TEENSY CONVOLUTION SDR

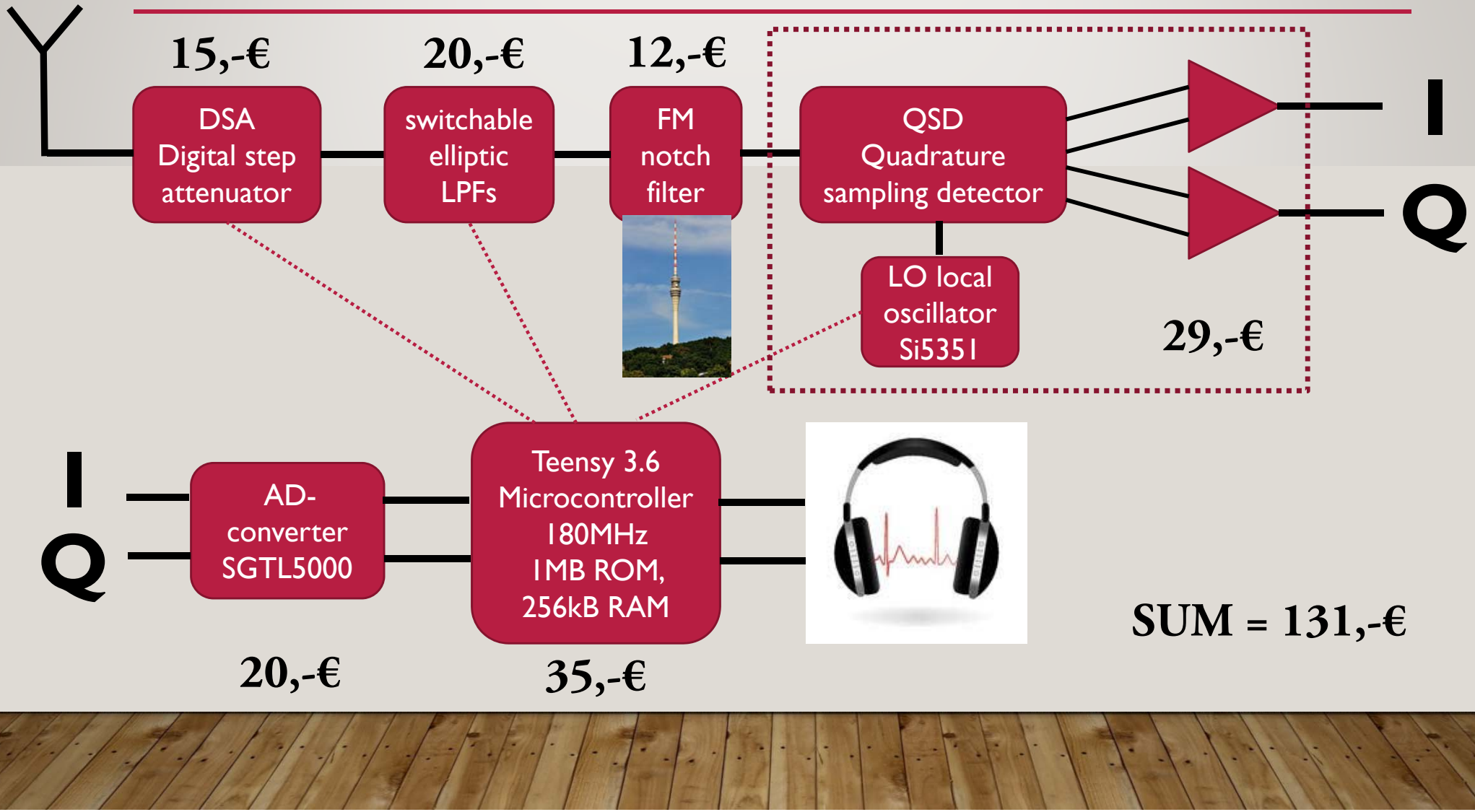
STANDALONE SOFTWARE DEFINED RECEIVER

MAI 2017

TEENSY CONVOLUTION SDR

- Standalone software defined Radio Receiver with open source software (GPL v3)
- 10kHz to 30MHz and FM Stereo reception
- Spectrum display with192kHz bandwidth
- DSP microcontroller Teensy 3.6 (Cortex M4 with 180MHz, 256kbyte RAM)
- Moderate power consumption (5V, 250mA)
- Demodulation of: LSB, USB, AM, DSB Stereo, Synchronous-AM, one-sideband-SAM, Stereo-SAM, FM-W, FM-Stereo
- Filter bandwidth freely adjustable 100Hz bis 6500Hz [Bandpass-Filter in prep]
- DIY – costs: < 150€

