

Operating Instructions High Performance DVB-T ATV Setup

by Rick Peterson, WA6NUT

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Table of Contents

1.	Introduction	3
2.	Transmit.....	4
3.	Receive.....	9
4.	URLs for Downloading Software/Firmware.....	12
5.	Notes.....	14

Figures

1.	DVB-T Transmit Setup Diagram.....	17
2.	Router-to-Pluto Connection Details.....	18
3.	DVB-T Transmit Setup Screenshot.....	19
4.	DVB-T Receive Setup Diagram.....	20
5.	DVB-T Receive Setup Screenshot.....	21

Operating Instructions High Performance DVB-T ATV Setup

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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 the best ATV setup I've found. It uses receiving software from DDØCW and transmitting software from F1EJP and F5OEO (with the laptop linked to the transmitting SDR via Ethernet).

The Ethernet link between the PC and Pluto was added after I found references to this scheme on the BATC forums. Other ATV'ers found the Ethernet link faster than USB (of course, USB could be used to link the PC to the Pluto).

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>

DVB-T ATV Setup

TRANSMIT (see Figures 1 - 3)

Laptop: Acer Aspire 7740-5691, Windows 10 (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"

Wireless Network Router, Netgear WNR-1000

USB-to-Ethernet Adapter, TP-Link UE306

USB Wall Charger (available from many sources)

USB Y Data Charge Cable, HIGHROCK-usb01

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/pdf/files/PA5RA30H4047M.pdf>

SureCom Pwr/SWR Meter

25W Dummy Load

DVB-T ATV Setup

HP ATX 12Vdc Power Supply (for RA30H4047M Amp)
ATX PC Power Adapter Board

Microphone, Eivotor YX-3

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

Advanced IP Scanner (for setting up LAN)

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 3 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

Settings --> Audio --> Global Audio Devices --> Mic/Auxiliary Audio = Microphone (2-High Definition Audio Device) --> OK

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

DVB-T ATV Setu

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

Mute speaker in Acer Aspire laptop Taskbar.

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 = 125 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

DVB-T ATV Setup

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 1 40 8282 1 (my IP, yours may vary)

Input/Entree = OBS + Virtual Cam

Encoder = SOFT Default FPS = 15

Audio sync $\pm$ 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 192.168.1.40/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 = 436.00

Freq-Channel = Custom

Mode = DVBT

Mod = QPSK

DVB-T ATV Setup

SR = 125 125 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 126 kb/s on DATV-Easy app.

On browser "Controller" page note red "ON AIR" text and red border around Modulator settings. When DATV-Easy "Start +" button is clicked, "Buffer" on the "Controller" page should change from "Underflow" to "Nominal." The DATV-Easy "Stop" button is not clicked until the end of the ATV session.

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 PTT "Switch OFF" button on browser "Controller" page.

DVB-T ATV Setup

To transmit, press RA30H4047M Amplifier PTT button, then click F5OEO PTT “Switch ON” button. The SureCom Pwr/SWR meter should read 3-4 watts output power. To end transmission, click F5OEO PTT “Switch OFF” button, then press RA30H4047M Amplifier PTT button.

Allow for a 12-15 sec delay between clicking the F5OEO PTT “Switch ON” 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 --> Levels

Click “Analysis” button at top of browser “Controller” page. Note “Null Packets” on bargraph and data to right on the “Analysis” page. “Null packets among 125 666 kbits/s” should be < 20%. Note “Video buffer analysis” graph at bottom of 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 “Controller” page by clicking browser “back” <-- button.

RECEIVE (see Figures 4 and 5)

Laptop: HP 17z-cp200 Laptop (Athlon), Windows 11:

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.”

DVB-T ATV Setup

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

SDR Receiver (RTL-SDR V3)

Amplified speakers

Software: GNURadio Companion v. 3.9.0.0

Knucker_ZF_RTL_dvbt_rx.zip (by DDØCW)

(after unzipping, all the Knucker files should be located in the same folder)

VLC Media Player

- 1 Apply power to the GE Antenna Amplifier.

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

- 2 Open **VLC Media Player** (“traffic cone” icon on desktop).

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

Media --> Open Network Stream --> `udp://@230.0.0.1:1234` --> Play

- 3 Open **GNURadio Companion** (“run GRC shortcut” icon on desktop)

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 “**Knucker_ZF_RTL_dvbt_rx**” tab.

