SDR

Software Defined Radio

Radio i digital teknikk

Håvard Nasvik

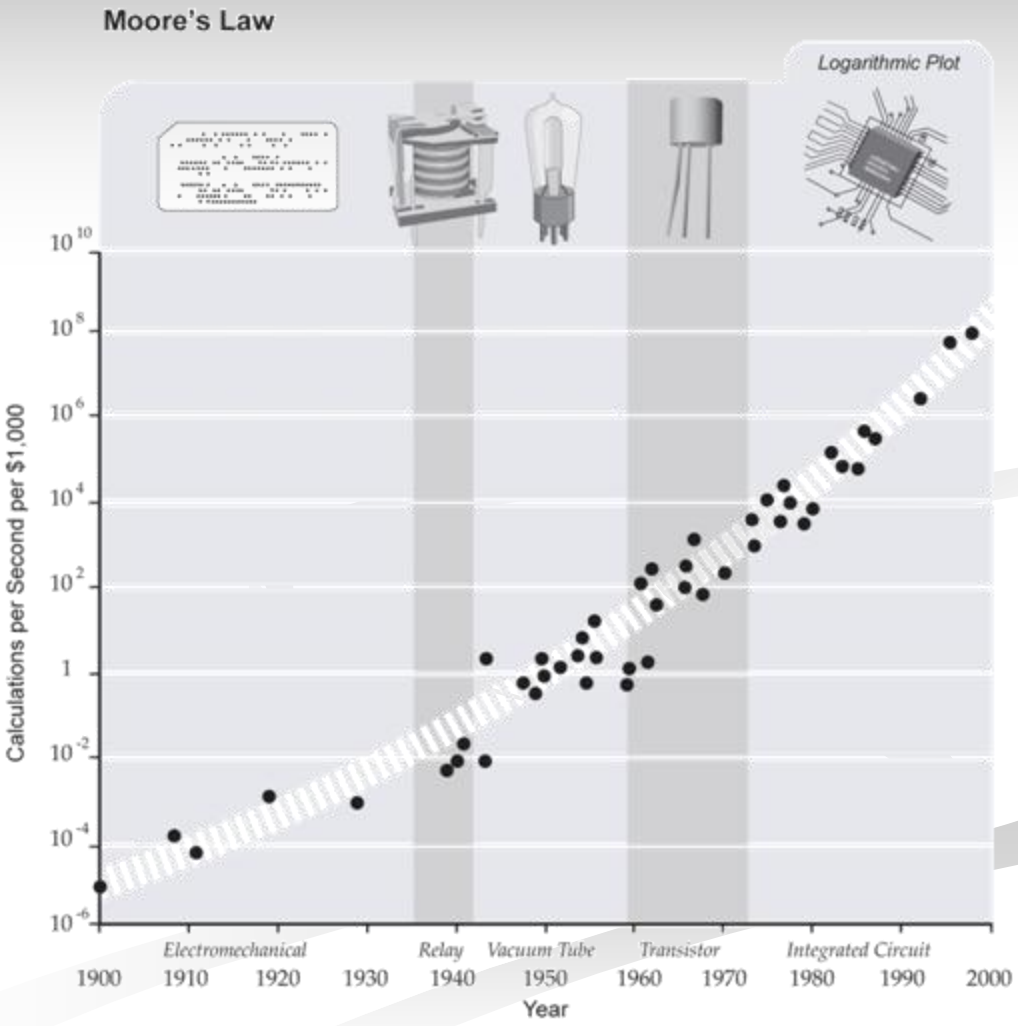
LB9RE

Allerede kjente digitale radiotyper

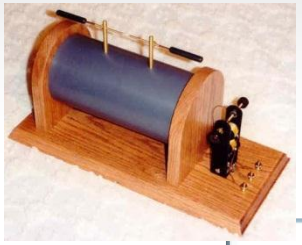
- GSM
- DAB
- Tetra
- DVT
- SDR
- Militæret, romfart, etc; mange flere…

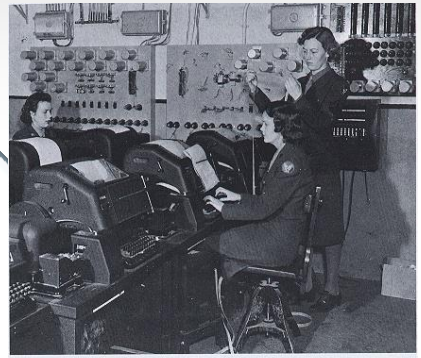
Radio Follows Moore's Law Too

- First 50 Years
  - Electro Mechanical
  - Vacuum Tube
- Second 50
  - Transistor
  - IC
- Next… ?

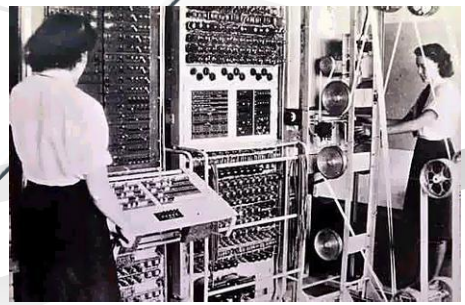


No Software

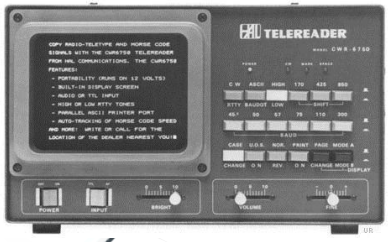


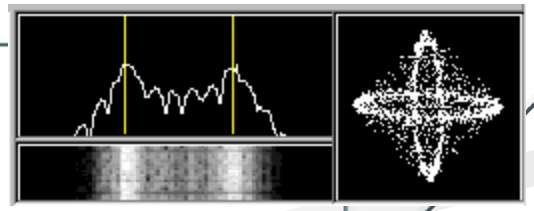


WACs assigned to the Eighth Air Force in England operate teletype machines. (DOD photograph)



Peripheral Software





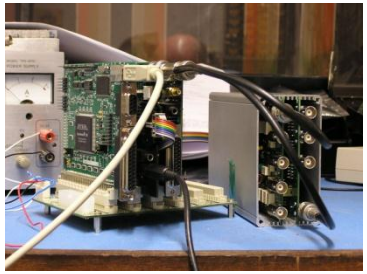
Integrated!


FLEX-5000A
FlexRadio Systems

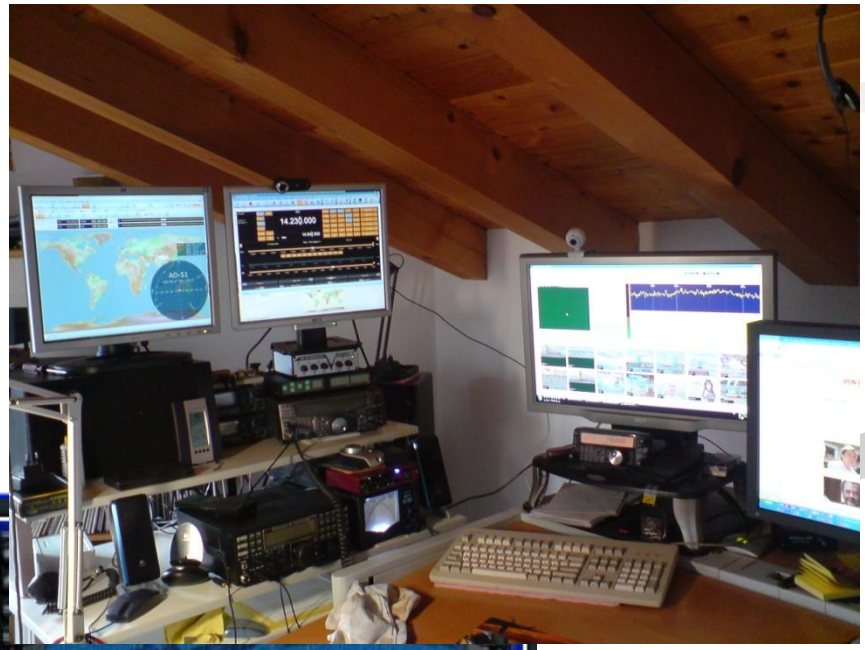

ORION II
14.040.000
15.000.000


ELECRAFT K3 TRANSCEIVER
14.195.000
14.200.000


KENWOOD




RXB
TXA
TXB
RXA
ALTERA
Cyclone




14.195.000
14.200.000
YAESU
FTdx9000D

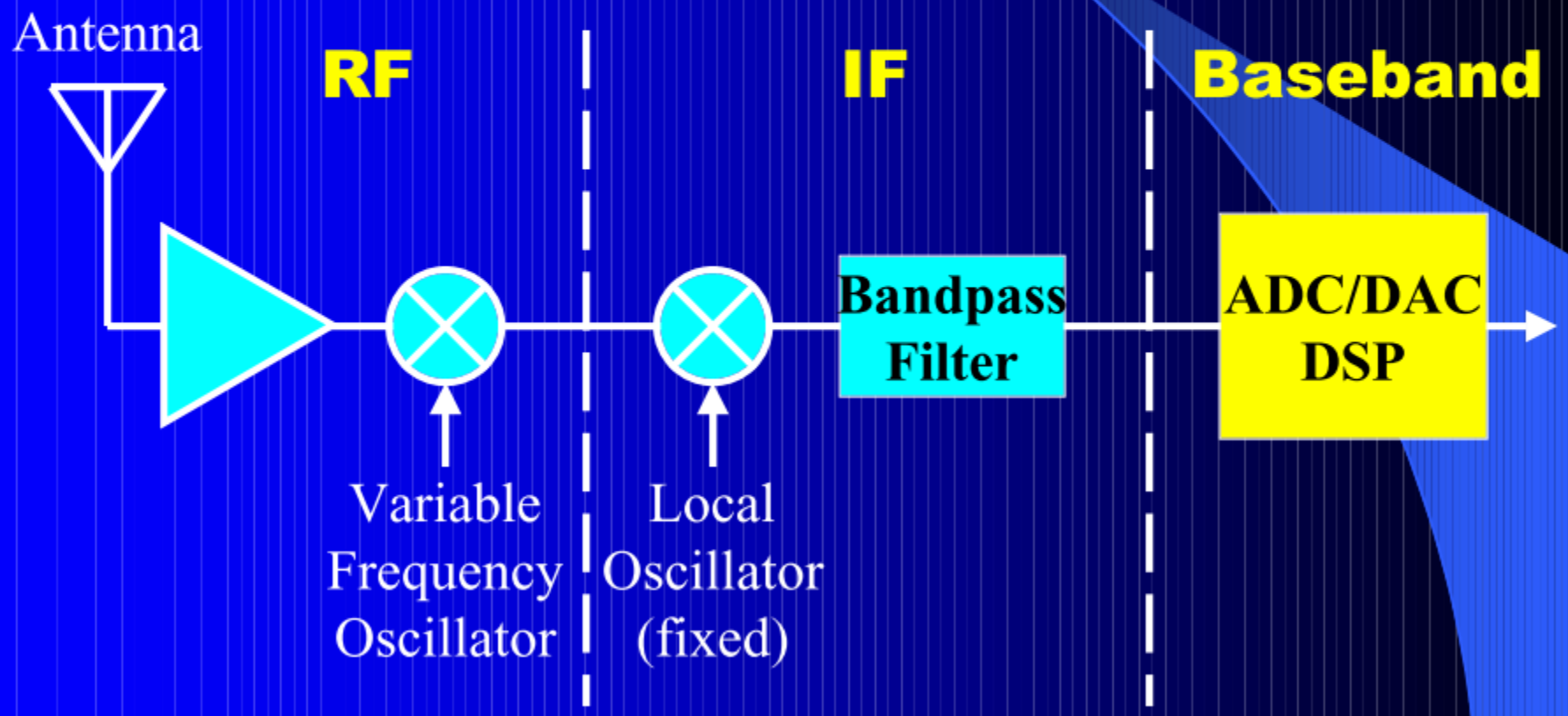
De siste dinosaurene?

