DVB-T
with
Pluto (TX)
and SDRplay
or RTL-SDR (RX)

by Rick Peterson, WA6NUT

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INTRODUCTION

This document provides the procedure for setting up the DVB-T station at WA6NUT. Settings for OBS Studio, DATV-Easy, F5OEO firmware, DVB-T receiver, and VLC Media Player are given. Other details are specific to the WA6NUT setup, and may not apply to your station.

This document describes an ATV setup compatible with SDRplay or RTL-SDR receiver hardware. It uses receiving software derived from DVB-T receivers by YO3IIU, F4FDW, and DDØCW and transmitting software from F1EJP and F5OEO. And all on one $179 HP laptop! (2024 Cyber Monday price – at this writing the price is now back to $599! – I paid $299 on Cyber Monday in 2023).

This document is a rewrite of the earlier “DVB-T with Pluto (TX) and AirSpy Mini (RX)” document, with the SDRplay SDR receiver substituted for the AirSpy Mini SDR previously used. The higher sample rate of the SDRplay (vs. only 6 M samples/sec for the AirSpy Mini) permits receiving DVB-T signals at higher bandwidths (if not limited by computer speed and/or software availability). And the receiver design is compatible with RTL-SDR hardware, when a lower sample rate is acceptable.

The DVB-T receiver uses an older version (3.7) of GNU Radio Companion, compatible with SDRplay (and RTL-SDR) hardware.

The DVB-T receiver GNU Radio flowgraph is simplified by eliminating all Chooser blocks. Bandwidth is selected using charts (located below the bandwidth_decim_factor Variable block and Rational Resampler block on the flowgraph) giving block parameters corresponding to the desired bandwidth. Each block is edited by entering the appropriate parameters. FEC for the receiver is not adjustable, with only a fixed value = 2/3. Only QPSK is supported.

The default GNU Radio flowgraph is configured for input from an RTL-SDR. Substituting input from the SDRplay Duo source block is simply a matter of changing the Rational Resampler block input connection from the Osmocom source block to the SDRplay Duo source block (sources for other SDRplay hardware can also be substituted).

Note that, when using the SDRplay Duo, the RF Gain (dB) control is disabled, and the SDRplay Duo output bandwidth is fixed (independent of the bandwidth_decim_factor setting).

You'll find many links to other documents and websites in this document. If you're reading this PDF document from a computer screen, each link is a hyperlink: to access a link, just position the cursor over the link and click the mouse once.

For the latest revision of this document, go to:

https://www.qsl.net/wa6nut/Pluto%20SDRplay%20RTL-SDR%20DVB-T.pdf

LAPTOP PC

HP 17z-cp200, Windows 11 (with camera)

Control Panel --> Hardware and Sound --> Power Options -->
Create a Power Plan:
Click on “Performance” radio button
“Turn off the display” = Never
“Put the computer to sleep” = Never
Click on “Create”

TRANSMIT (see Figures 1-4)

Hardware:

Camera (Logitech C920)

Mic (Eivotor YX-3)

USB Sound Card (Manhattan 151429)

USB Hub (GigaWare 26-424)

USB Wall Charger (available from many sources)

USB-C to USB-A Adapter Cable (Amazon Basics)

Transmitter hardware:

ADALM Pluto Rev. C with F5OEO 0303 firmware

Leo Bodnar Mini Precision GPS Reference Clock

SBB5089/SZA2044 Amplifier: See KH6HTV review p. 6
https://kh6htv.files.wordpress.com/2023/02/tv-rptrs-rptr-122.pdf

(the above items are housed in the DVB-T Transmitter)

13.5/30Vdc 1A AC Adapter (for DVB-T Transmitter)
(set to 13.5Vdc)
Radio Shack 273-1668

RA30H4047M Amplifier See W6ORG website:
https://hamtv.com/pdffiles/PA5RA30H4047M.pdf

SureCom Pwr/SWR Meter
25W Dummy Load

HP ATX 12Vdc Power Supply (for RA30H4047M Amp)

ATX PC Power Adapter Board (diymore from Amazon)

Software: Mini GPS Clock Configuration app
Logitech Capture (Driver for C920)
OBS Studio v. 27.2.4 (64-bit)
DATV-Easy v. 2.16 (by F1EJP)
Microsoft Edge browser: Pluto Controller and Analysis pages

Ensure that the SMA connector on the DVB-T Transmitter front panel is connected to the amplifier input, and that the DVB-T Transmitter power receptacle is connected to the 13.5 VDC power supply (the front panel green LED should be illuminated). The amplifier output should be connected to the SureCom Pwr/SWR meter input, and the meter output should be connected to the 25W dummy load. Ensure that the SMA connector on the DVB-T Transmitter rear panel is connected to the GPS antenna, and that the 2 USB ports are connected to the PC.

1 Open **Mini GPS Clock Configuration** app. Check that the PLL Lock text box indicates “PLL Lock OK.” If it is not locked:

Advanced –-> Update

2 Open **OBS Studio (with OBS VirtualCam 2.0.5 plugin installed)**:

See F1EJP DATV-Easy 2.16 PDF instructions p. 2

Source = Video Capture Device
HD Pro Webcam C920

Settings --> Audio --> Global Audio Devices --> Mic/Auxiliary Audio = Microphone (3-C-Media USB Headphone Set) --> OK

Tools --> VirtualCam --> uncheck “AutoStart” --> Stop --> Exit

Settings --> Video

Select: Base (Canvas) Resolution = 1920 x 1080
Output (Scaled) Resolution = 1920 x 1080
Common FPS Values = 25 PAL

Apply --> OK

Tools --> VirtualCam --> check “AutoStart” --> Start --> Exit

Settings --> Output

Select: Streaming Bitrate = 2500 kbps
Audio Bitrate = 150

Apply --> OK

Minimize OBS

3 Open **DATV-Easy**

Click “Easy.” Select “436.00 DX”. Click “Valid.” “436.000” is shown under “Frequency MHz.”

