What is a Software Defined Radio

- Processes I and Q Quadrature Signals
- Detection, Filtering, and other Receive Processes use Digital Signal Processing
- Transmit Information Generated by DSP and Converted to Analog with D to A

Advantages

- "Brick Wall" Filters
- Demodulate Anything Including AM, FM, SSB, RTTY, PSK All in Software
- Support New Modes With Software Upgrades
- Panadapters and "Waterfall Displays" are Free because of Conversions to Frequency Domain

Two Methods to Digitize Signal

- Direct Digitization of Antenna Signal
- Quadrature Sample and Hold
- Both Produce I and Q Signals

Process Signals

- Originally Used PCs
- Use Better Sound Cards
- Dedicated DSP Hardware
- Higher and Higher Signal Rates

Direct Digitization

- Must Sample at Twice Desired Frequency
- 130 MHZ Limit of Hardware
- 16 Bit sample
- Problems Matching Antenna Impedance

QEX Article That Started It All

- A Software-Defined Radio for the Masses
- http://www.flexradio.com/Data/Doc/qex1.pdf
- Used Tayloe "Detector"
- Nearly Lossless
- High dynamic range

Quadature Sample and Hold

- "Down Converts" Analog Signal to High Audio Frequencies
- 24 Bit Analog to Digital Converters Available
- Still Need Band Pass Filters

Analog To Digital Converter

- Imagine 1 Volt Peak to Peak 1 khz Sine Wave
- In Time Domain - Trace on Osciliscope
- Sample at 4 khz
- 0, 1, 0, -1 Volts

Nyquist Frequency

- Must Sample at 2 x Frequency
- Audio 20 hz to 20 khz
- CD Sample Rate 44.1 khz
- PC Sound Cards - 16 bit 44.1 khz

