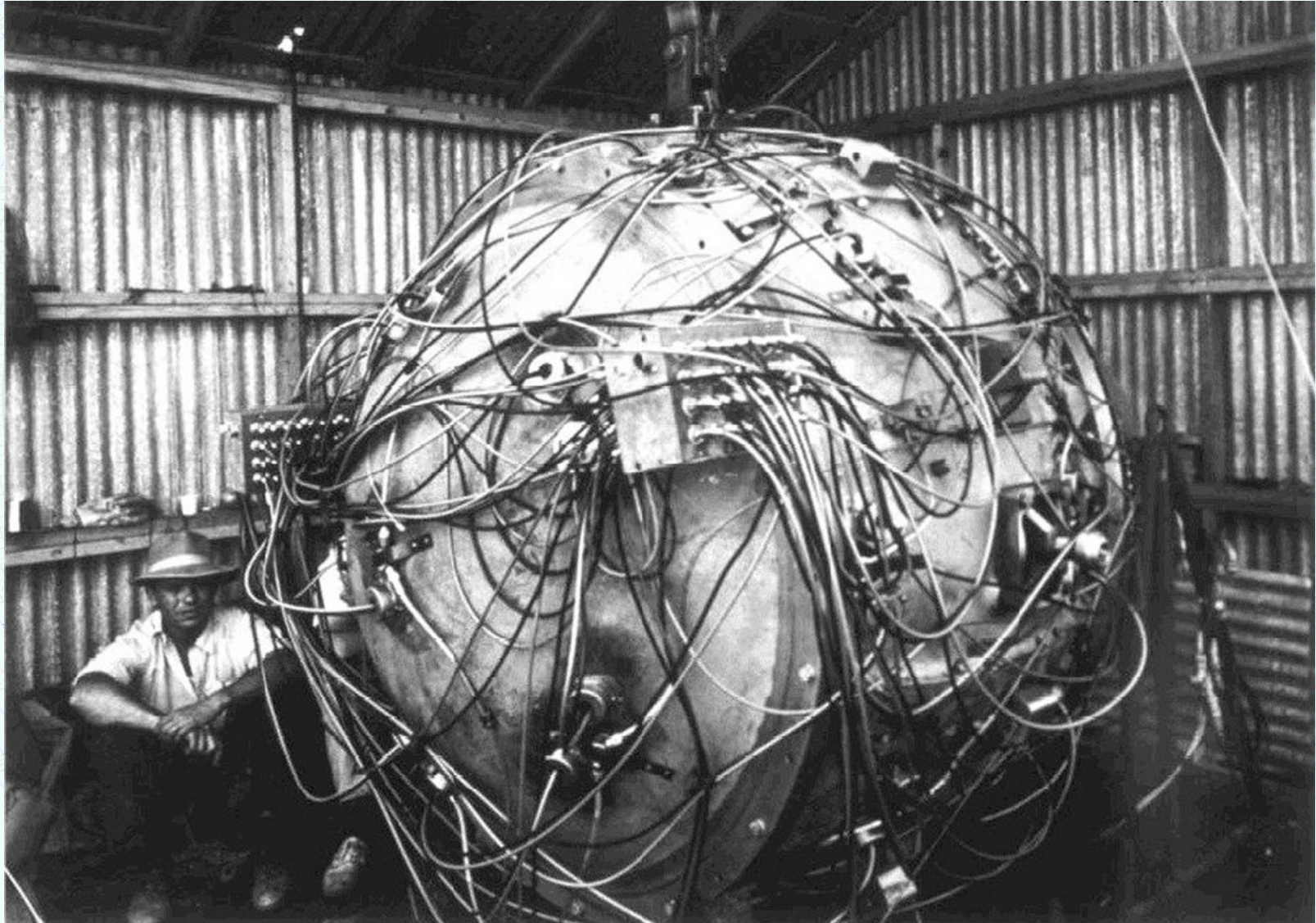
# W3SZ SDR Controller 2.0

The original OSX SDR Controller used multiple instances of PowerSDR [one for each radio]

The first question was,

“Should I modify PowerSDR to create the desired Server/Client architecture?”

# Hardware Equivalent of PowerSDR





AEC-54-4984

# W3SZ SDR Controller 2.0

- New controller uses KISS Konsole as base
  - KISS Konsole was originally written by Phil Harman, VK6PH, “as a straightforward program that will allow beginners to get their feet wet. KK is intended as a learning experience and not as a competitor or replacement for any existing code”
  - KK is well documented
  - Like PowerSDR, KK is written in C# (C Sharp)
  - KK is much less likely to blow up when modified than is PowerSDR
  - KK was extensively reworked for this project

# Modifications to KISS Konsole

-Split into Server and Client-

## • Server

- Add Adjustable FFT Size for spectrum / waterfall (4096-524288)
- Add Wisdom FFT optimization
- Send Spectrum/waterfall/ receive audio data to client
- Receive radio commands and mic audio and CW keying data from client
- Provide receive audio at server computer as well

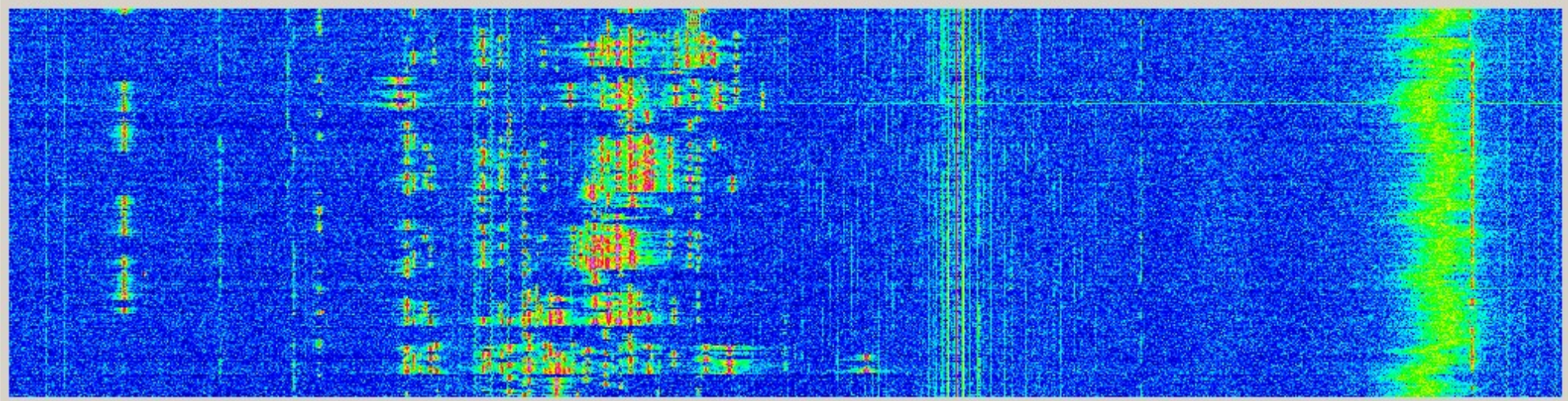
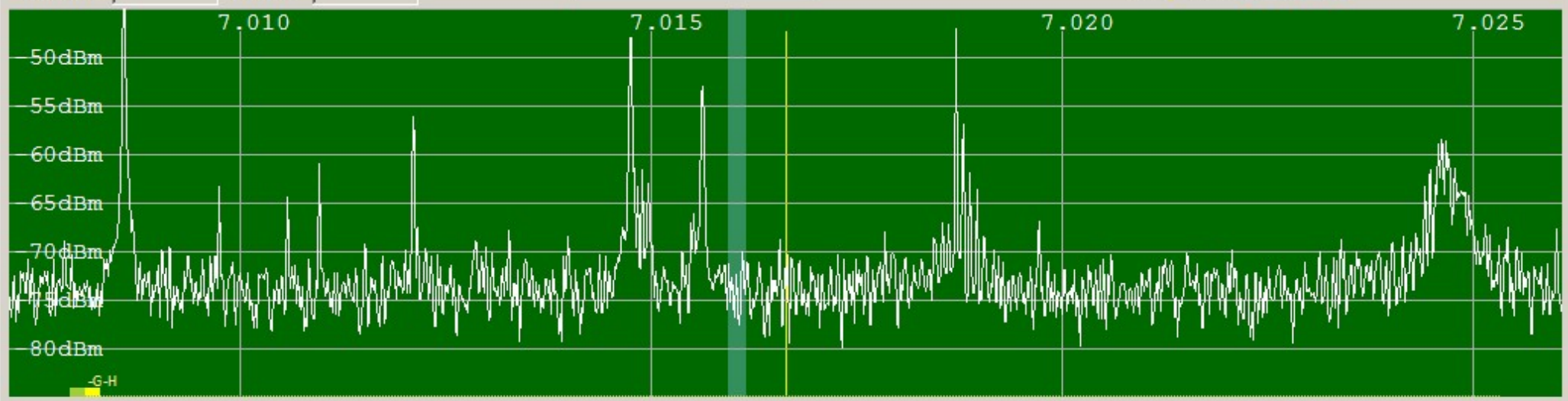
## • Client