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

GR Companion will convert the flow graph to a receiver control/display

DVB-T ATV Setup

screen (GUI). Watch progress in text displayed at lower left.

Receiver controls and displays (GUI) appears.

Receiver settings:

Bandwidth = 125K

FEC = 2/3

Start QRG (Hz) = 436000000 (press "Enter" key after entry)

RX act. QRG (Hz) = 436000000 (press "Enter key after entry)

QRG Rough = -4.0 (my setting, yours may vary)

Fine = -222 (my setting, yours may vary)

RF Gain (dB) = 11.0 (my setting, yours may vary)

When receiving the other station, the "Constellation" display should show four distinct clusters (QPSK pattern).

- 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

DVB-T ATV Setup

If reception of the DVB-T signal becomes intermittent, try stopping (“pause” square 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:

Receiver:

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

Click the “Kill the flow graph” button (“pause” square 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/>

DVB-T ATV Setup

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

PlutoSDR-M2k-USB-Drivers.exe

libiio-0.24.gc4498c2-Windows-setup.exe

Also install Advanced IP Scanner (used to set up LAN)

<https://www.advanced-ip-scanner.com/download/>

Receive

GNURadio Companion v. 3.9.0.0 (see Note 4 below)

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

DVB-T ATV Setup

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>

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 the other station's receiver lacks AFC.

- 3 Set up the LAN hardware as shown in Figures 1 and 2. Use the Advanced IP Scanner app to find an unused IP address in your LAN network (for the WA6NUT setup, 192.168.1.40 – the same as F1EJP's example – was available). Configure the Pluto config.txt file as shown in the F1EJP DATV-Easy 2.16 PDF instructions p. 7.

DVB-T ATV Setup

Open the Microsoft Edge browser and enter 192.168.1.40/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 Version 3.9.0.0 downloads as a .zip file from the archive.org website. After unzipping, go to GNURadio-3.9 --> bin --> run_GRC. Right-click on run_GRC and select "Create Shortcut." Then drag the shortcut to the desktop. Now you can open GNURadio Companion by double-clicking on the "run_grc Shortcut" icon on the desktop.

After downloading and unzipping the Knucker_ZF_RTL_dvbt_rx.zip file, the 6 files and _pycache_ folder should be placed in the same folder (in the author's setup, the c:\users\arand\Documents\DVB-T folder). Open GNU Radio Companion, navigate from File to Open, highlight Knucker_ZF_RTL_dvbt_rx.grc, then click on Open at the bottom of the page. GNU Radio Companion will set up the Knucker receiver flow graph, with a "Knucker_ZF_RTL_dvbt_rx.grc" tab above the flow graph. In the future, the tab will be available to select the Knucker receiver after GNU Radio Companion is opened.

- 5 The DDØCW receiver has a useful (and entertaining!) feature, accessible via the "read OFDM data file" button. DDØCW refers to this feature as a "constellation view kick starter." The receiver plays the GNU.ofdm_data_in file. It seems to work best with settings: SR = 500K, FEC = 1/2. The accompanying audio is best with Windows 10, but choppy with Windows 11.
- 6 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>