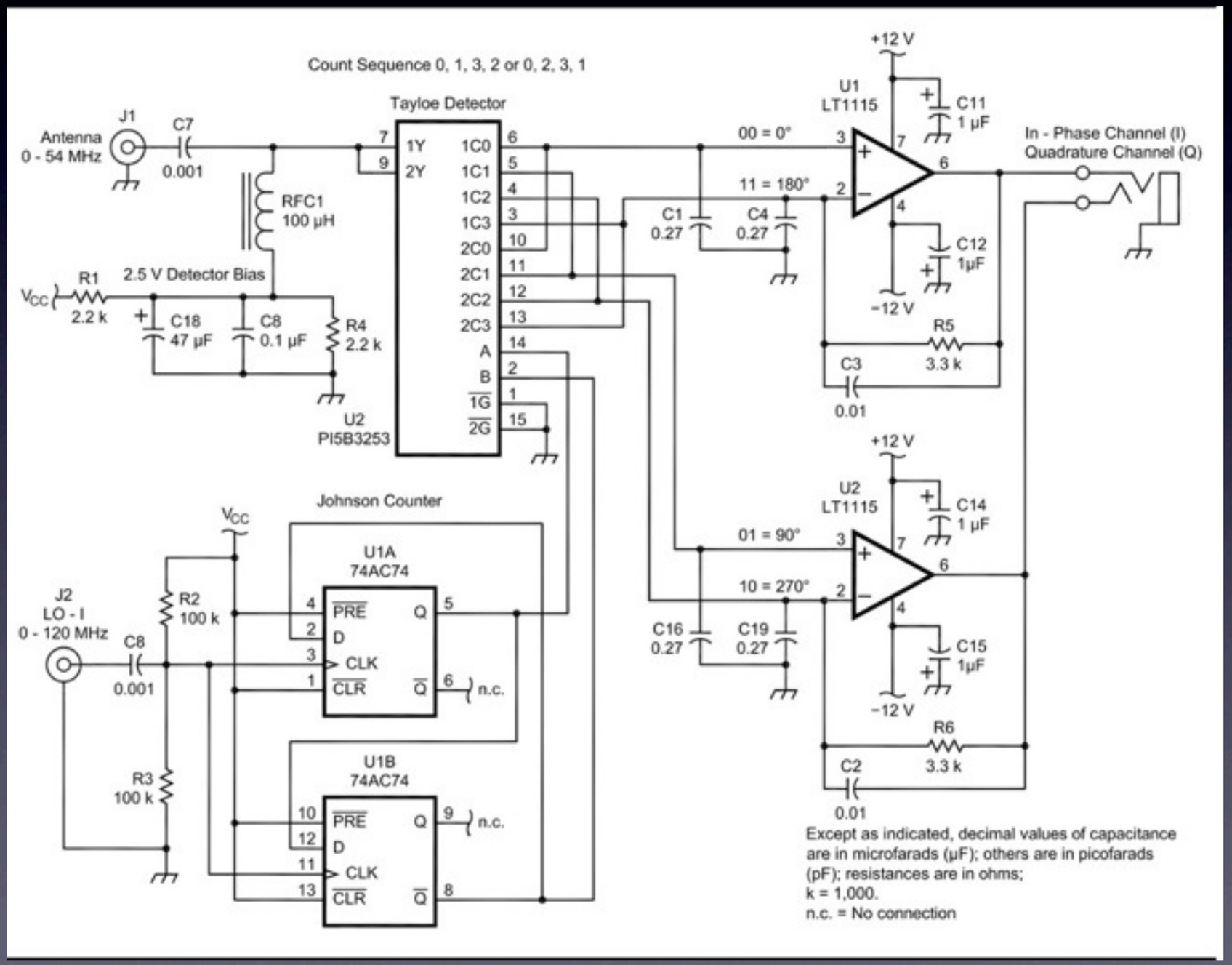
SDR Use I and Q

- Two Samples 90 Degrees out of phase
- Bandwidth Good for Sample Rate
- More Bits Better Dynamic Range and Less Noise
- Sound Cards Available 24 Bits 192 khz