- Receive spectrum / waterfall / audio data from servers, constantly display 7 bandscopes
- Send radio commands and mic audio data to server/radio combinations as appropriate
- Interface with N1MM Plus, appearing as two Kenwood TS-2000s, each covering 50 MHz through 24 GHz
- Switch CW key/keyer, microphone, receive audio, footswitch to appropriate radios without need for additional hardware

# Server and Client

additional modifications common to both

- Add CW sidetone
- Add spectrum & waterfall zoom
- Add multiple waterfall palettes
- Add frequency adjustment by up/down arrows
- Add key-adjustable step size for frequency adjustment
- Add key-adjustable mode selection
  - Last 3 above so that ShuttlePro can be used to control these parameters



ON Sync ADC  
MOX TUN

Band 40m  
Step Size 10Hz

AGC Slow  
Mode CWL

Show Spectrum  
 Show Waterfall

Quick Memory  
STO RCL

ANF  NR  
 NB1  NB2  
 Preamp  
 Sidetone

Bass Cut  Mic AGC  
Speech Processor 14.9 dB  
VOX 400 Hang (mS)  
Mic Gain Clip  
Noise Gate  
Drive 13

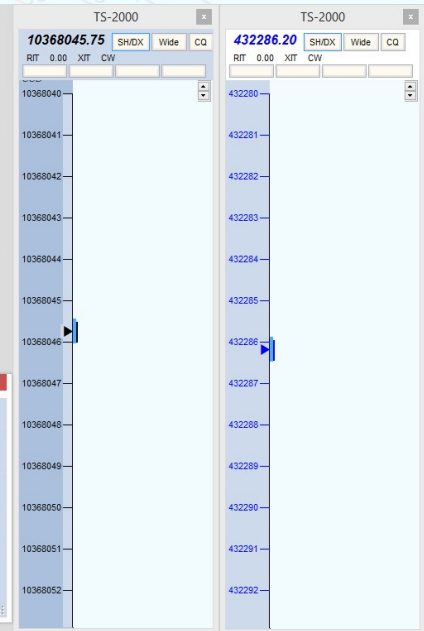
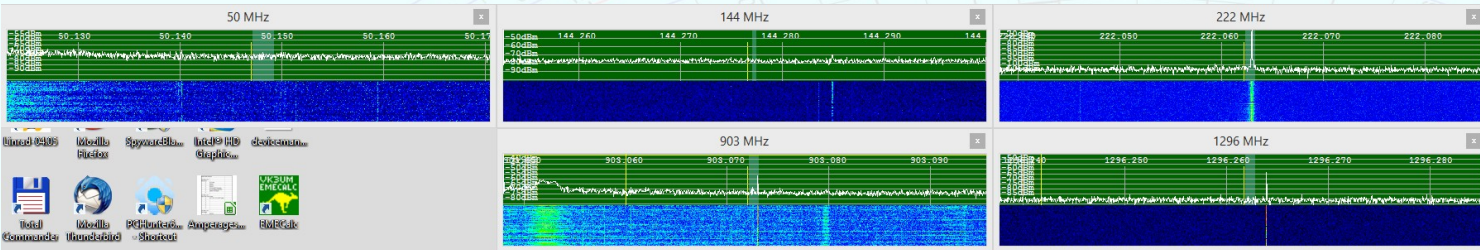
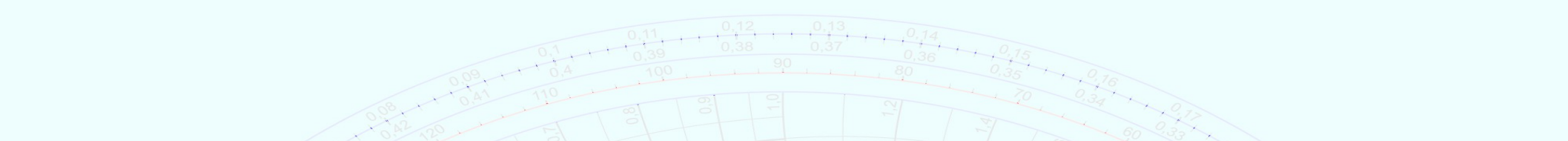
Squelch  
Bandscope  Filter   
-85

ZOOM  
100 75 50 25  
ZOOM OUT ZOOM IN

Volume AGC-Gain

Filter Width  
226





Micro

60dBm 10368.030 10368.040 10368.050 10368.060

10368.045 750

Vol FwdPwr RevPwr Drive 50

TUN AGC Gain IMOX

Filter Width 1000

Gate 0 dB

Mode CWU

AGC Fast

Step Size 10Hz

3 cm CW TS-2000

File Edit View Tools Config Window Help

CW PH Snt Rcv Grid

6m 6m

2m 2m

1.25m 1.25m

70cm 70cm

35cm 35cm

23cm 23cm

Run S&P 14

F1 F2 F3 Tu F4 F5 Hia F6

F7 F8 F9 Nr? F10 F11 F12

Esc: Stop W Lo Edi Ma Stg Sp QR

Heading appears here when  
Call history UserText appears

10368 81/42 21,546

432 MHz

50dBm 432.200 432.220 432.240 432.260 432.280 432.300 432.320 432.340 432.360 432

432.286 200

Vol FwdPwr RevPwr Drive 13

TUN AGC Gain IMOX

Filter Width 1000

Gate 7.23 dB

Mode CWU

AGC Fast

Step Size 10Hz

432286.20 CW TS-2000

File Edit View Tools Config Window Help

CW PH Snt Rcv Grid

6m 6m

2m 2m

1.25m 1.25m

70cm 70cm

35cm 35cm

23cm 23cm

Run S&P 32

F1 F2 F3 Tu F4 F5 Hia F6

F7 F8 F9 Nr? F10 F11 F12

Esc: Stop W Lo Edi Ma Stg Sp QR

Heading appears here when  
Call history UserText appears

432 81/42 21,546

8/12/2015 21:43:19Z ARRL UHF Aug - hams.s3db

MM-DD HH:MM	Call	Freq	Snt	Rcv	Grid	P
08-02 13:43	K3TUF	103681...	59	59	FN10	12
08-02 14:03	K3TUF	902098.62	599	599	FN10	6
08-02 14:20	WZ1V	222110.00	59	59	FN31RH	3
08-02 14:21	WZ1V	432104.99	59	59	FN31RH	3
08-02 14:27	WZ1V	129610...	59	59	FN31RH	6
08-02 14:54	W3HMS	129609...	59	59	FN10MF	6
08-02 15:11	W3HMS	902098.49	599	5999	FN10MF	6

W3SZ Multi SDR Controller

MAIN 50 144 222 432 903 1296 2304 3456 5760 10G 24G L Foot

AUX 50 144 222 432 903 1296 2304 3456 5760 10G 24G

Mute Mute Mic Preset Aud Reset

M2 Terrestrial Azi...