DVB-T ATV Setup

- 7 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

- 8 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 revised: 6/3/24

DVB-T ATV Setup

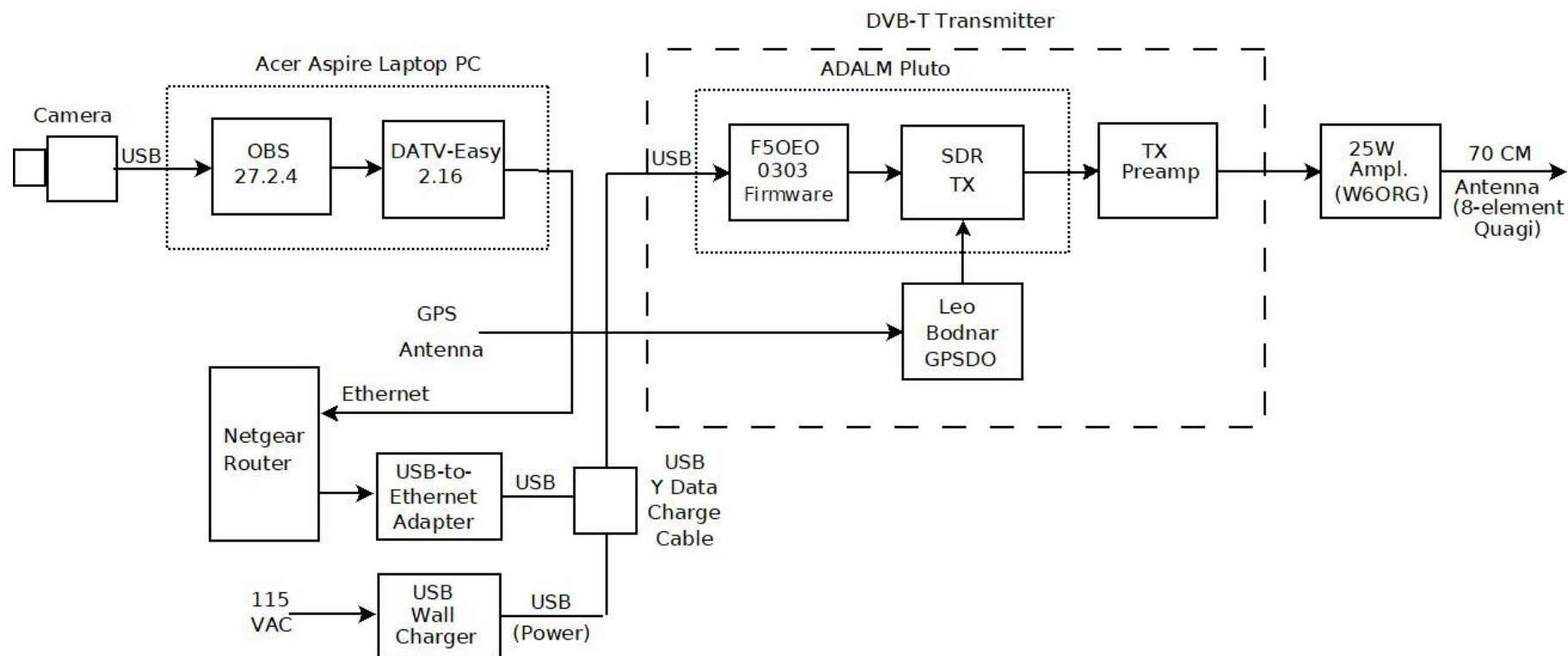


Figure 1: DVB-T Transmit Setup Diagram. A LAN is used, giving faster data transfer via Ethernet (in comparison to USB). See Figure 2 for details of the connections between the router and Pluto SDR.