HARDWARE = STANDARD-LOWCOST-SDR



QUADRATURE SAMPLING DETECTOR QSD

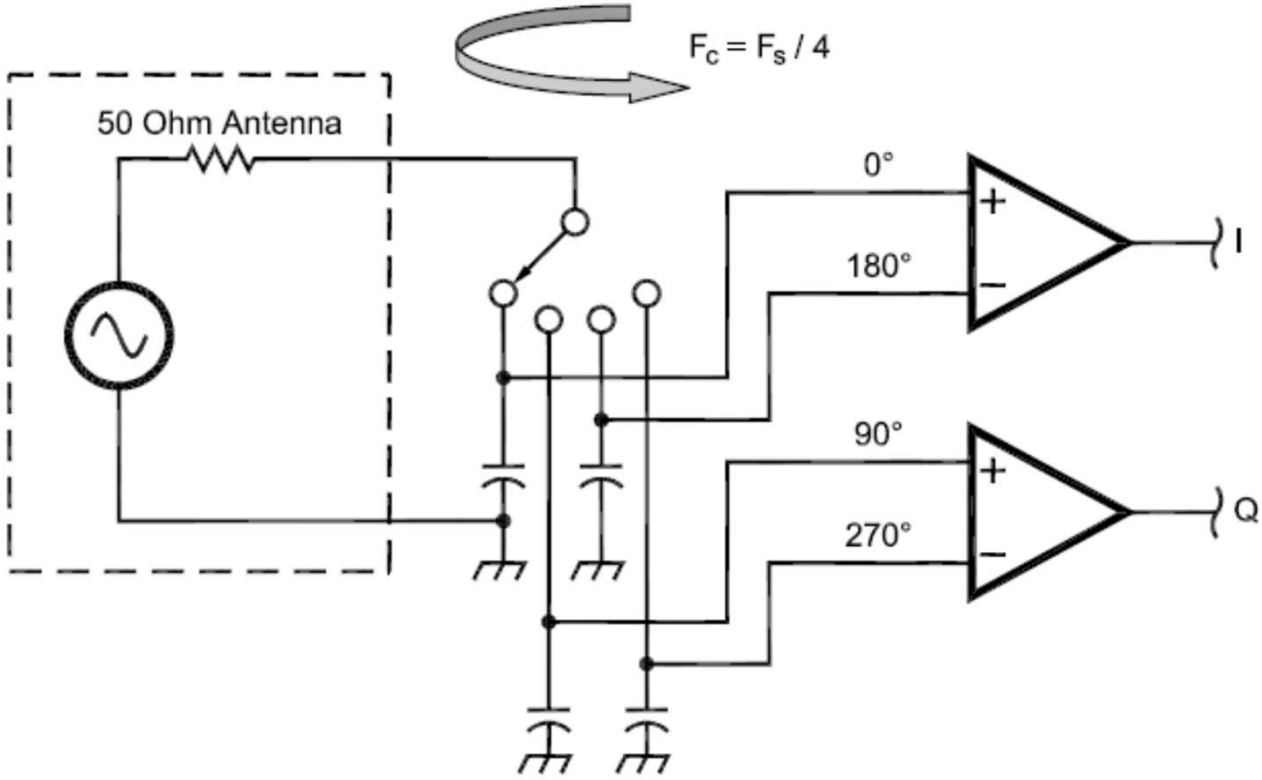
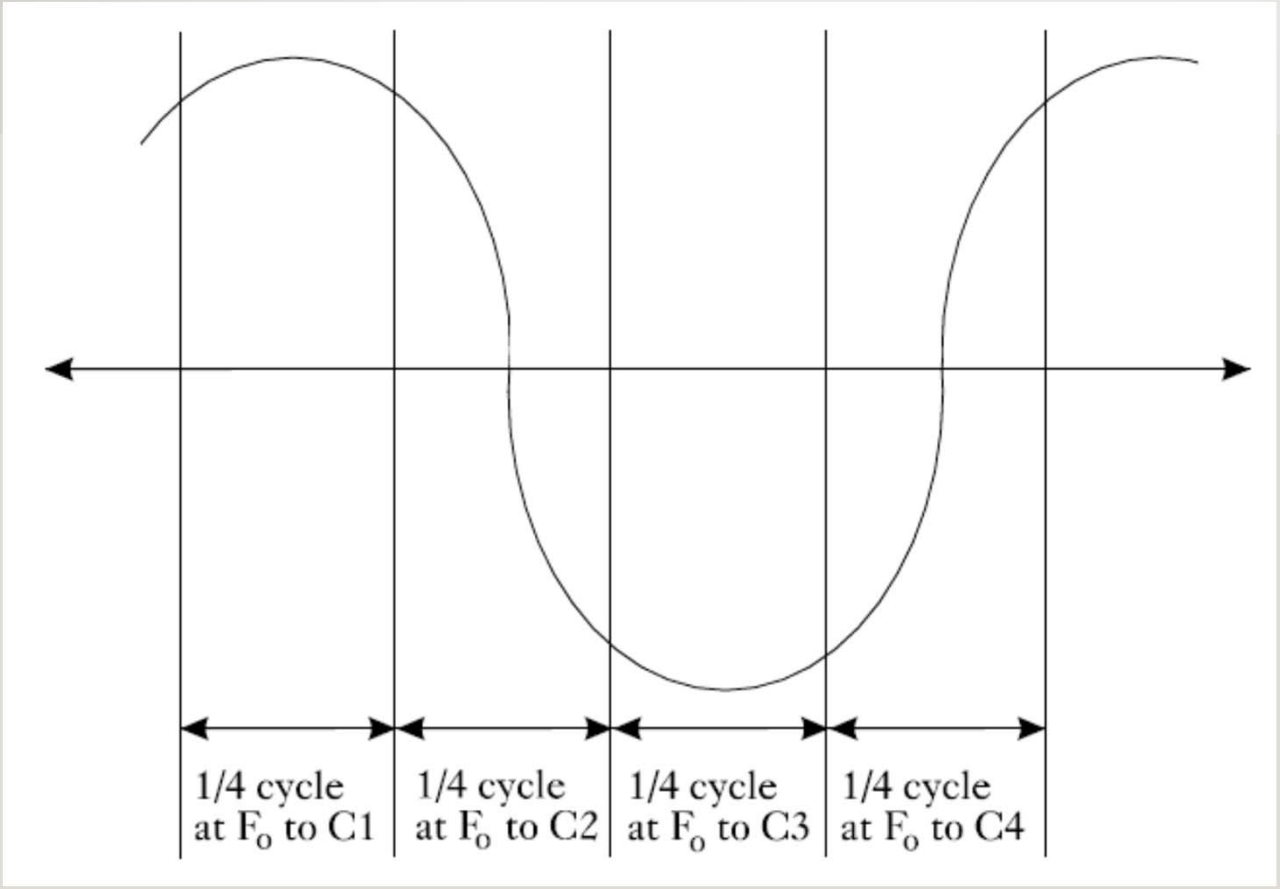


Fig 10—Tayloe detector: The switch rotates at the carrier frequency so that each capacitor samples the signal once each revolution. The 0° and 180° capacitors differentially sum to provide the in-phase (*I*) signal and the 90° and 270° capacitors sum to provide the quadrature (*Q*) signal.