DVB/MPEG-TS tab (see F1EJP DATV-Easy 2.16 PDF instructions p. 8)

DVB = DVB-T QPSK (see Note 1) Codec = H262

Bandwidth = 1000 kHz Image size 16/9 = 640 x 360

FEC = 2/3 FPS = 15

Guard Factor = 1/32 Audio Codec = AAC+

Mode = 2K Audio kb/s = 12 kb/s

Configuration tab (see F1EJP DATV-Easy 2.16 PDF instructions p. 3)

Settings/Equipment = Pluto F5OEO 0303 2402 60 100

Adalm Pluto SDR IP = 192 168 2 1 8282 1 (my IP, yours may vary)

Input/Entree = OBS + Virtual Cam

Encoder = AMD Default FPS = 15

Audio sync ±ms = 0 Audio SR = 44100

DVB Tables tab (see F1EJP DATV-Easy 2.16 PDF instructions p. 6)

Default values

4 Open **Microsoft Edge browser** (See Note 3)

Click “ADALM Pluto DV . . .” tab on Windows Toolbar.

Brings up 192.168.2.1/pluto.php (my IP, yours may vary)

Click “Controller” button at top.

“ADALM-PLUTO DATV Controller” page is displayed.

On browser “Controller” page, the following settings are required:

Modulator Settings:

Power = -11.3 dB

PCR/PTS = 2000 ms PAT period = 1000 ms

Freq-Manual = 436000000.000 Freq-Channel = Custom

Mode = DVBT Mod = QPSK

SR = 1000 1000 KS FEC = 2/3

On browser “System” --> “Setup” page, the following settings are required:

Main mode selection = DATV
DATV operating mode = UDP

Pluto Configuration

USB on Ethernet

Host name = pluto
IP Address = 192.168.2.1
Host IP address (computer) =192.168.2.10
Network mask = 255.255.255.0

Ethernet

IP Address = 192.168.1.40 (my IP, yours may vary)
Network mask = 255.255.255.0
Gateway IP Address = 192.168.1.1

Click “Start +” button. The green LEDs light. “Transmission” reads about 1005 kb/s on DATV-Easy app.

On the browser “Controller” page note the red “ON AIR” text and red border around Modulator settings. When the DATV-Easy “Start +” button is clicked, “Buffer” on the “Controller” page should change from “Underflow” to“Nominal.”

Initialize the DVB-T transmitter by reducing the F5OEO “Controller” page power setting by 1-2 dB, then increasing it by 1-2 dB to the original setting (don't ask why, it just works!).

Click the “Stop” button on the DATV-Easy app.

To transmit, press the RA30H4047M Amplifier PTT button, then click the DATV-Easy “Start +” button. The SureCom Pwr/SWR meter should read 3-4 watts output power. To end transmission, click the DATV-Easy “Stop” button, then press the RA30H4047M Amplifier PTT button (the RA30H4047M Amplifier PTT button is an alternate action push-on push-off switch controlling the amplifier TX/RX relay. Sequencing with the DATV-Easy Start+ and Stop buttons is required to avoid “hot-switching” the relay contacts).

Allow for a 12-15 sec delay between clicking the DATV-Easy “Start +” button and VLC displaying your video at the receiving station. Typical latency in the received video is about 7-9 sec.

Adjust Mic gain from Windows Sound (Recording) as needed:

> Sound --> Sound Settings --> Sound Control Panel --> Recording --> Microphone (3-C-Media USB Headphone Set) --> Levels

OBS Audio Mixer: Mic/Aux control settings: Set no higher than 50% to avoid TX audio feedback/intermittency.

Transport Stream Troubleshooting: Click the “Analysis” button at the top of the browser “Controller” page. Note “Null Packets” on bargraph and data to right on the “Analysis” page. “Null packets among 1 005 345 kbits/s” should be < 20%. Note the “Video buffer analysis” graph at the bottom of the page. This graph shows the health of the transport stream

being applied to the Pluto transmitter. Note how the graph is disturbed when the camera detects rapid motion.

Return to the “Controller” page by clicking the browser “back” <-- button.

RECEIVE (see Figures 1-4)

Receiver Hardware: GE 42178 Antenna Amplifier: See AH2AR/N8ZM video:
https://www.youtube.com/watch?v=Gekwf6SgM8k&ab_channel=W8BIATVRepeater

SDR Receiver (SDRplay Duo)
https://www.sdrplay.com/rspduo/

or

RTL-SDR
https://www.rtl-sdr.com/rtl-sdr-quick-start-guide/

Amplified speakers

Software: GNU Radio Companion 3.7

dvbt_rx_demo1.grc (adapted from YO3IIU, F4FDW, DDØCW)

VLC Media Player

1 Apply power to the GE Antenna Amplifier.

Turn laptop ON and let it boot up to opening screen.

2 Open the **GNURadio 3.7** tab in the Windows Start menu.

Open **GNURadio Companion**

Command line black screen opens, GNURadio sets up GR Companion (this will take a while)

When setup is complete, a flow graph is displayed.

Click on "**dvbt_rx_demo1**" tab.

Click "Execute the flow graph" button ("play" triangle on button).