DVB-T ATV Setup

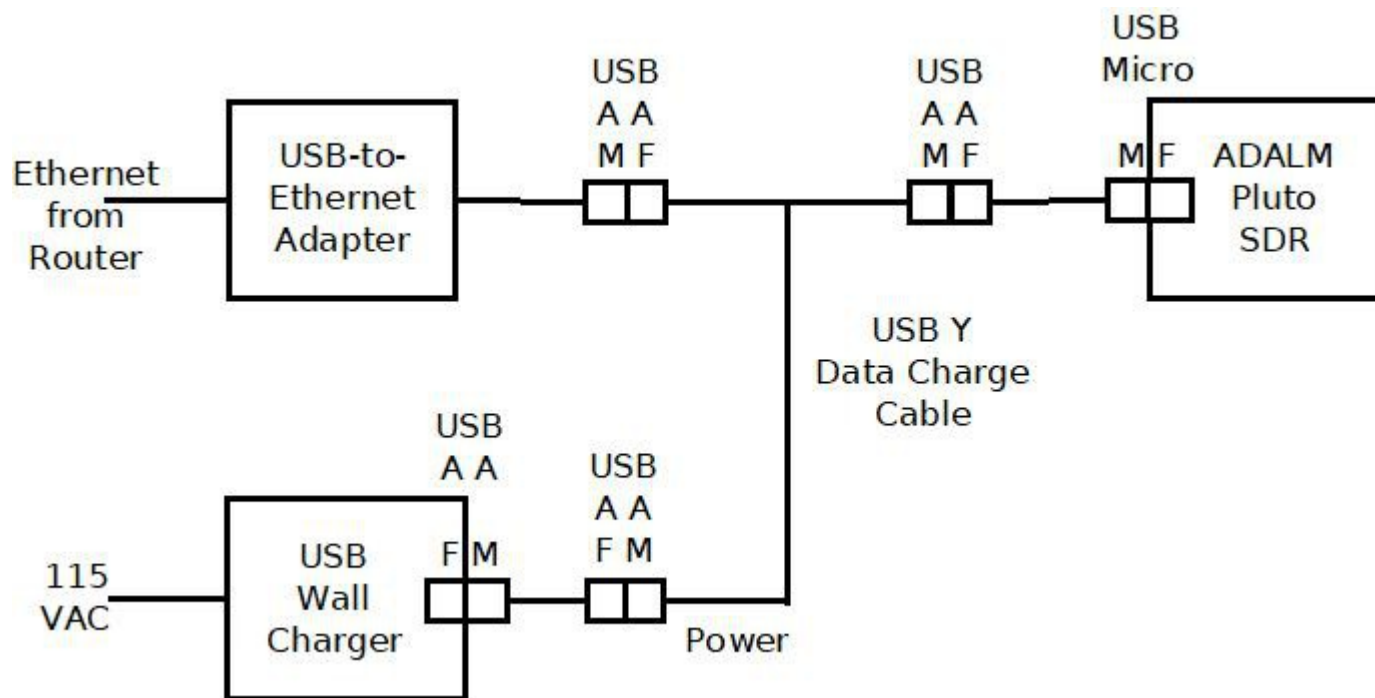


Figure 2: Router-to-Pluto Connection Details: Showing the connections between the router and Pluto SDR, using a USB Data Charge Cable. Also see the article by DD1US (link below).

<https://dd1us.de/Downloads/Connecting%20the%20ADALM%20Pluto%20to%20the%20Local%20Area%20Network%20v5.pdf>