Amateur Radio Software Domains

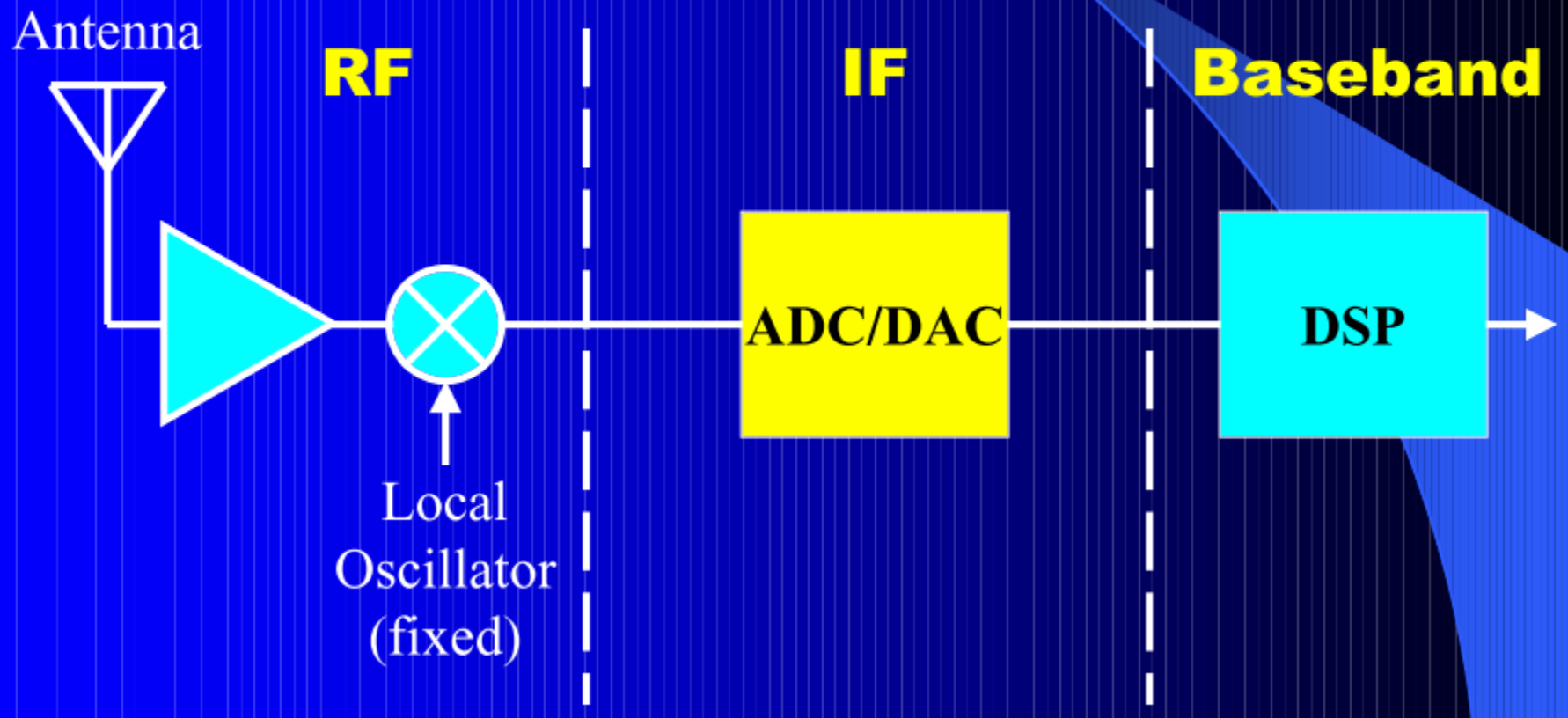
- Housekeeping and Convenience
  - Logging and Contest
  - Web-based (e.g. DX Spots, QRZ)
- Engineering
  - CAD
  - Antenna Design
  - Propagation
- Control and Automation
  - Station Control
  - Remote Stations
- Signal Processing
  - DSP
  - Data and Voice
  - Spectrum
- Software Defined Radio
  - Software is the Radio
- Individualized (Custom) Software

Converging

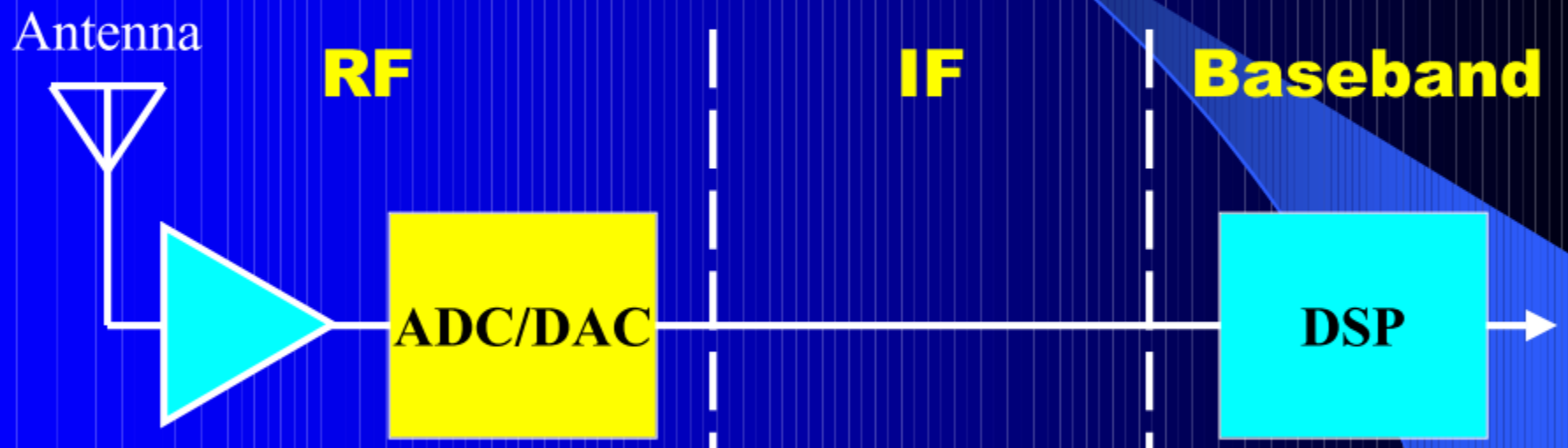
Block Diagram
Software Defined Radio



Block Diagram
Software Defined Radio

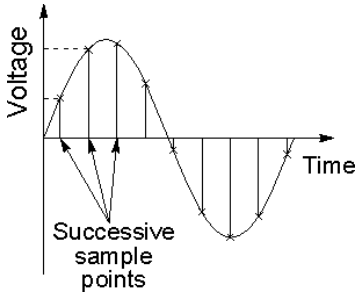


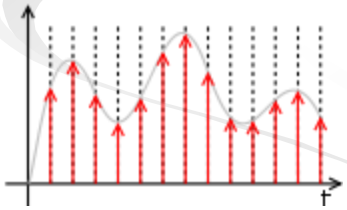
Block Diagram Software Radio



Digital Signal Processing

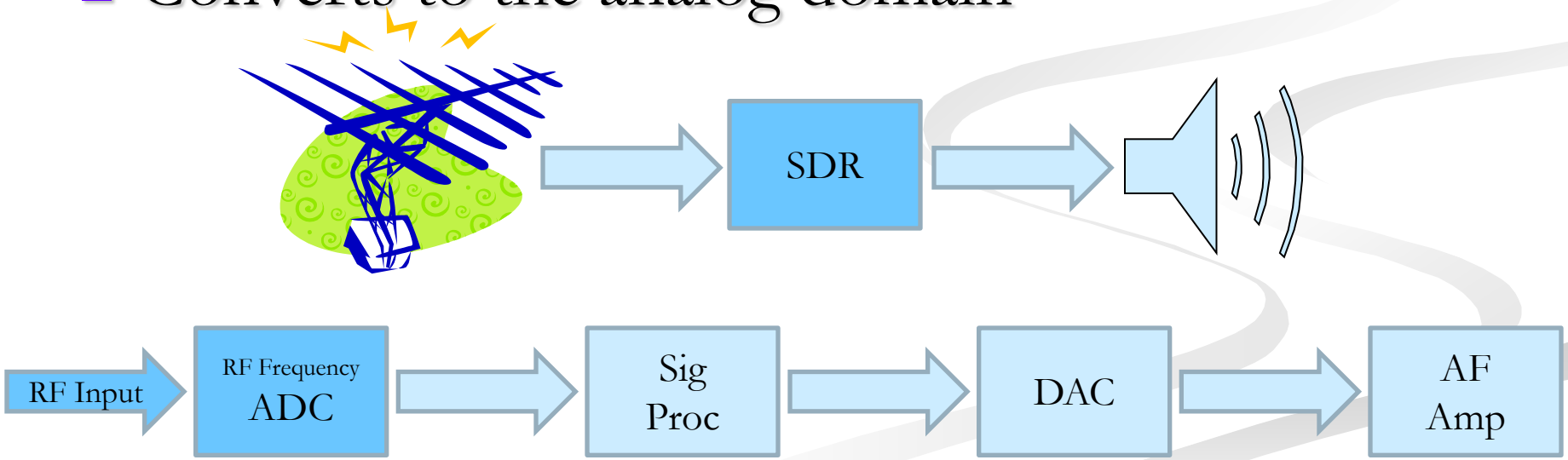
- Converts signal to the digital domain
- Analyzes and Processes the data
- Converts back to the analog domain
- Upgrade: AF to IF





The Ideal (Digital) Radio

- Direct RF Conversion (zero IF)
- Signal analysis and processing
- Converts to the analog domain



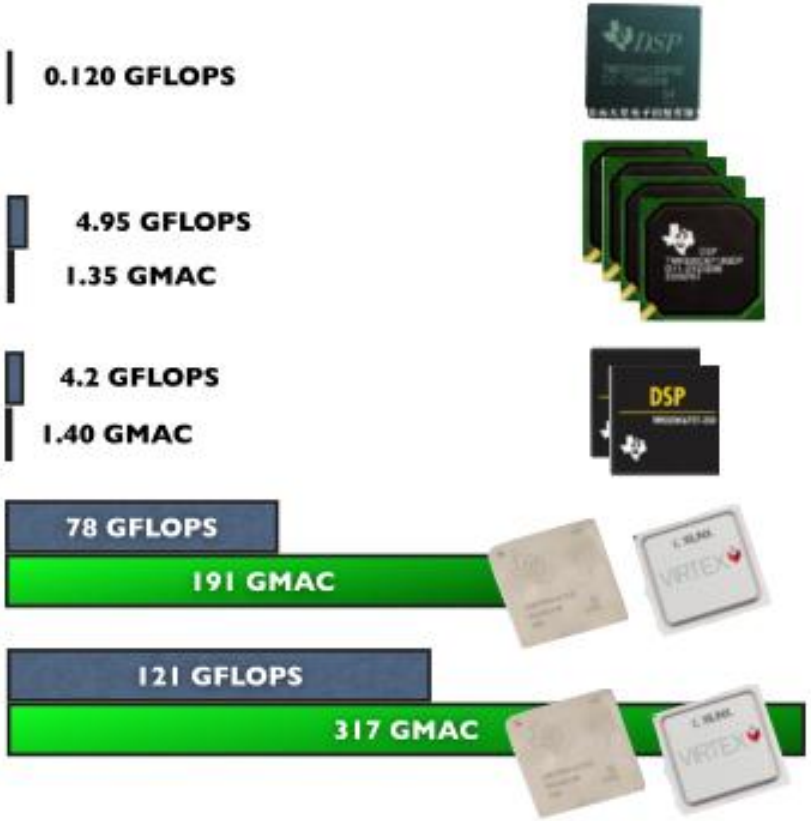
Brand A
Texas Instruments TMS320VC33

Brand B
Texas Instruments TMS320C6713 x3 + TMS320C6711

Brand C
Texas Instruments TMS320C6727B x2

FLEX-6500
Texas Instruments TMS320DM8168 + XC6VLX75T

FLEX-6700 / FLEX-6700R
Texas Instruments TMS320DM8168 + XC6VLX130T



NERG
North - East Radio Group Inc.

History of SDR

- The history of SDR began in the mid 1980's. One of the first major developments for SDR was the SpeakEasy, a transceiver platform designed by Hazeltine and Motorola, based on SDR technology for Rome AFB.
- The SpeakEasy was designed to provide tactical military communications from 2 MHz to 2 GHz and to provide interoperability between the different air interface standards of the different branches of the armed forces.

PRODUCT REVIEW

FlexRadio Systems FLEX-5000A HF/50 MHz Transceiver

Reviewed by Rick Lindquist, WW3DE
NCJ Managing Editor

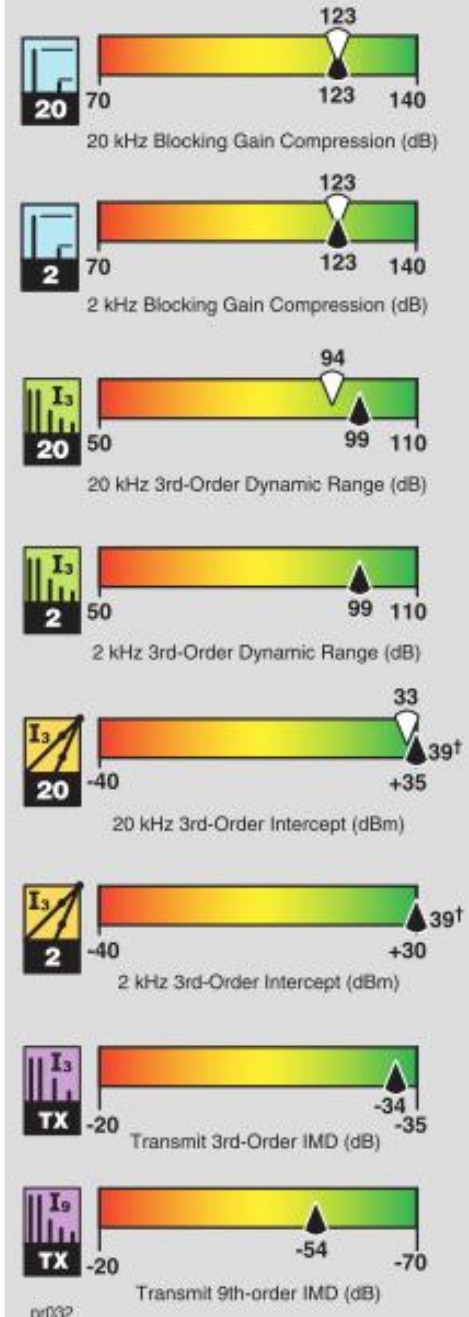
As we said in May 1998 *QST* when reviewing the first commercially available strictly computer controlled Amateur Radio transceiver, the Kachina 505DSP: "The relegation of functionality from hardware to software and firmware opens broad vistas of future capability." *Are we there yet?* Or did our flight to nirvana get canceled? A decade down the road, Kachina is kaput in the amateur market, and the newer software defined ham radio bar another notch.