GR Companion will convert the flow graph to a receiver control/display screen (GUI). Watch progress in text displayed at lower left.

Receiver controls and displays (GUI) appears.

Receiver settings:

Bandwidth = 1 MHz (use charts below bandwidth_decim_factor Variable block and Rational Resampler block to set block parameters for desired bandwidth. See Figure 5.)

FEC = 2/3 (GNU Radio graph is hard-wired for this FEC value)

Center Freq. (Hz) = 435998000 (my setting, yours may vary)

Offset Freq. (ppm) = -1 (my setting, yours may vary)

RF Gain (dB) = 20.0 (my setting, yours may vary)

3 Open **VLC Media Player** ("traffic cone" icon on desktop).

Audio --> Audio Device = Default: Headphone (Realtek (R) Audio)

Media --> Open Network Stream --> tcp://@127.0.0.10:10000 --> Play

When receiving the other station, the "Constellation" display should show four distinct clusters (QPSK pattern). The clusters should not be too tight (avoiding receiver overload) nor too loose (ensuring VLC lock).
The counter below the lower left corner of the VLC display window should be incrementing.

When using lower bandwidths (i.e., 125 kHz), you'll find that receiver tuning is narrower: decoding may be obtained with only one Center Freq. setting and fine tuning may be necessary using the Offset Freq. control.

4 VLC lock to the input stream from the receiver is indicated when the orange search activity bar (just below displayed image) stops scanning and disappears.

Digital noise or audio from other station will be heard on speakers (adjust speaker volume from Taskbar as required). The received image is displayed on the VLC screen. Maximize the VLC display for a full-screen image. Adjust the receiver RF Gain slider control for maximum height of the displayed spectrum above the spectrum “shoulders.”

Display VLC Current Media Information to check the health of the UDP stream from the DVB-T receiver:

Tools --> Media Information --> Statistics

If reception of the DVB-T signal becomes intermittent, try stopping (red “stop sign” on button) and restarting (“play” triangle on button) the DVB-T receiver flow graph (after minimizing the receiver control/display screen). Or VLC may need to be stopped and restarted:

Playback --> Stop
Media --> Open Network Stream --> Play

5 To EXIT:

<u>Receiver</u>:

Minimize the receiver controls/display screen to return to the flow graph.

Click the “Kill the flow graph” button (red “stop sign” on button).

File --> Quit. Command line black screen will be briefly displayed.

VLC Media Player:

Media --> Quit

Turn GE Antenna Amplifier OFF.

URLs for Downloading Software/Firmware

Transmit

F5OEO 0303 Firmware for ADALM Pluto (See Note 2 below)

https://www.f5uii.net/en/patch-plutodvb/

mini GPS clock configuration: Leo Bodnar Mini Precision GPS Reference Clock

http://www.leobodnar.com/shop/index.php?main_page=index&cPath=107

http://www.leobodnar.com/shop/index.php?main_page=product_info&cPath=107&products_id=301

OBS Studio v. 27.2.4 (OBS-Studio-27.2.4-Full-Installer-x64.exe & obs-virtualcam-2.0.5-Windows-Installer)

https://github.com/obsproject/obs-studio/releases
https://github.com/Fenrirthviti/obs-virtual-cam/releases

DATV-Easy v. 2.16 (by F1EJP) Be sure to download both the software (.zip file) and the instructions (.pdf file).

http://www.vivadatv.org//viewtopic.php?f=84&t=982

Also see DATV-Easy presentation by PA3FBX at:
https://www.youtube.com/watch?v=mp05-faLtHU&ab_channel=BATCOnline

Also install the following (included in the SetupF1EJP-DATV-Easy-V2.16 folder):

PlutoSDR-M2k-USB-Drivers.exe
libiio-0.24.gc4498c2-Windows-setup.exe

Logitech Camera Driver (Logitech Capture)

https://www.logitech.com/en-us/software/capture.html

Receiver

GNU Radio Companion 3.7.13.5 (see Note 4)

https://www.sdrplay.com/software/GnuRadio_3.7.13.5_SDRplay_Windows.zip

See the Windows Workflow chart at:
https://www.sdrplay.com/new-easy-sdrplay-set-up-for-gnu-radio-on-windows/

and
https://youtu.be/sv-xVBQyDwk

dvbt_rx_demo1.grc DVB-T Receiver by YO3IIU F4FDW DDØCW (see Note 5)
https://www.qsl.net/wa6nut/dvbt_rx_demo1.zip

VLC Media Player
https://www.videolan.org/vlc/download-windows.html

Notes:

1 If there is no “DVB-T QPSK” option in the “MPEG Transport Stream” “DVB” text box, try typing “DVB-T QPSK” into the text box. You may find that the text will complete itself before you finish typing!

2 Install F5OEO 0303 firmware using the instructions at the ZR6TG website (here's the link):

https://www.zr6tg.co.za/2022/06/28/adalm-pluto-rev-c-d-configuration-for-datv/

You'll need the PuTTY utility to do this. Download PuTTY from:

https://www.putty.org/

The ZR6TG website also gives instructions for configuring the Pluto for an external 40 MHz clock (the Leo Bodnar Mini Precision GPS Reference Clock). The external clock replaces the Pluto's clock oscillator (with ±25 ppm stability). An accurate, stable transmitted signal is especially important when when the other station's receiver lacks AFC.

3 Open the Microsoft Edge browser and enter 192.168.2.1/pluto.php (my IP, yours may vary) in the search window. Press the Enter key, and the F5OEO Pluto screen should appear. Set this address as a favorite in the Edge browser, so that it can be opened in the future by simply clicking on a tab.