File Tools Help

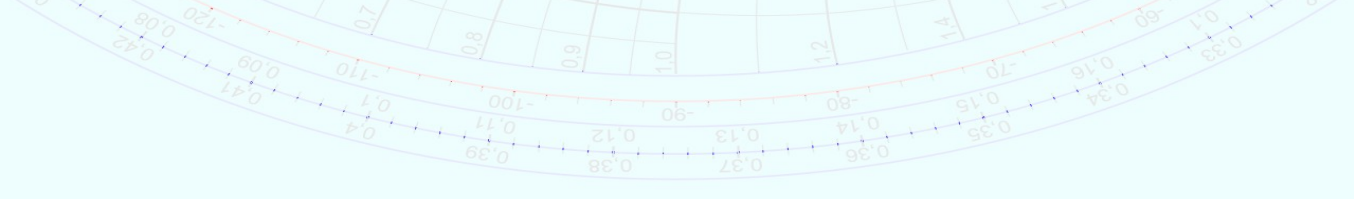
119°

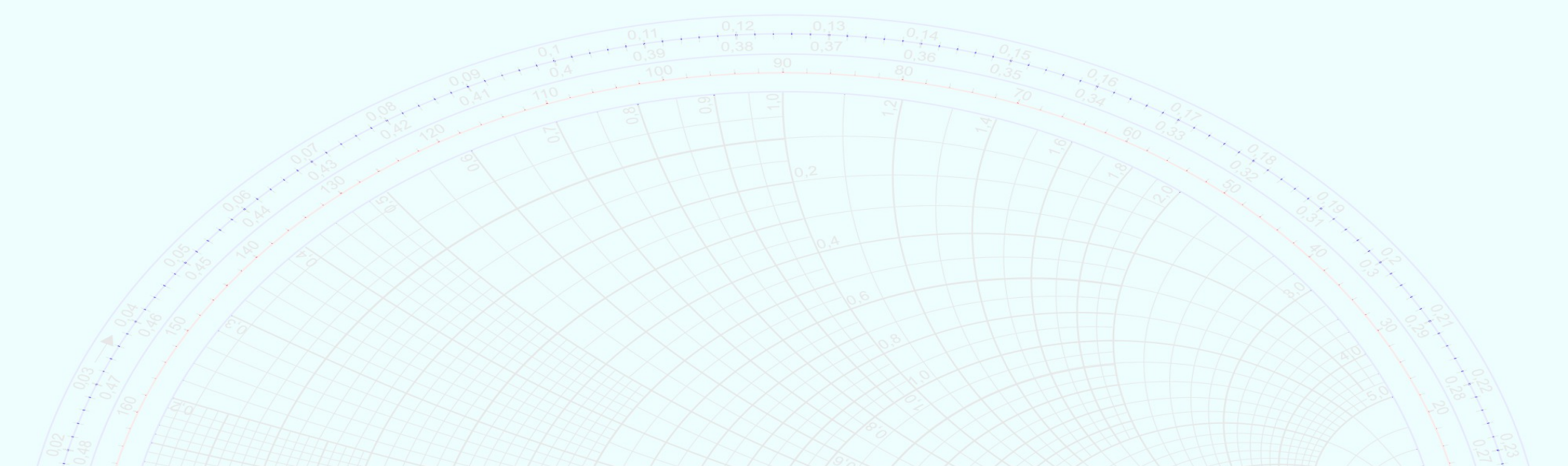
Stop Turn

10 30 90 120 150

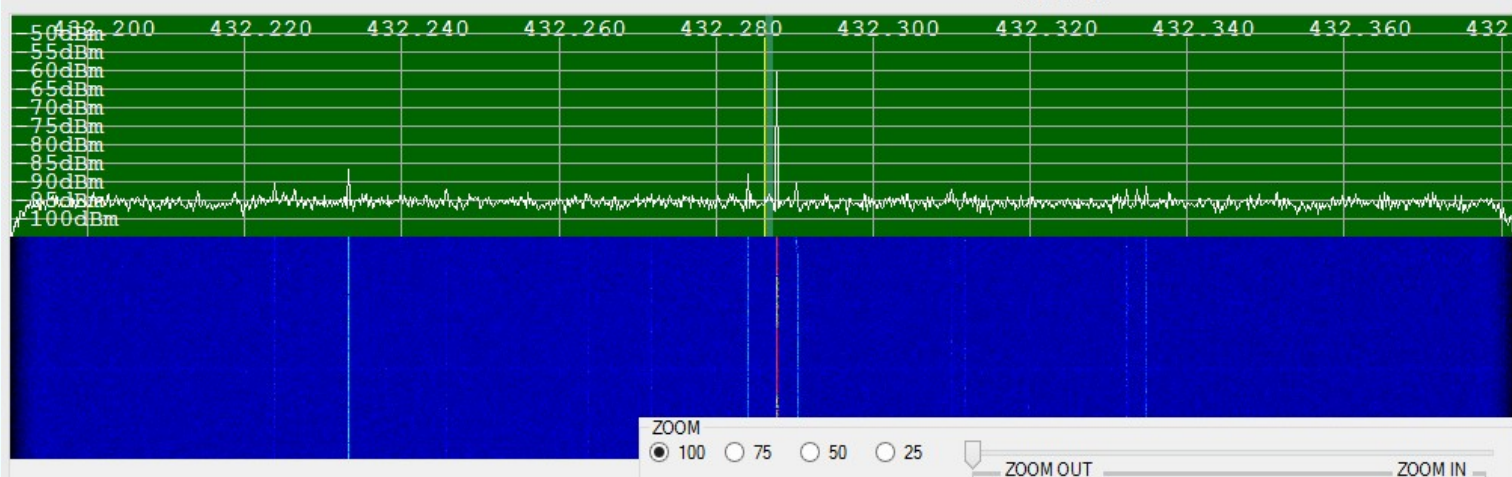
180 210 240 270 360

8





432 MHz



**432.286 200**

1 3 5 7 9 +20 +40 +60

ON

Vol

FwdPwr

RevPwr

TUN

AGC Gain

Drive

13

MOX

1000

Mic Gain

Proc

7.23 dB

NB1 Filter Width

Gate

NB2  NR  ANF

Preamp  Sidetone

VNC

Squelch

Mode CWU

Bandscope  Filter

AGC Fast

Setup

-85

Step Size 10Hz

# Client

W3SZ Multi SDR Controller

MAIN	<input type="radio"/> 50	<input type="radio"/> 144	<input type="radio"/> 222	<input type="radio"/> 432	<input type="radio"/> 903	<input checked="" type="radio"/> 1296	<input type="radio"/> 2304	<input type="radio"/> 3456	<input type="radio"/> 5760	<input type="radio"/> 10G	<input type="radio"/> 24G	L Foot	<input checked="" type="radio"/>	Mic	<input type="radio"/>	Key	<input checked="" type="radio"/>	Mute	<input type="checkbox"/>	Mute	<input checked="" type="checkbox"/>	Mic Reset	<input type="button" value=""/>	Aud Reset	<input type="button" value=""/>
AUX	<input type="radio"/> 50	<input checked="" type="radio"/> 144	<input type="radio"/> 222	<input type="radio"/> 432	<input type="radio"/> 903	<input type="radio"/> 1296	<input type="radio"/> 2304	<input type="radio"/> 3456	<input type="radio"/> 5760	<input type="radio"/> 10G	<input type="radio"/> 24G	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Audio 1	<input type="checkbox"/>	Audio 2	<input checked="" type="checkbox"/>	Setup	<input type="button" value=""/>	<input type="button" value=""/>	<input type="button" value=""/>