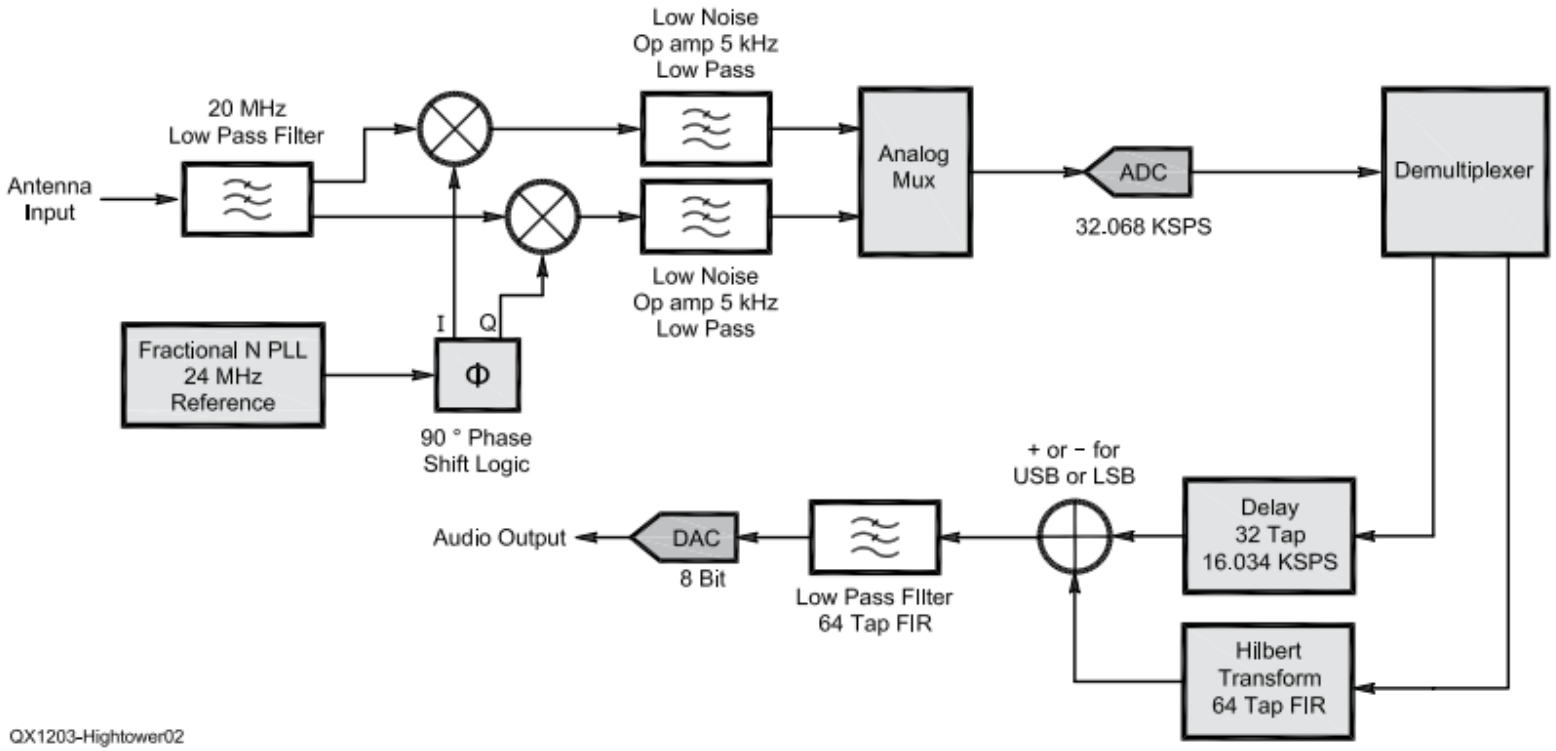
Expanding Your Vocabulary

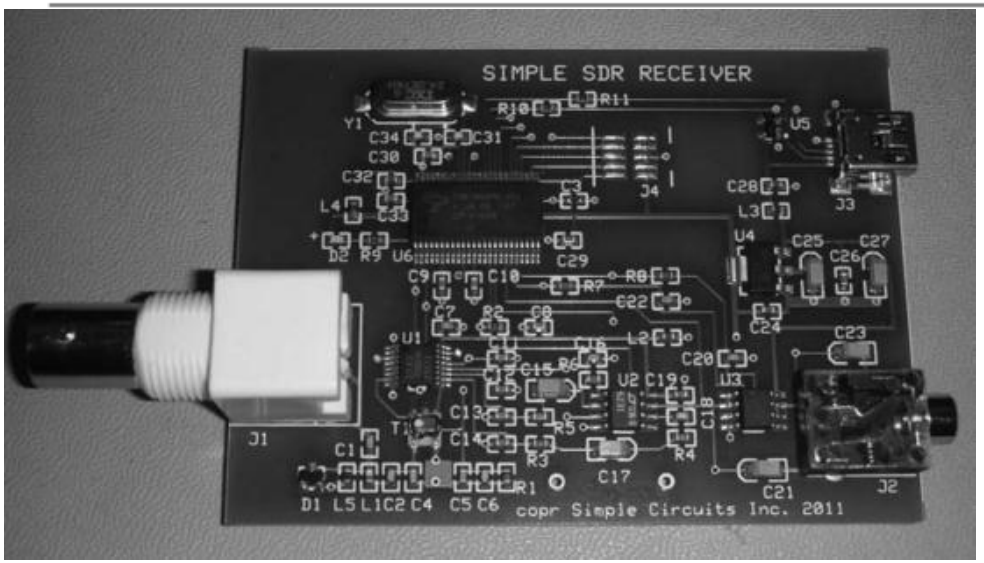
Just as hams once fretted about grid drive, overmodulation and key clicks, the very nature of SDRs has given rise to a new crop of issues with names like "latency" and "sampling rate." This is *serious* technology, and it's not necessarily for the faint of heart.

In an SDR, analog RF signals are converted to a digital bit stream, and everything

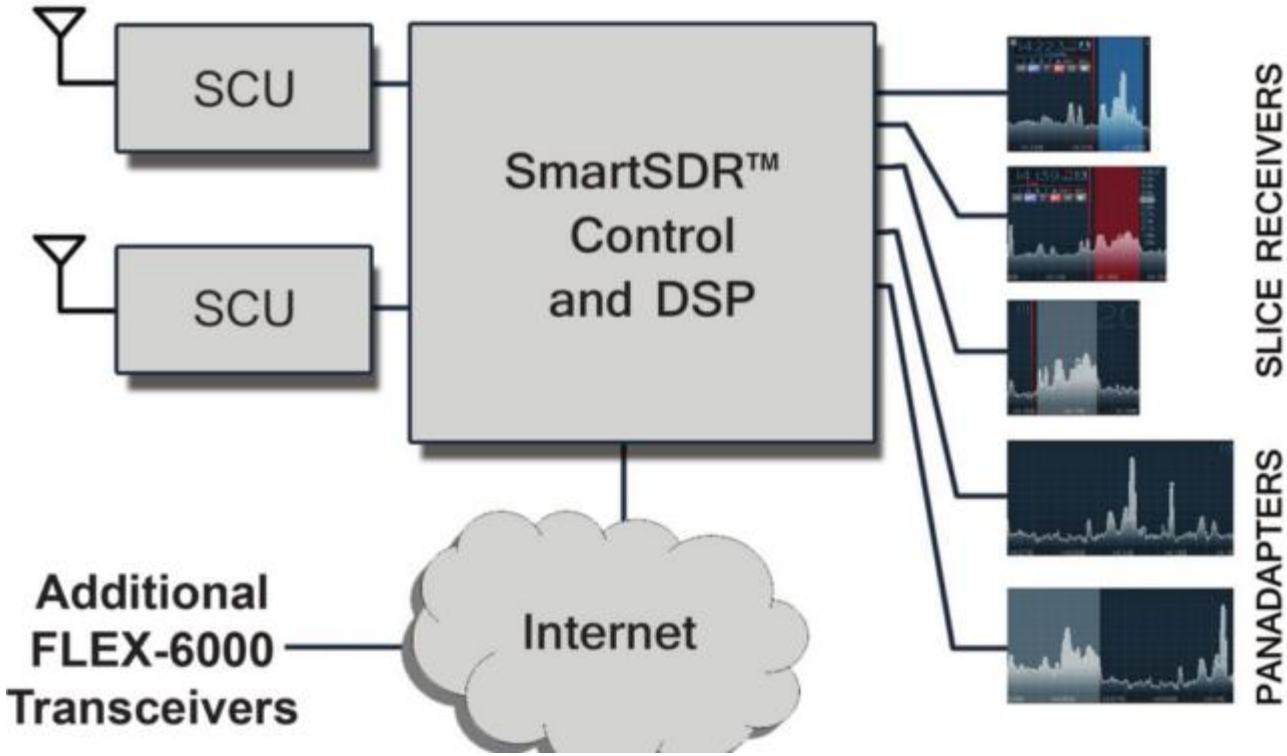
Key Measurements Summary

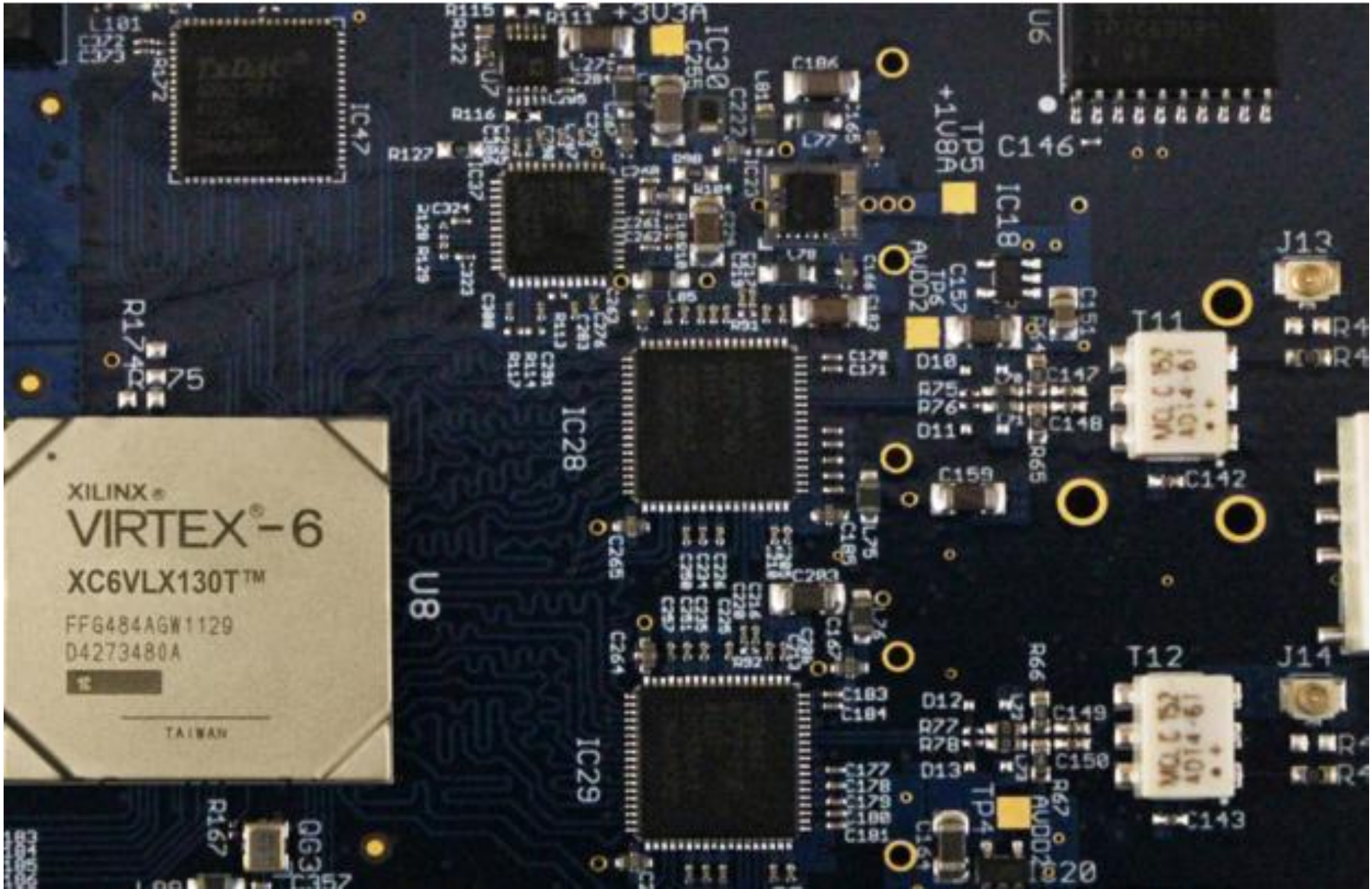



Low Noise
Op amp 5 kHz
Low Pass
20 MHz
Low Pass Filter
Antenna
Input
Analog
Mux
ADC
32.068 KSPS
Demultiplexer
Low Noise
Op amp 5 kHz
Low Pass
I
Q
Fractional N PLL
24 MHz
Reference
Φ
90 ° Phase
Shift Logic
+ or − for
USB or LSB
Delay
32 Tap
16.034 KSPS
Audio Output
DAC
8 Bit
Low Pass FIlter
64 Tap FIR
Hilbert
Transform
64 Tap FIR
QX1203-Hightower02


