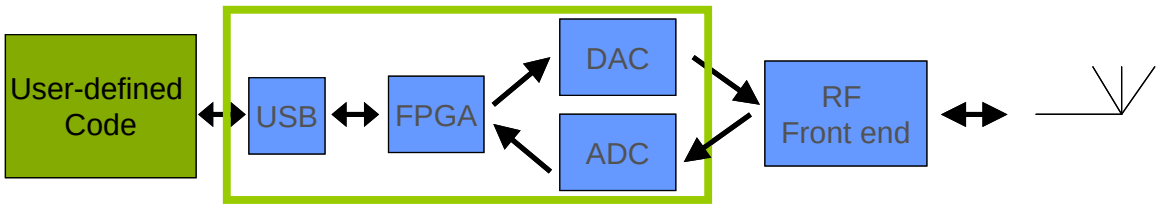
Soft real-time development environment based on software radio

- Written in C++
- Runs on Linux
- Soft real-time
- Based on USRP hardware
- A number of built-in telecommunication transmitters and receivers
- Virtual instruments: oscilloscope, spectrum analyzer, BER meter, signal constellation view

HARDWARE



System block diagram with hardware details

USB

- Supports USB2.0
- Supports 32MB/sec across the USB.
- All samples sent over the USB interface are in 16-bit signed integers in IQ format, 16-bit I and 16-bit Q data (complex), resulting in 8M complex samples/sec across the USB.

FPGA

- Includes digital down converters (DDC) implemented with cascaded integrator-comb (CIC) filters.
- DDC
  - Down converts the signal from the IF band to the base band.
  - Decimates the signal so that the data rate can be adapted by the USB 2.0 and is reasonable for the computers' computing capability.
- Digital up converters (DUCs) on the transmit side are actually contained in the AD9862 CODEC chips, not in the FPGA.
- The only transmit signal processing blocks in the FPGA are the interpolators.

ADC/DAC

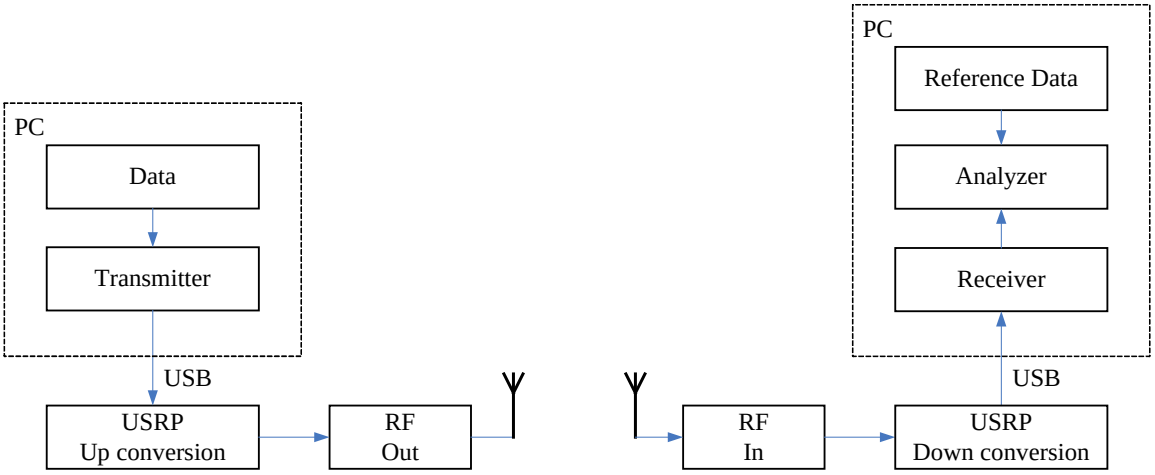
- 4 high-speed 14-bit DA converters, DAC clock frequency is 128 MS/s.
- 4 high-speed 12-bit AD converters, sampling rate is 64M samples per second.

RF Front end

- One motherboard supports up to four daughter boards
- Currently supported daughter boards:
  - 1.2 GHz (RFX1200)
  - 2.4 GHz (RFX2400)
- RFX1200, RFX2400
  - Frequency Range: 1.1 – 1.3 GHz (RFX1200), 2.3 – 2.9 GHz (RFX2400)
  - Transmit Power: 100 mW (RFX1200), 50 mW (RFX2400)

- 30 MHz transmit and receive bandwidth
- All functions controllable from software or FPGA
- Independent local oscillators (LOs) for TX and RX enable split-frequency operation
- < 200us PLL lock time, can be used for frequency hopping
- Built-in T/R switching
- 70 dB of AGC range
- Adjustable transmit power
- Full-duplex capable (with some limitations)

SOFTWARE



System block diagram with software details

- Written in C++ and runs on Linux
- The communication via USB interface is performed using *libusb* library
- Block *Data* generates and repeats a pseudorandom sequence
- The same sequence is generated within the *Reference Data* block.
- Block *Transmitter* performs baseband processing and generates modulated signal
- Modulated signal is then transferred to USRP via USB interface.
- USRP receives data from USB interface and performs digital to analog conversion and up-conversion to 2.4 GHz band
- At the receiver chain, similar processing is performed.
- After down-conversion and analog to digital conversion in the USRP, signal is transferred via USB interface to PC
- *Receiver* block performs demodulation and baseband processing.
- The received data are compared to the sent data in *Analyzer* block.

HIGHLIGHTS

- Real-time system
  - may be used for the research in the area of communication algorithms (development and verification)
- Integrated graphical user interface,
  - developed using wxWidgets graphic library
  - GUI and communication subsystems run on different threads
  - does not influence the performance of the communication subsystem
  - offers the possibility of observing signals in time and frequency domains, signal constellation, error probability, and statistical properties of the signals
- Modularity
  - already integrated a number of modules for MPSK and MDPSK signal transmitters and receivers
  - the possibility of development and analysis of different transmitter/receiver modules
- Debugging
  - graphical representation of watched signals during the development and analysis of modules

ACKNOWLEDGEMENT

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