

Operating Instructions

F4DFW DVB-T Receiver v.4.2 (Python)

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October 2023

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Operating Instructions F4FDW DVB-T Receiver v.4.2

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INTRODUCTION

This document provides the procedure for setting up and using the F4FDW DVB-T receiver v.4.2 at WA6NUT. Software receivers written in Python are preferred, especially at higher bandwidths ($\geq 500\text{K}$). The author's experience is that, when transmitting and receiving software are used, the receiver (not the transmitter) is the limiting factor when higher bandwidths are required.

Some details are specific to the WA6NUT setup, and may not apply to your station.

TSReader Lite is used to take the TCP stream from the F4FDW receiver and apply a video stream to VLC Media Player. TSReader Lite is useful for monitoring the quality of the TCP stream, and allows the operator to start or restart the VLC display by simply pressing the CTRL+0 keys. And TS Reader Lite serves as an excellent tuning aid for the F4FDW DVB-T receiver. The Lite version of TSReader limits the VLC display time to one minute (the \$99 Standard version of TSReader provides unlimited display time).

VLC Media Player is used to play the received video (and audio).

Details of the transmitting setup at WA6NUT are found in a separate document, and can be downloaded from:

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

The above document describes operation at 125K bandwidth, the maximum usable rate for the software receiver used. However, the transmitting setup described works well at higher bandwidths, so the document can be used for setting up your transmitting hardware and software, for use with the F4FDW receiver at higher bandwidths.

SETTING UP THE RECEIVER

PC: HP Laptop 17z-cp200 (Processor: AMD Athlon@3700 MHz)

Receiver hardware: USB SDR dongle, RTL-SDR V3

GE 42178 preamp

Receiver software: dvbt_rx_v42.py by F4FDW

GNURadio v. 3.8.2.0

TSReader Lite

VLC Media Player

Download and Install Apps

Download dvbt_rx_v42.py from the F4FDW website (shown as “Fichier python version 4.2” link at top of page). It should be installed in the C:\ folder. This app is written in Python 3, so it will run with the Python included in GNURadio-3.8 without modification.

Download and install the GNURadio-3.8 software from the archive.org website (it will install itself in the C:\Program Files folder). Find the run_gr.bat batch file in the c:\Program Files\GNURadio-3.8\bin folder, and create a desktop “run_gr-Shortcut” so GNURadio-3.8 can be opened by clicking a desktop icon.

Download and install TSReader Lite from the website. It should install a blue “DVB” icon on the PC desktop.

Download and install VLC Media Player from the website. It should install an orange traffic cone icon on the PC desktop (it won't be necessary to manually open VLC Media Player, as TSReader Lite allows it to be opened with simple CTRL+0 keystrokes).

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Opening the Apps

Set up your DVB-T transmitter for FEC=2/3, bandwidth=500k, and a suitable power level. For ease of operation, leave the transmitter running as you start the receiver software.

Make sure the RTL-SDR is connected to a USB port on your PC. Left double-click the “run_gr-Shortcut” icon on the desktop. At the prompt, type `cd c:\program files\gnuradio-3.8`, and the `C:\Program Files\GNURadio-3.8` prompt should appear. At this prompt, type `python c:\dvbt_rx_v42.py`, and the F4FDW v.4.2 app GUI should appear (see Screenshot 1). See Note 1.

Set the RIT to -2 (default value) and set the RF Gain for the correct configuration of the Constellation clusters (a setting found by experimentation).

Left double-click the TSReader Lite icon on the desktop. The first time this is done you'll select “TCP” from the menu, and then you'll enter the TCP address (127.0.0.10) and port (10000). These parameters will be remembered by the app for future use (see Note 2).

Some time will be required for TSReader to acquire the TCP stream from the receiver. The PAT values in the “MPEG-2 Statistics” box will start counting up when the stream is acquired, and a thumbnail image of the first frame will appear in the Video Decode window (see Screenshot 1). Press the CTRL+0 (zero) keys (or double left-click on the thumbnail image) to open VLC Media Reader, and the received video will be displayed for one minute. Press the CTRL+0 keys (or double left-click on the thumbnail image) again to restart the VLC display (see Screenshot 1).

USING THE RECEIVER

(see Screenshot 1)

Controls: The F4FDW DVB-T v.4.2 receiver has four controls:

- 1 **RF Gain dB:** 0 to 42 dB (default = 26 dB)
- 2 **RIT:** -100 to +100, steps of 1 ppm (default = -2)
- 3 **center_freq:** 50 – 1300 MHz, steps of 250 Hz (default = 436 MHz).
Frequencies can also be entered into the text box from the keyboard.
- 4 **Bandwidth:** “ Bandwidth – with start (menu)” (“Largeur de bande – avec (menu) de démarrage”): The following values can be entered by simply clicking on the corresponding radio button:

66k, 225k, 250k, 333k, 500k + 1000 (menu)

Select 125k using the procedure below. The 500k + 1000 (menu) radio button is selected by default, providing 500k. It is also used to select 1000k using the procedure below.