SIMPLE SDR RECEIVER
copr Simple Circuits Inc. 2011

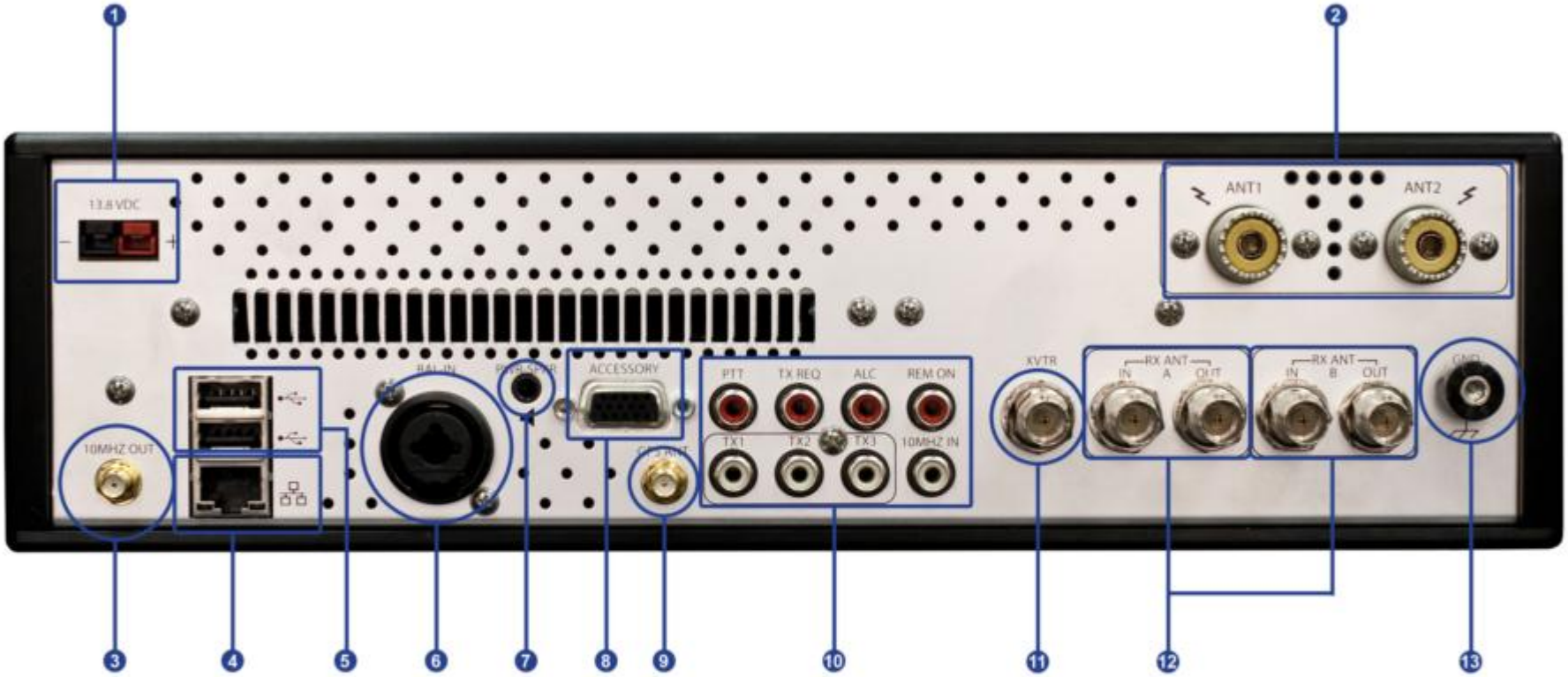

FlexRadio Systems
FLEX-6700
MIC
PHONES
KEY
FlexRadio Systems


SCU
SCU
SmartSDR™
Control
and DSP
Internet
Additional
FLEX-6000
Transceivers
SLICE RECEIVERS
PANADAPTERS

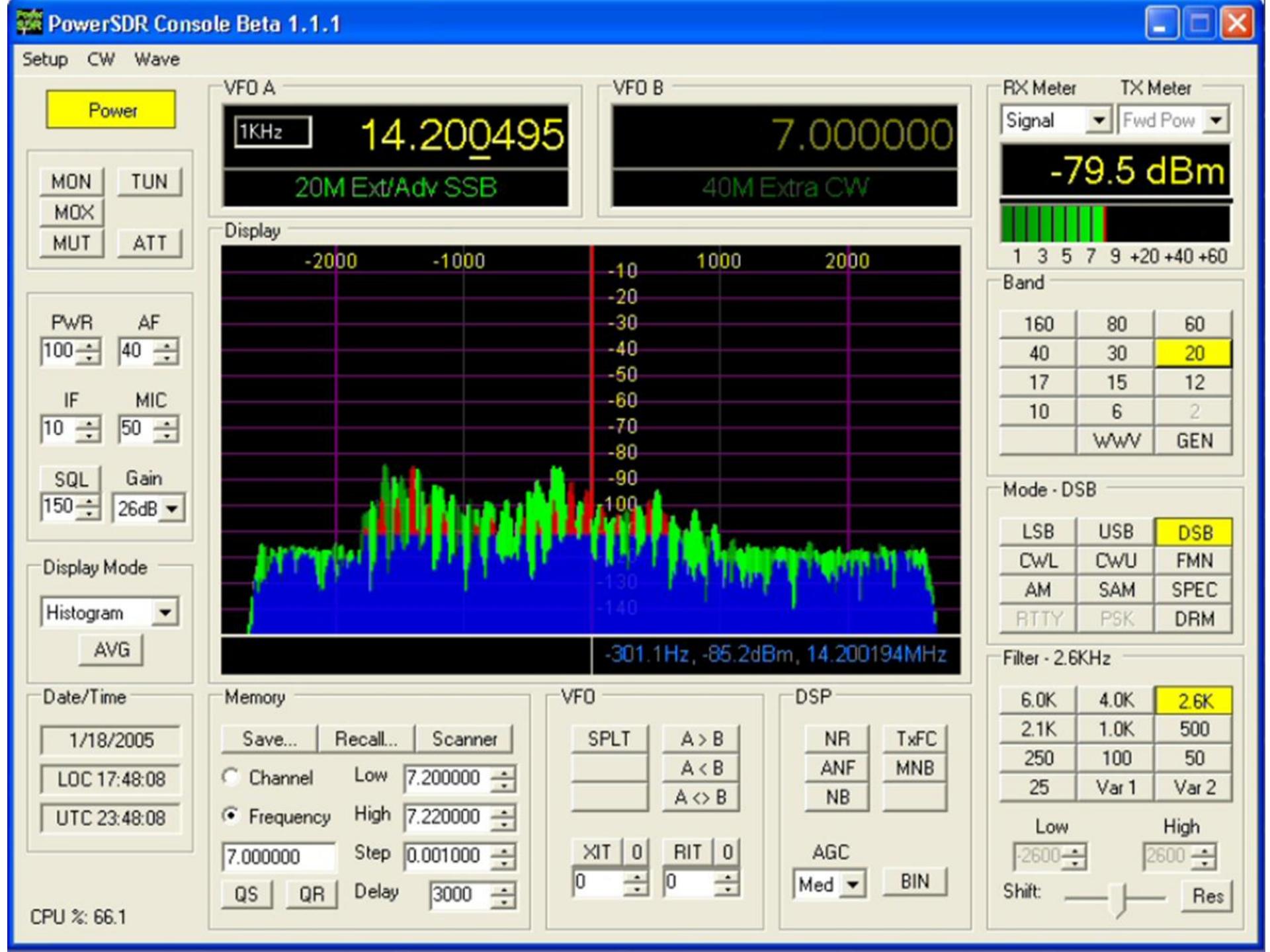

XILINX
VIRTEX-6
XC6VLX130T
FFG484AGW1129
D4273480A
TAIWAN
U8
IC28
IC29
IC30
IC47
IC18
U6
U7
+3V3A
+1V8A
TP5
TP4
TP6
AVDD2
C146
C142
C143
T11
T12
J13
J14
R174
R167
QG3
C357

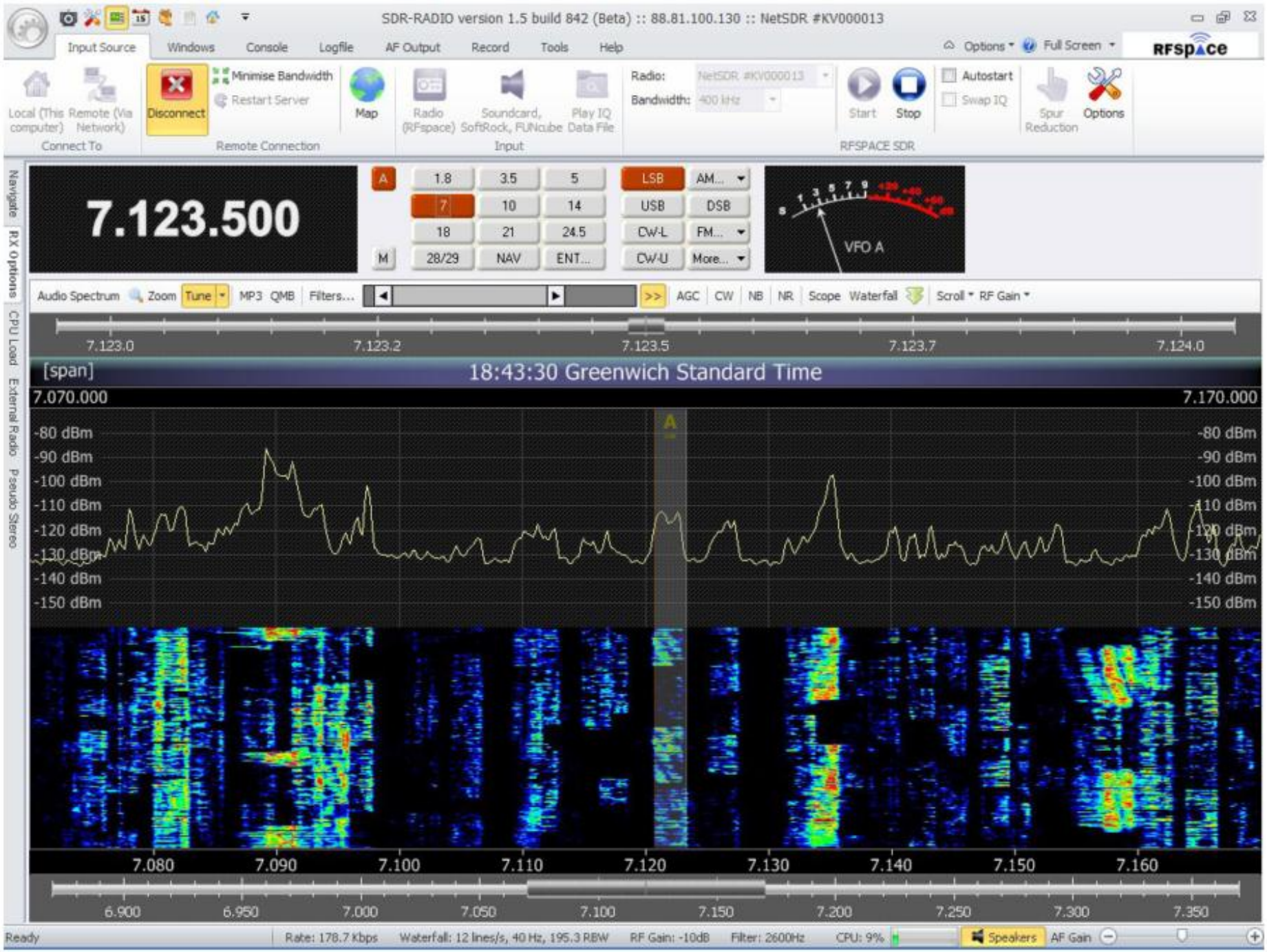

File View Help
FlexRadio Systems
14.139
B
14.223
A
USB ANT2 IT SPLT DSP
USB ANT1 IT SPLT DSP
3.3k
5.0k
4.4k
3.8k
3.3k
2.9k
0.7k
2.4k
2.1k
1.8k
1.0k
20m
-50
-60
-70
-80
-90
-100
-110
dBm
14.078
14.098
14.118
14.138
14.158
14.178
14.198
14.218
14.238
14.258
14.278
14.298
C
D
20m
-70
-80
-90
-100
-110
dBm
13.998
14.018
14.038
14.058
14.078
14.098
14.118
14.138
14.158
14.178
14.198
14.218