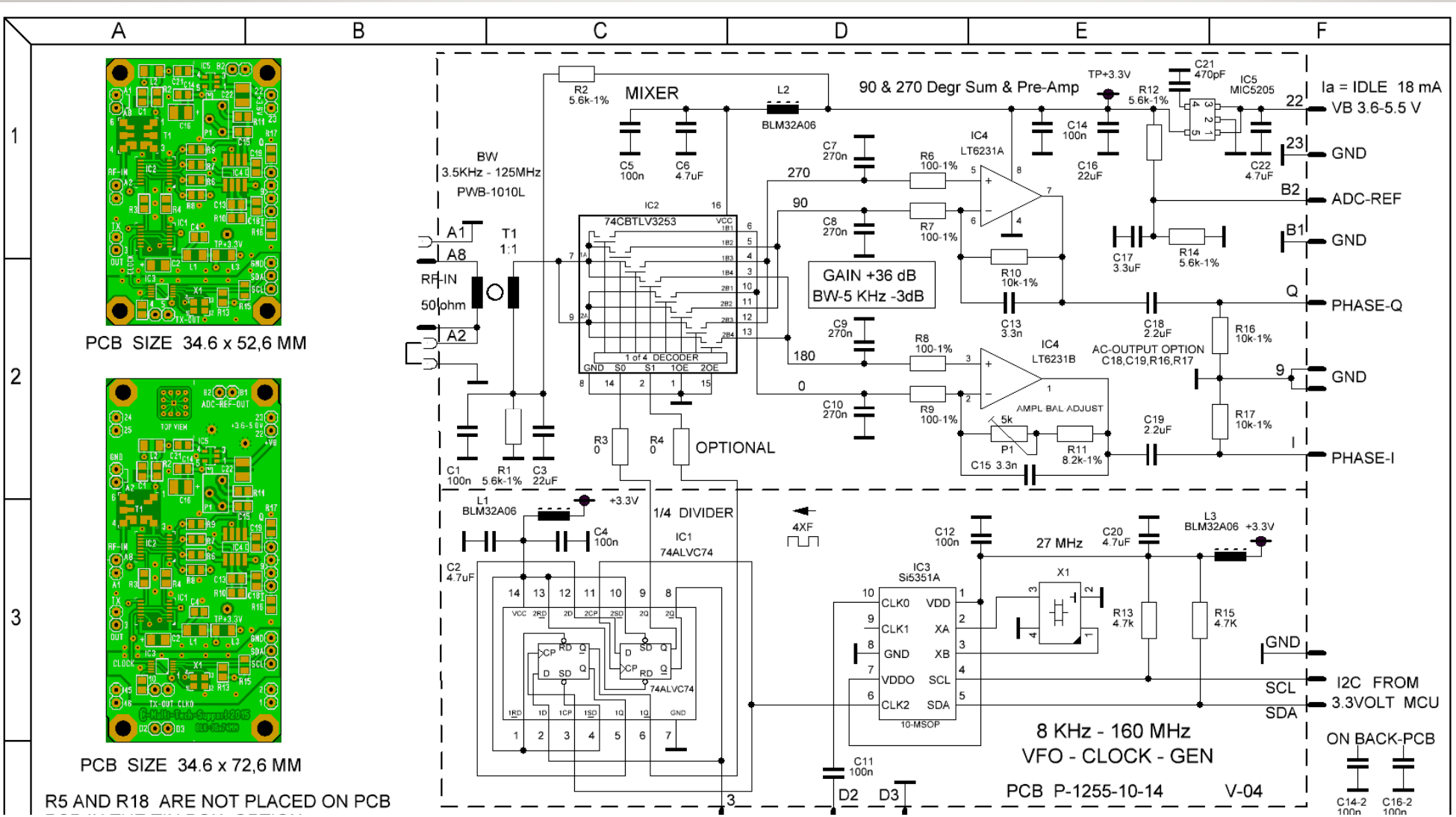
Youngblood 2002

QUADRATURE SAMPLING DETECTOR



Dan Tayloe

QSD, ULTRA-LOW-NOISE OPAMPS & LO



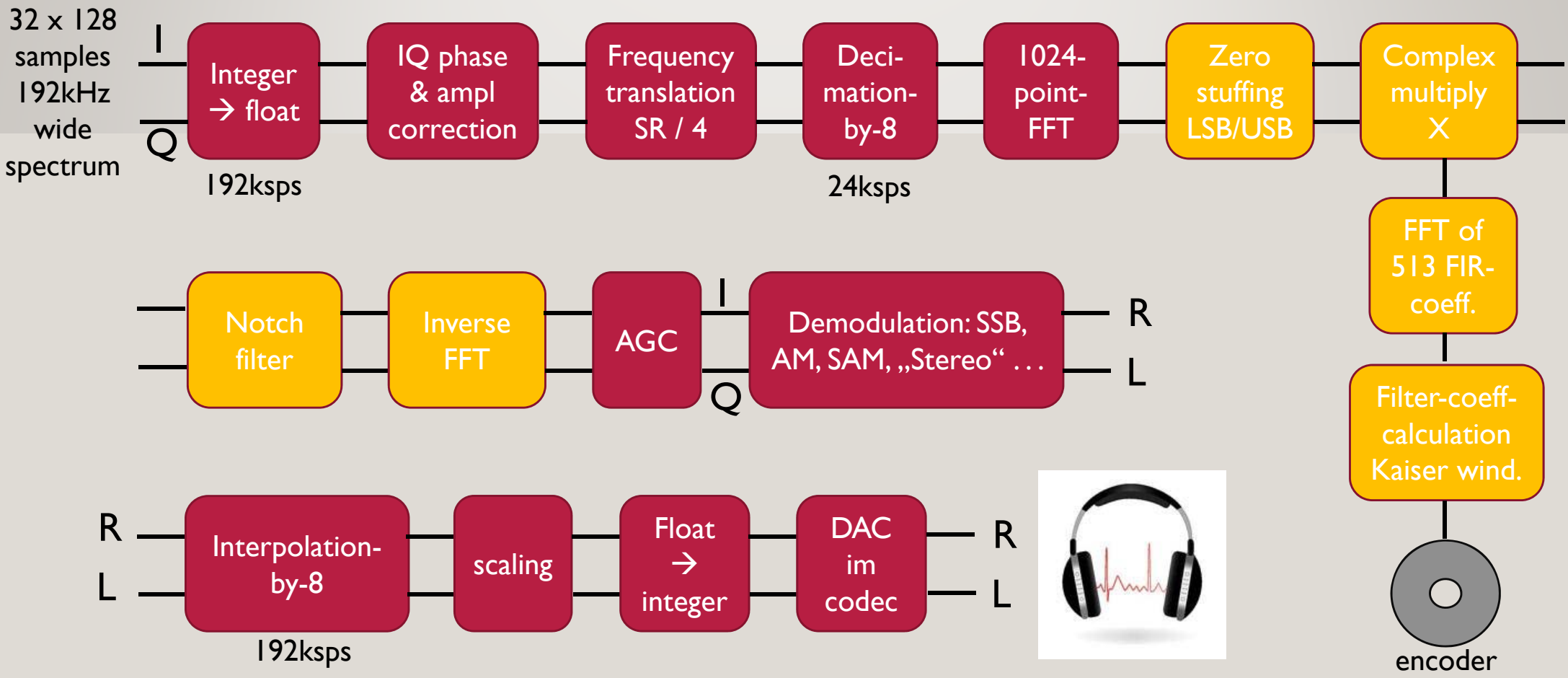
PCB SIZE 34.6 x 52,6 MM