125k: To open the app, type `python c:\dvbt_rx_v42.py -b 125`
After the app opens, click the 125k (menu) radio button.

1000k: To open the app, type `python c:\dvbt_rx_v42.py -b 1000`
The app will open with 1000k bandwidth (the 500k + 1000 (menu) radio button is already selected by default)

Displays: The F4FDW DVB-T v.4.2 receiver has four displays:

- 1 **Constellation:** Each constellation cluster represents a value in the received symbol (i.e., a QPSK symbol has four possible values, hence its constellation displays four clusters). Deviation from the ideal (center) for each cluster is caused by noise and other error sources (see MER below).

Instructions: F4FDW DVB-T Receiver v.4.2

- Spectrum:** Displays the spectrum of the received DVB-T signal (note that the horizontal frequency axis is incorrectly labeled when 125k and 1000k bandwidths are selected).
- MER:** The Modulation Error Ratio measures ratio (in dB) of the signal level to the mean deviation of the constellation clusters from the ideal (center) for each cluster. Deviation from the ideal (center) is caused by noise and other error sources. It is a useful measure of the signal vs. noise and other error sources.
- Waterfall** (“Calibrage”): Displays the spectrum vs. time for the received DVB-T signal (note that the horizontal frequency axis is incorrectly labeled when 125k and 1000k bandwidths are selected).

Other options: Other options for receiver operation, beside bandwidth, are available at startup. After typing `python c:\dvbt_rx_v42.py`, type a space, the abbreviation for the parameter, a space, then the value, as shown below. If you want to use a default value for a parameter, don't enter anything for that parameter. Press the Enter key after entering the last value, and, after a delay, the app will open.

Parameter:	Type abbrev.:	Type a space, then the value below:
mode	-c or --cons	Enter qam16 or qam64. Default is qpsk.
FEC (Viterbi rate)	-r or --fec	Enter 1/2, 3/4, 5/6, or 7/8. Default is 2/3.
Guard interval	-g or --guard	Enter 1/16, 1/8, or 1/4. Default is 1/32.
Center frequency	-f or --freq	Enter frequency in Hz (i.e., 437e6). Default is 436 MHz

Instructions: F4FDW DVB-T Receiver v.4.2

Parameter:	Type abbrev.:	Type a space, then the value below:
Bandwidth	-b or --channel	Enter rate in ks/sec (i.e., 125 or 1000). Default is 500 Use the radio buttons to select other bandwidth values.
Help	-h or --help	Enter no value (leave blank). Displays the options listed above, then returns to prompt.

Tuning the Receiver

- 1 While receiving the transmitting station's DVB-T signal, set RIT and RF Gain for continuous PAT counts in the TSReader Lite "MPEG-2 Statistics" box (start with RIT and RF Gain default values of -2 and 26 dB, respectively).
- 2 After the PAT count starts and the thumbnail first frame is displayed in the Video Decode window, press the CTRL+0 keys to play the transmitting station's video and audio in VLC (after each timeout (about 1:18 on the VLC timer in lower left corner), press the keys again to maintain VLC video and audio from the transmitting station). If VLC doesn't start with the CTRL+0 keys, double-click on the image in the Video Decode window.
- 3 If the PAT count stops, if error counts are rapidly increasing, or if the "Mux bitrate" and/or "Last sec" readings are incorrect:

Set the receiver RIT control for increasing TSReader Lite PAT counts or correct readings for "Mux bitrate" and "Last sec" (correcting for RTL-SDR frequency drift). The correct receiver RIT settings will normally be in the $-3 \leq \text{RIT} \leq +3$ ppm range. Use the center_freq control for fine tuning.

Minimal frequency adjustment will be required after the RTL-SDR reaches thermal equilibrium.

OR,

Instructions: F4FDW DVB-T Receiver v.4.2

Exit TSReader Lite

Exit dvbt_rx_v42.py

Restart dvbt_rx_v42.py

Type python c:\dvbt_rx_v42.py

Set RIT = last setting (or default)

Set RF Gain = last setting (or default)

Restart TSReader Lite

(this procedure should rarely be necessary)

- 4 The RTL-SDR V3 receiver has a TCXO for 0.5-1 ppm frequency stability, however, some V3 receivers may exhibit drift up to 6 ppm.
- 5 See Table 1 (page 10) for receive frequencies obtained with combinations of RIT and center_freq settings. Example: If RIT and center_freq are set to -1 ppm and 436 000 500 respectively, the receiver is tuned to 436 000 064 Hz (assuming no frequency offset or drift in the RTL-SDR clock).