Baksiden, opptrent som før…

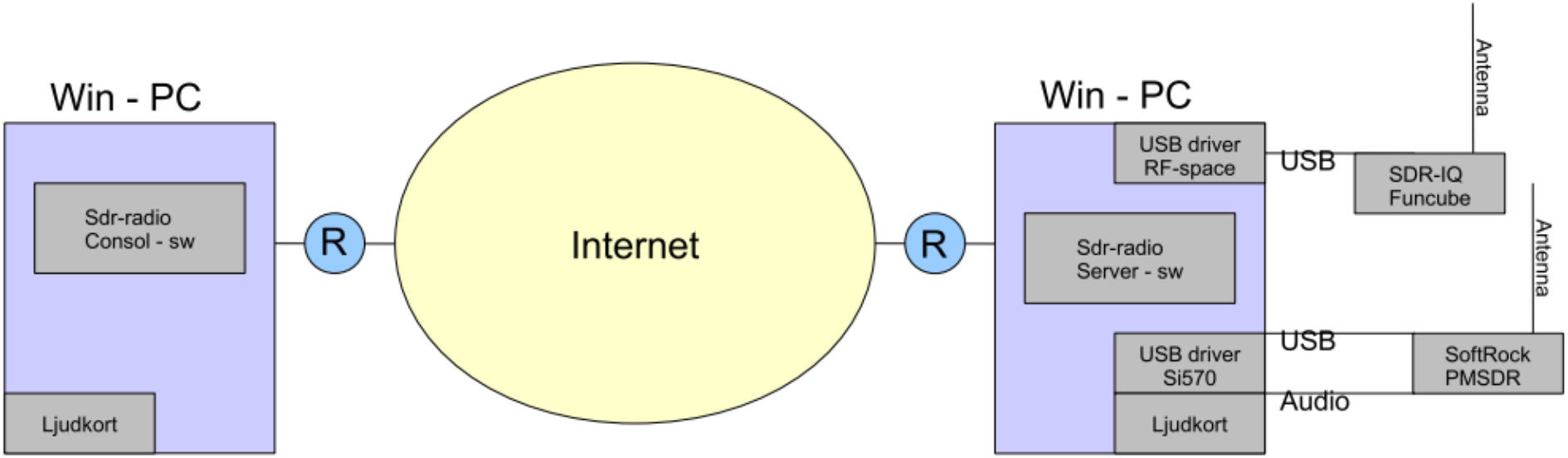


1. +13.8V DC Power In
2. Antenna Connectors
3. Optional 10 MHz GPSDO Output
4. 1 Gb Ethernet Connector
5. USB 2.0 Peripheral Connections
6. Balanced Microphone/Line Input
7. Powered Speaker/Line Output
8. Accessory Connector
9. Optional GPS Antenna Input
10. TX Relay Control
11. Transverter IF Connector
12. SCU Receive Antenna Connectors
13. Ground Terminal


PowerSDR Console Beta 1.1.1
Setup
CW
Wave
Power
MON
TUN
MOX
MUT
ATT
PWR
100
AF
40
IF
10
MIC
50
SQL
150
Gain
26dB
Display Mode
Histogram
AVG
Date/Time
1/18/2005
LOC 17:48:08
UTC 23:48:08
CPU %: 66.1
VFO A
1KHz
14.200495
20M Ext/Adv SSB
VFO B
7.000000
40M Extra CW
Display
-2000
-1000
1000
2000
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-130
-140
-301.1Hz, -85.2dBm, 14.200194MHz
Memory
Save...
Recall...
Scanner
Channel
Frequency
Low
7.200000
High
7.220000
7.000000
Step
0.001000
QS
QR
Delay
3000
VFO
SPLT
A > B
A < B
A <> B
XIT
0
RIT
0
0
0
DSP
NR
TxFC
ANF
MNB
NB
AGC
Med
BIN
RX Meter
TX Meter
Signal
Fwd Pow
-79.5 dBm
1 3 5 7 9 +20 +40 +60
Band
160
80
60
40
30
20
17
15
12
10
6
2
WWV
GEN
Mode - DSB
LSB
USB
DSB
CWL
CWU
FMN
AM
SAM
SPEC
RTTY
PSK
DRM
Filter - 2.6KHz
6.0K
4.0K
2.6K
2.1K
1.0K
500
250
100
50
25
Var 1
Var 2
Low
-2600
High
2600
Shift:
Res


SDR-RADIO version 1.5 build 842 (Beta) :: 88.81.100.130 :: NetSDR #KV000013
Input Source
Windows
Console
Logfile
AF Output
Record
Tools
Help
Options
Full Screen
RFspace
Local (This computer)
Remote (Via Network)
Connect To
Disconnect
Minimise Bandwidth
Restart Server
Remote Connection
Map
Radio (RFspace)
Soundcard, SoftRock, FUNcube
Play IQ Data File
Input
Radio:
NetSDR #KV000013
Bandwidth:
400 kHz
Start
Stop
Autostart
Swap IQ
RFSPACE SDR
Spur Reduction
Options
Navigate
RX Options
CPU Load
External Radio
Pseudo Stereo
7.123.500
A
M
1.8
3.5
5
7
10
14
18
21
24.5
28/29
NAV
ENT...
LSB
AM...
USB
DSB
CW-L
FM...
CW-U
More...
VFO A
Audio Spectrum
Zoom
Tune
MP3
QMB
Filters...
AGC
CW
NB
NR
Scope
Waterfall
Scroll
RF Gain
7.123.0
7.123.2
7.123.5
7.123.7
7.124.0
[span]
18:43:30 Greenwich Standard Time
7.070.000
7.170.000
-80 dBm
-90 dBm
-100 dBm
-110 dBm
-120 dBm
-130 dBm
-140 dBm
-150 dBm
7.080
7.090
7.100
7.110
7.120
7.130
7.140
7.150
7.160
6.900
6.950
7.000
7.050
7.100
7.150
7.200
7.250
7.300
7.350
Ready
Rate: 178.7 Kbps
Waterfall: 12 lines/s, 40 Hz, 195.3 RBW
RF Gain: -10dB
Filter: 2600Hz
CPU: 9%
Speakers
AF Gain

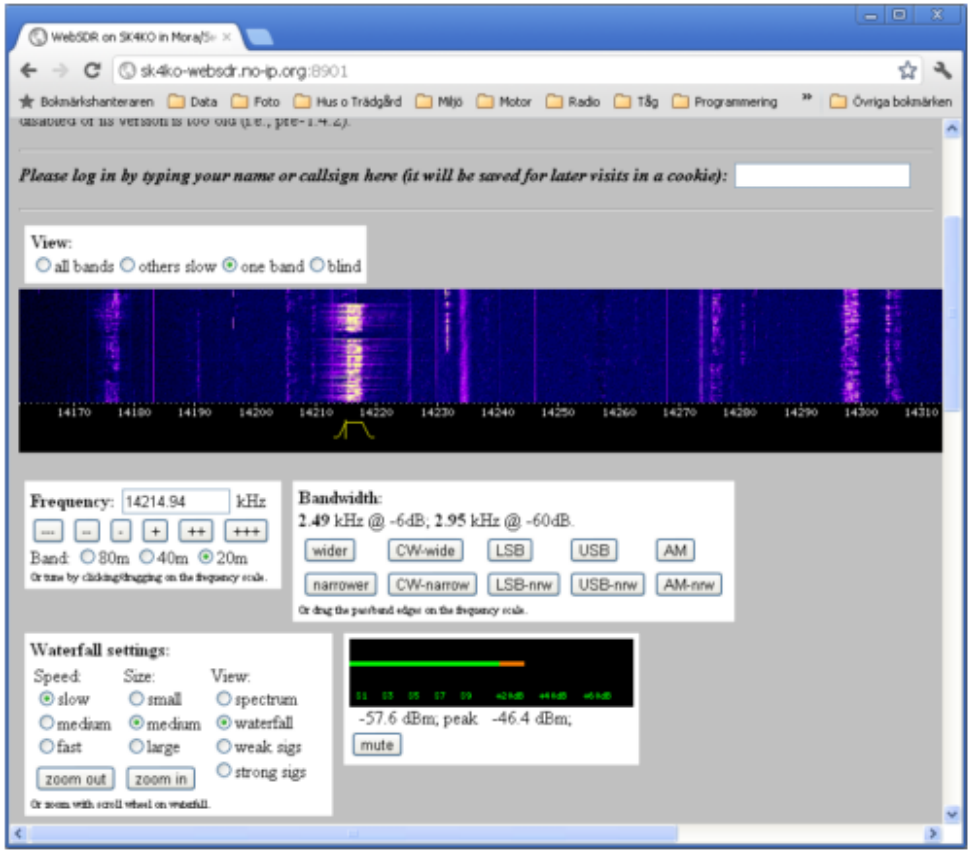
sdr-radio / Remote

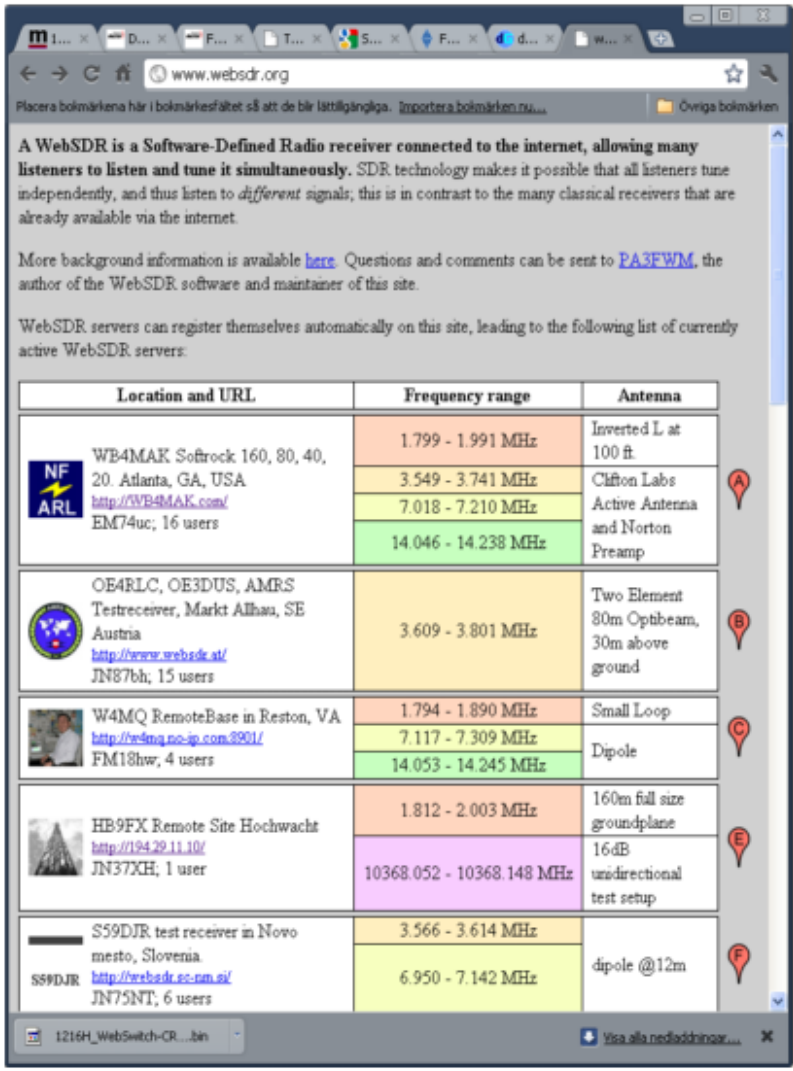


Direkt-SDR på nätet

http://www.WebSDR.org

Titta efter: SK4KO Siljansbygden

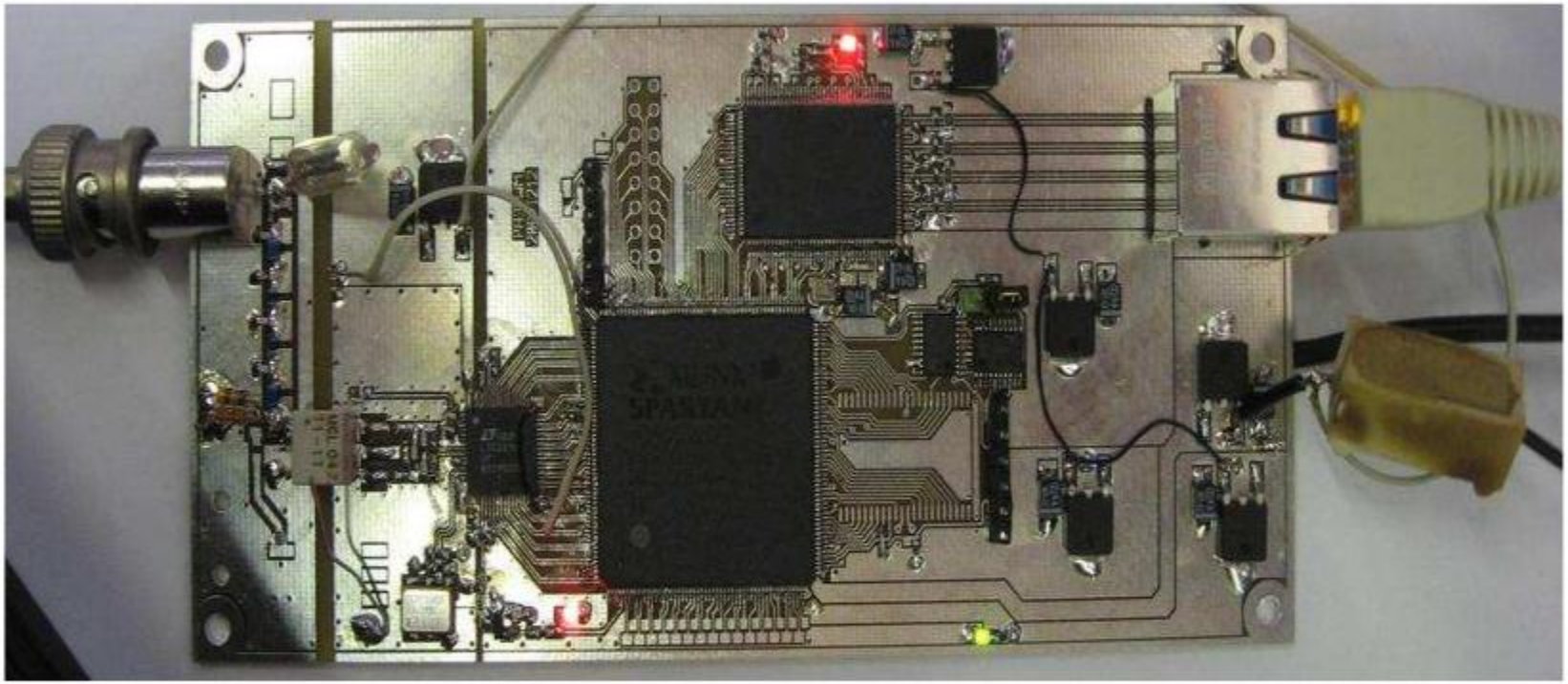




NERG
North - East Radio Group Inc.