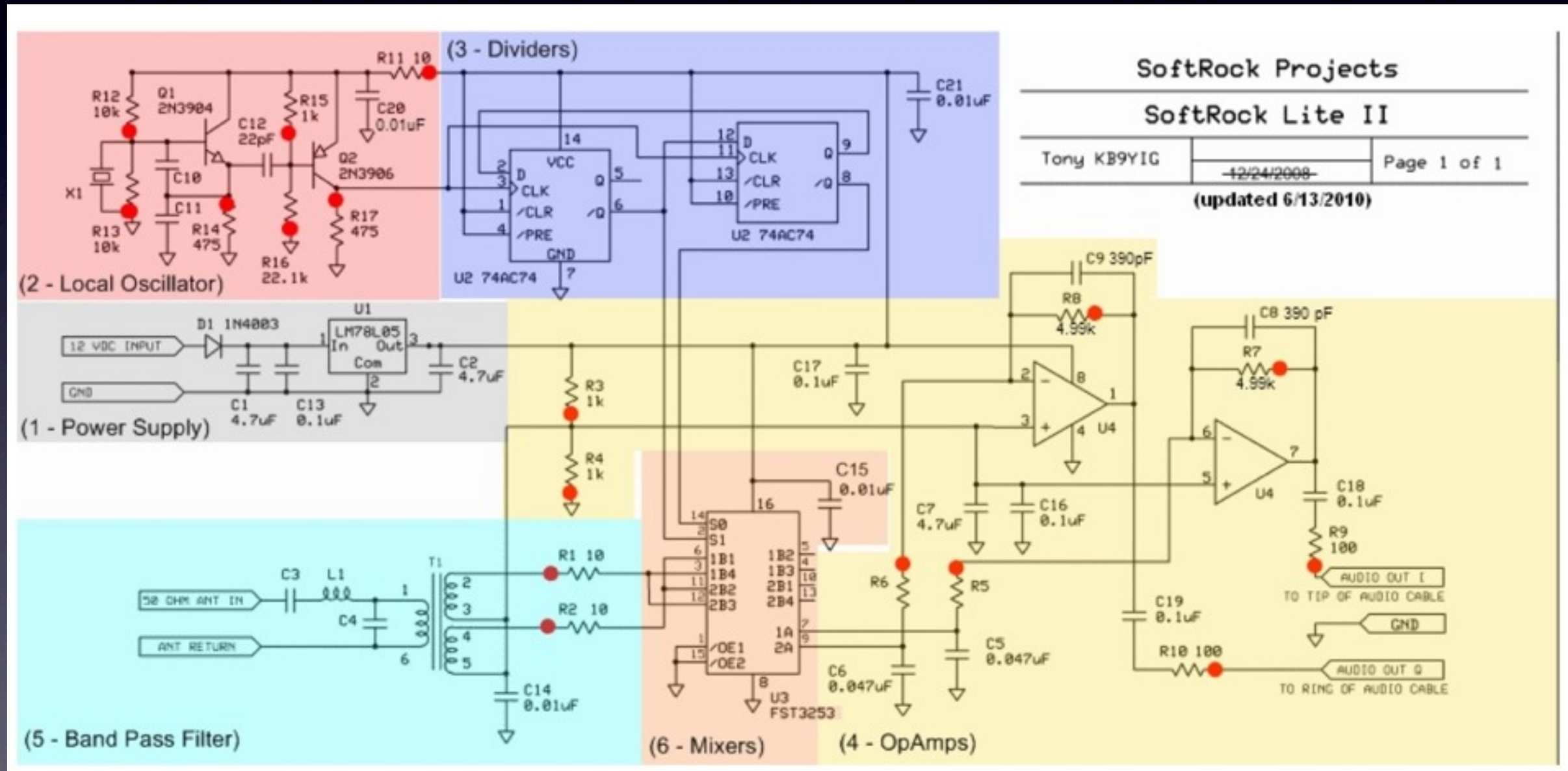
Convert RF to Baseband

- Dan Tayloe N7VE
- http://www.norcalqrp.org/files/Tayloe_mixer_x3a.pdf
- http://www.amrad.org/pipermail/tacos/1998/000464.html
- Nearly Lossless
- Simple Hardware

