uSDX+ Transceiver

August 17, 2023

uSDX⁺ HF Transceiver

21.074.08 USB

All Mode 8 Band SDR

MENU   HP   KEY /MIC   MOT
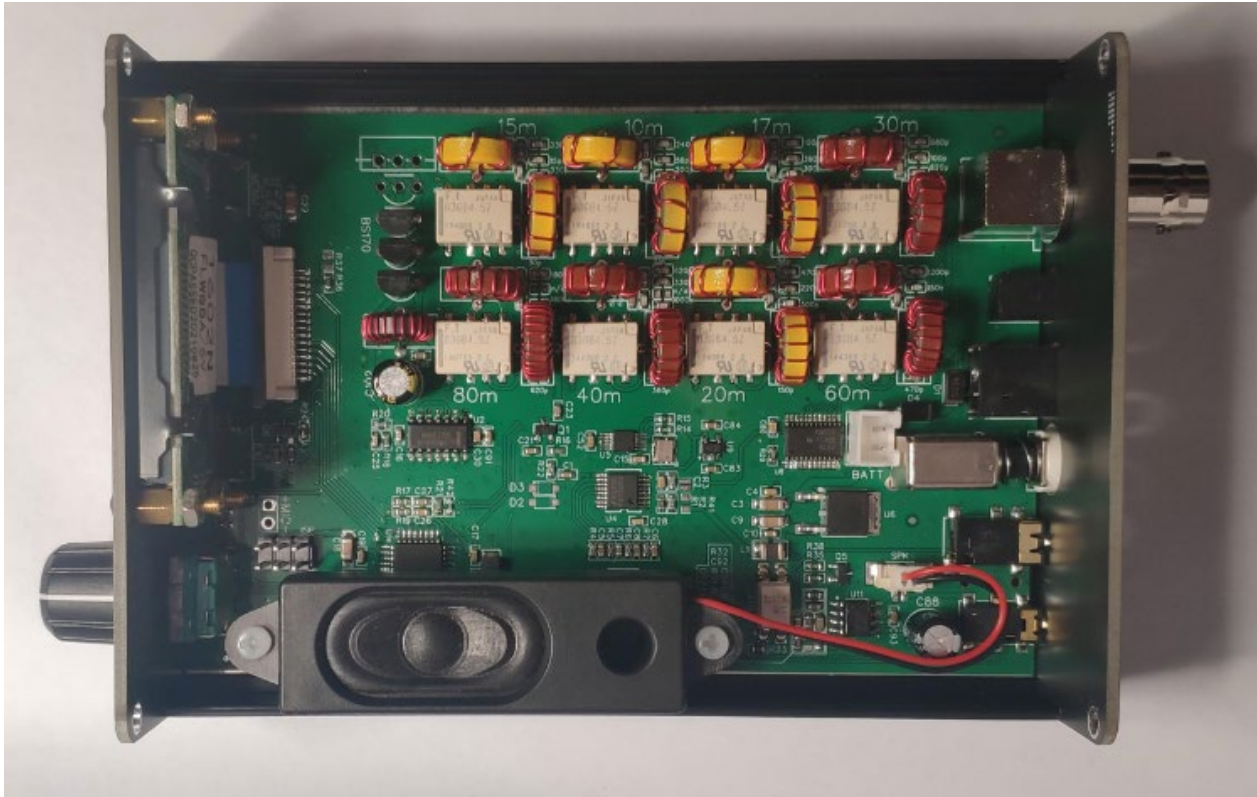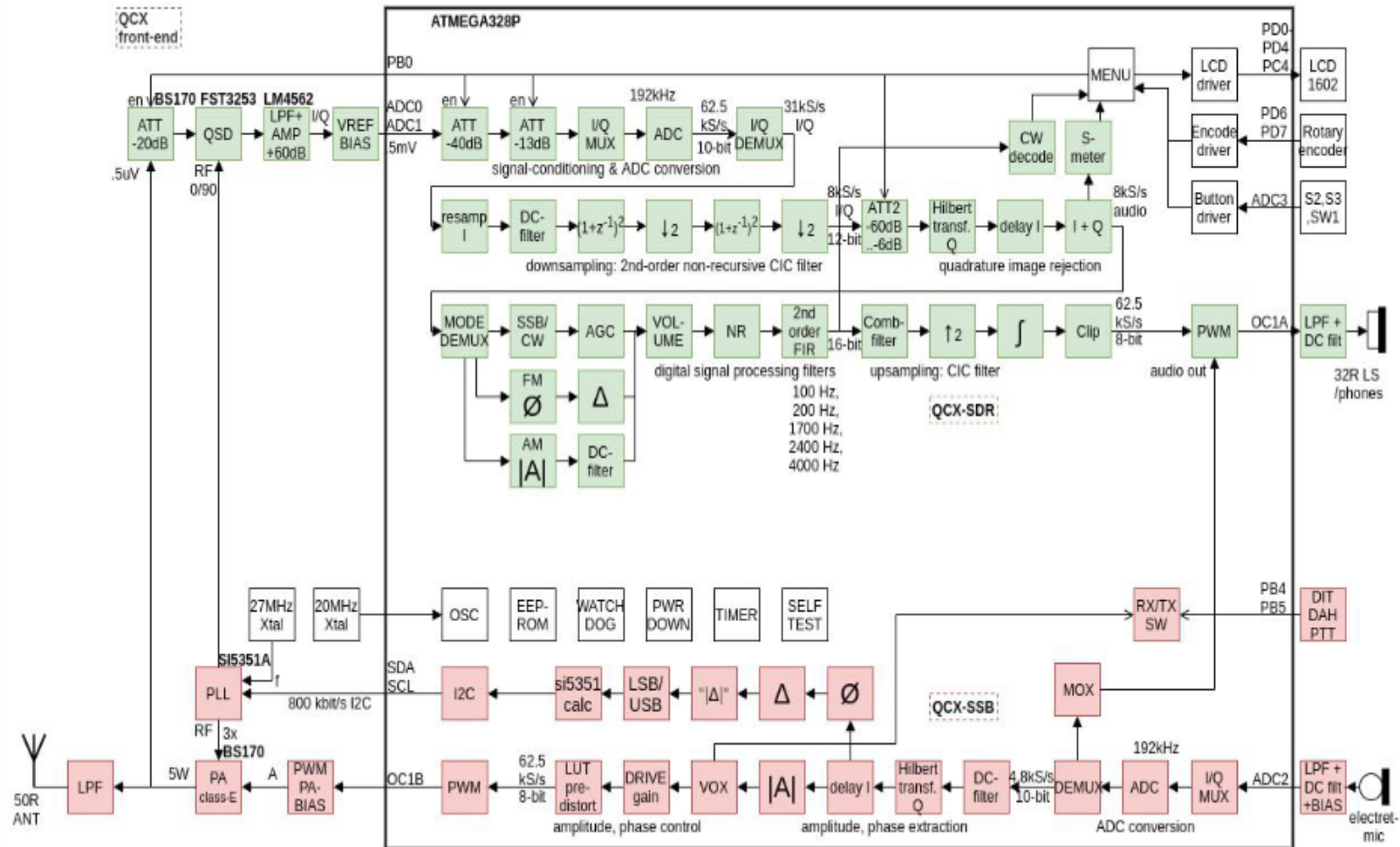
Front and Back view
Cost – with 4000mAH battery, charger, speaker mic $155