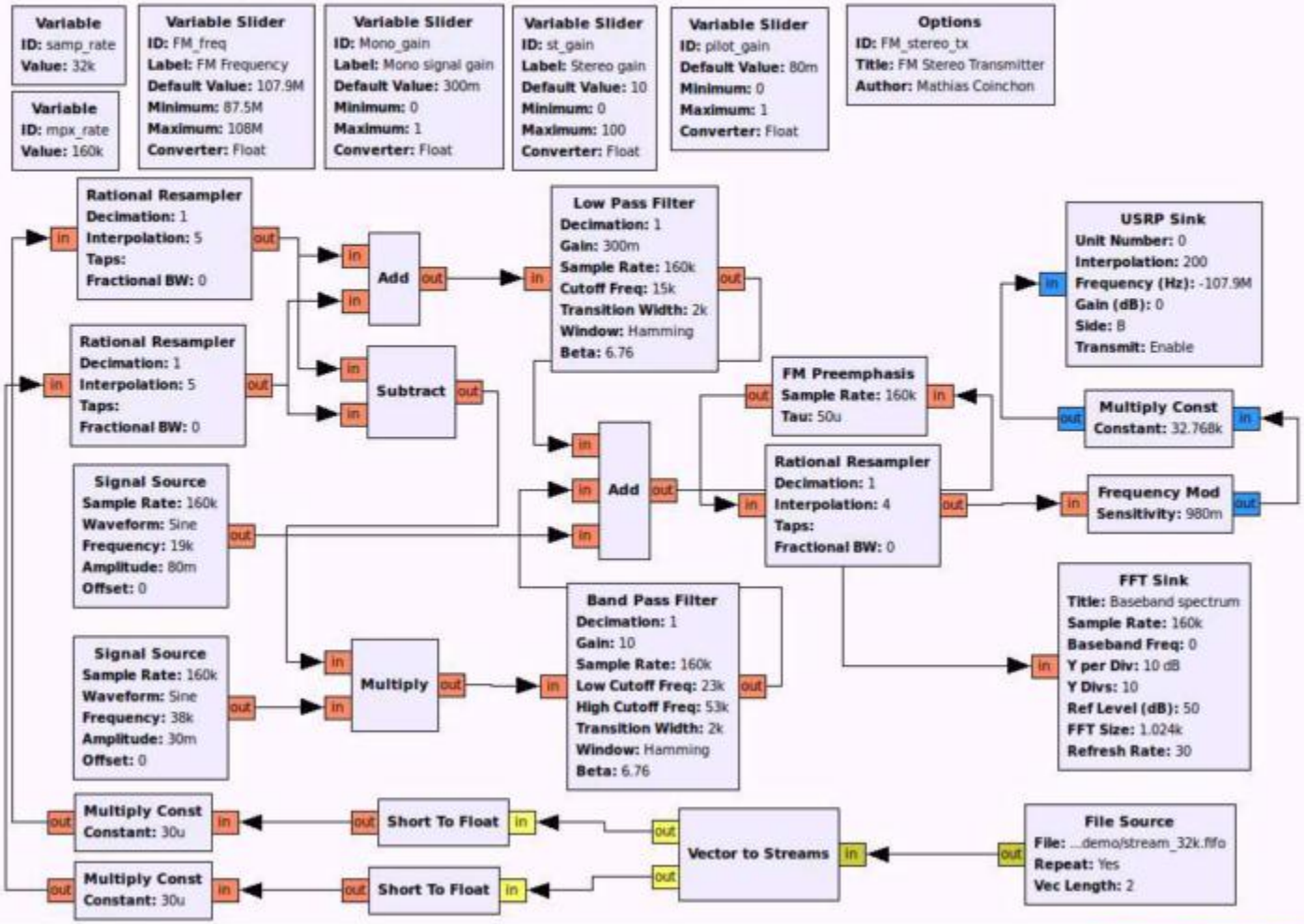
Software Defined Internet Radio??

http://websdr.ewi.utwente.nl:8901/



NERG
North - East Radio Group Inc.

Example: DYI Stereo Transmitter



SDR Empfänger FunCube

- Einfacher VHF / UHF SDR von 54 bis 2100 MHz !!

SDR's

€ 20 SDR Receiver

Original ppt by Edgar KC2UEZ, updated by PA3GJM Hans Vreeswijk

How this cheap SDR works?

- Input from an antenna is down sampled, filtered by The E4000 tunerchip and passed to an analog to digital converter (RTL2832U) the output is then sent to the computer by USB.
- All filtering, demodulation and other processing is done by the computer.
- Audible output is then played back on the computer speakers.

How this cheap SDR works?

- Input from an antenna is down sampled, filtered by The E4000 tunerchip and passed to an analog to digital converter (RTL2832U) the output is then sent to the computer by USB.
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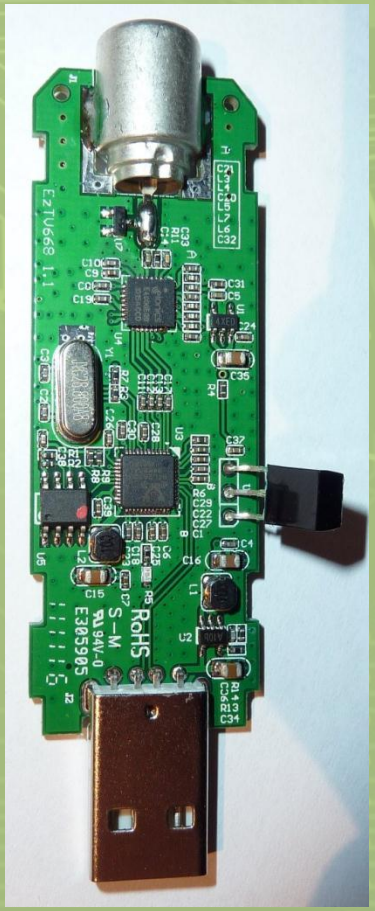
- Audible output is then played back on the computer speakers.

Compatible USB Devices

VID	PID	tuner	device name
0x0bda	0x2832	all of them	Generic RTL2832U (e.g. hama nano)
0x0bda	0x2838	E4000	ezcap USB 2.0 DVB-T/DAB/FM dongle
0x0ccd	0x00a9	FC0012	Terratec Cinergy T Stick Black (rev 1)
0x0ccd	0x00b3	FC0013	Terratec NOXON DAB/DAB+ USB dongle (rev 1)
0x0ccd	0x00d3	E4000	Terratec Cinergy T Stick RC (Rev.3)
0x0ccd	0x00e0	E4000	Terratec NOXON DAB/DAB+ USB dongle (rev 2)
0x185b	0x0620	E4000	Compro Videomate U620F
0x185b	0x0650	E4000	Compro Videomate U650F
0x1f4d	0xb803	FC0012	GTek T803
0x1f4d	0xc803	FC0012	Lifeview LV5TDeluxe
0x1b80	0xd3a4	FC0013	Twintech UT-40
0x1d19	0x1101	FC2580	Dexatek DK DVB-T Dongle (Logilink VG0002A)
0x1d19	0x1102	?	Dexatek DK DVB-T Dongle (MSI DigiVox? mini II V3.0)
0x1d19	0x1103	FC2580	Dexatek Technology Ltd. DK 5217 DVB-T Dongle
0x0458	0x707f	?	Genius TVGo DVB-T03 USB dongle (Ver. B)
0xd393	FC0012	GIGABYTE	GT-U7300
0x1b80	0xd394	?	DIKOM USB-DVBT HD
0x1b80	0xd395	FC0012	Peak 102569AGPK
0x1b80	0xd39d	FC0012	SVEON STV20 DVB-T USB & FM



Mine came from: http://s.dealextreme.com/search/44326

Took a look at Soft-Rock 40

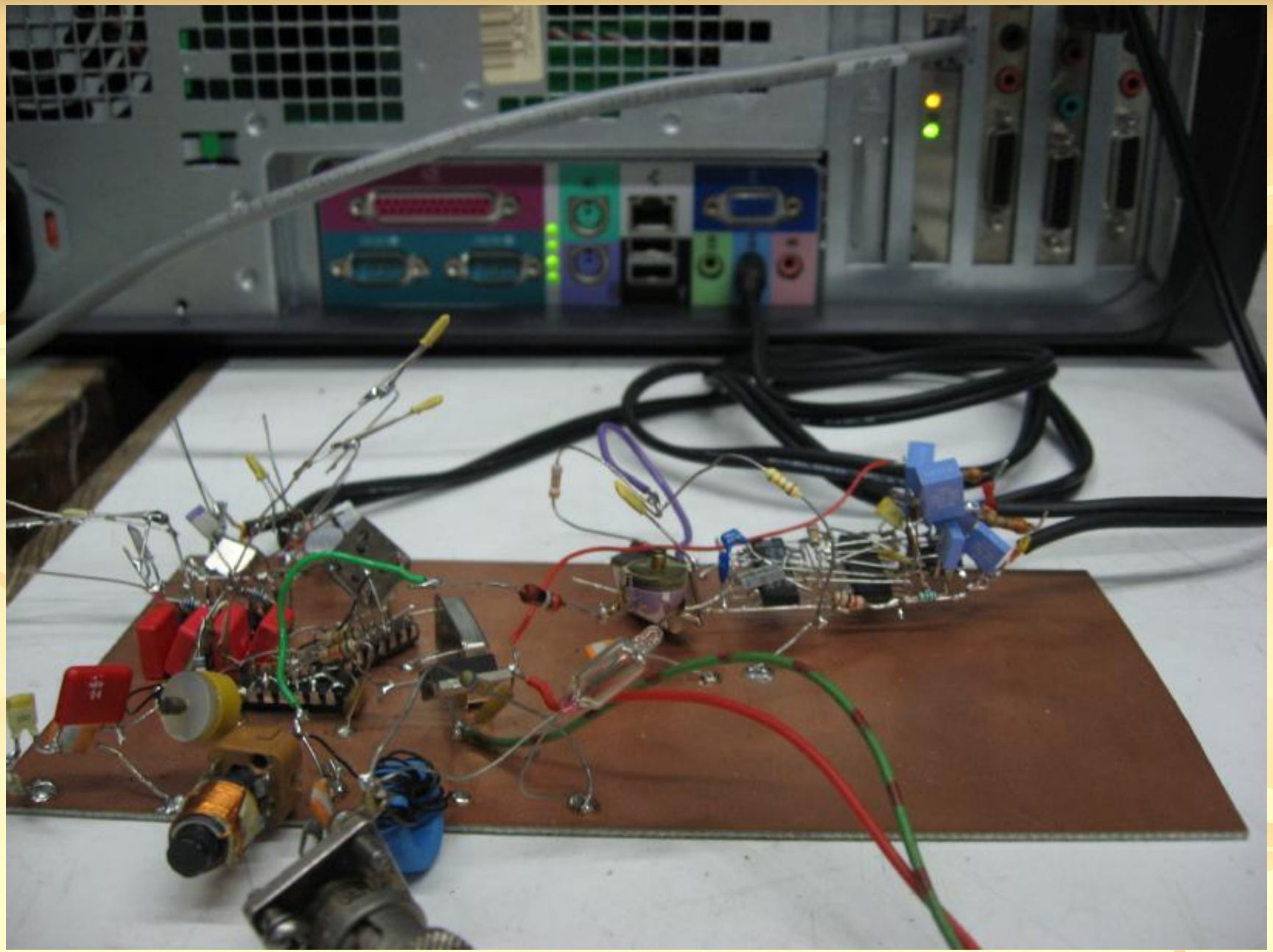
- Sold as kits or preassembled

- Initially receivers only, but exciters became available as well
- Inexpensive, good intro to SDR