Examination of Table 1 shows that, using both RIT and center_freq controls together improves the tuning resolution, giving a tuning resolution of ± 186 Hz (= 436 - 250 Hz), for tuning in steps of 186 Hz.

Tuning in 186 Hz increments is a two-step process (refer to Table 1 to see how this works):

Tuning UP: Increase the RIT setting by one step, then
 Decrease the center_freq setting by one step

Tuning DOWN: Decrease the RIT setting by one step, then
 Increase the center_freq setting by one step

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RIT
(ppm)
(-3 to 3)

Table 1: F4FDW DVB-T Receiver v.4.2 Tuning Chart
Red: Begins with 435 9 Black: Begins with 436 0

-3	97 692	97 942	98 192	98 442	98 692	98 942	99 192	99 442	99 692
-2	98 128	98 378	98 628	98 878	99 128	99 378	99 628	99 878	00 128
-1	98 564	98 814	99 064	99 314	99 564	99814	00 064	00 314	00 564
0	99 000	99 250	99 500	99 750	00 000	00 250	00 500	00 750	01 000
1	99 436	99 686	99 936	00 186	00 436	00 686	00 936	01 186	01 436
2	99 872	00 122	00 372	00 622	00 872	01 122	01 372	01 622	01 872
3	00 308	00 558	00 808	01 058	01 308	01 558	01 808	02 058	02 308
	99 000	99 250	99 500	99 750	00 000	00 250	00 500	00 750	01 000

center_freq (435 9|99 000 to 436 0|01 000)

Instructions: F4FDW DVB-T Receiver v.4.2

- 6 Operation at Lower Bandwidths: The preceding comments 1 - 5 apply to operation at higher bandwidths, i.e., 500K. At these bandwidths, frequent retuning is required for about one hour after startup, and TS Reader PAT/PMT errors will be noted. After about an hour, the frequency tuning setting is more stable, and, when required, retuning the center_freq control only one step (± 250 Hz) at a time will be needed.

But at lower bandwidths, i.e., 125K, the receiver behavior is different. Immediately after startup, the frequency tuning setting is stable, with zero TS Reader PAT/PMT errors. And if the receiver stalls (with TS Reader PAT/PMT errors), simply increment or decrement the center_freq control up or down (usually only one ± 250 Hz step will be required). You should see the TS Reader PAT count resume, as well as the VLC counter resuming. You can also check the quality of the receiver transport stream using the VLC Statistics page at:

Tools --> Codec Information --> Statistics

URLs FOR DOWNLOADING SOFTWARE

dvbt_rx_v42.py (DVB-T Python receiver v.4.2 by F4FDW)

http://f4fdw.free.fr/dvbt_gnu.html

(shown as “Fichier python version 4.2” link at top of the page). Several other DVB-T receivers can be downloaded from the F4FDW website. Use Google Translate for an English version of the webpage.

GNURadio v. 3.8.2.0

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

TSReader Lite

<https://www.coolstf.com/purchase/purchase/downloadlite.html>

VLC Media Player

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

NOTES

- 1 Occasionally the dvbt_rx_v42.py app will not start, and a series of zeroes (0000000000) will be displayed on the command line. This indicates overflow in GNU Radio, and the PC can't keep up with the GNU Radio flowgraph. The app will usually start on a second try (if it doesn't, try closing down other apps or processes that may be slowing down the PC).

The dvbt_rx_v42.py app will require a PC with high clock speed. The following shows the author's results with four PC's including three laptops (all at bandwidth = 500k, FEC = 2/3 default values):

PC: HP Slimline Desktop PC 270-p043w

Processor: i3-7100 CPU@3900 MHz

Results: Steady constellation, PAT counts, thumbnail image, VLC image after CTRL+0 (with occasional 0000000 overflow indication at startup of dvbt_rx_v42.py).

PC: HP Laptop 17z-cp200

Processor: AMD Athlon@3700 MHz

Results: Steady constellation, PAT counts, thumbnail image, VLC image after CTRL+0 (with occasional 0000000 overflow indication at startup of dvbt_rx_v42.py).

PC: Acer Aspire 7740-5691 laptop

Processor: i3 CPU M330@2133 MHz

Results: TSReader Lite won't acquire DVB-T, no PAT counts, no thumbnail image, constellation eventually freezes.

PC: HP Elitebook 8540w laptop

Processor: i7 CPU Q820@1734 MHz

Results: TSReader Lite won't acquire DVB-T, no PAT counts, no thumbnail image, constellation eventually freezes.