PCB SIZE 34.6 x 72,6 MM

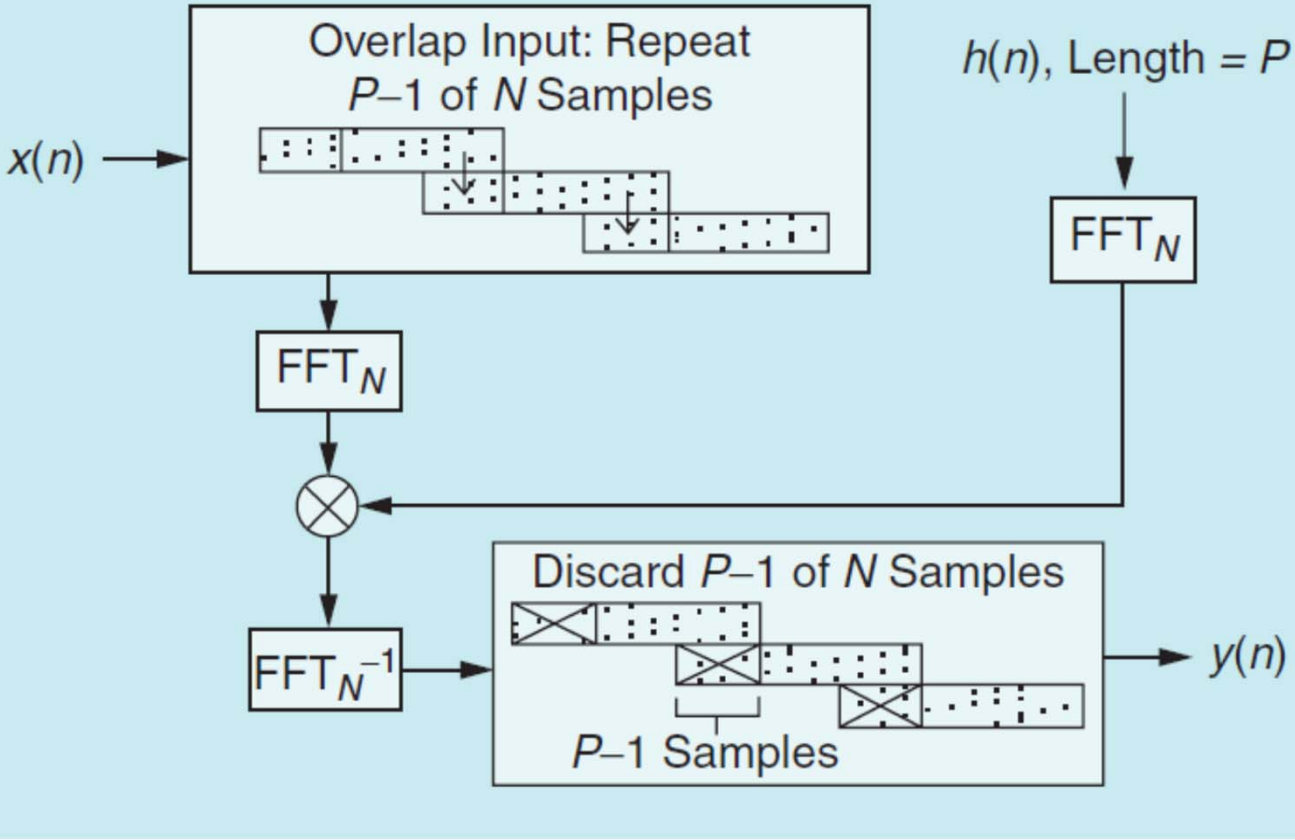
R5 AND R18 ARE NOT PLACED ON PCB

Joris kthkit

SOFTWARE – AUDIOPFAD



FAST CONVOLUTION