Setup

Server IP | **Transverters** | GainByBand | Common Parameters

Band	Remote IP	Radio Manager COM Port	Audio Manager COM Port	N1MM Main Radio COM Port	N1MM Liaison Radio COM Port
50 MHz	<input type="text" value="192.168.1.109"/>	<input type="text" value="COM11"/>	<input type="text" value="COM13"/>	<input type="text" value="COM15"/>	<input type="text" value="COM17"/>
144 MHz	<input type="text" value="192.168.1.37"/>				
222 MHz	<input type="text" value="192.168.1.113"/>				
432 MHz	<input type="text" value="192.168.1.149"/>				
903 MHz	<input type="text" value="192.168.1.88"/>				
1296 MHz	<input type="text" value="192.168.1.108"/>				
GHz	<input type="text" value="192.168.1.111"/>				
HF	<input type="text" value="192.168.10.55"/>				<input checked="" type="checkbox"/> HF

Setup

Server IP | **Transverters** | GainByBand | Common Parameters

Band	LO (MHz)	LO Offset (Hz)
50 MHz	<input type="text" value="22"/>	<input type="text" value="0"/>
144 MHz	<input type="text" value="116"/>	<input type="text" value="0"/>
222 MHz	<input type="text" value="194"/>	<input type="text" value="0"/>
432 MHz	<input type="text" value="404"/>	<input type="text" value="0"/>
903 MHz	<input type="text" value="875"/>	<input type="text" value="0"/>
1296 MHz	<input type="text" value="1268"/>	<input type="text" value="0"/>
2304 MHz	<input type="text" value="2276"/>	<input type="text" value="0"/>
3456 MHz	<input type="text" value="3428"/>	<input type="text" value="0"/>
5760 MHz	<input type="text" value="5732"/>	<input type="text" value="0"/>
10368 MHz	<input type="text" value="10340"/>	<input type="text" value="0"/>
24192 MHz	<input type="text" value="24164"/>	<input type="text" value="0"/>

# Client

Setup

Server IP Transverters GainByBand Common Parameters

Gain By Band (%)

160m	50	17m	50
80m	50	15m	50
40m	50	12m	50
30m	50	10m	50
20m	50	6m	50

Gain By Band (%)

50	50	2304	50
144	50	3456	50
222	50	5760	50
432	50	10G	50
903	50	24G	50
1296	50		

Setup

Server IP Transverters GainByBand Common Parameters

CW

Pitch (Hz) 700

Sidetone Volume

Ethernet  
 Hardwired

Receive Audio

Ethernet  
 Hardwired

Transmit Audio

Ethernet  
 Hardwired

Select VNC Executable File

C:\Program Files\TightVNC\tnvviewer.exe

VNC Password

WinKeyer Control COM Port

COM5

CW Key Input

WinKeyer or Straight Key

COM4

MOX Control

Ethernet  
 Hardwired

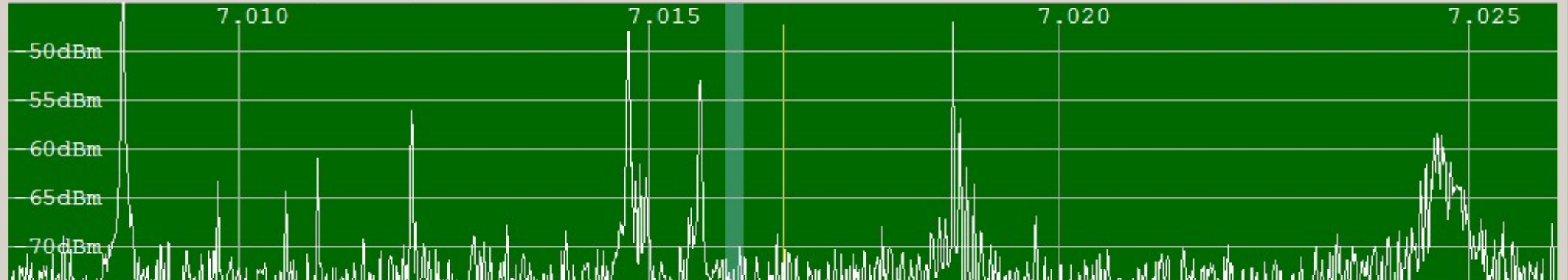
Waterfall Pallet

Enhanced

FWD Pwr [ ] REV Pwr [ ]

7.016 750

SMeter: Avg -105.0 : Inst -111.3



**Setupform**

Configuration | Display | AGC | Noise Reduction | Transmitter | Ext Ctrl | Alex | Ethernet

Call Sign:

Sample Rate:  Hz

FFT Size:

Hardware Present:

- Hermes
- Penelope
- PennyLane
- Excalibur
- Apollo
- Alexarias

Configuration:

- 20dB Mic Boost
- Line-in
- 10MHz Reference-
  - Atlas
  - Mercury
  - Penelope/PennyLane

Code Version:

- FX2
- Metis V0
- Mercury V0
- Penelope/PennyLane V0

Skip Version Checking

Ethernet Client

Remote IP:

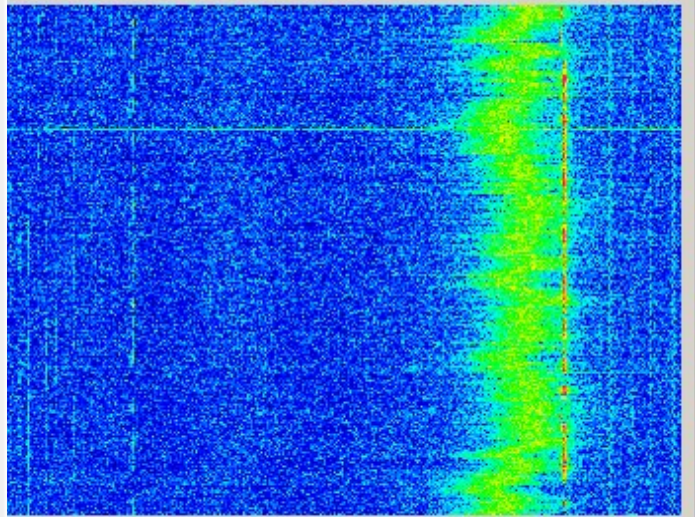
Ethernet Audio and CW Keying

Local Computer Audio

Band:

CW Pitch (Hz):

Sidetone Volume:



ANF  NB1  NB2  Preamp  Sidetone

Filter Width:

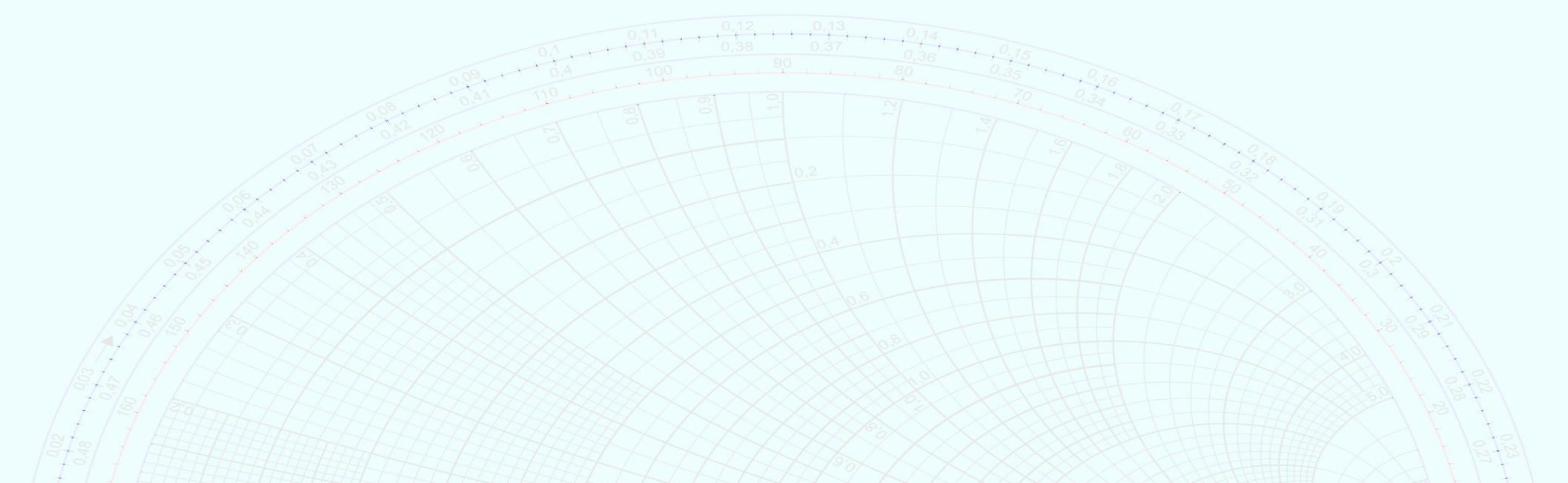
Bass Cut  Mic AGC  Speech Processor:  dB

VOX:  Hang (mS)

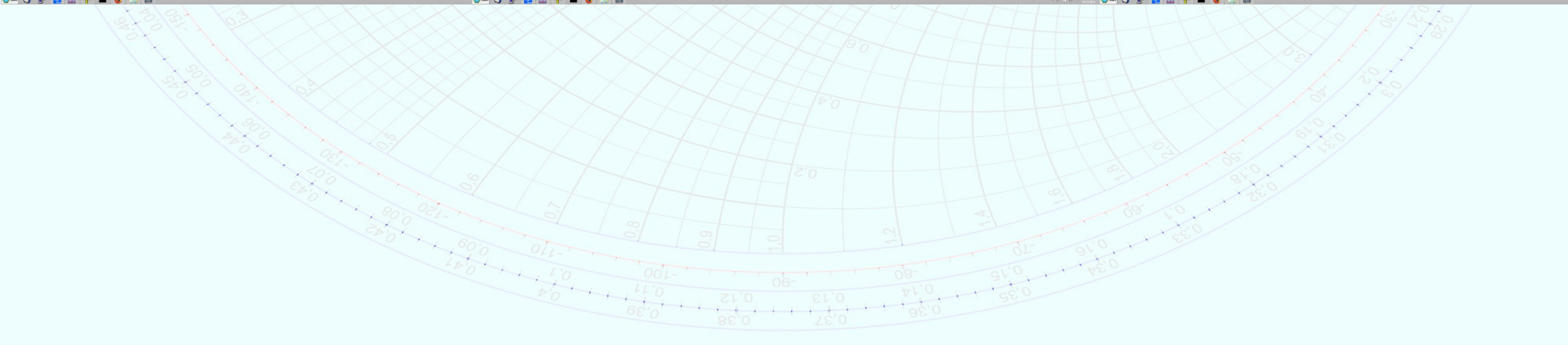
Mic Gain:  Clip

Noise Gate:

Drive:

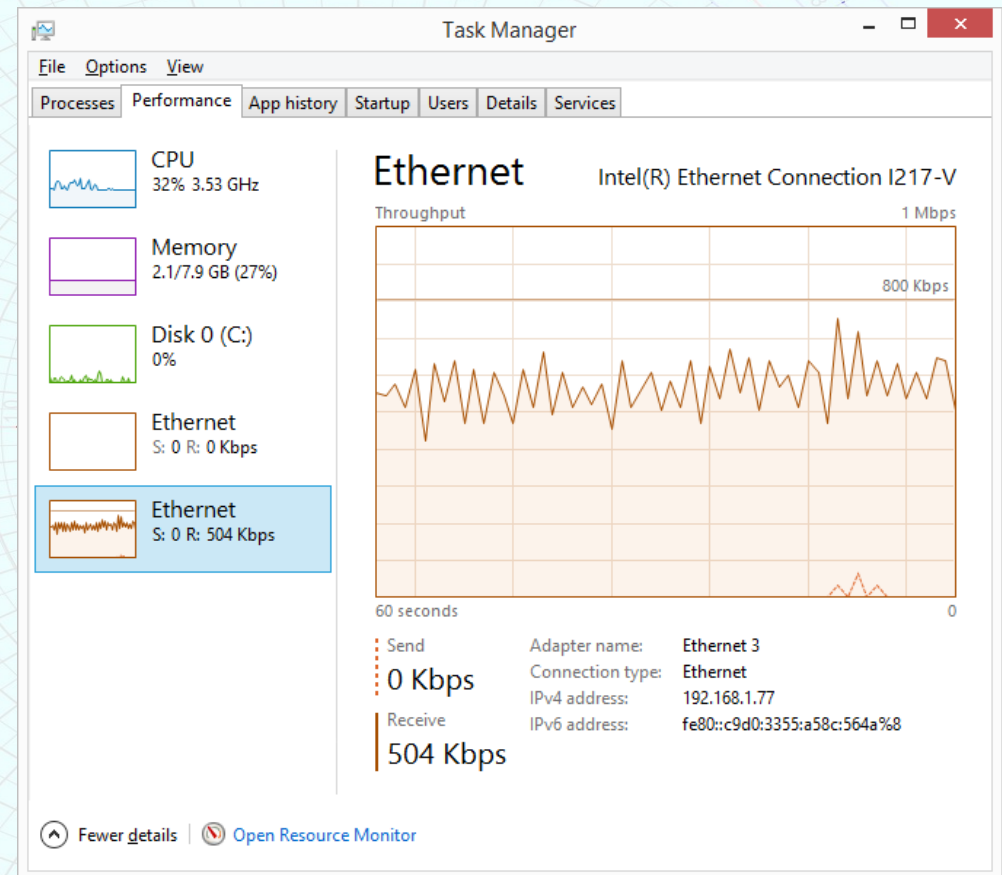


This section contains a collage of various software windows. On the left is a spreadsheet with columns for 'Call Name', 'Frequency', 'Power', and 'Status'. In the center is a spectrum analyzer showing frequency bands from 100 MHz to 220 MHz. Below it is a waveform viewer displaying a signal waveform. On the right is a calculator window showing a list of call signs and their frequencies. Other windows include a system tray with a clock and various application icons.