Inside view - very nicely layed out. No heat sinks.
Power output transistors are at top left. BS170 fets.

QCX front-end

ATMEGA328P

PB0

Signal-conditioning & ADC conversion

en BS170 FST3253 LM4562

ATT -20dB → QSD → LPF+ AMP +60dB → VREF BIAS

.5uV   RF 0/90   I/Q

ADC0 ADC1 5mV → en ATT -40dB → en ATT -13dB → I/Q MUX → ADC (192kHz) → 62.5 kS/s 10-bit → I/Q DEMUX (31kS/s I/Q)

MENU → LCD driver → LCD 1602 (PD0-PD4 PC4)

Encode driver → Rotary encoder (PD6 PD7)

CW decode   S-meter

Button driver → S2,S3 ,SW1 (ADC3)

downsampling: 2nd-order non-recursive CIC filter

resamp I → DC-filter → $(1+z^{-1})^2$ → ↓2 → $(1+z^{-1})^2$ → ↓2 → 8kS/s I/Q 12-bit → ATT2 -60dB ..-6dB → Hilbert transf. Q → delay I → I + Q (8kS/s audio)

quadrature image rejection

digital signal processing filters

MODE DEMUX → SSB/ CW → AGC → VOL-UME → NR → 2nd order FIR (16-bit) → Comb-filter → ↑2 → ∫ → Clip (62.5 kS/s 8-bit) → PWM → OC1A → LPF + DC filt → 32R LS /phones

