Using GRC to Build Radios

Kick Start: help the novice to use the flow graph in GNU Radio

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https://w7fu.com/make-the-flow-graph-work-for-you-talk-ham-radio-january-16-2021/
Major Topics

• Getting started with GRC
• Basic flow graph workspace organization
• Flow graph details
• Data flow problem solving
• Practical odds and ends for real radios
• Group discussion
Getting Started with GNU Radio

How to install GNU Radio
https://wiki.gnuradio.org/index.php/InstallingGR

Guided Tutorials
https://www.youtube.com/watch?v=N9SLAnGIgQs&list=PL618122BD66C8B3C4
(novice flowgraph techniques, an oldie but goodie)

(sophisticated and advanced techniques)
Workspace Organization
Why Important?

• Promotes an understanding of signal processing logic
• Makes flow graph modifications easier
• Facilitates trouble shooting and problem solving
• Reduces risk of workspace mistakes
Flow Graph Details

• Options or ‘top block’
• Note blocks
• Block rotation
• Virtual Sources and Sinks
• Samp_rate logic and gain distribution
• Nested Python commands to control multiple functions
Options Block or ‘top block’
Note Blocks

Keep track of your thinking
Block Rotation
Notes and Virtual Sources and Sinks
Samp_rate Logic and Gain Distribution
Nested Python Commands
Control Multiple Parameters
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Control Multiple Parameters
Flow Graph Problem Solving

- Source and Sink not in your DSP library
- Console data interpretation
- Version and subversion problems
- Signal tracing
- Fractional resampler - ‘U’ and ‘aU’ interruptions
- Bypass block option
- Undo button on task bar
Source and Sink Drivers not in DSP Library

Solution: Download and install driver for your hardware

Pluto SDR

https://wiki.gnuradio.org/index.php/PlutoSDR_Source

Lime SDR


HackRF

Console Data – GRC version + samp_rate error

<<< Welcome to GNU Radio Companion 3.7.13.4 >>>

Block paths:
/usr/local/share/gnuradio/grc/blocks

Loading: "~/home/john/Desktop/presentation flow graph.grc"
>>> Done
Generating: '~/home/john/Desktop/Multi_mode_HF_VHF_transceiver.py'
Executing: /usr/bin/python2 -u/home/john/Desktop/
Multi_mode_HF_VHF_transceiver.py

linux; GNU C++ version 7.5.0; Boost_106501; UHD_003.009.005-0-g32951af2

Error: Failed to enable real-time scheduling.
- Opening a USRP2/N-Series device...
- Current recv frame size: 1472 bytes
- Current send frame size: 1472 bytes
- Detecting internal GPSDO... No GPSDO found

UHD Warning:
Unable to set the thread priority. Performance may be negatively affected.
Please see the general application notes in the manual for instructions.
EnvironmentError: OSError: error in pthread_setschedparam

UHD Warning:
The hardware does not support the requested RX sample rate:
Target sample rate: 0.384000 MSPs
Actual sample rate: 0.384615 MSPs

UHD Warning:
Setting IQ imbalance compensation is not possible on this device.

UHD Warning:
The hardware does not support the requested TX sample rate:
Target sample rate: 0.384000 MSPs
Actual sample rate: 0.384615 MSPs
Warning: the blks2 selector block is deprecated.
Warning: the blks2 valve block is deprecated.
Warning: the blks2 selector block is deprecated.
INFO: Audio source arch: alsa
INFO: Audio sink arch: alsa
Error: failed to enable real-time scheduling.
-- Opening a USRP2/N-Series device...
-- Current recv frame size: 1472 bytes
-- Current send frame size: 1472 bytes

UHD Warning:
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UHD Warning:
Setting IQ imbalance compensation is not possible on this device.
Warning: the blks2.selector block is deprecated.
Warning: the blks2.valve block is deprecated.
Warning: the blks2.selector block is deprecated.
Warning: the blks2.selector block is deprecated.
INFO: Audio source arch: alsa
INFO: Audio sink arch: alsa
Version Problems: GRC v3.7 vs. v3.8

• Version 3.7 flow graphs will not run on a Version 3.8 installation: a blank workspace
• Version 3.8 flow graphs will not run on a Version 3.7 installation: missing blocks

Solution: Hand build flow graph: block by block, parameter by parameter from your DSP library. Not a Copy and Paste solution
GRC v3.7 Subversion Problems: missing blocks

Solution: Replace missing blocks with blocks from your DSP library
Solution: Try replacing Source and Sink blocks first. Otherwise, hand Rebuild from your DSP library.
Signal Tracing and Stimulus Response Testing

• **Signal Tracing**: Output to an instrumentation GUI widget, e.g. FFT display to study data stream frequency components

• **Stimulus Response testing**: Use a Signal Source or Noise Source to study frequency response of filters, phase shifters, etc.
Fractional Resampler
‘U’ and ‘aU’ Interruptions

Adjust ‘Ratio’ GUI slider to reduce ‘U’ and ‘aU’ interruptions
Block ‘Bypass’ Option

A convenient means to functionally remove a block from a data stream. 
<Right> click block and select <Bypass> from menu

Unbypassed block

Bypassed block
‘Undo’ Button on Task Bar

Easy way to undo workspace mistakes, especially common with congested flow graphs using computers with touch pads, small screens.
Odds and Ends

• Eliminate Receiver DC artifact
• Selector switch
• Analog TX/RX hardware logic control schematic
• Software TX/RX control using duplex mode
Eliminate Receiver DC Artifact

Solution: Offset Source center frequency and Freq Xlating filter center frequencies by the same amount in opposite directions, e.g. +/- 100e3 Hz
Eliminate Receiver DC Artifact

Properties Boxes

[Image of properties boxes]

Properties: UHD: USRP Source
- Ch0: Center Freq (Hz): 144.52e6-100e3
- Ch0: Gain Value: 1
- Ch0: Gain Type: Normalized
- Ch0: Antenna: RX2
- Ch0: Bandwidth (Hz): samp_rate

Properties: Frequency Xlating FFT Filter
- ID: freq_xlating_fft_filter_ccc_1
- Decimation: 2
- Taps: firdes.low_pass(1,(samp_rate),(samp_rate/21),30
- Center Frequency: 144.52e6+100e3
- Sample Rate: samp_rate
- Sample Delay: 0
- Num. Threads: 1
Selector Switch

Selector interrupts data flow and turns off Sink. Useful for hardware derived logic for TX/RX switching systems.
Analog TX/RX Hardware Control

Solution: Use a small amount of current from the SDR RX or TX LED as a logic source. Use the current to drive a high gain transistor switch array. The transistor switch then controls other system switches and relays, i.e. PA’s, preamplifiers, antenna relays, etc.
Analog TX/RX Hardware Control
Schematic Diagram
Software TX/RX Control: Duplex Mode

**Solution:** Use nested commands

**Receive mode:** The Source center frequency is selected for the desired operating frequency. The Sink center frequency is selected to “0” frequency. (or some out-of-bounds frequency)

**Transmit mode:** The Sink center frequency is selected for the desired operating frequency. The Source center frequency is selected to “0” frequency. (or some out-of-bounds frequency)
Software TX/RX Control: Duplex Mode
Group Discussion

• What additional flow graph techniques do you want to share?

• What are your current GRC projects or problems?