# New W3SZ SDR Controller

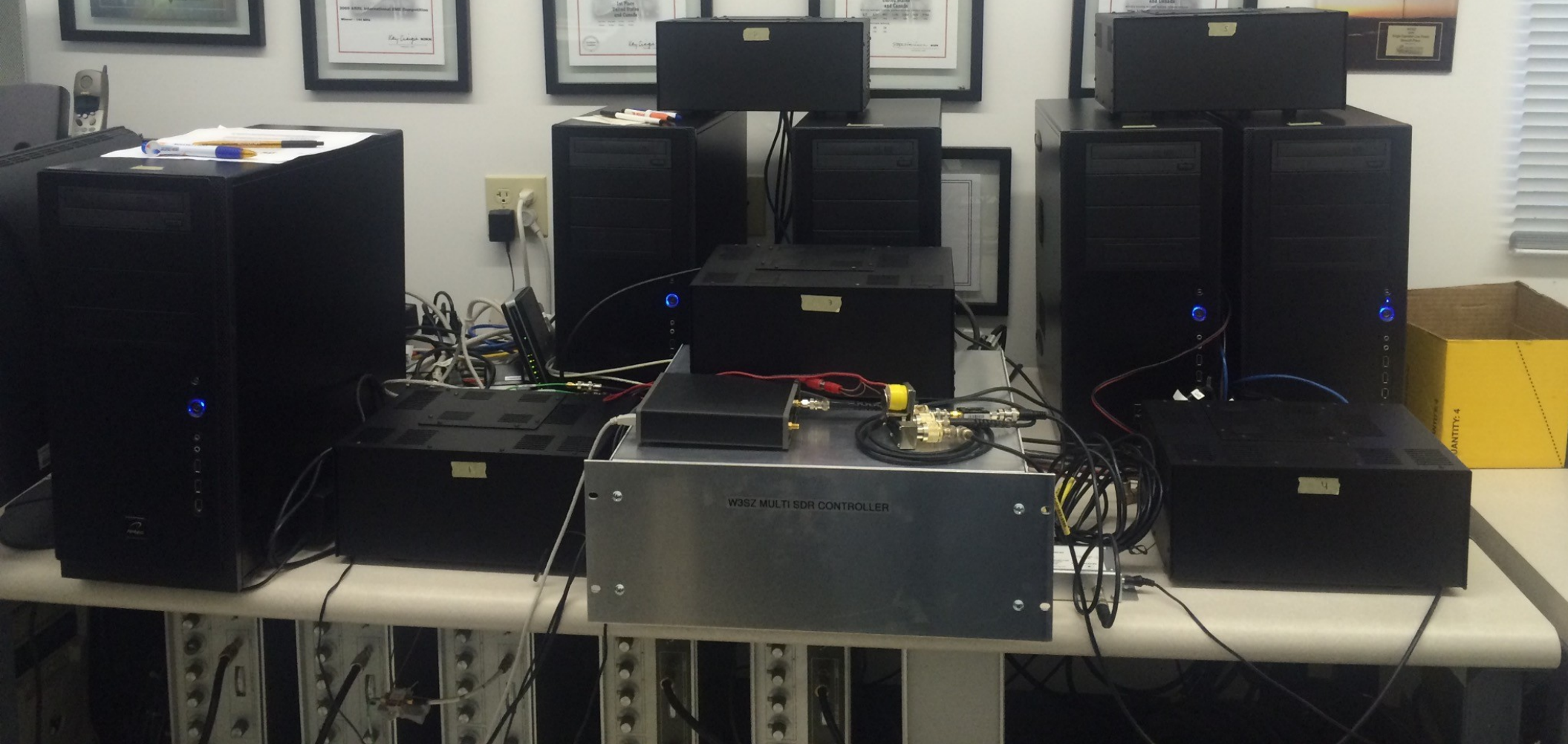
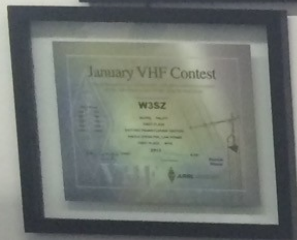
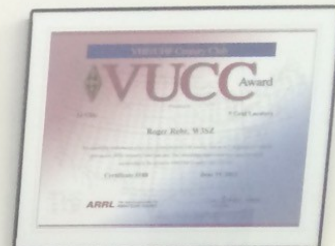
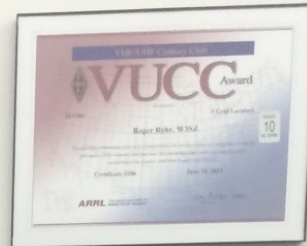
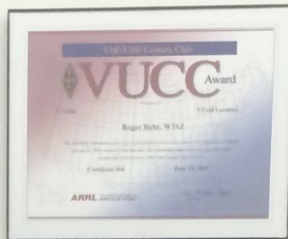
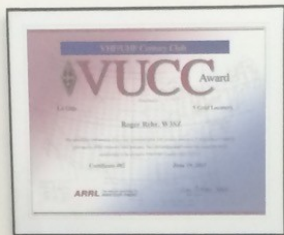
- Runs on Intel I3 4160  
3.6 GHz
- CPU utilization 32%  
with other processes  
running
- Network utilization  
0.5% of 100 Mbps  
bandwidth



# Network Utilization

- Bandwidth for receive stereo audio for two receivers is ~3 Mbps for 48 kHz sampling rate [which is mandated by the openHPSSDR protocol] ( $48000 * 16 * 2 * 2 = 3,072,000$ )
- Opus codec reduces the bandwidth for the audio for two such receivers to 48 kbps
- Bandwidth / latency for CW keyer is minimized by sending only state changes from client to server
- Transmit audio is also sent at 48 kHz sampling rate using Opus codec, with 24 kbps bandwidth

