

DDØCW
“Knucker”
DVB-T Receiver

Block Diagram

by Rick Peterson, WA6NUT

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Introduction

The DDØCW software receiver was originally intended to receive and process the 5 MHz IF output from the BATC “Knucker” receiver. It was available for download from the BATC forum, but is no longer available. I modified it for general purpose use (I use it on the 70 cm band), and the modified version can be downloaded from my website. I have found the receiver to be more robust than others, requiring no adjustment over many hours of operation. No additional software (i.e., TS Reader) is required for tuning, as a feature (the “sig. out activity” window) monitors the data flow from the receiver to the VLC display software. And it also has the usual constellation and spectrum displays. See the link below for more information on the original Knucker receiver software:

<https://forum.batc.org.uk/viewtopic.php?f=134&t=8239>

A document including operating details for the receiver can be downloaded from:

<https://www.qsl.net/wa6nut/High%20Performance%20DVB-T.pdf>

This document (the one you're reading) was prepared to show the details of the GNU Radio implementation of the DDØCW DVB-T receiver. Details of each GNU Radio block are found at:

https://wiki.gnuradio.org/index.php?title=Category:Block_Docs

For more information on GNU Radio, check out the “Field Expedient SDR” books by Paul Clark and David Clark. You'll find the first three volumes useful, especially if you want to customize a GNU Radio flow graph.

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For more information, go to:

<http://www.factorialabs.com/fieldxp/>

Or search in Amazon for “field expedient sdr.”

The books recommend implementing GNU Radio Companion in Linux (rather than in Windows), probably because the Windows version worked poorly back in 2015. But today, in 2024, you'll find the Windows version much simpler to implement and use.

URLs for Downloading Software

GNU Radio Companion v. 3.9.0.0

<https://web.archive.org/web/20220316012358/gcnddevelopment.com/gnuradio>

Knucker_ZF_RTL_dvbt_rx.zip DVB-T Receiver by DDØCW

https://www.qsl.net/wa6nut/Knucker_ZF_RTL_dvbt_rx.zip

VLC Media Player

<https://www.videolan.org/vlc/download-windows.html>

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GNU Radio Blocks (see Figure 1 p. 9)

- 1 Osmocom Source (interface to RTL-SDR)
REF2, p. 106; REF3, p. 36 (see Notes p. 8)
<https://osmocom.org/projects/gr-osmosdr/wiki>
- 2 Selector (routes Osmocom Source to Rational Resampler for selected 1 of 11 BW)
<https://wiki.gnuradio.org/index.php/Selector>
- 3 Rational Resampler (each of 11 Rational Resamplers sets interpolation & decimation for selected BW)
REF1, pp. 86, 190-195; REF2, pp. 45, 48, 184
https://wiki.gnuradio.org/index.php/Rational_Resampler
- 4 Fast Multiply Const. (in 2 of 11 inputs to selector (5))
https://wiki.gnuradio.org/index.php/Fast_Multiply_Const
- 5 Selector (routes Rational Resampler to OFDM Symbol Acq. and Spectrum GUI for selected 1 of 11 BW)
<https://wiki.gnuradio.org/index.php/Selector>
- 6 OFDM Signal Acquisition (Time sync: uses autocorrelation function to position FFT sampling window into area free of inter-symbol interference)
https://wiki.gnuradio.org/index.php/OFDM_Symbol_Acquisition
REF4, pp. 393-398
- 6A QT GUI Frequency Sink (Spectrum GUI)
https://wiki.gnuradio.org/index.php/QT_GUI_Frequency_Sink
- 7 FFT (transforms COFDM symbols back to frequency domain, with 2048 real and imaginary parts, not yet corrected for phase and distortion)
REF4, pp.393-398
<https://wiki.gnuradio.org/index.php/FFT>
- 8 Selector (routes FFT or file to Demod Reference Signals for selected QPSK, 16QAM or 64QAM)
<https://wiki.gnuradio.org/index.php/Selector>

