

# GNU Radio Tutorial

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## Getting the source code

- Make sure you have all of the dependencies. Summarized at:  
`viral.media.mit.edu/wiki/tiki-view_blog.php?blogId=3`
- Checkout the source code from svn with: `svn co`  
`http://gnuradio.org/svn/gnuradio/trunk gnuradio`

in that directory and as root, do:

```
./bootstrap; ./configure  
make; make check; make install
```

# Basic Block Diagram

Typical RX path for a software radio:

Antenna -> Receive RF Front End -> ADC -> Software Code

Typical TX path for a software radio:

Software Code -> DAC -> Transmit RF Front End -> Antenna

Primary function is to translate modulated signal to baseband.

Low Noise Amplifier (LNA) -> Low Pass Filter (LPF) ->  
Mixer -> LPF -> ADC -> Local Oscillator

- Traditional analog radio design uses an Intermediate Frequency and this basically emulates that.

# Analog Digital Converter

- Sampling Rate - Number of samples per second
- Dynamic Range - Range between lowest and highest sample value

# The Universal Software Radio Peripheral (USRP)

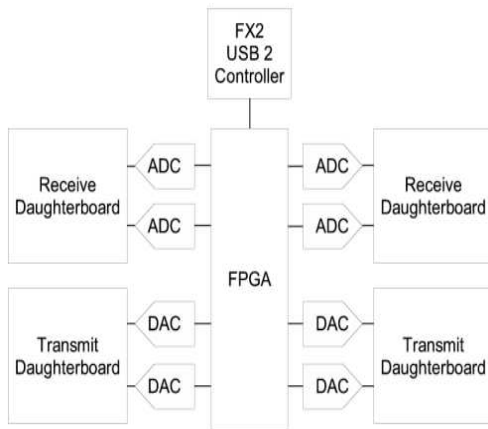


Figure: USRP Block Diagram

- 4 - 12bit A/D Converters
- 64M samples/sec each (theoretically a 32MHz wide band)
  - 42.66M samples/s, 32M samples/s ... also possible.
- subrange of A/D is 2V peak to peak
  - Can use PGA to increase gain up to 20db before A/D if signal is weak

# USRP D/A Converters

- 4 - 14bit D/A Converters
- 128M samples/s each
  - This implies a 64 MHz bandwidth signal but to be safe, should not attempt more than 50 MHz



# USRP D/A, A/D Converters

- Effectively, we have 4 input and 4 output channels
- Usually use a complex signal input/output so 2 complex input and 2 complex output
- There is also onboard interpolation in the FPGA (DDC) for both TX and RX

# USRP FPGA

- DDC brings the IF band signal to baseband
- All samples sent across the USB are 16-bit signed integer values
- USB can only handle 32Megabytes/s or less

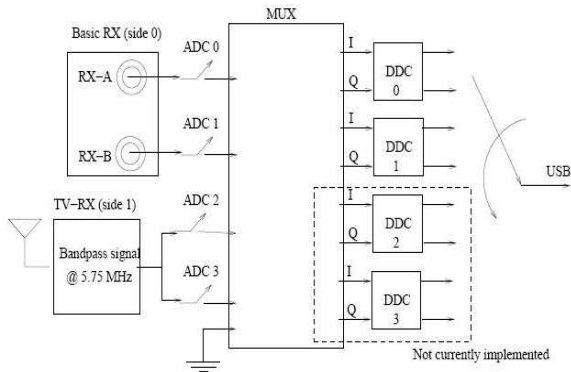


Figure: FPGA Diagram

# USRP FPGA - example

- Each DDC can be viewed as a Low Pass Filter followed by a downsampler (Decimator)
- Result of several inputs is an interleaved complex signal
- Blocks exist in software to access these FPGA parameters

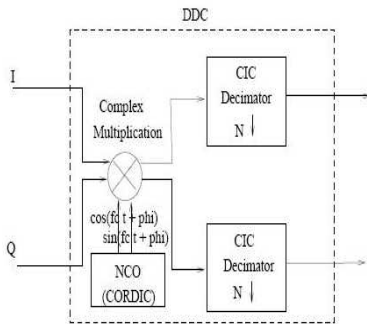


Figure: FPGA Receive

- GNU radio is full duplex. The only limiting factor is the USB interface.
- Within software, we work with complex signals
- Any considerable work will most likely be done in GNU radio C++ blocks
- We leave most of the FPGA settings alone
- The best place for help is doxygen:  
<http://www.gnu.org/software/gnuradio/doc/index.html>