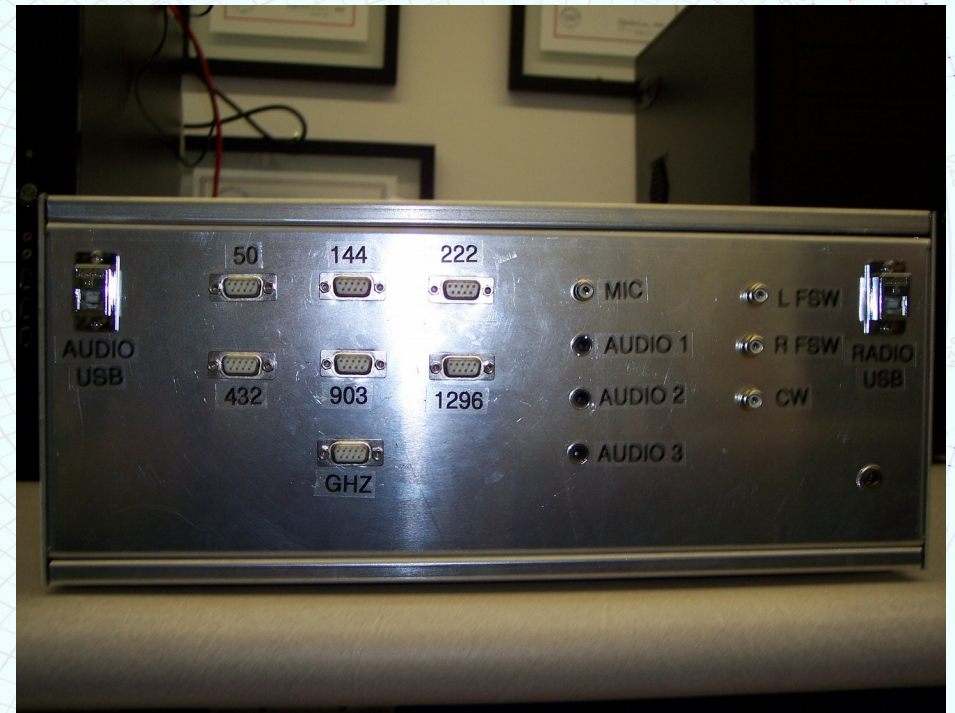




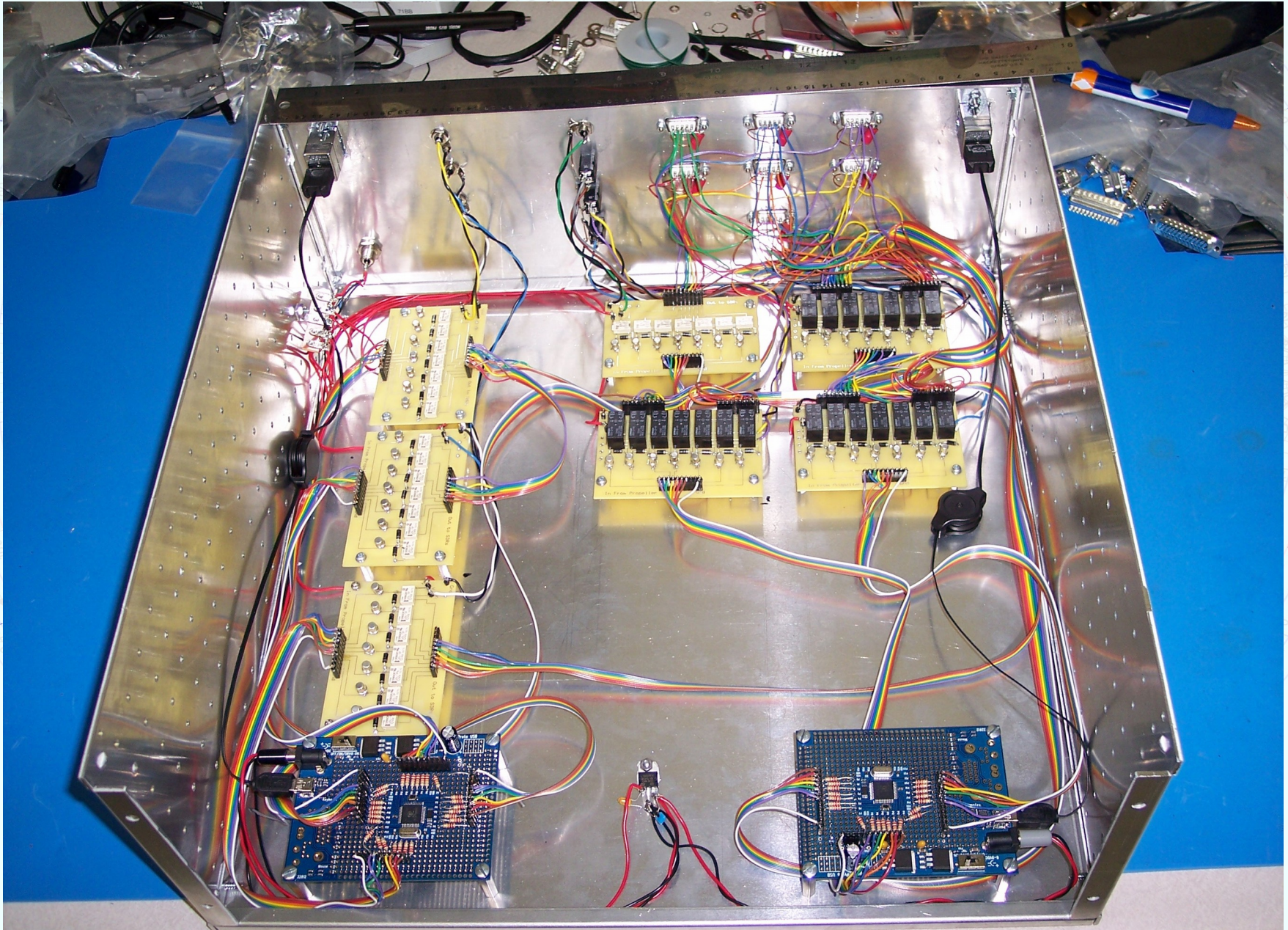
# Hardware SDR Controller

no longer needed with version 2.0

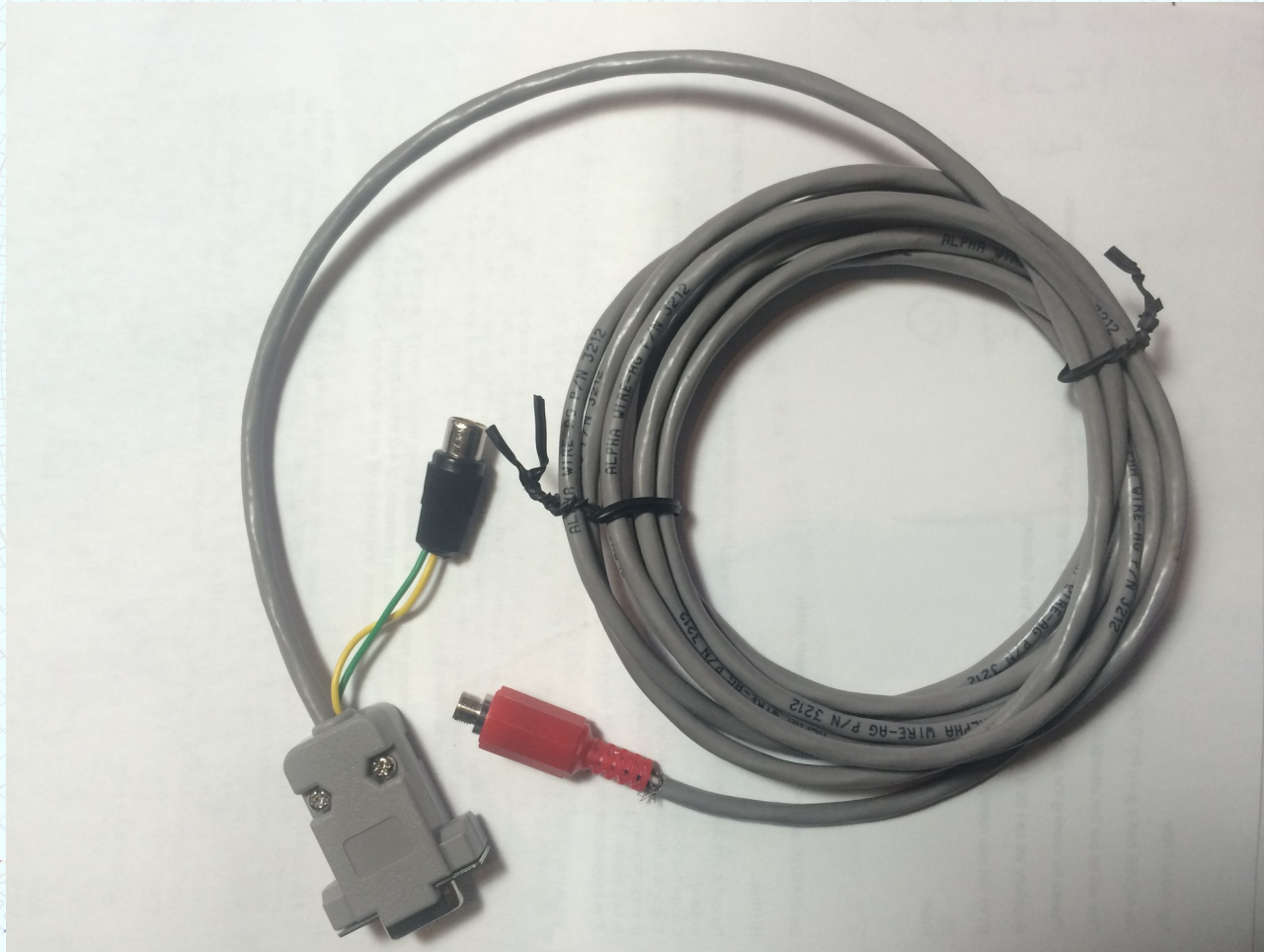
Its all done in software!