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- 8A File Source: GNU.ofdm_data_in file (plays DDØCW kitten video w/music)
REF1, p. 78; REF2, p. 39; REF3, p. 41
https://wiki.gnuradio.org/index.php/File_Source
- 8B Stream to Vector (format conversion)
https://wiki.gnuradio.org/index.php/Stream_to_Vector
- 9 Selector (routes FFT or file to Demod Reference Signals for selected 1 of 5 FEC)
<https://wiki.gnuradio.org/index.php/Selector>
- 10 Demod Reference Signals (Channel correction: Uses pilot signal information to rotate and compress or expand constellation diagram, remove amplitude distortion)
https://wiki.gnuradio.org/index.php/Demod_Reference_Signals
- 10A Selector (routes Demod Reference Signal for selected 1 of 5 FEC to Constellation GUI)
<https://wiki.gnuradio.org/index.php/Selector>
- 10B Vector to Stream (format conversion)
https://wiki.gnuradio.org/index.php/Vector_to_Stream
- 10C Selector (routes Demod Reference Signal for selected QPSK, 16QAM, or 64QAM to Constellation GUI)
<https://wiki.gnuradio.org/index.php/Selector>
- 10D QT GUI Constellation Sink (Constellation GUI)
REF3, pp. 70-95; 251-281
https://wiki.gnuradio.org/index.php/QT_GUI_Constellation_Sink
- 11 DVB-T Demap (uses de-mapping table to extract data and form data stream to channel decoder blocks)
REF4, pp. 231, 234, 393-398; REF5, p. 104
https://wiki.gnuradio.org/index.php/DVB-T_Demap

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- 12 Symbol Inner Interleaver (re-sorts de-mapped data for input to Viterbi decoder)
REF4, pp. 270, 393-398, 711, 739; REF5, p. 105; REF6, pp. 111-113
https://wiki.gnuradio.org/index.php/Symbol_Inner_Interleaver
- 13 Bit Inner De-Interleaver (re-sorts de-mapped data for input to Viterbi decoder)
REF4, pp. 270, 280, 393-398; REF5, p. 105; REF6, pp. 111-113
https://wiki.gnuradio.org/index.php/Bit_Inner_Deinterleaver
- 14 Vector to Stream (format conversion)
https://wiki.gnuradio.org/index.php/Vector_to_Stream
- 15 Viterbi Decoder (Error correction, FEC)
REF4, pp. 275, 280, 393-398; REF5, p. 105; REF6, pp. 205-207
https://wiki.gnuradio.org/index.php/Viterbi_Decoder
- 16 Convolutional De-Interleaver (breaks up error bursts by undoing interleaving for input to the Reed-Solomon decoder)
REF4, pp. 270, 280, 393-398; REF5, p. 105; REF6, pp. 111-113
https://wiki.gnuradio.org/index.php/Convolutional_Deinterleaver
- 17 Reed-Solomon Decoder (corrects up to 8 bit errors per packet)
REF4, pp. 393-398; REF5, pp. 105-106; REF6, pp. 108, 204-205
https://wiki.gnuradio.org/index.php/Reed-Solomon_Decoder
- 18 Energy Descramble (energy dispersal removal: also sync byte inversion removal, making MPEG-2 TS available for output to UDP Sink)
REF4, pp. 268, 393-398; REF5, p. 106; REF6, pp. 106-108
https://wiki.gnuradio.org/index.php/Energy_Descramble
- 19 Selector (routes Energy Descramble for selected 1 of 5 FEC to UDP Sink and Eye Sink GUI)
<https://wiki.gnuradio.org/index.php/Selector>

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- 20 Selector (routes Energy Descramble for selected QPSK, 16QAM or 64QAM to UDP Sink and Eye Sink GUI)
<https://wiki.gnuradio.org/index.php/Selector>
- 20A Char. to Float (format conversion)
https://wiki.gnuradio.org/index.php/Char_To_Float
- 20B QT GUI Eye Sink (sig. out activity GUI: monitors stream to UDP Sink – which outputs to VLC Media Player)
https://wiki.gnuradio.org/index.php/QT_GUI_Eye_Sink
- 21 UDP Sink (stream to VLC Media Player: 230.0.0.1:1234)
https://wiki.gnuradio.org/index.php/UDP_Sink

Notes:

- REF1: *Introduction to Software Defined Radio: Field Expedient SDR Vol. 1*
Clark, P. & Clark, D., Meadow Registry Press
- REF2: *Basic Analog Radio: Field Expedient SDR Vol. 2*
Clark, P. & Clark, D., Meadow Registry Press
- REF3: *Basic Digital Communications: Field Expedient SDR Vol. 3*
Clark, P. & Clark, D., Meadow Registry Press
- REF4: *Digital Video and Audio Broadcasting Technology*, 3rd Edition
Walter Fischer, Springer-Verlag, 2010
- REF5: *Digital Television*, 2nd Edition
Mark Massel, digitalTVbooks.com, 2008
- REF6: *Digital Television*, 3rd Edition
Herve Benoit, Elsevier, 2006

Last revised: 7/22/24

DD0CW "Knucker" DVB-T Receiver Block Diagram

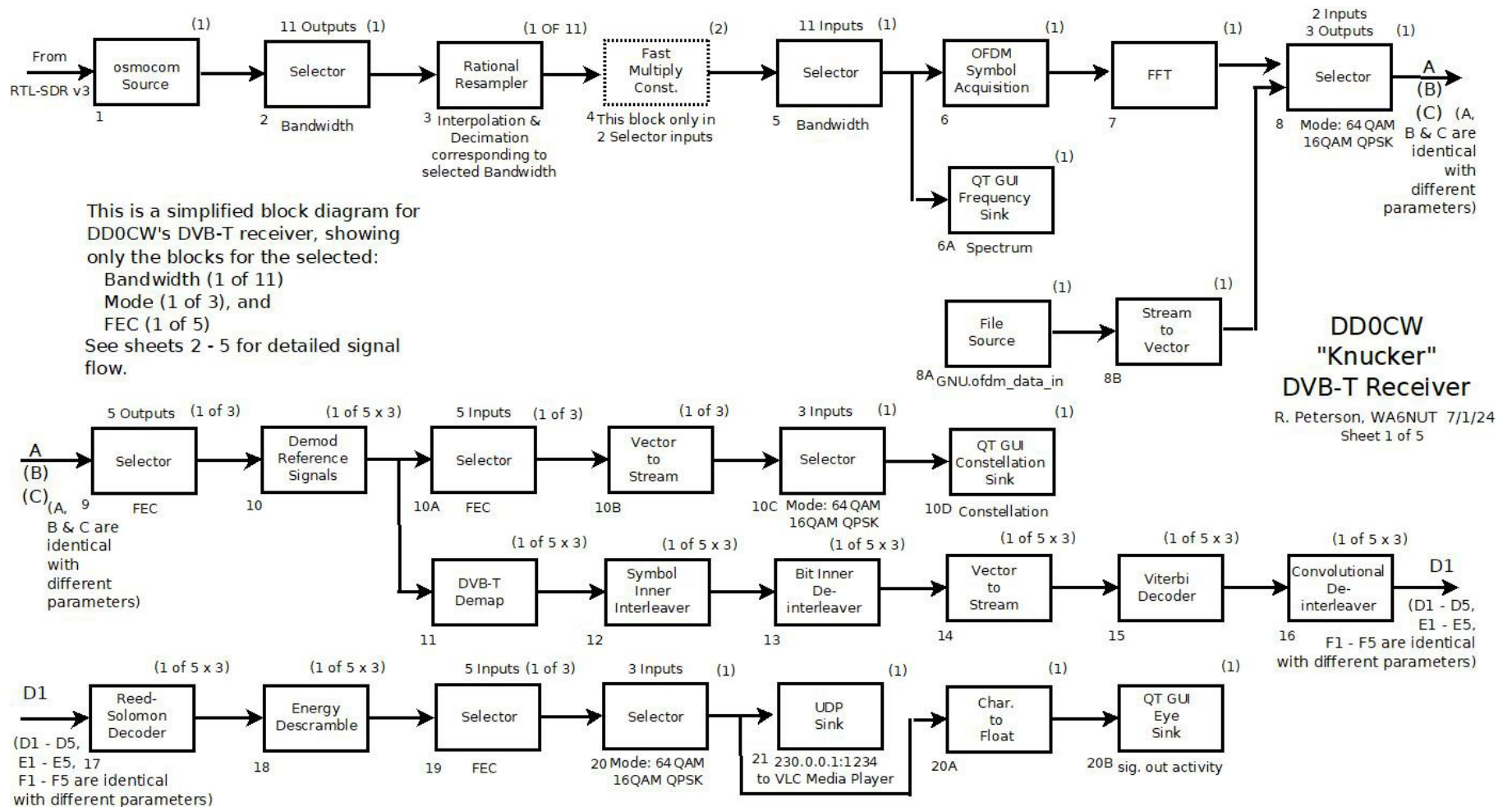
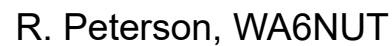