FA-SDR Transceiver Bausatz

Lowest Cost

SoftRock RXTXv6.2



SDR Examples: Hardware

Perseus VLF- HF Receiver

- 14-bit 80Ms/s ADC
- Step input attenuator, 10-band preselector
- High IP3 preamp
- 10kHz – 30MHz Receiver
- 10kHz – 40MHz spectrum analyzer
- No sound system required
- USB 2.0 connection to computer
- Perseus Control Software for Windows 2000, XP, Vista
- Cost: £553 (€694, US$1075) excl vat

http://www.microtelecom.it/perseus

Hamvention Booths 652-653

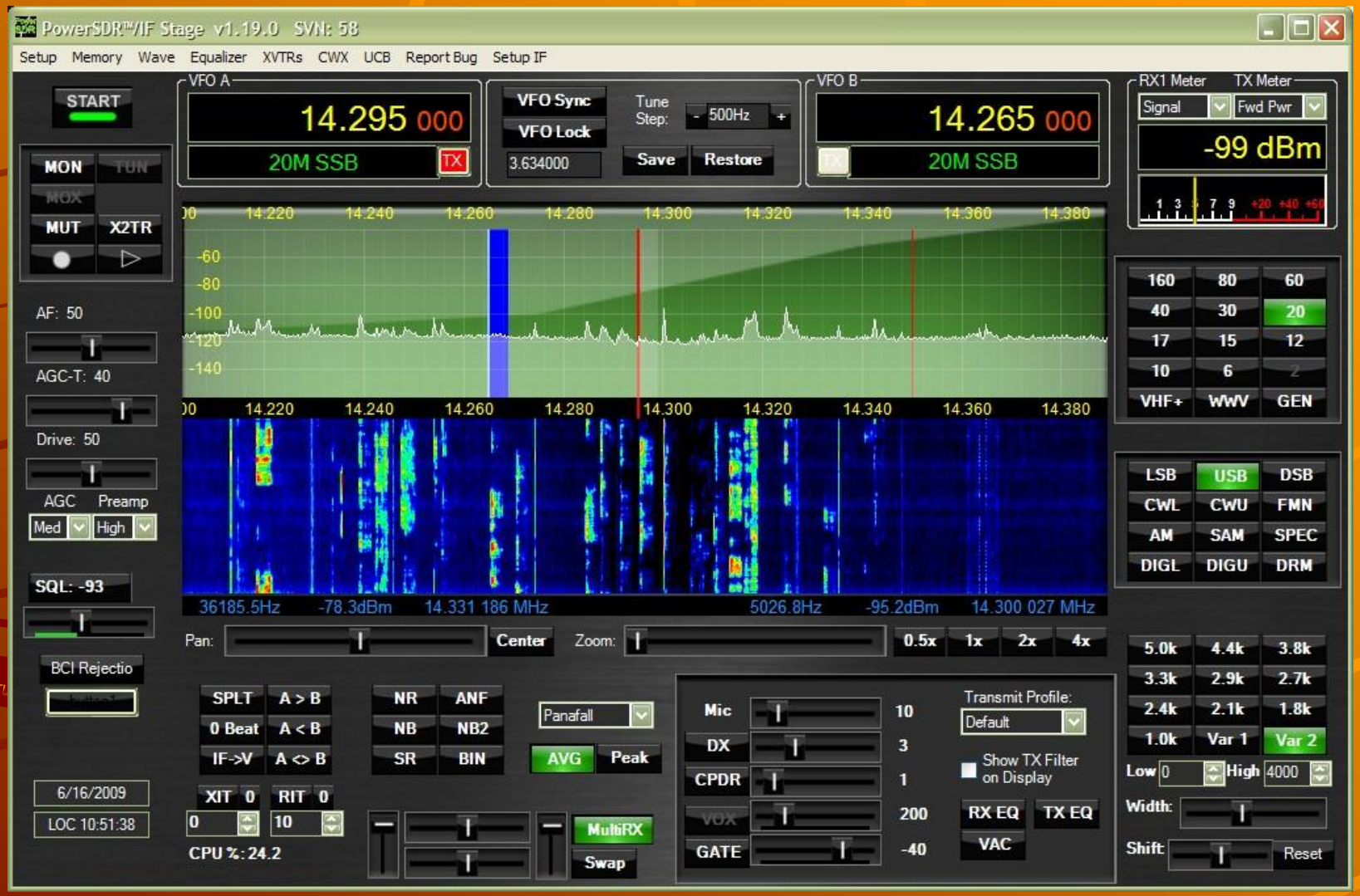
SDR Examples: Hardware

RF Space SDR-IQ VLF – HF Receiver

- 14-bit 66.6Ms/s ADC
- Switched input attenuators and filters
- 500Hz – 30MHz Receiver/Spectrum Analyzer
- No sound system required
- USB 2.0 powered – no power supply
- Network Server for Linux/Windows allows remote use
- SpectraVue Software for Windows 2000, XP, Vista
- Cost: US$499

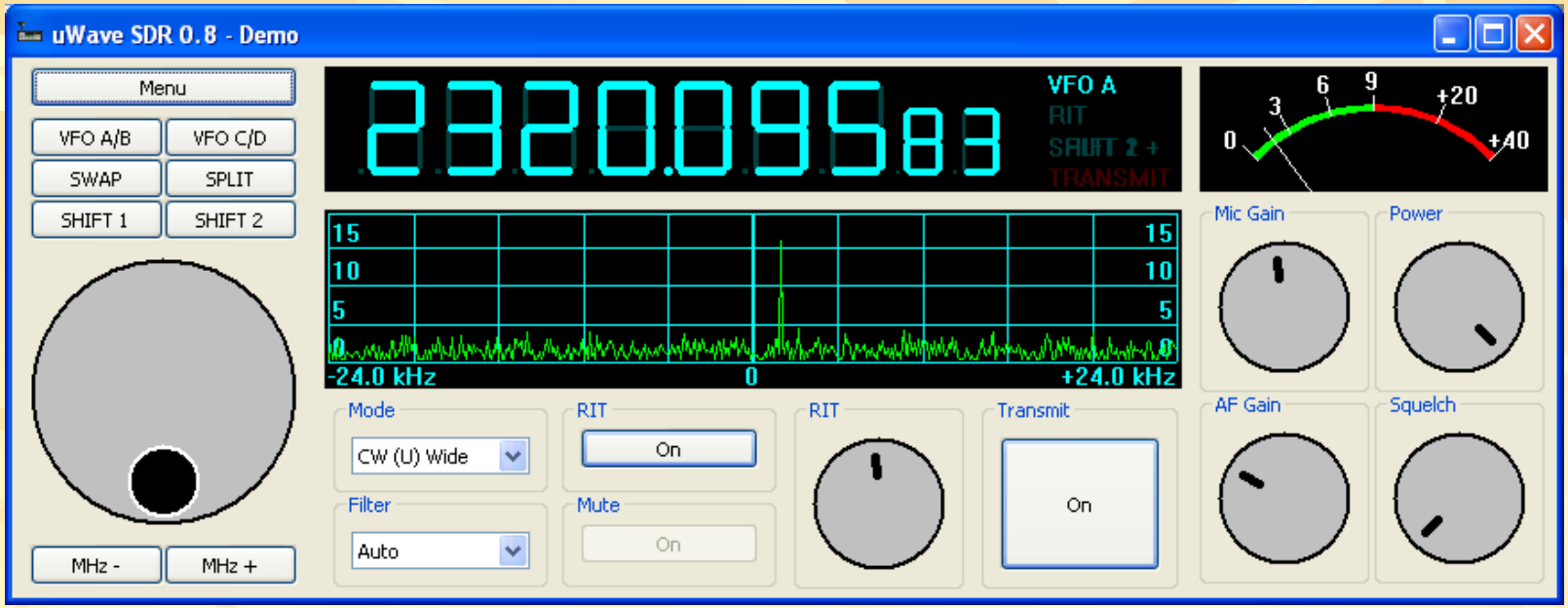
http://www.rfspace.com
http://groups.yahoo.com/group/SDR-IQ