[FIG1] **Overlap-save (OS) filtering,** $y(n) = x(n) * h(n)$.

Borgerding 2006

FAST CONVOLUTION – SIDEBAND SELECTION & NOTCH FILTER

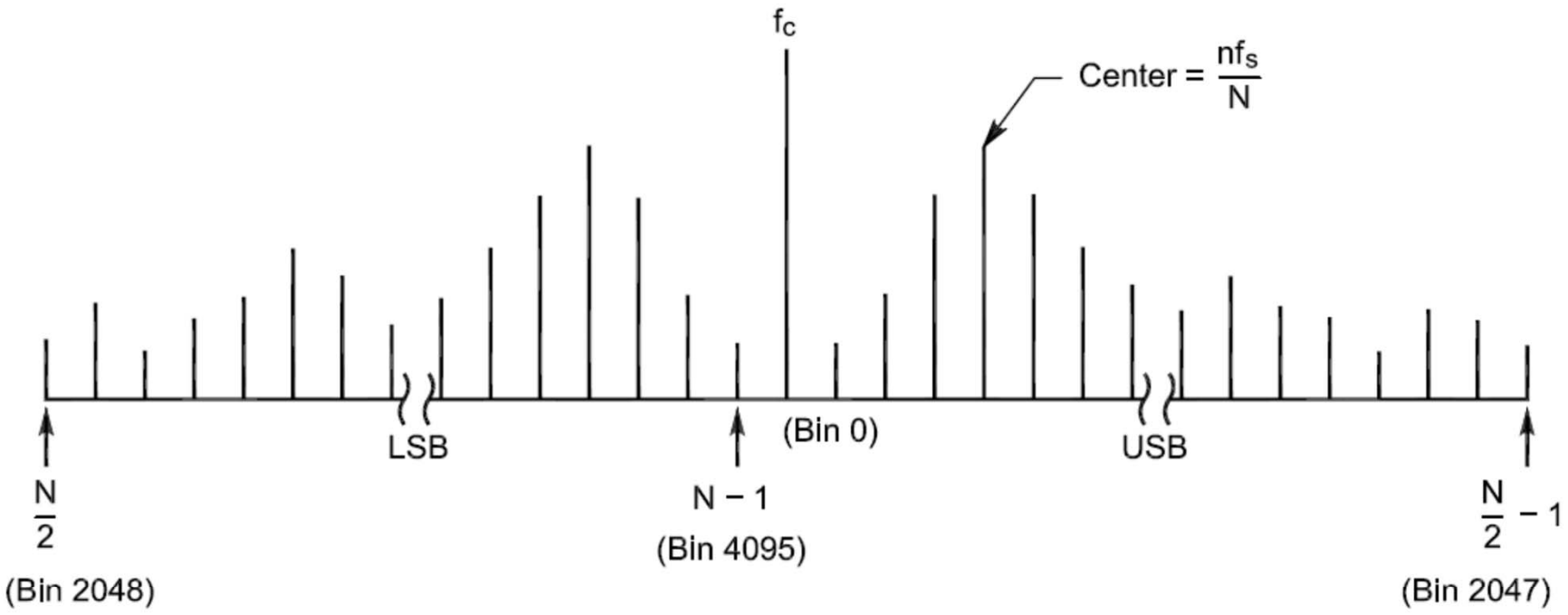
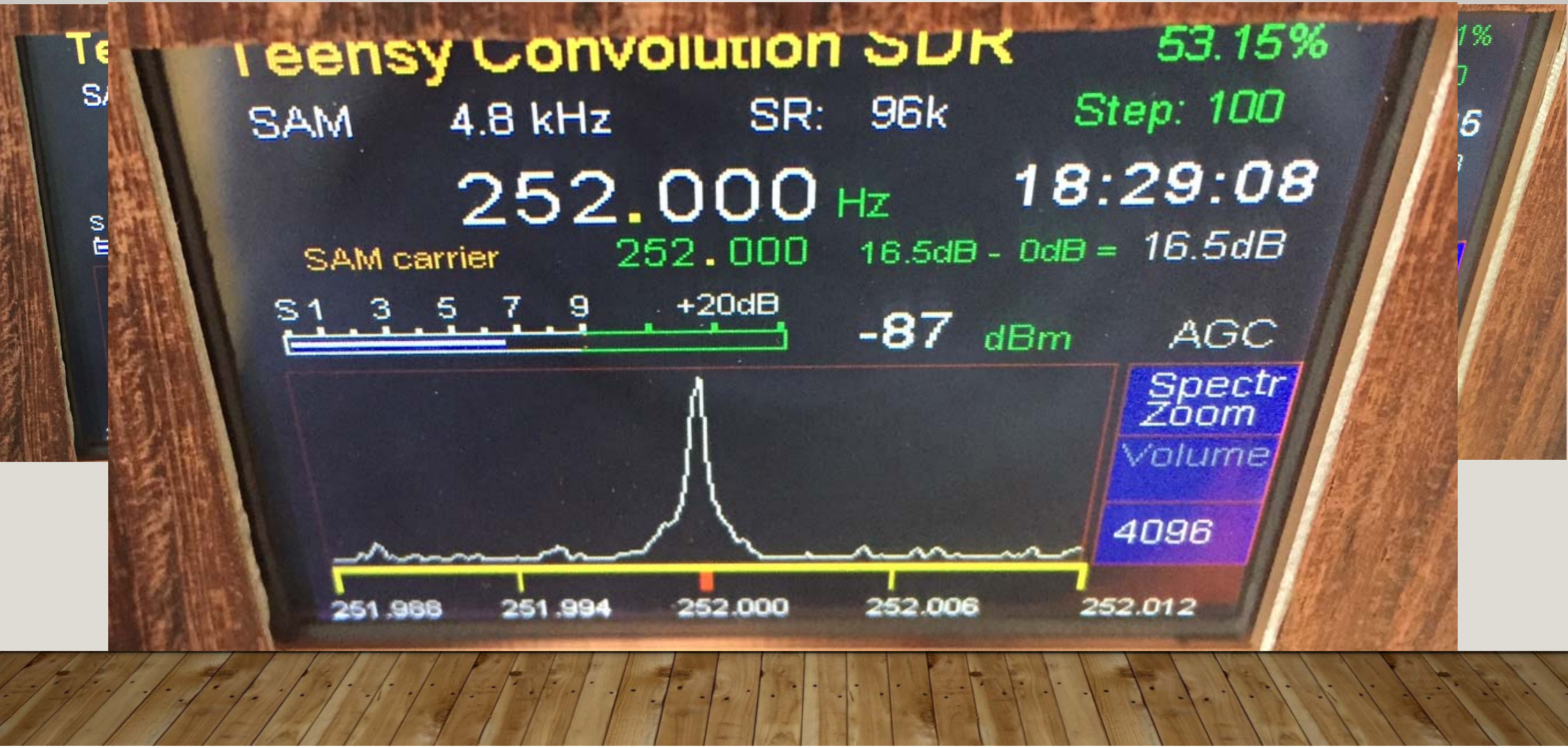