Balanced Tayloe Detector



Softrock Ensemble



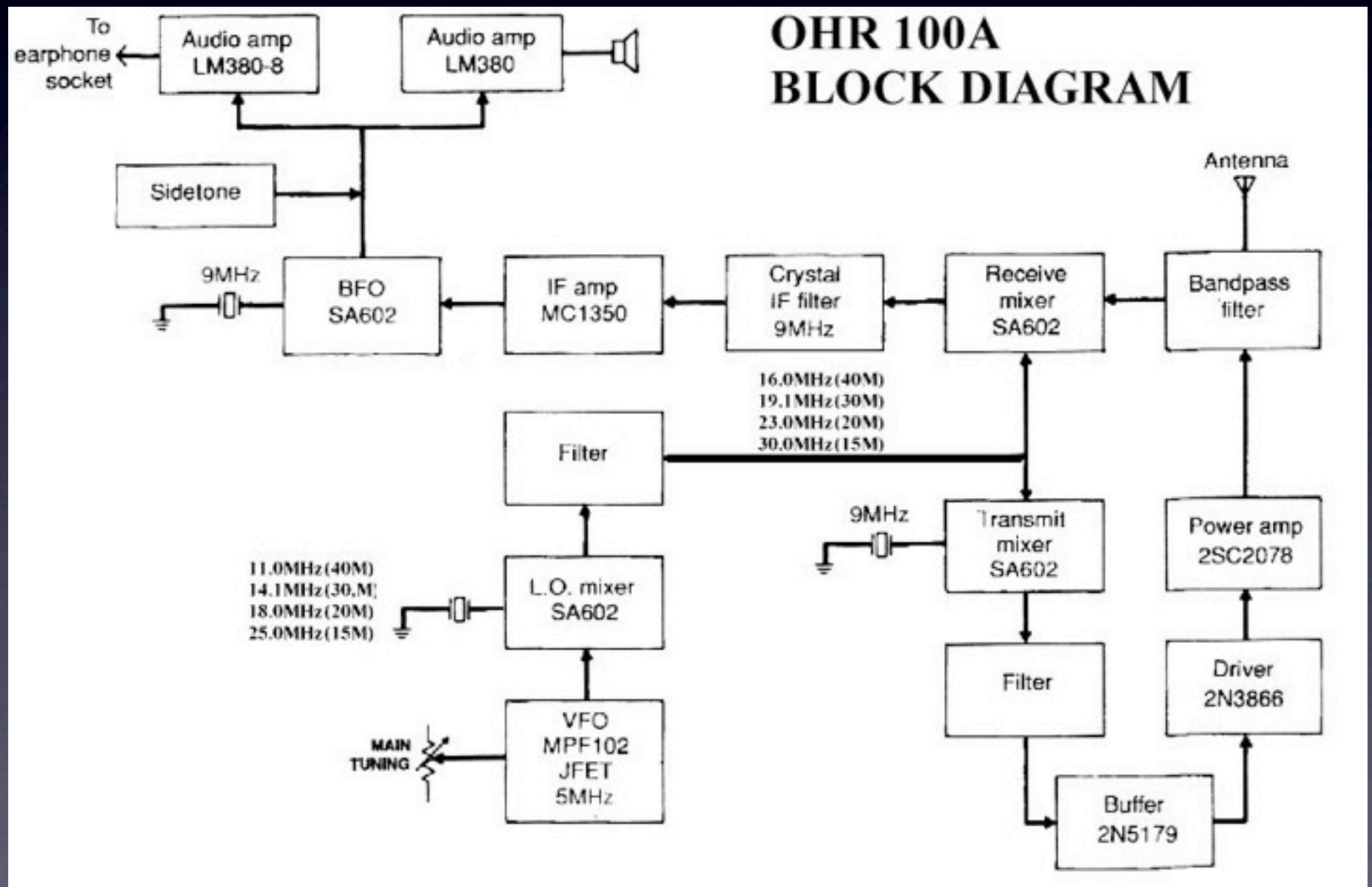
Digital Signal Processing

- Use Computer or DSP to process I and Q Signals
- Fast Fourier Transform to Convert to Frequency Domain
- Math can Provide Nearly Perfect Filters