4 Follow the steps in the Windows Workflow chart at the SDRplay website:

https://www.sdrplay.com/new-easy-sdrplay-set-up-for-gnu-radio-on-windows/

or see the YouTube video at: https://youtu.be/sv-xVBQyDwk

SDRplay only: Get and install the API appropriate for your system from:

https://www.sdrplay.com/api/

https://www.sdrplay.com/legacy-software/

SDRplay and RTL-SDR: GnuRadio_3.7.13.5_SDRplay_Windows.zip downloads as a .zip file from the SDRplay website.

https://www.sdrplay.com/software/GnuRadio_3.7.13.5_SDRplay_Windows.zip

After extracting the contents of the .zip file, double-click on gnuradio_3.7.13.5_win64.msi to install GNU Radio Companion.

After installing, the “GNURadio 3.7” folder will be accessible from the Windows Start menu. You'll find “GNURadio Companion” in the folder.

SDRplay only: Copy the mir_sdr_api.dll (included in the zip file) to the c:\Program Files\GNURadio-3.7\bin folder.

5 After downloading the dvbt_rx_demo1.grc file, the file should be placed in a folder (in the author's setup, the c:\users\arand\Documents\DVB-T folder). Open GNURadio Companion from the Windows Start menu, navigate from File to Open, highlight dvbt_rx_demo1.grc then click on Open at the bottom of the page. GNURadio Companion will set up the DVB-T receiver flow graph, with a “dvbt_rx_demo1” tab above the flow graph. In the future, the tab will be available to select the DVB-T receiver after GNURadio Companion is opened.

6 To avoid marginal operation, it's a good idea to check the % CPU Utilization (Windows Task Manager, under the Performance tab: Open Task Manager by right-clicking on a blank space on the Task Bar at the bottom of the screen).

Figure 6 shows the % CPU Utilization while transmitting and receiving at 1 MHz bandwidth. Note % CPU Utilization is 71% with BW = 1 MHz, low enough to maintain operation without excessive dropped frames.

7 The author discovered that operation up to 1 MHz is possible if, prior to an operating session, a system cleaner utility (CCleaner) is used to scan and clean the PC operating environment. See https://www.ccleaner.com/

8 For troubleshooting the transport stream from DATV-Easy (to Pluto) or from the DVB-T receiver (to VLC), you can use TSReader Lite.

Download TSReader Lite from:

https://www.tsreader.com/purchase/purchase/downloadlite.html

9 For troubleshooting the ADALM-Pluto, you can use the IIO Oscilloscope from Analog Devices. Download the IIO Oscilloscope from:

https://github.com/analogdevicesinc/iio-oscilloscope/releases

For more information, go to:

https://wiki.analog.com/resources/tools-software/linux-software/iio_oscilloscope

10 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 2025, you'll find the Windows version much simpler to implement and use.

Last revised: 5/8/25

For the latest revision of this document, go to:

https://www.qsl.net/wa6nut/Pluto%20SDRplay%20RTL-SDR%20DVB-T.pdf

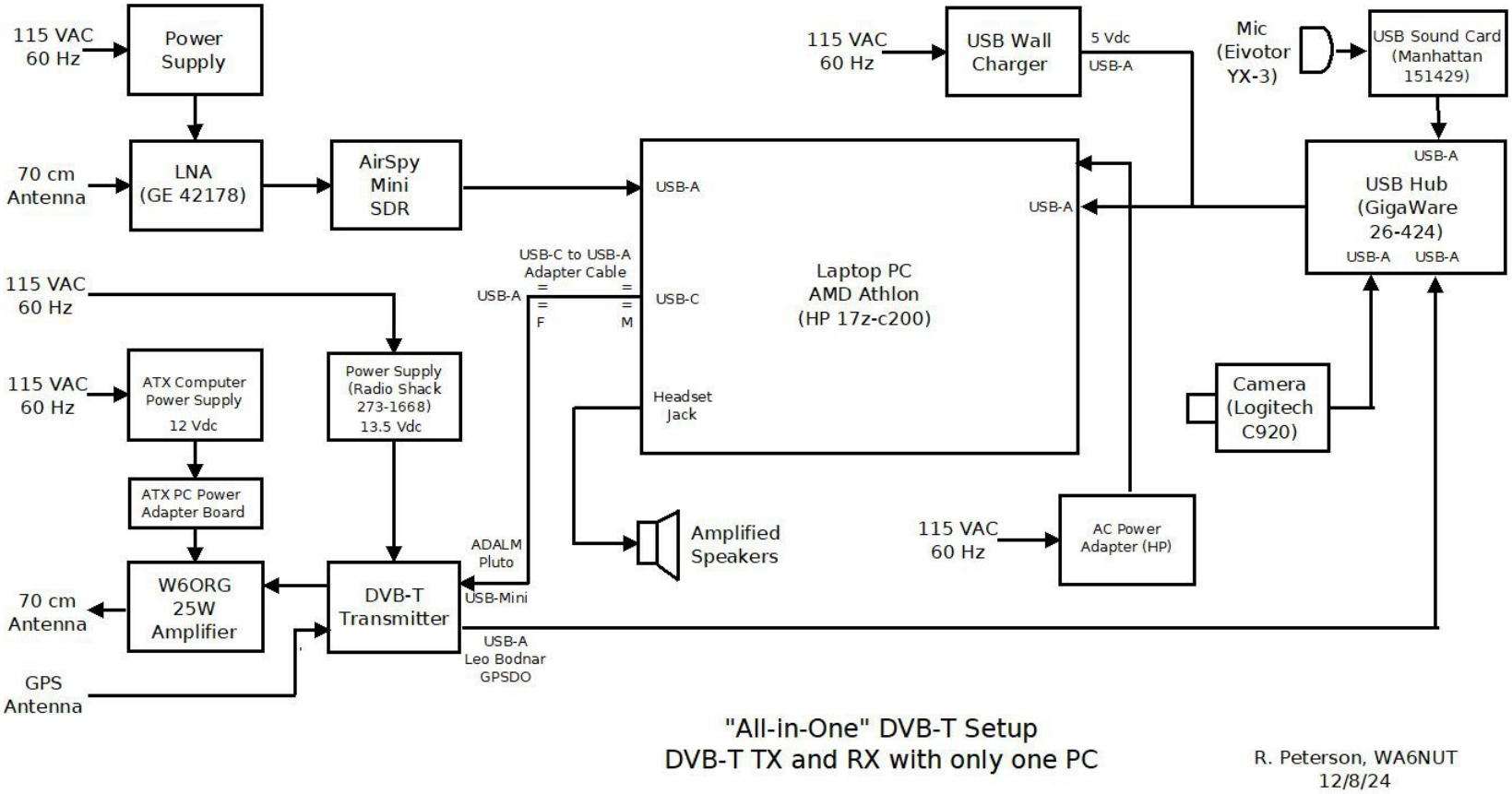

Figure 1: Block Diagram: All-in-One DVB-T Setup

Substitute SDRplay or RTL-SDR for “AirSpy Mini SDR” shown in diagram

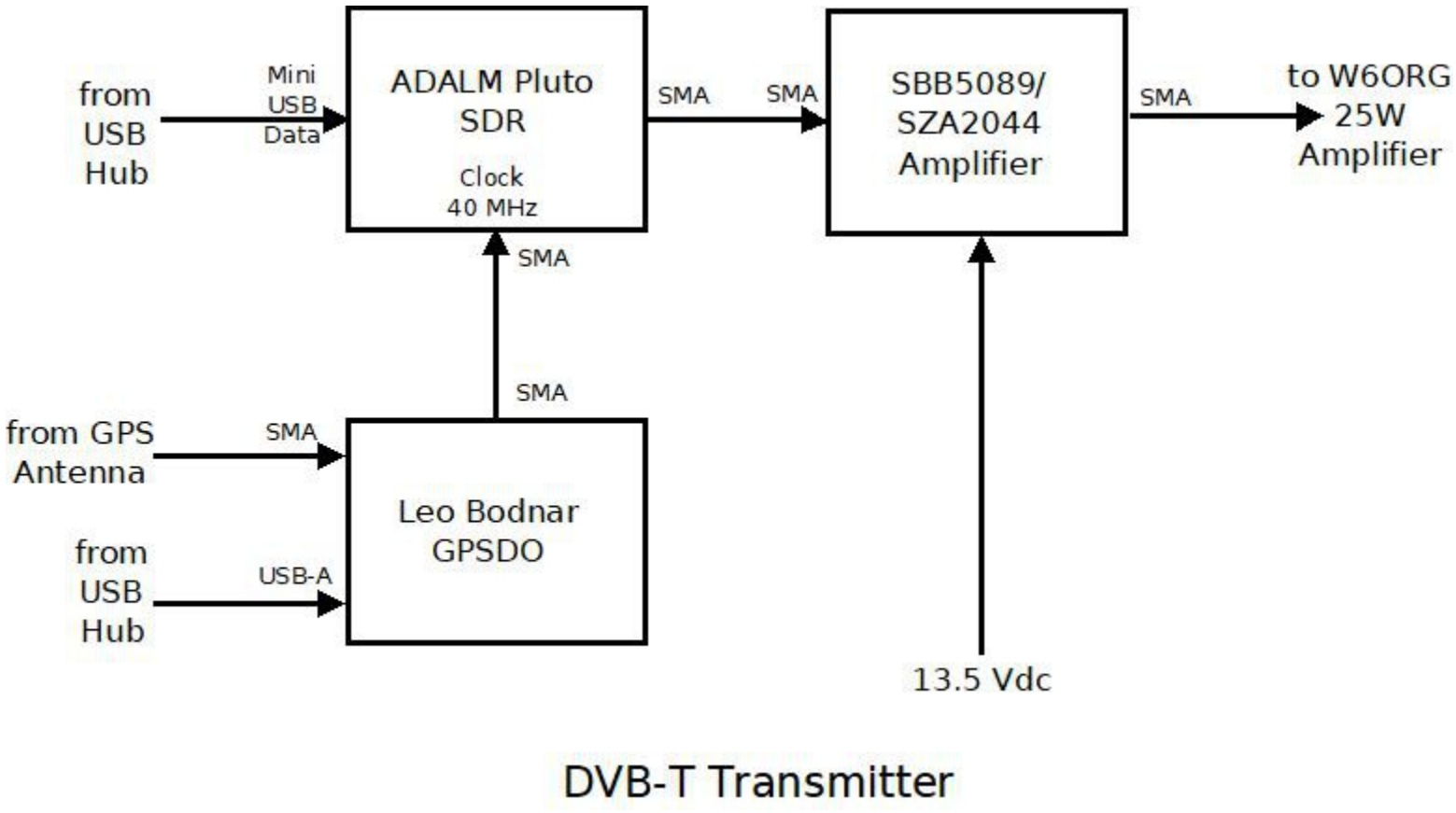

Figure 2: DVB-T Transmitter

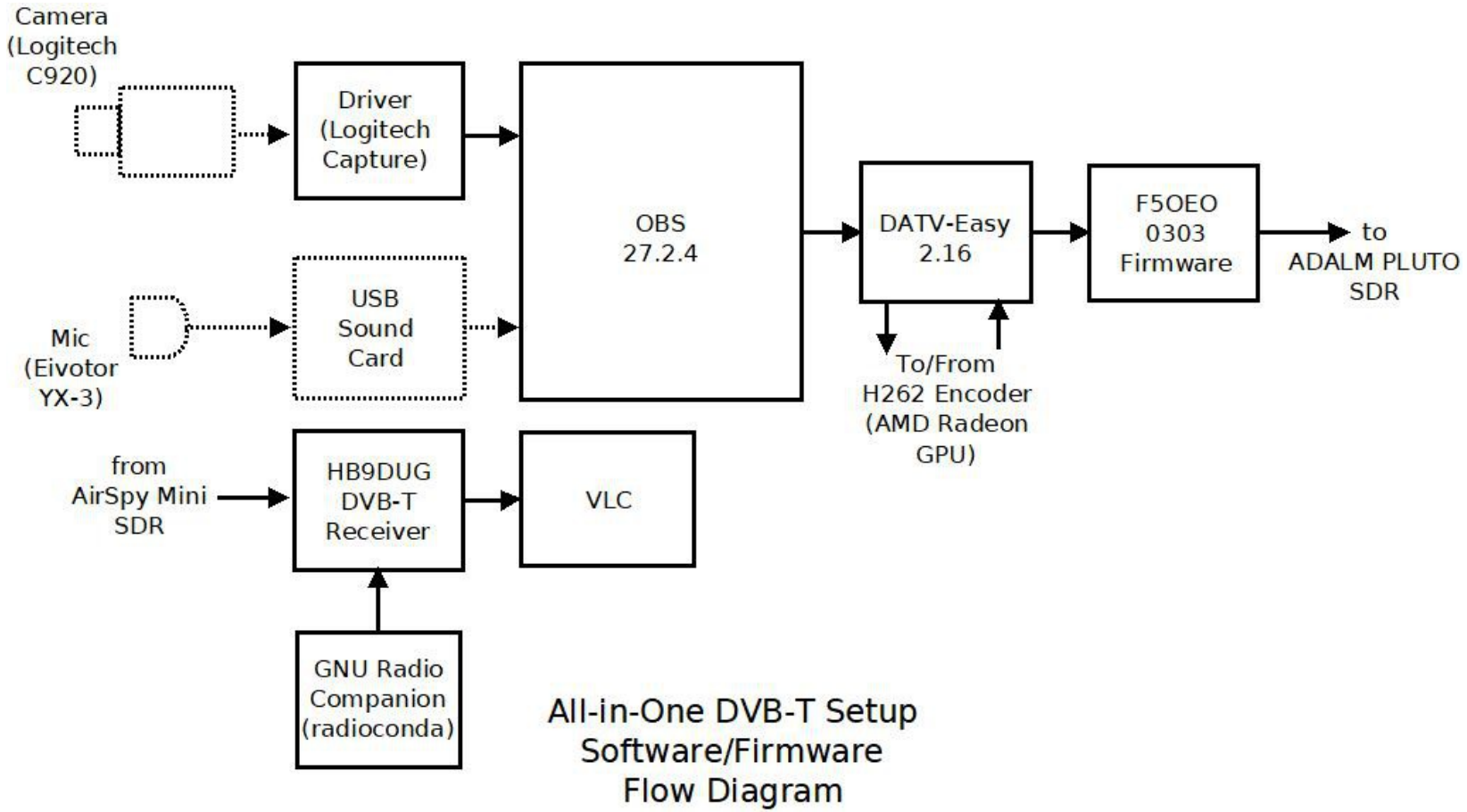

Figure 3: All-in-One DVB-T Setup Software/Firmware Flow Diagram

Substitute SDRplay or RTL-SDR for “Airspy Mini SDR” shown in diagram
and DVB-T Receiver for “HB9DUG DVB-T Receiver” shown in diagram.

See DATV-Easy presentation by PA3FBX at: https://www.youtube.com/watch?v=mp05-faLtHU&ab_channel=BATCOnline

DVB-T with Pluto (TX) and SDRplay or RTL-SDR (RX)