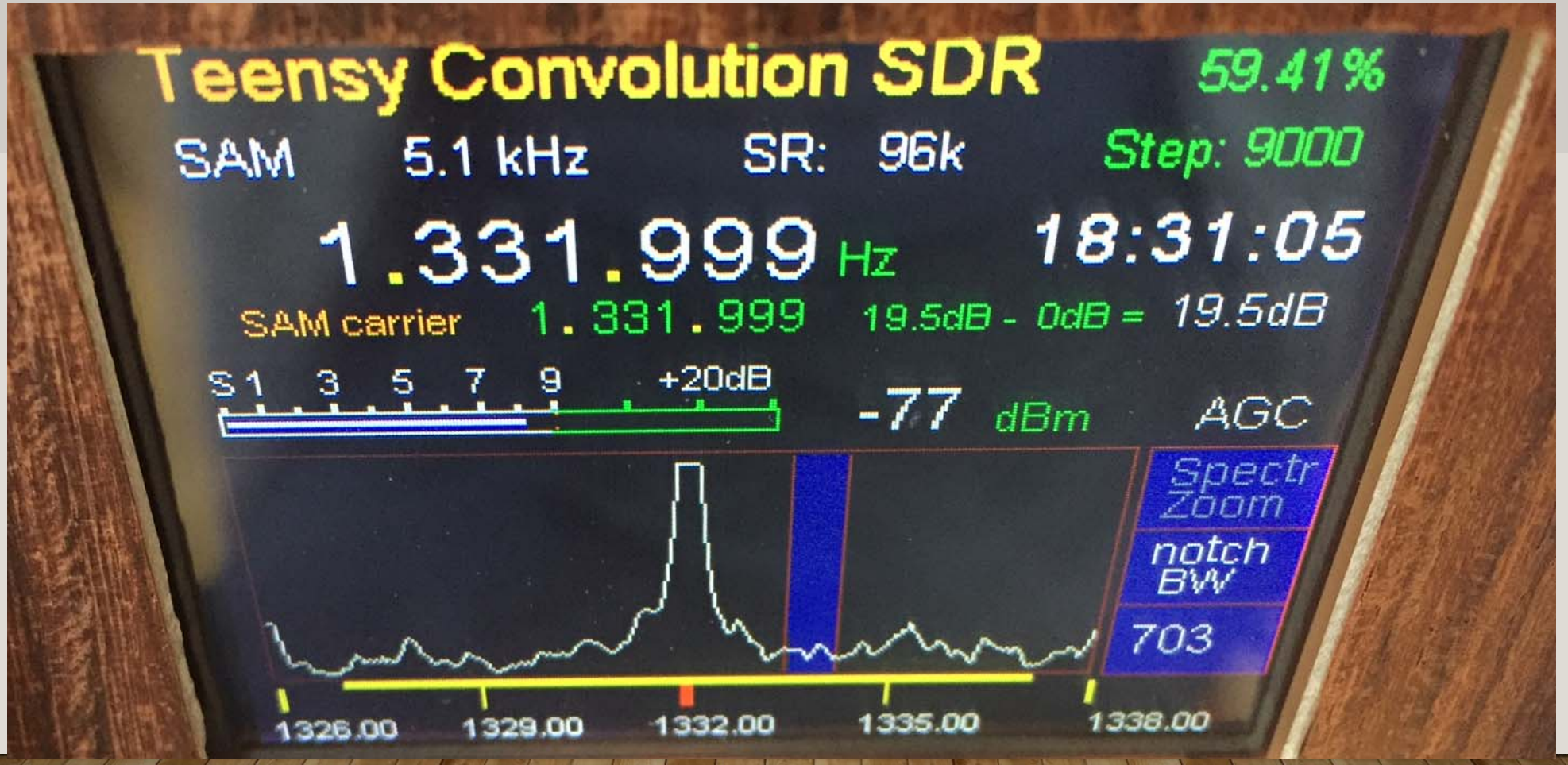
Fig 8—Complex FFT output: The output of a complex FFT may be thought of as a series of band-pass filters aligned around the carrier frequency, f_C, at bin 0. *N* represents the number of FFT bins. The upper sideband is located in bins 1 through *(N*/2)–1 and the lower sideband is located in bins *N*/2 to *N*–1. The center frequency and bandwidth of each bin may be calculated using Eqs 5 and 6.