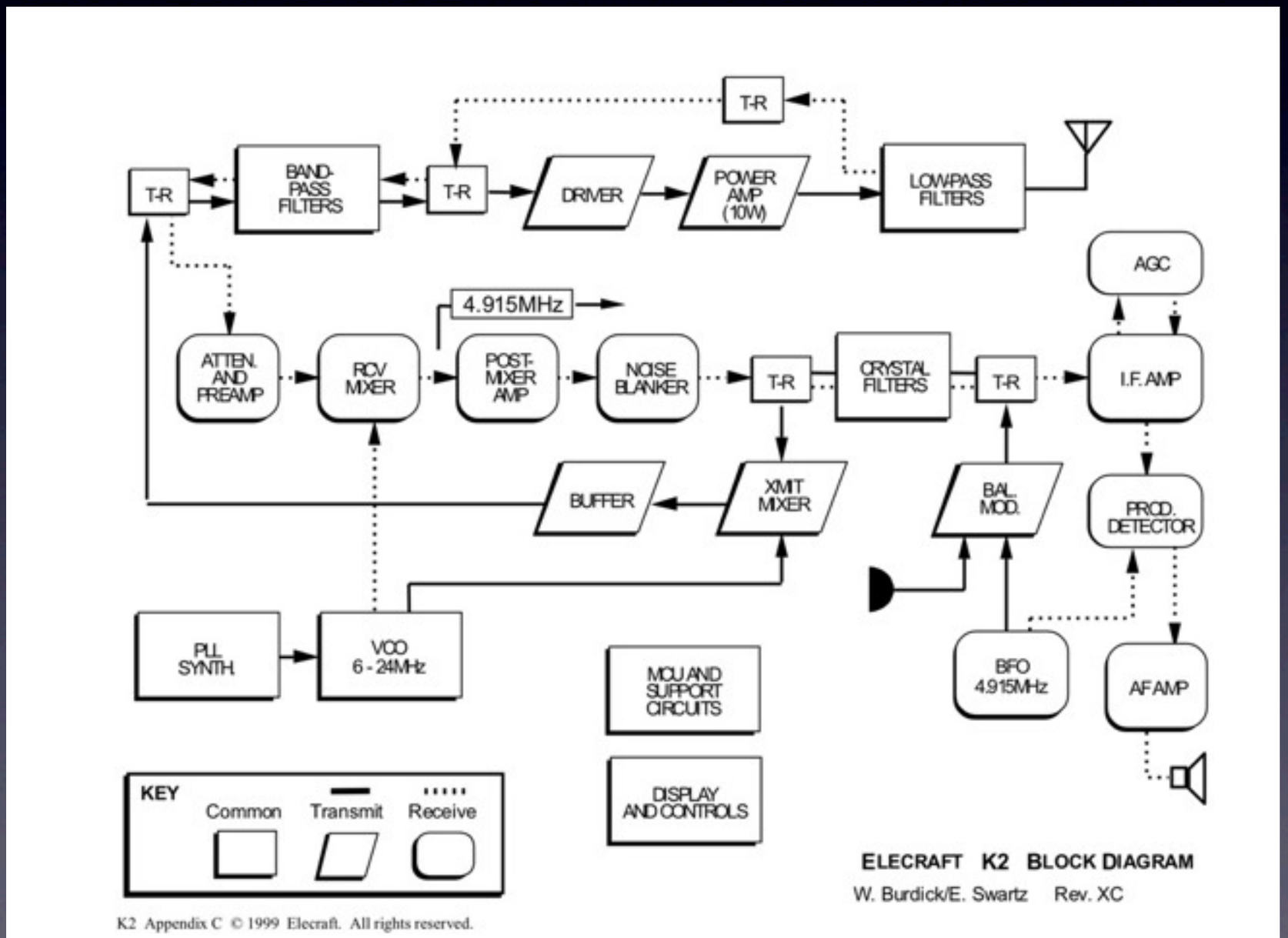
Evolution of Radios

- All Analog - OHR 100A
- Computer Control - K2
- Software Defined - Flex, K3, Softrock