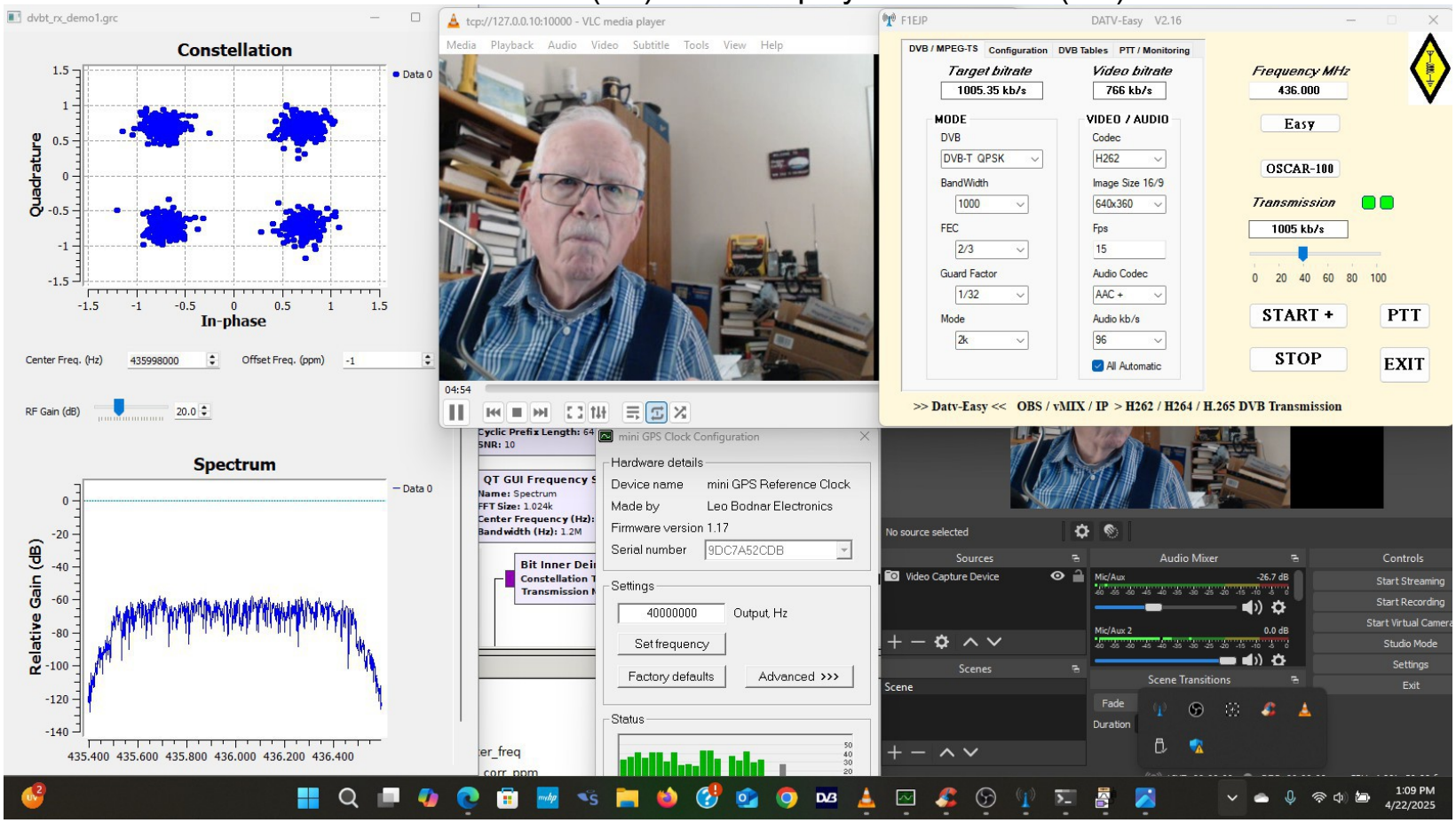

Figure 4: Screenshot showing apps used for DVB-T. Clockwise from upper right: DATV-Easy 2.16, OBS 27.2.4 (showing TX audio levels), Leo Bodnar GPSDO, GNURadio Companion (in background), dvbt_rx_demo1.grc Receiver, VLC (displaying received video)