Youngblood 2002

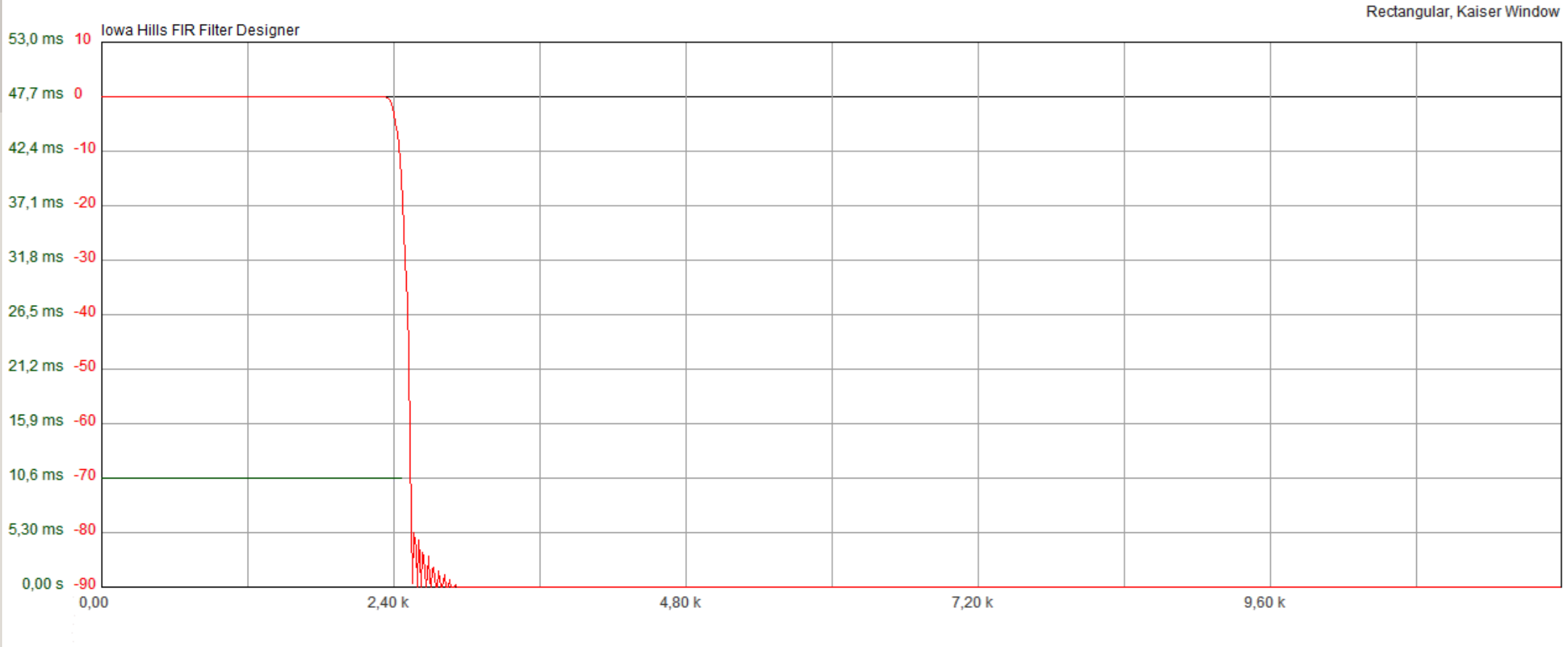
SPECTRUM DISPLAY – ZOOM FFT



FAST CONVOLUTION – NOTCH FILTER



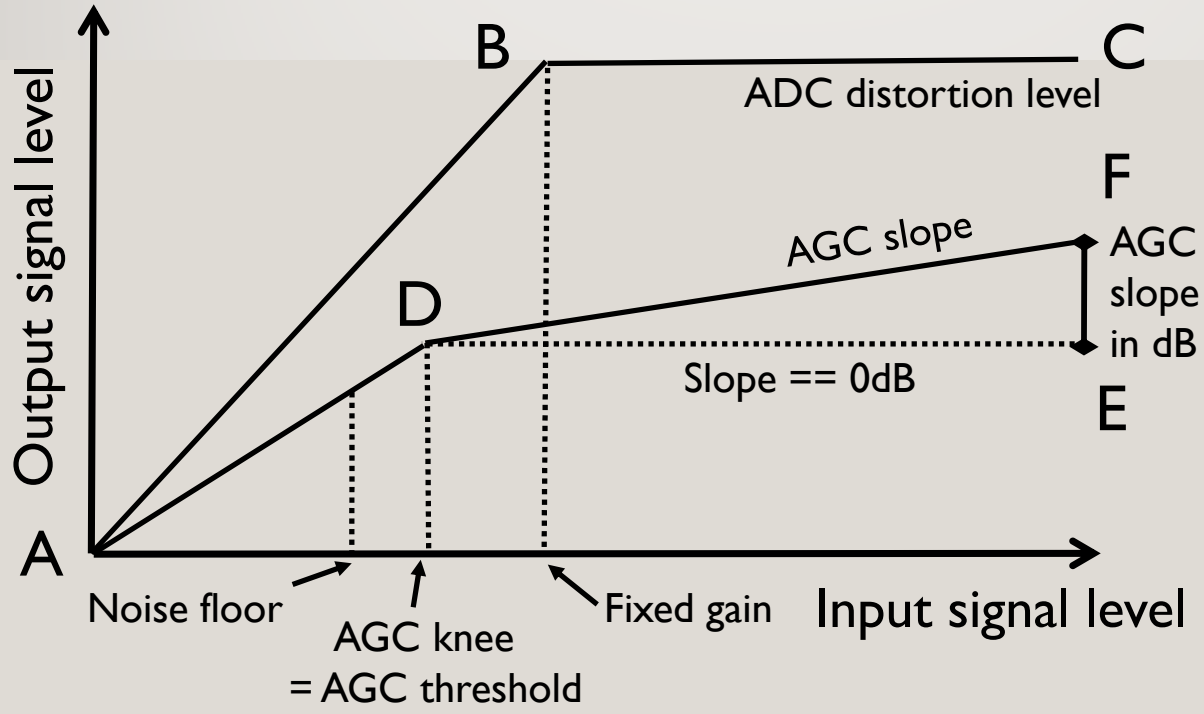
FILTERKURVE FIR 513 TAPS = BRICKWALL



MORE FEATURES

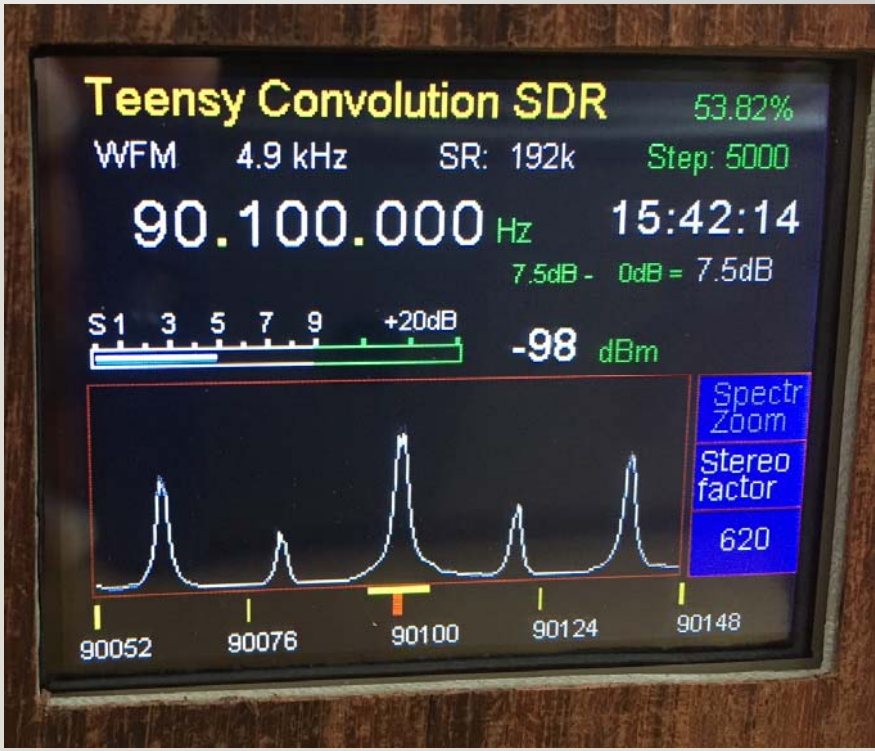
- Filter-Bandwidth freely adjustable from 100Hz bis 6300Hz
- Sample rate adjustable (48ksps – 192ksps) → thanks, Frank Boesing
- Automatic IQ Phase- and Amplitude-correction
- Realtime clock
- EEPROM Save and Load
- Digital step attenuator 0-31dB in 1dB-steps
- Audio Equalizer 5-Band
- MP3 / AAC – files can be played from the micro-SD-card
- High end – AGC from PowerSDR (wdsp-lib by Warren Pratt)
- HiFi FM – Stereo reception

AUTOMATIC GAIN CONTROL - AGC



FM STEREO RECEPTION – WFM DEMODULATOR

- How does that work, if the LO only allows f < 280MHz and thus only allows receive up to 70MHz ?
- 3 times undersampling → 9dB attenuation
- 29.985.333Hz → 90.1MHz
- 192kHz RF-bandwidth at 192ksps sample rate
- Simple FM Stereo demodulation algorithmus, but still:
- Very good Audio-Quality
- Stereo-reception with adjustable Stereo factor
- Next step: RDS-Decoder !??



WELL, THE CASE STILL NEEDS SOME TWEAKING . . .

- Thanks for your attention !
- DD4WH.SWL@gmail.com
- Source code here: https://github.com/DD4WH/Teensy-ConvolutionSDR
- Forum here: https://forum.pjrc.com/threads/40590-Teensy-Convolution-SDR-(Software-Defined-Radio)