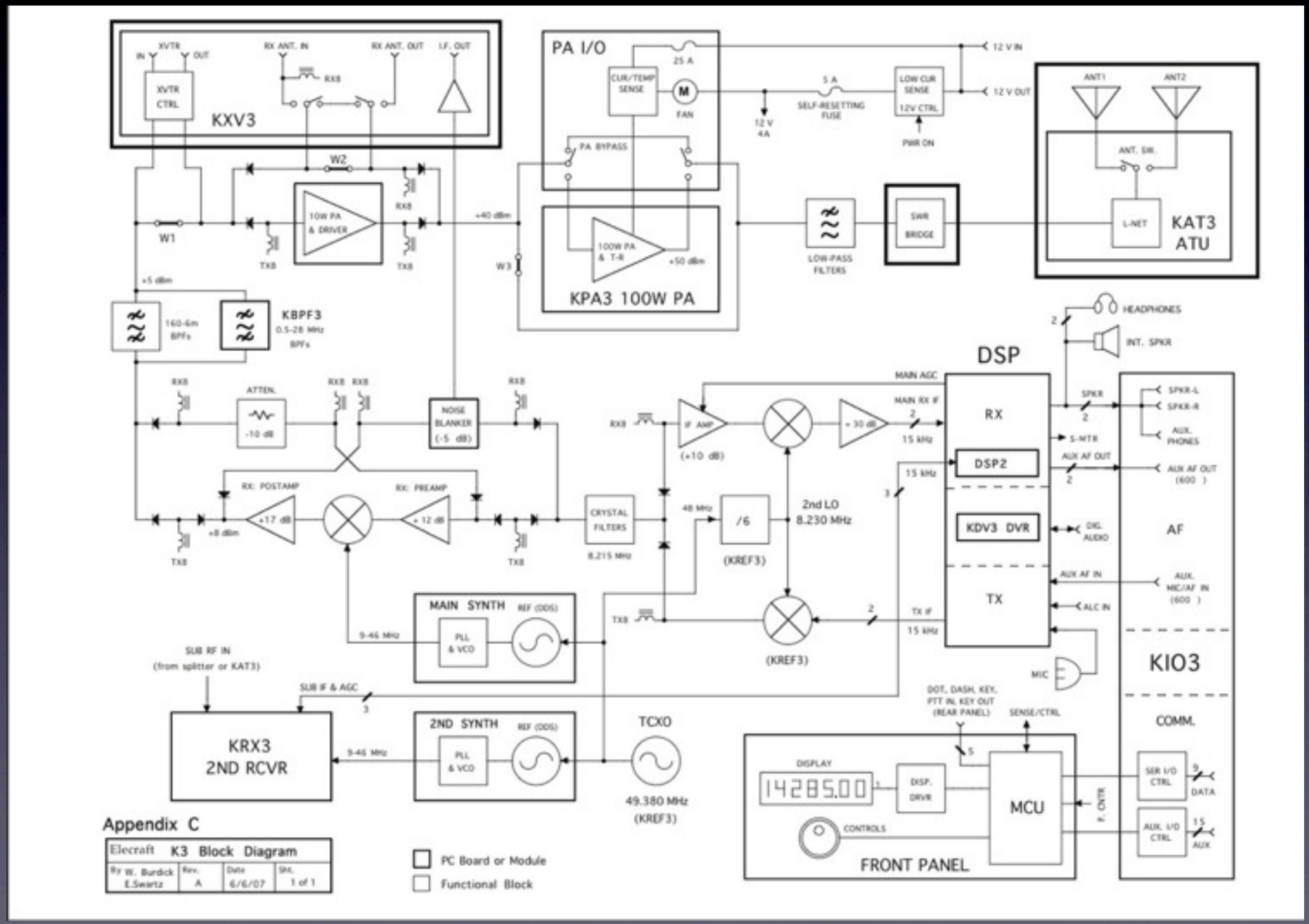
OHR 100A


OHR 100A
BLOCK DIAGRAM
To earphone socket
Audio amp LM380-8
Audio amp LM380
Sidetone
Antenna
9MHz
BFO SA602
IF amp MC1350
Crystal IF filter 9MHz
Receive mixer SA602
Bandpass filter
16.0MHz(40M)
19.1MHz(30M)
23.0MHz(20M)
30.0MHz(15M)
Filter
9MHz
Transmit mixer SA602
Power amp 2SC2078
11.0MHz(40M)
14.1MHz(30,M
18.0MHz(20M)
25.0MHz(15M)
L.O. mixer SA602
Filter
Driver 2N3866
MAIN TUNING
VFO MPF102 JFET 5MHz
Buffer 2N5179