Software Power SDR



SDR Examples: Software

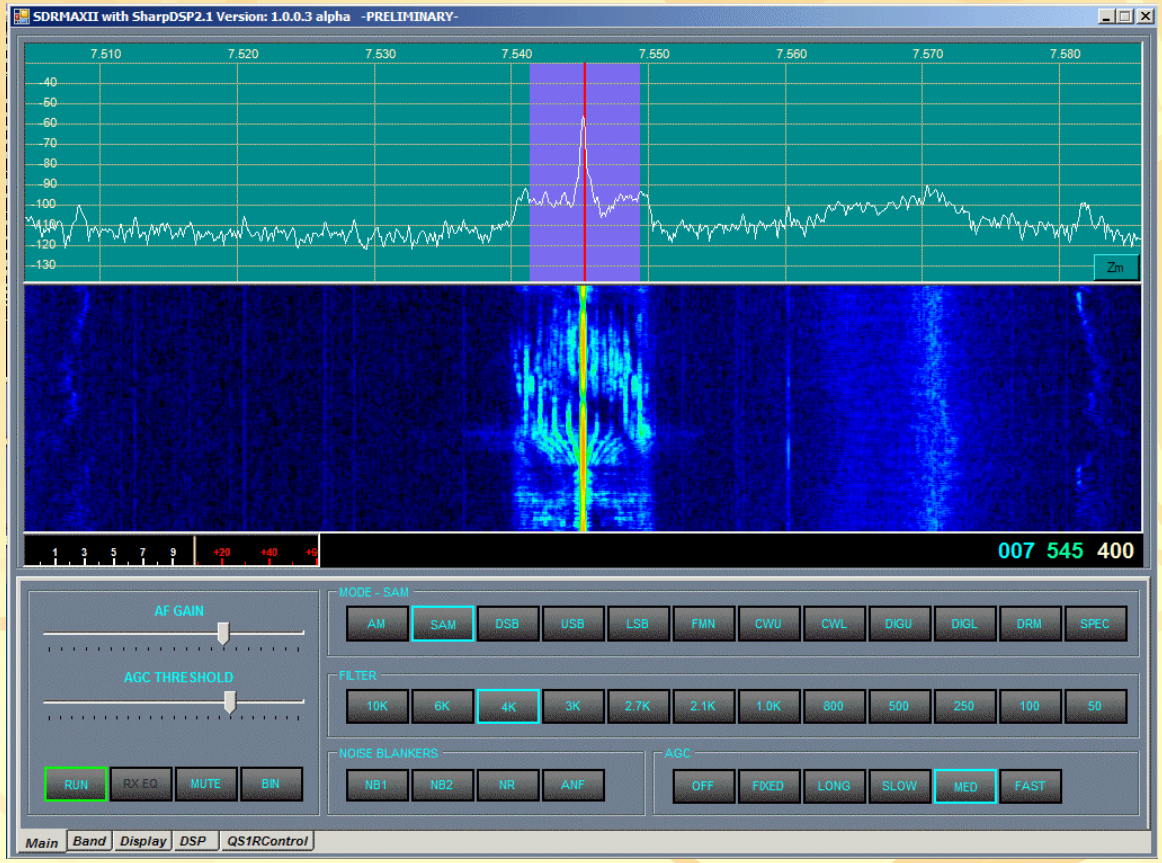
uWSDR GUI



http://uwsdr.berlios.de

SDR Examples: Software

SDRMAXII

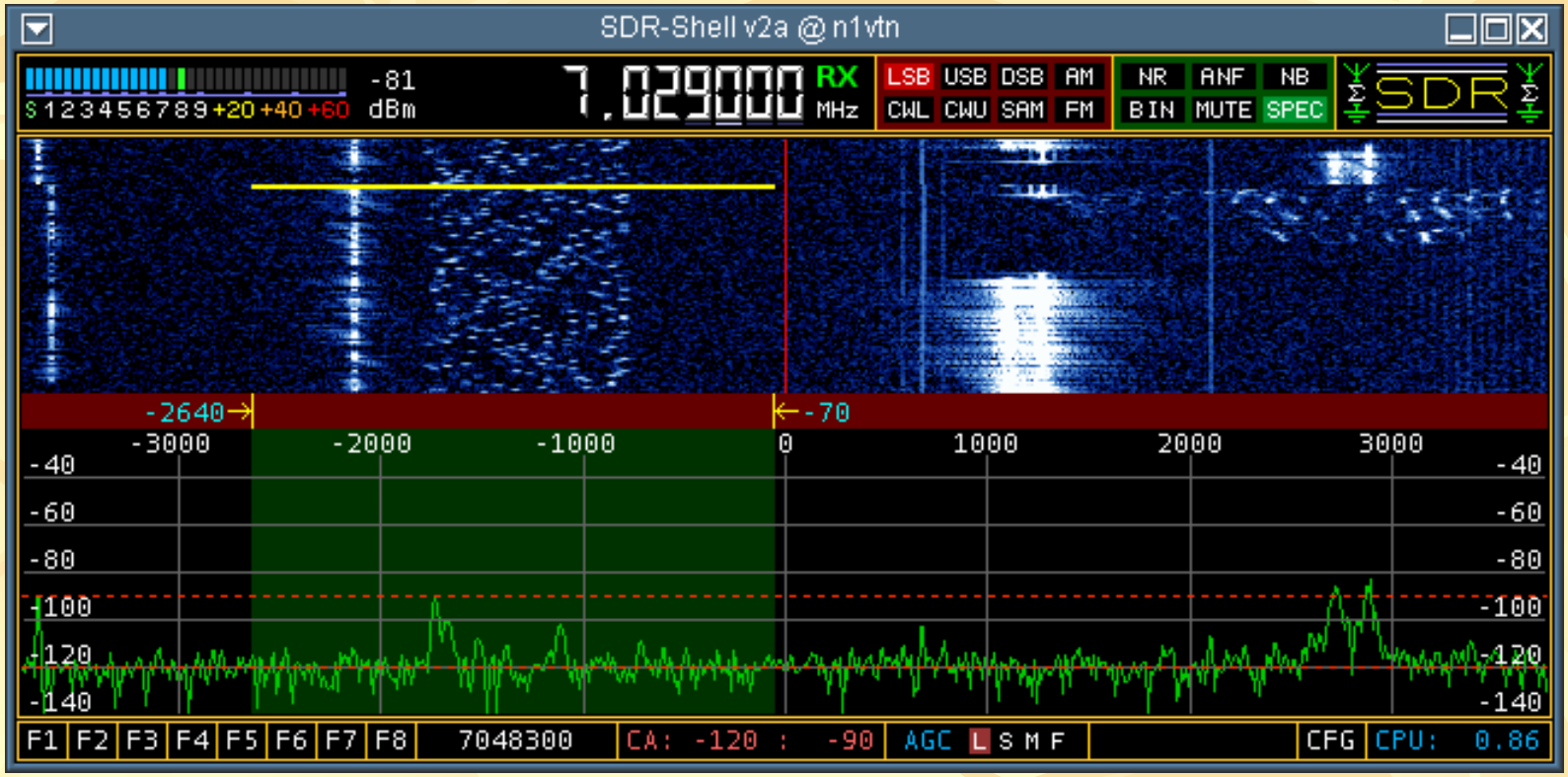


http://www.philcovington.com/QuickSilver

http://groups.yahoo.com/group/qs1r

SDR Examples: Software

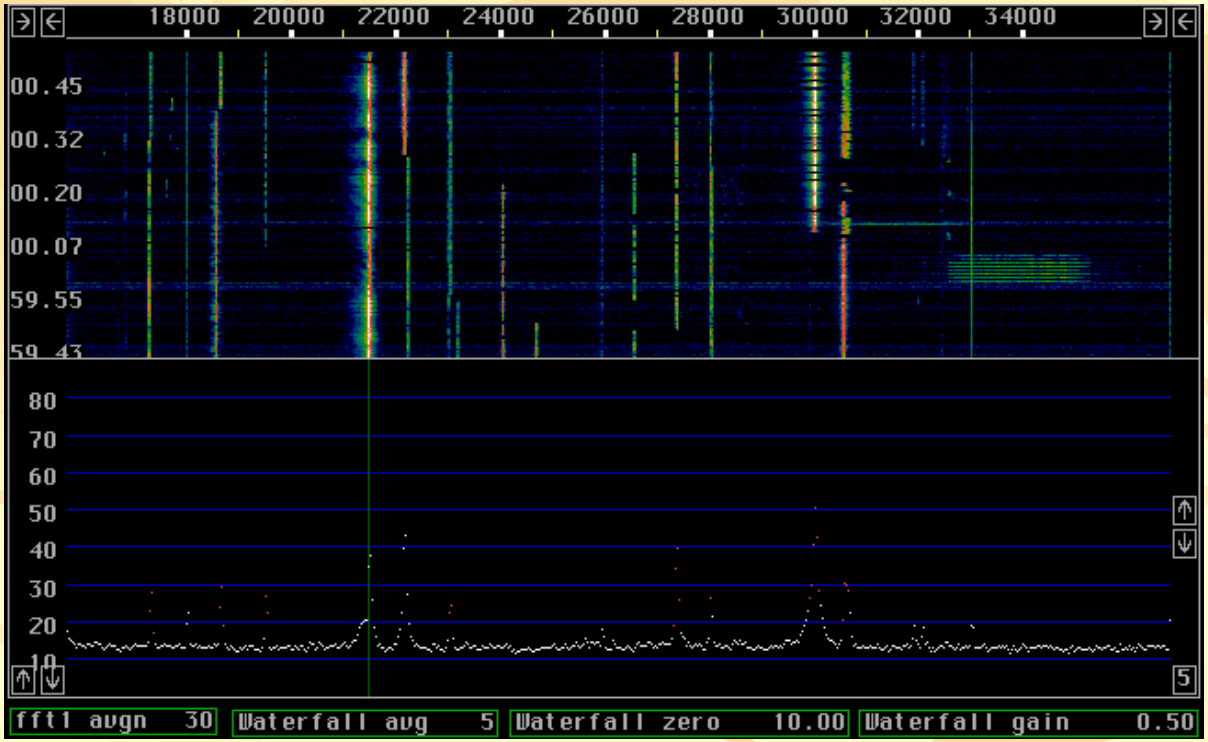
SDR Shell



http://ewpereira.info/sdr-shell

SDR Examples: Software

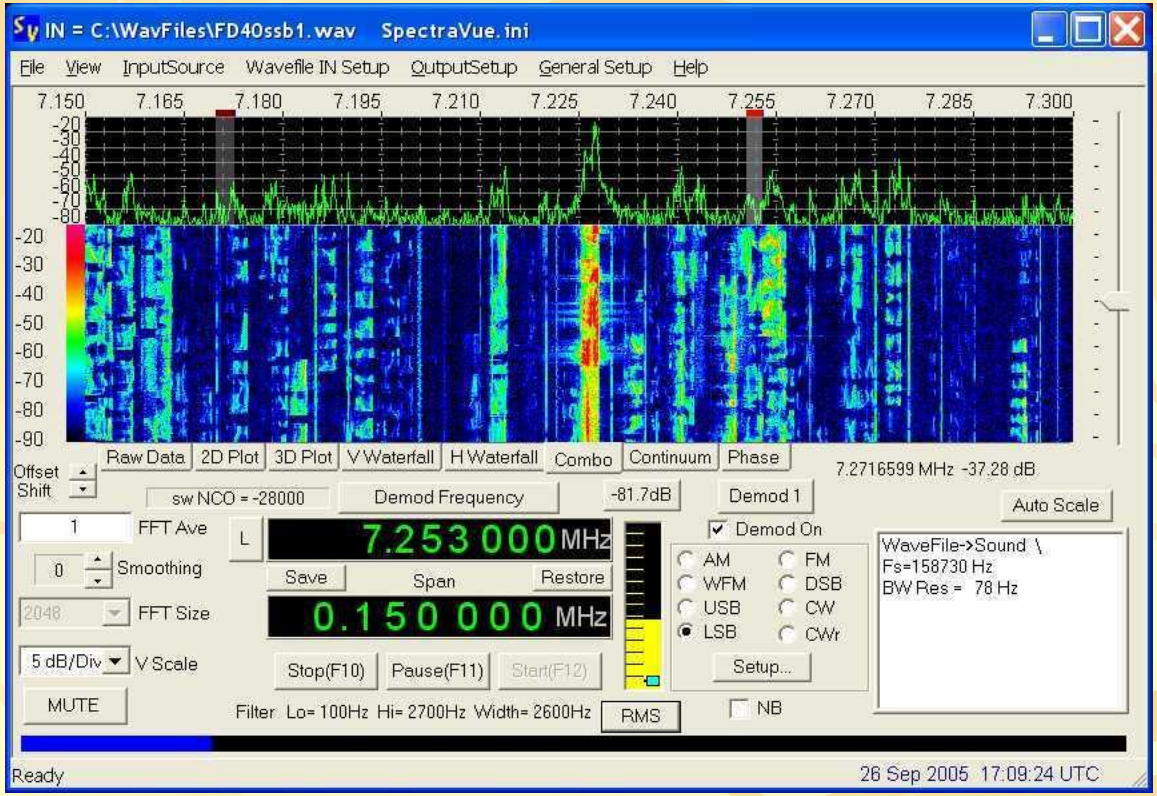
Linrad



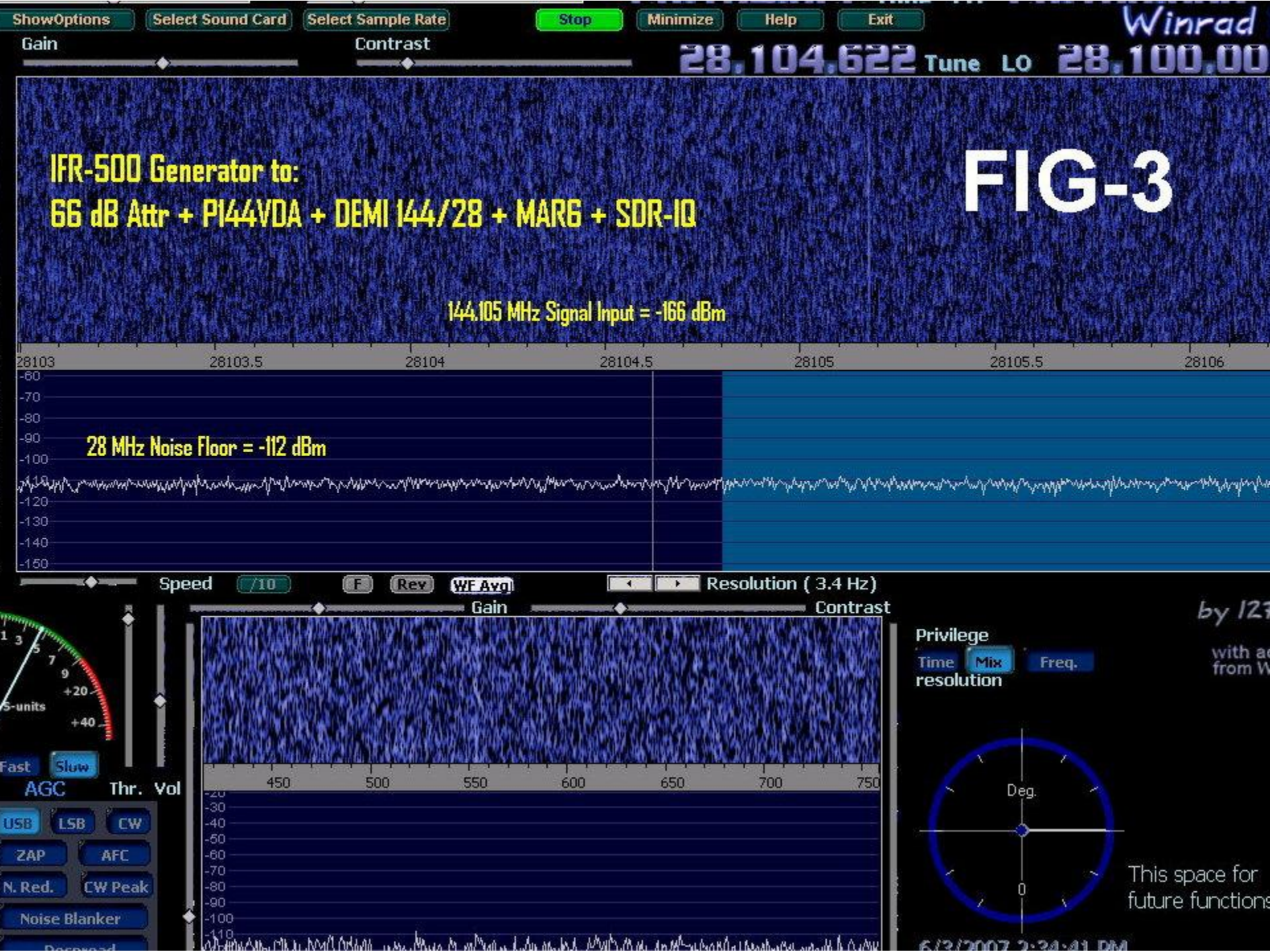
http://www.nitehawk.com/sm5bsz/linuxdsp/linrad.htm

SDR Examples: Software

SpectraVue



http://www.rfspace.com/Support.html


ShowOptions
Select Sound Card
Select Sample Rate
Stop
Minimize
Help
Exit
Winrad
Gain
Contrast
28.104.622 Tune LO 28.100.00
IFR-500 Generator to:
66 dB Attr + P144VDA + DEMI 144/28 + MAR6 + SDR-IQ
FIG-3
144.105 MHz Signal Input = -166 dBm
28103
28103.5
28104
28104.5
28105
28105.5
28106
28 MHz Noise Floor = -112 dBm
Speed
/10
F
Rev
WF Avg
Resolution (3.4 Hz)
Gain
Contrast
Privilege
Time
Mix
Freq.
resolution
Deg.
This space for
future functions
S-units
Fast
Slow
AGC
Thr.
Vol
USB
LSB
CW
ZAP
AFC
N. Red.
CW Peak
Noise Blanker

Videoer

- A apper
- B Youtube mobil app
- C Youtube SDR
- D Flexradio
- E Hermes
- F websdr.org