FM Ø → Δ

AM |A| → DC-filter

100 Hz, 200 Hz, 1700 Hz, 2400 Hz, 4000 Hz

upsampling: CIC filter

audio out

QCX-SDR

27MHz Xtal   20MHz Xtal → OSC   EEP-ROM   WATCH DOG   PWR DOWN   TIMER   SELF TEST

RX/TX SW (PB4 PB5) → DIT DAH PTT

SI5351A

PLL ← I2C ← si5351 calc ← LSB/ USB ← "|Δ|" ← Δ ← Ø

SDA SCL   800 kbit/s I2C

MOX

QCX-SSB

RF 3x BS170

amplitude, phase control

50R ANT → LPF ← 5W PA class-E ← A PWM PA-BIAS ← OC1B → PWM ← 62.5 kS/s 8-bit → LUT pre-distort ← DRIVE gain ← VOX ← |A| ← delay I ← Hilbert transf. Q ← DC-filter ← 4.8kS/s 10-bit → DEMUX ← ADC (192kHz) ← I/Q MUX ← ADC2 ← LPF + DC filt +BIAS → electret-mic

amplitude, phase extraction   **ADC conversion**

Weight 1 lb 2oz with 4000mAh LiOn Battery

5 x 3.5 x 1 inch - fits in a big pocket

VDD - 8-15 volts
5 watts CW - slightly under 10 watts SSB
Built in speaker
Consumes about 90ma on received

- High emission efficiency, 80m/60m/40m/30m/20m efficiency is higher than 80%, 17m efficiency is higher than 70%, 15m/10m efficiency is higher than 60%.

- High-precision KDS brand TCXO, frequency accuracy is better than 1PPM, frequency stability is better than   0.5PPM - great for FT8

uSDX+HF transceiver short wave QRP SSB/CW transceiver
5W (slightly less than 10 watts at 13.8V)
All mode 8-band upgraded version USDX

General coverage HF receive from 3 MHz-30MHz
8 Transmit frequency bands:
 - 80 meters
 - 60 meters
 - 40 meters
 - 30 meters
 - 20 meters
 - 17 meters
 - 15 meters
 - 10 meters
 -   Even covers CB band

All mode AM, SSB, CW, digital
DSP filters - 4000, 2500, 1700, 500, 200, 100, 50 Hz pass-band

DSP noise reduction - built in

CW decoder, CW keyer, CW programmable message

Three independent switchable analog front-end receiver attenuators - 0dB, -13dB, -20dB, -33dB, -53dB, -60dB, -73dB

The most interesting thing is the Class E (aka Class S) amplifier.

Extremely efficient. 85% plus

Math was worked on 30 years ago in IEEE Transaction on Communications.

S andrezej - Ph.D dissertation 2010

uSDR+ is optimized and modified based on the open source work uSDX/QCX-SSB
uSDX/QCX-SSB GitHub：
https://github.com/threeme3/QCX-SSB/tree/feature-rx-improved
Groups：
https://groups.io/g/usdx-users/topics
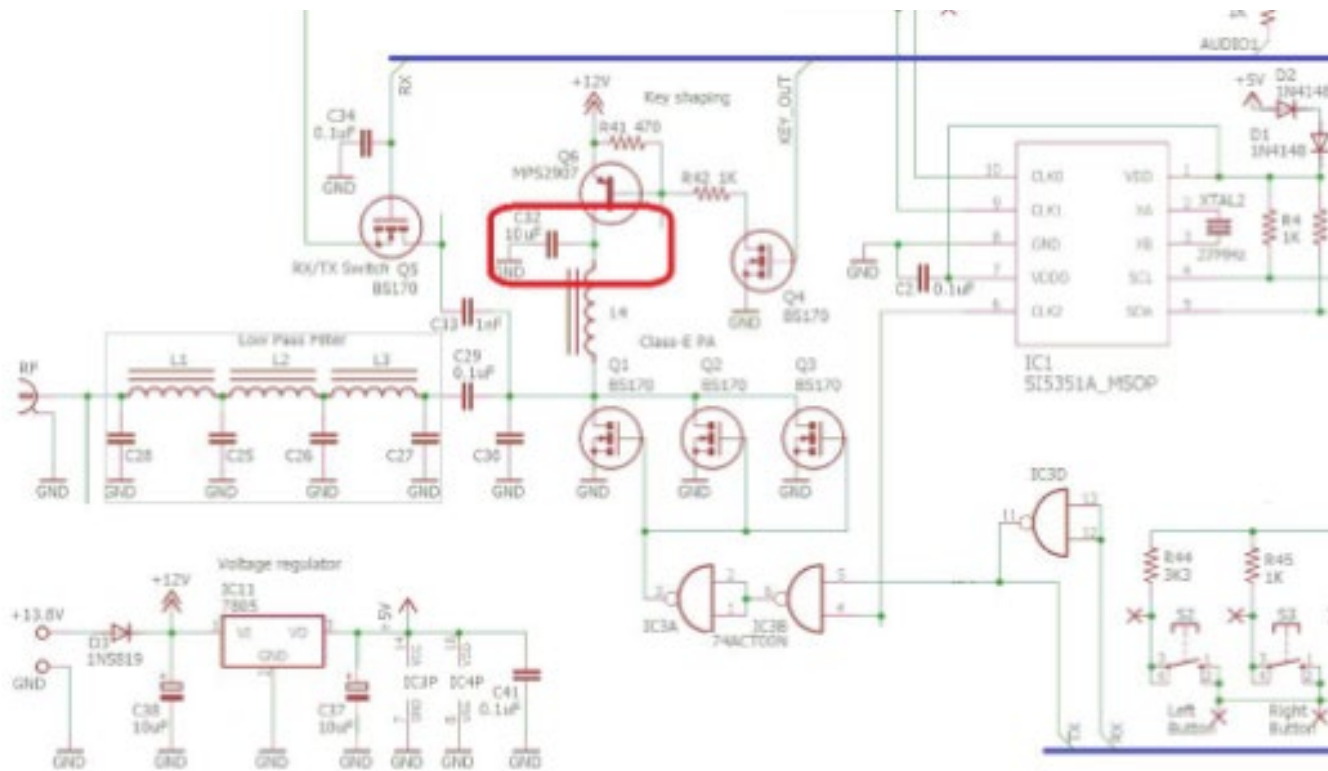
Schematic of the final Class S amplifer