K2 Block Diagram



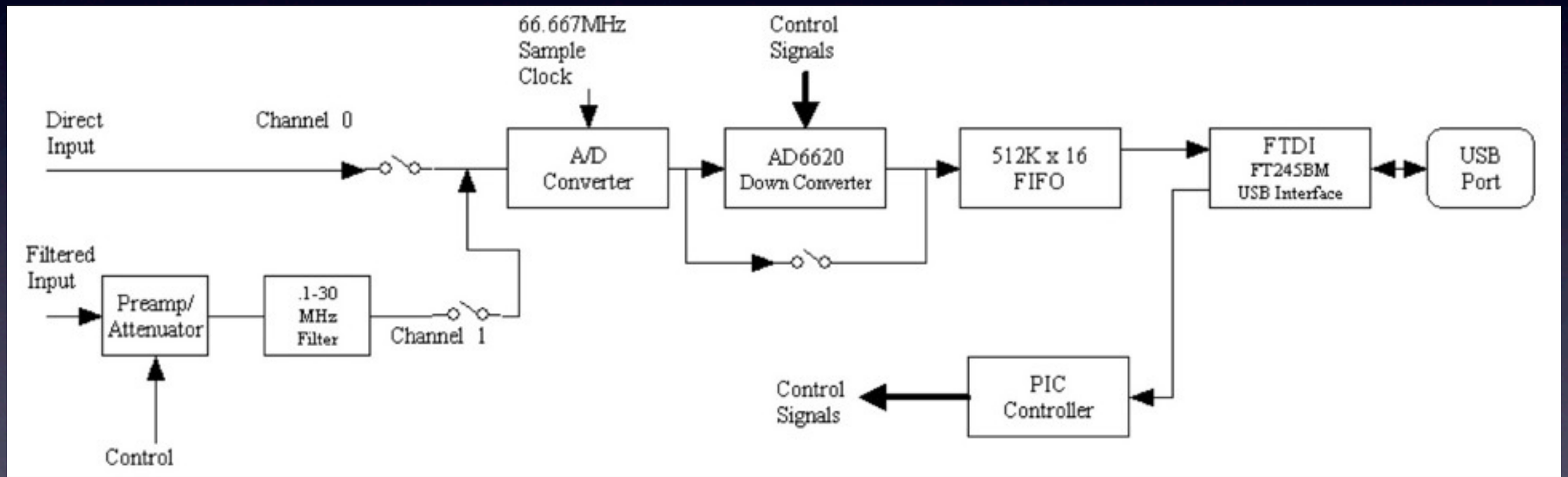
K3 Block Diagram



Direct Sample SDRs

- Perseus
- High Performance Software Defined Radio
- SDR-14
- AMRAD Charleston SDR
- RFSpace NetSDR
- All are Receivers

SDR-14 Block Diagram



Other Uses

- Generate I and Q Signals for Panadapter
- LP-Pan Panadapter
- Ensemble as Panadapter

Receiver Ratings

Receiver Test Data

(Sorted by Dynamic Range Narrow Spaced)

Updated 15 June 2011

Device Under Test	Noise Floor (dBm)	AGC Thrshld (uV)	dB	100kHz Blocking (dB)	Sensitivity (uV)	LO Noise (dBc/Hz)	Spacing kHz	Front End Selectivity	Filter Ultimate (dB)	Dynamic Range Wide Spaced (dB)	kHz	Dynamic Range Narrow Spaced (dB)	kHz
Added 12/01/10 Yaesu FTdx-5000D	-123 -135[b] - 141[b1]	4.6 1.2[b] 0.33[b1]	3	127[s]	1.1 0.27[b] 0.13[b1]	135	10	B Band Pass	90[f]	104	20	101[f]	2
Added 2/15/08 Elecraft K3	-130 -138[b]	2.1 0.6[b]	3	140[s]	0.33 0.19[b]	138	10	B Band Pass	105	104	20	101[pf] 96[qf] 95[r]	2
Updated 7/2/09 Perseus	-123 -125[b]	0.15 0.1[b]	3	125	0.8 0.6[b]	147	10	B Band Pass	109[f]	99	20	99	2
Added 2/15/08 FlexRadio Systems FLEX-5000A	-123 -135[b]	2.0 0.5[b]	3	123[s]	1.3 0.3[b]	123	10	B Band Pass	98	96	20	96	2
Added 4/16/06 Ten-Tec Orion II	-125 -133[b]	2.7 0.65[b]	3	130	0.75 0.3[b]	126	10	B Band Pass	100[f]	95[f]	20	95[i]	2

Where are we?

- SDR Receivers Are Close to the Best
- SDR Transmitters May Have Keying Problems
- Direct Sampling and Quadrature Sampling About Equal
- No Direct Sampling Transceivers
- Direct Sampling Receivers are Expensive