Figure 1: Simplified GNU Radio Block Diagram Sheet 1 of 5
Showing signal flow for single set of selected Bandwidth, Mode, and FEC parameters

Figure 2: Detailed GNU Radio Block Diagram Sheet 2 of 5
Showing how Bandwidth, Mode, and FEC parameters are selected.



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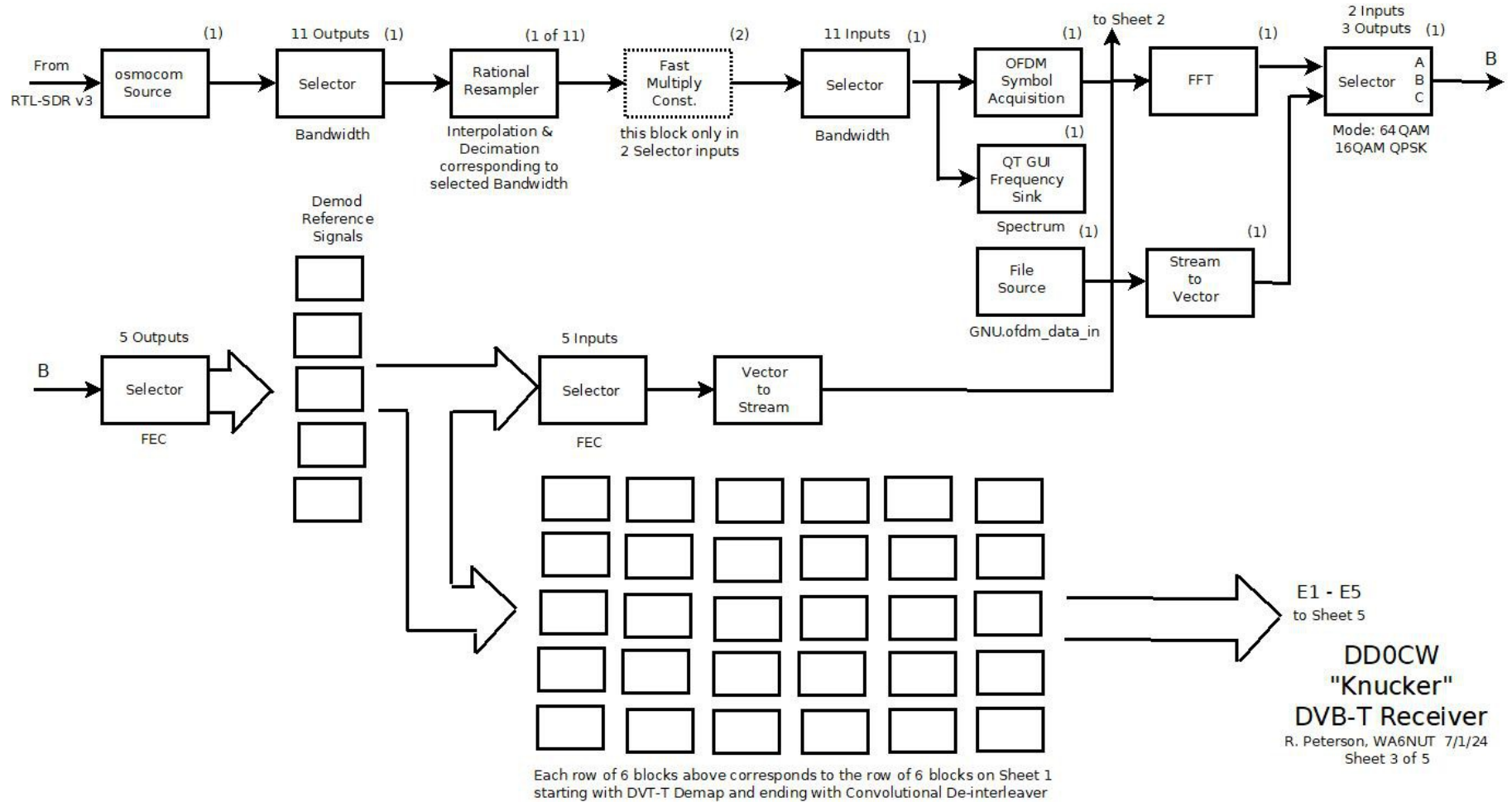


Figure 3: Detailed GNU Radio Block Diagram Sheet 3 of 5
Showing how Bandwidth, Mode, and FEC parameters are selected.

