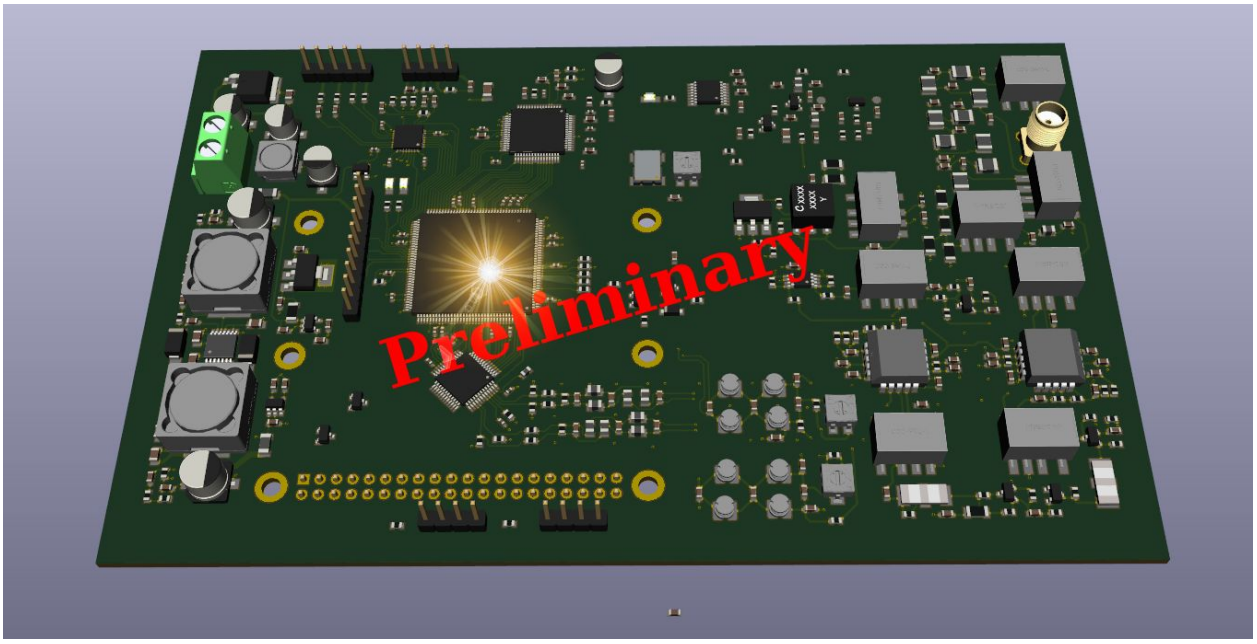
Tuja SDR transceiver specifications



About TujaSDR

Tuja is an FPGA based software defined radio (SDR) transceiver characterised by a high dynamic range in receive mode and clean spectrum emissions in transmit. It is very different from other low or medium priced SDRs that often suffer from poor dynamic range and spurious emissions. Tuja has been optimized for narrow band communications and works great for weak signal modes like SSB, CW and low speed digital modes such as WSPR, FT-8 and PSK31. The high dynamic range also makes Tuja an excellent choice for VHF/UHF/SHF operation (in conjunction with a transverter). High speed digital modes such as 4G and WiFi are not supported.

Tuja integrates with the popular Raspberry Pi platform (like a “hat” but Eurocard format) for control and signal processing. The use of a Raspberry Pi enables flexible programming, easy spectrum presentation and remote operation. The Tuja board has an audio codec with microphone input and speaker/headphone output for stand-alone operation. It is possible to connect an LCD-display and a physical buttons/knobs for operation without any computer monitor or network connection.

Tuja is designed with modern components and well-proven radio architecture in mind. In receive mode it uses the superheterodyne architecture with ultra linear analog mixers and a steep intermediate frequency filtering. A bandwidth of 100 kHz is digitized to 24 bits where further filtering in an FPGA reduces it to 50-60 kHz usable bandwidth. Baseband data is sent to the Raspberry Pi as 24 bit I/Q samples over the I2S bus.

In transmit, the Raspberry Pi generates I/Q baseband data that is sent to the Tuja board for modulation of the carrier by analog mixers. Carrier frequency in transmit, as well as local oscillator signals in receive, are generated by the FPGA connected to a high-speed DAC, running on a very clean clock source.

Output power is in the order of 100 mW (subject to change) which should be enough to drive a variety of power amplifiers. For transverters it can generate a more convenient low level (1 mW typ.) without sacrificing signal-to-noise ratio.

Key Facts

Hardware

General

Frequency coverage: 9 kHz - 30 MHz.
Frequency stability: Less than 1 ppm from onboard TCXO.
Prepared for easy integration with external transverters for 144 MHz etc.

Receiver

Architecture: Superheterodyne
Intermediate Frequencies (IF): 10.7 MHz 1st, 168 kHz 2nd
IF filter bandwidth: 100 kHz
Digital filter bandwidth: 50 kHz
ADC bits: 24
Effective Number of Bits (ENOB), typical: TBD
Blocking Dynamic Range, typical: TBD dB
Mirror frequency rejection: TBD dB

Transmitter

Noise emissions, close to carrier, typical: TBD dBc/Hz @ 10 kHz offset, TBD dBc/Hz @ 100 kHz offset
Spuriouses, non-harmonics: TBD dBc
Harmonic suppression: TBD dBc
Carrier suppression, typical: TBD dB (self calibrating)
Output power: TBD dBm / TBD mW

Software

Open Source software hosted on GitHub https://github.com/TujaSDR. Implemented in C and C++. Based on the popular liquidsdr, GNUradio and SoapySDR libraries.
Website: https://www.tujasdr.com
Google groups: https://groups.google.com/d/forum/tujasdr, tujasdr@googlegroups.com

Interfaces

Tuja board

Buses: I2S, SPI, I2C, GPIO and power to/from Raspberry Pi 40 pin header.
Power: 12V power input, for supply of both Tuja board and Raspberry Pi (No USB/5V needed).
RF (antenna, in/out): SMA.
Audio out: Mono 0.5W in 8 Ohm + optional low-level stereo .
Audio in: Microphone connection + optional line in.
GPIO: I2C and GPIO header for optional LCD display, buttons and knobs.
FPGA GPIO: Sequenced connections for control of TX/RX relays, power amplifiers and/or transverters.
Aux: PTT and CW-KEY inputs.

Raspberry Pi

Access to all GPIO, Ethernet and USB. Tuja uses SPI, i2c and I2S. Ethernet and USB exposed and the short edge of the Eurocard.

Mechanical

Tuja board size: 100x160 mm (Eurocard format)

About the designers

Daniel / SM6VFZ

The Tuja electronic circuits are designed by Daniel/SM6VFZ. They are the evolution of his many years of experimenting with an FPGA based radio platform, of which one derivative was published in the Elektor magazine in 2017. Daniel was born in 1981 and received a Master of Science degree in mathematics in 2006. He has since been working as an electronics design engineer. He is a licensed radio amateur since 1994 and has his main focus on weak signal modes on 144 MHz and above.

Albin / SM6WJM

Albin joined the project in 2017 and is responsible for the development of DSP software and Linux device drivers. The software for Tuja is the result of years of experimentation with real-time DSP on ARM CPUs. Albin was born in 1983 and received his MD degree in 2013, currently dividing his time between practicing anesthesiology and engineering. He received his amateur radio license in 1996 and has been developing software for Linux for more than 20 years.

A Tuja (or Thuja) is also known as an evergreen tree growing from 3 to 61 metres (10 to 200 feet) tall, with stringy-textured reddish-brown bark.