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- 2 TSReader Lite must be configured to recognize the TCP stream from dvbt_rx_v42.py and apply a video stream to VLC Media Player. On TSReader Lite: Playback --> Settings

General settings: TSReader controls player: "Enabled" checked
Data on TCP port: 1234

VLC settings: VLC Executable: C:\Program Files (x86)\
VideoLAN\VLC\vlc.exe

VLC configuration: Description: Play
Command: http://127.0.0.1:1234

Default Playback Application: "VLC" radio button filled in

Click the "OK" button (ignore the "Warning: One or more . . ." message).
Click the next "OK" button.

These settings will be remembered by the app for future use.

- 3 For more information on GNURadio, 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 GNURadio flow graph.

For more information, go to:

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

Or search in Amazon for "field expedient sdr."

The books recommend implementing GNURadio 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.

Last update: 4/4/24

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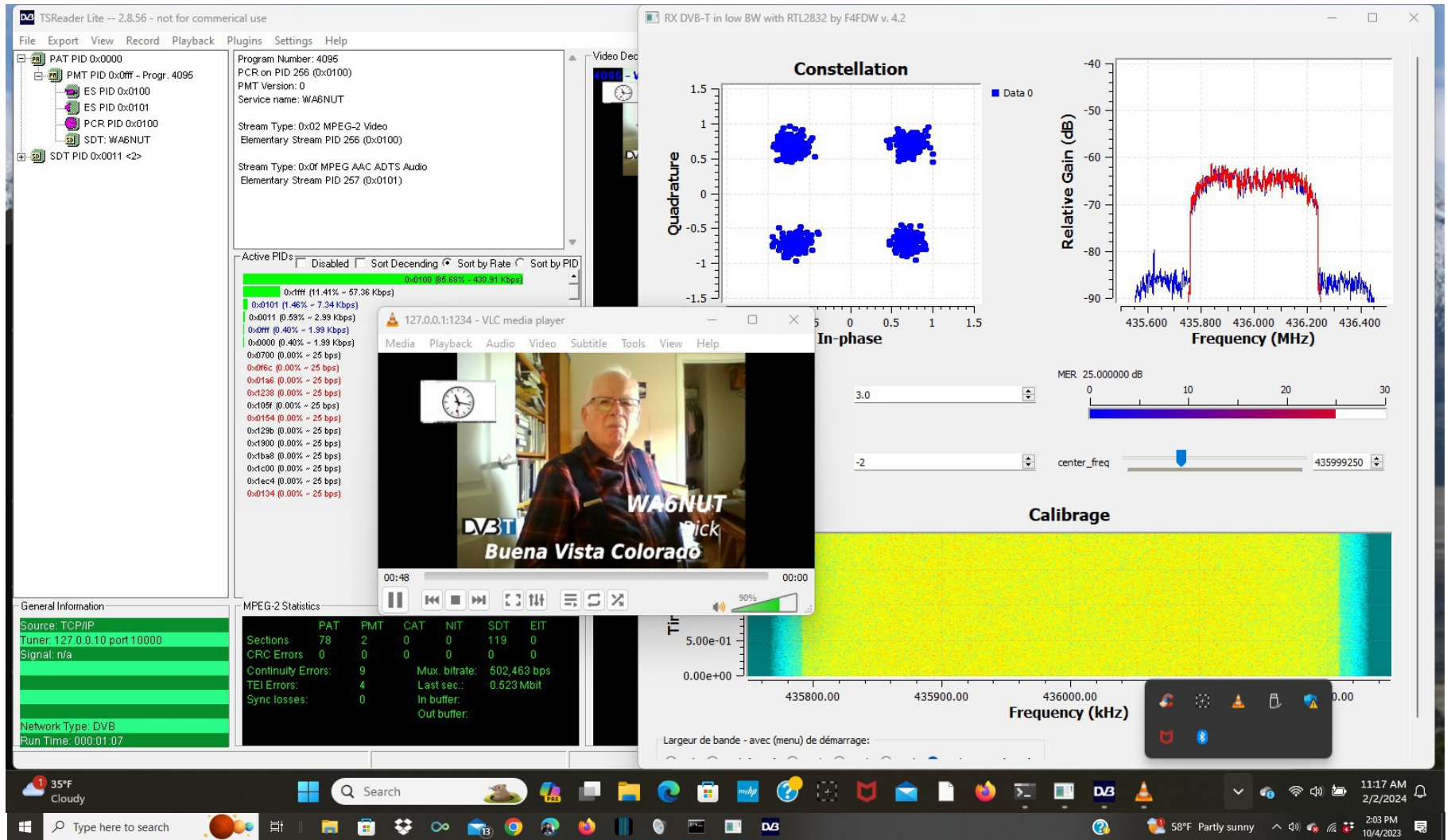


Figure 1: Screenshot: DVB-T Receive Setup: Showing DVB-T Receiver (right), TSReader Lite (left), and VLC Media Player (center). 436 MHz signal, Bandwidth = 500K, FEC = 2/3 (default settings)

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