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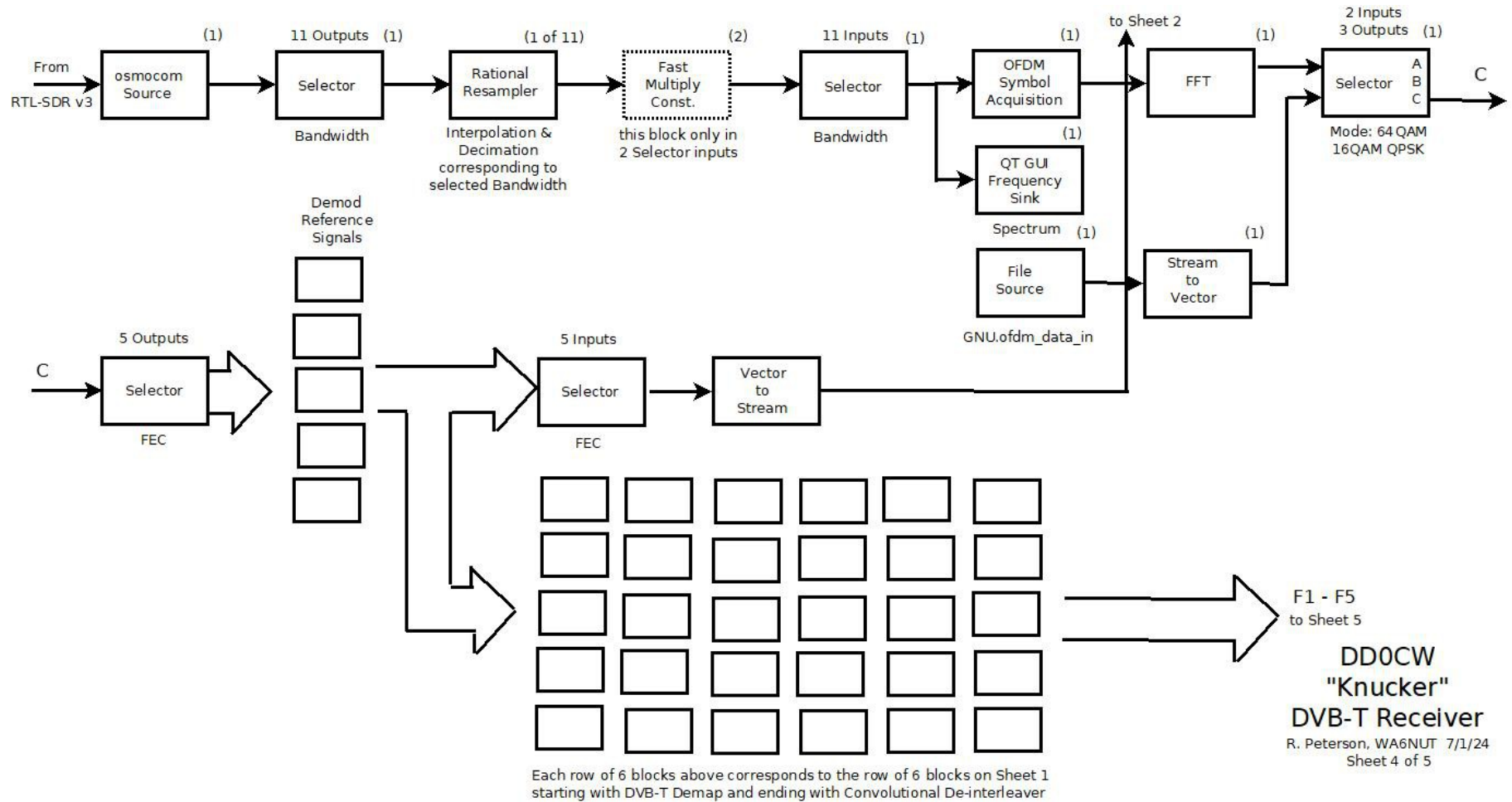


Figure 4: Detailed GNU Radio Block Diagram Sheet 4 of 5
Showing how Bandwidth, Mode, and FEC parameters are selected.