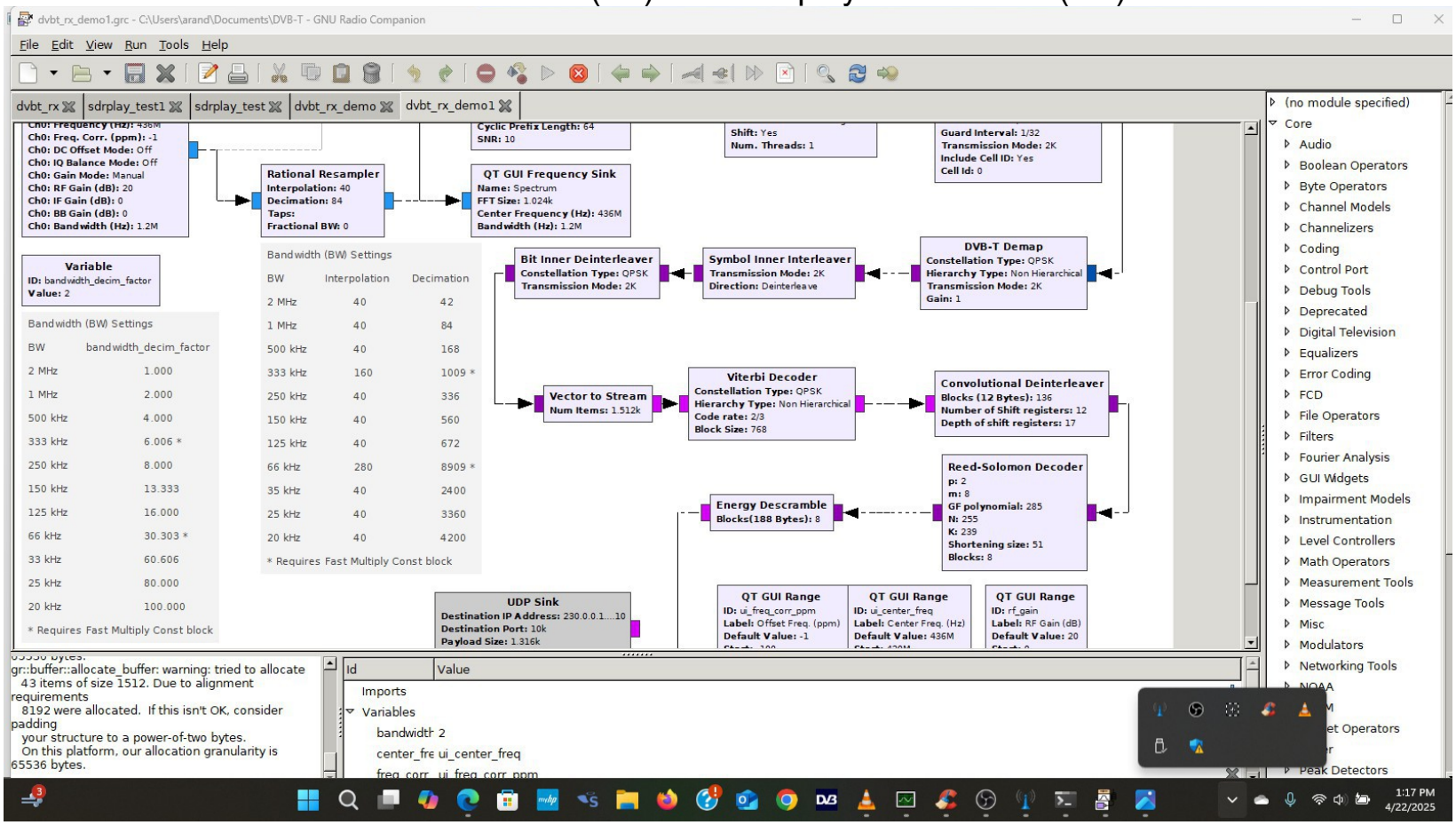

Figure 5: Screenshot showing Bandwidth Settings charts (chart below bandwidth_decim_factor Variable block and chart below Rational Resampler block). Note settings for 1 MHz bandwidth: bandwidth_decim_factor = 2, interpolation = 40, decimation = 84.

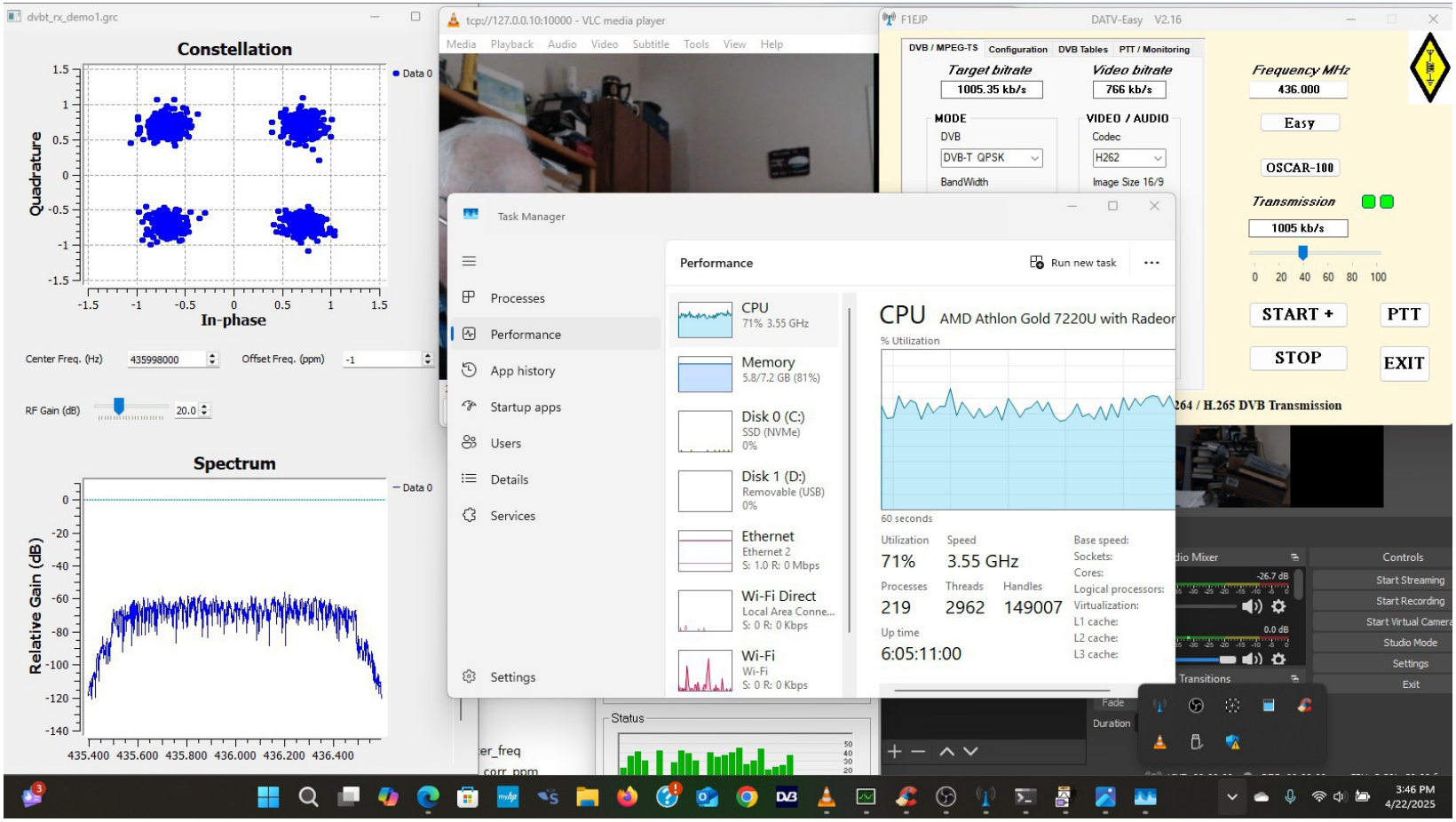

Figure 6: Screenshot showing % CPU Utilization. Note % CPU Utilization is 71% with BW = 1 MHz, low enough to maintain operation without excessive dropped frames.