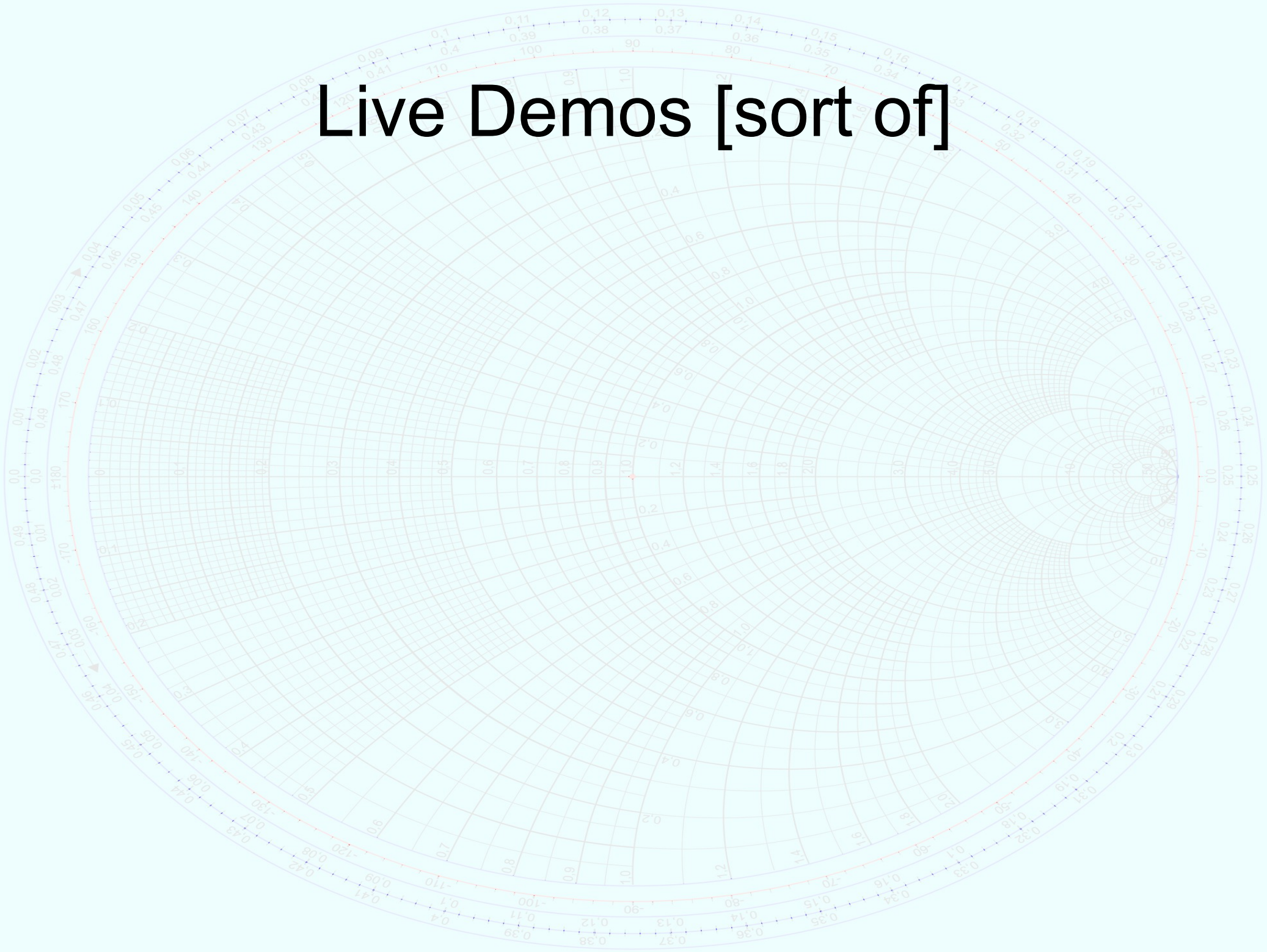
# Sayonara, Hardware SDR Controller



# Replacement for Hardware SDR Controller



# Live Demos [sort of]

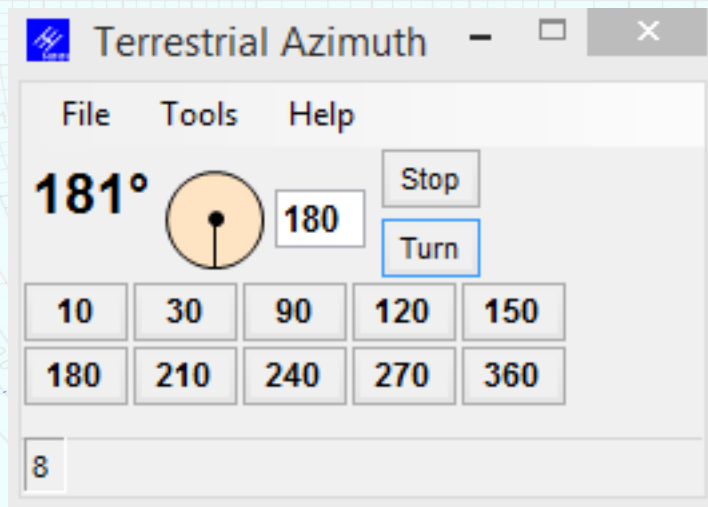


# Remote Operation



# Remote Serial Ports

- M2 RC2800PXAZ requires serial controller
  - Use EDS16PS Ethernet Serial Port Server



# Remote USB Ports

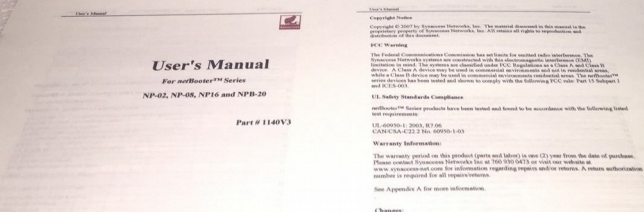
- RIGblaster Pro set up to use USB interface
  - NET-USB-4A 4-port USB 2.0 to Gigabit Ethernet Adapter provides remote control of USB ports





# Remote control of AC outlets

- Web Power Switch 7 by DLI gives Ethernet control of 8 AC receptacles
- NetBooster NP16 gives Ethernet control of 16 AC receptacles





# Summary

- OpenHPSDR Hardware/Software provide excellent platform for experimentation, homebrewing both hardware and software
- KISS Konsole provides an excellent base for software projects tailored to individual station requirements
- A system providing remote 11 band operation covering 50 MHz thru 24 GHz with the openHPSDR hardware is described