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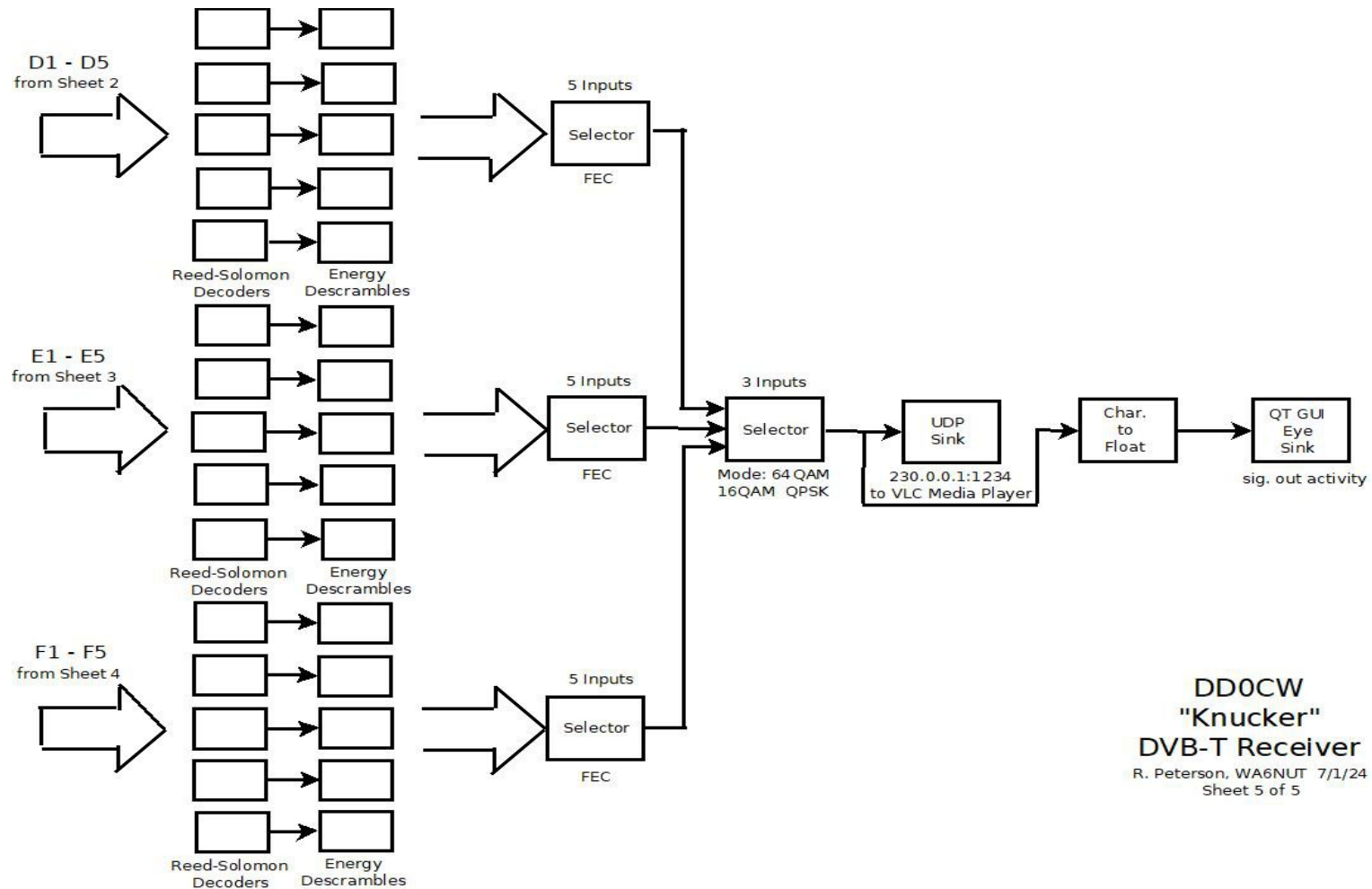


Figure 5: Detailed GNU Radio Block Diagram Sheet 5 of 5
Showing how Bandwidth, Mode, and FEC parameters are selected.