What is Class S amplifier?

S – comes from Sigma Delta

One can look at it as modified Class E amplifier. Most of us are familiar with PWM (pulse width modulated amplifiers - that have been use in audio for 40 years. They use switching waveforms (like effiecient switching power supply).

So how is linear output produced?
Start with a square wave. This is every efficient.

In a PWM amplifier - by controlling the width you control the energy at any given time. After filtering this produces an analog signal.

Less amplitude after filtering

more amplitude after filtering
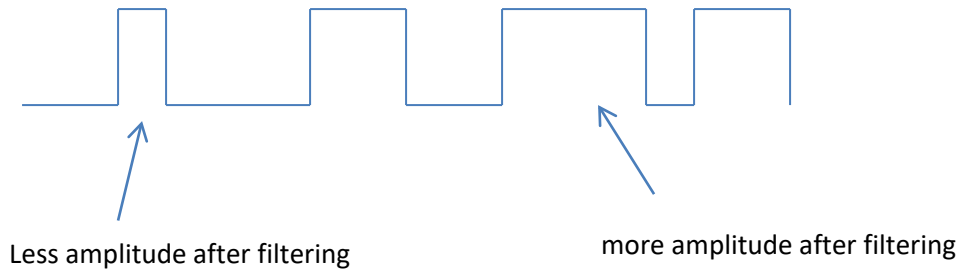
However, to produce a low distortion (less than 3%) analog signal requires you to sample at 100's KHz for an audio signal. For low distortion audio, sampling is done at several MHz.

This is not practical for RF. You would need switching transistors in the GHz range (never efficient)

In the Class S amplifier - the switching signal stays at the carrier frequency- such as 7.2 MHz for 40 meters.

Falling edge moves back and forth 800 KHz rate
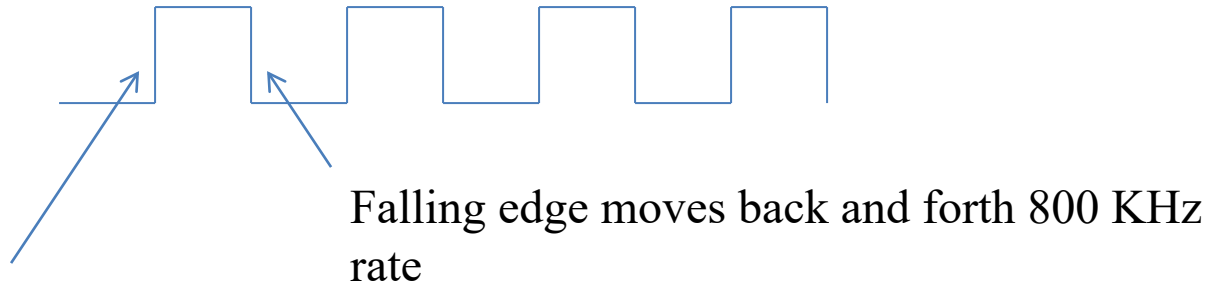
Rising edge moves back and forth 800 KHz rate

Processing of these edges are very math intensive. Basically how a DSP FIR filter works. - rising edge "adds" and falling edge "subtracts"

Much better mic – cost is $15. Also allows for internal speaker. The included mic with the uSDX+ is a speaker/mic compatible with the Kenwood/Baofeng pin outs which disables the internal speaker.

http://www.qrpkits.com/microphone.html