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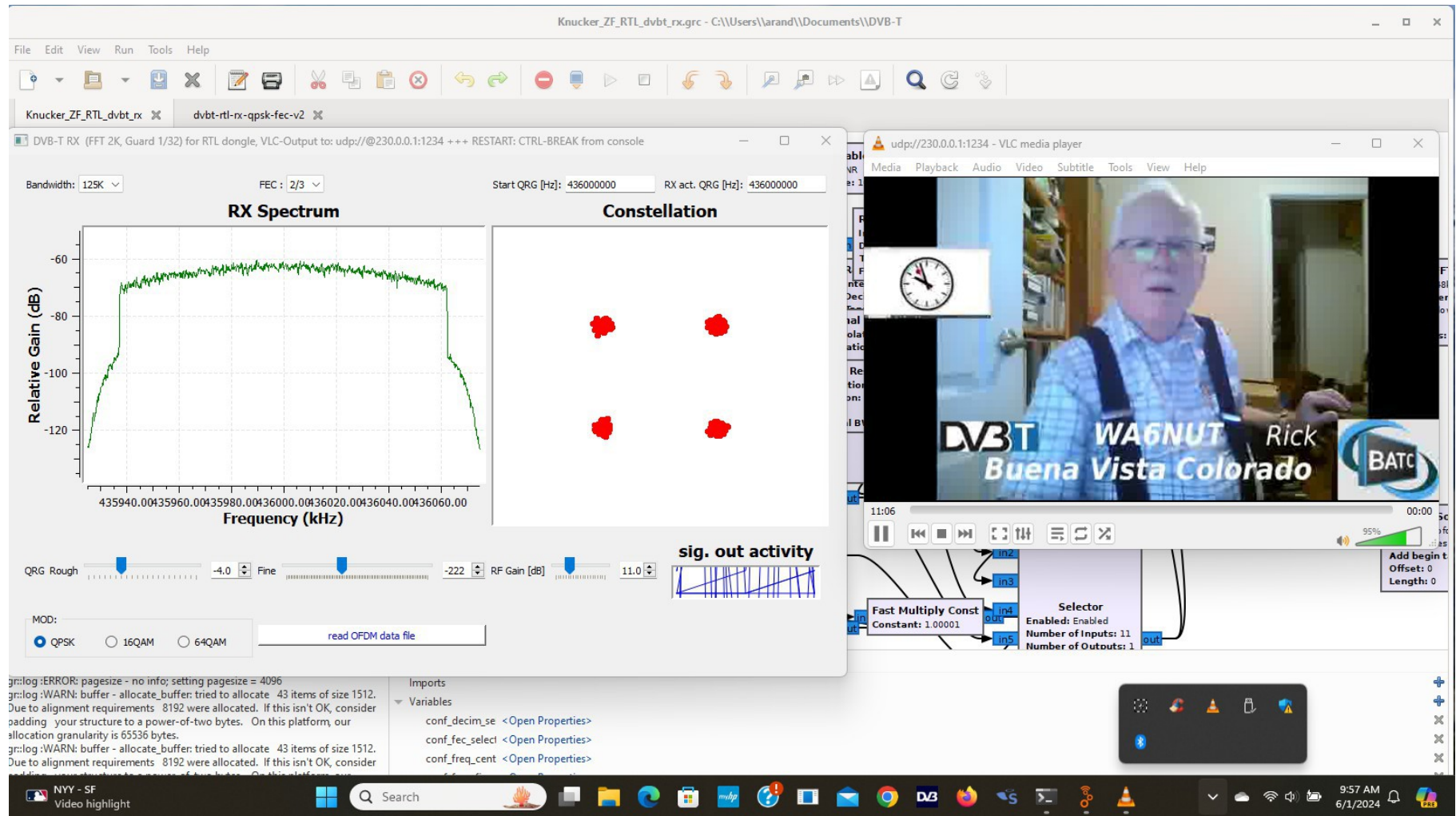


Figure 6: Screenshot of DDØCW DVB-T receiver (left), VLC Media Player (right), and GNU Radio Companion (background)