DVB-T ATV Setup

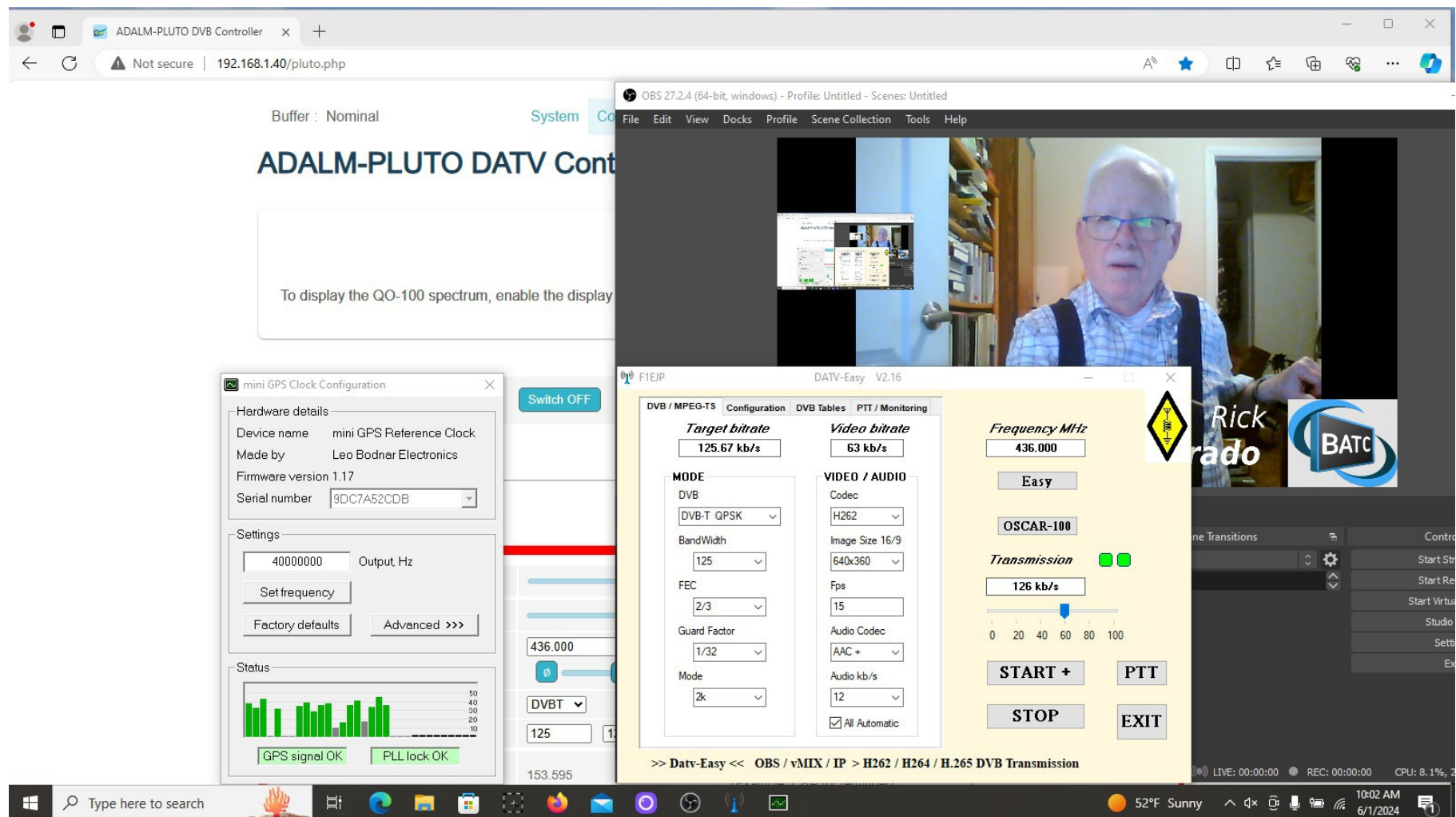


Figure 3: DVB-T Transmit Setup Screenshot. Transmitting at 125K s/sec at 15 fps and 640x360 image resolution. From left to right: Leo Bodnar GPSDO display, DATV-Easy 2.16, and OBS 27.2.4, with F5OEO Pluto Controller in the background (note the blue “Switch OFF” PTT button).

DVB-T ATV Setup

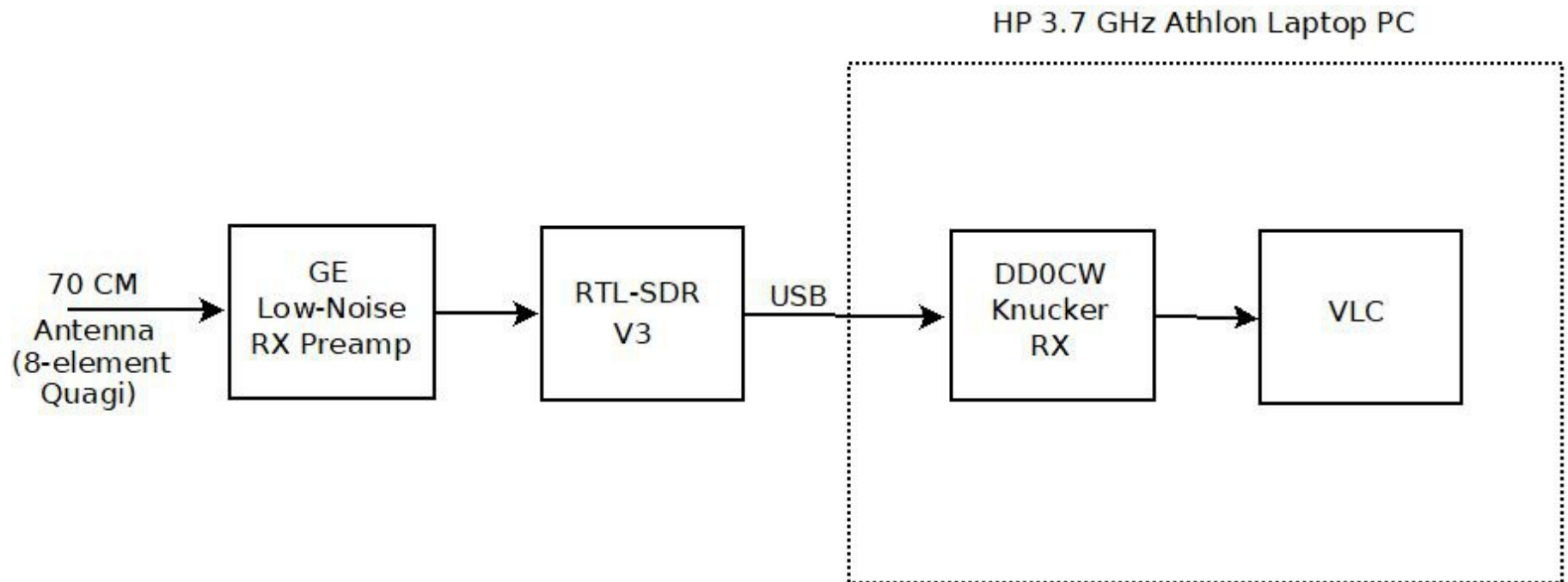


Figure 4: DVB-T Receive Setup Diagram. The DD0CW “Knucker” DVB-T receive software is robust, running for hours without retuning.

DVB-T ATV Setup

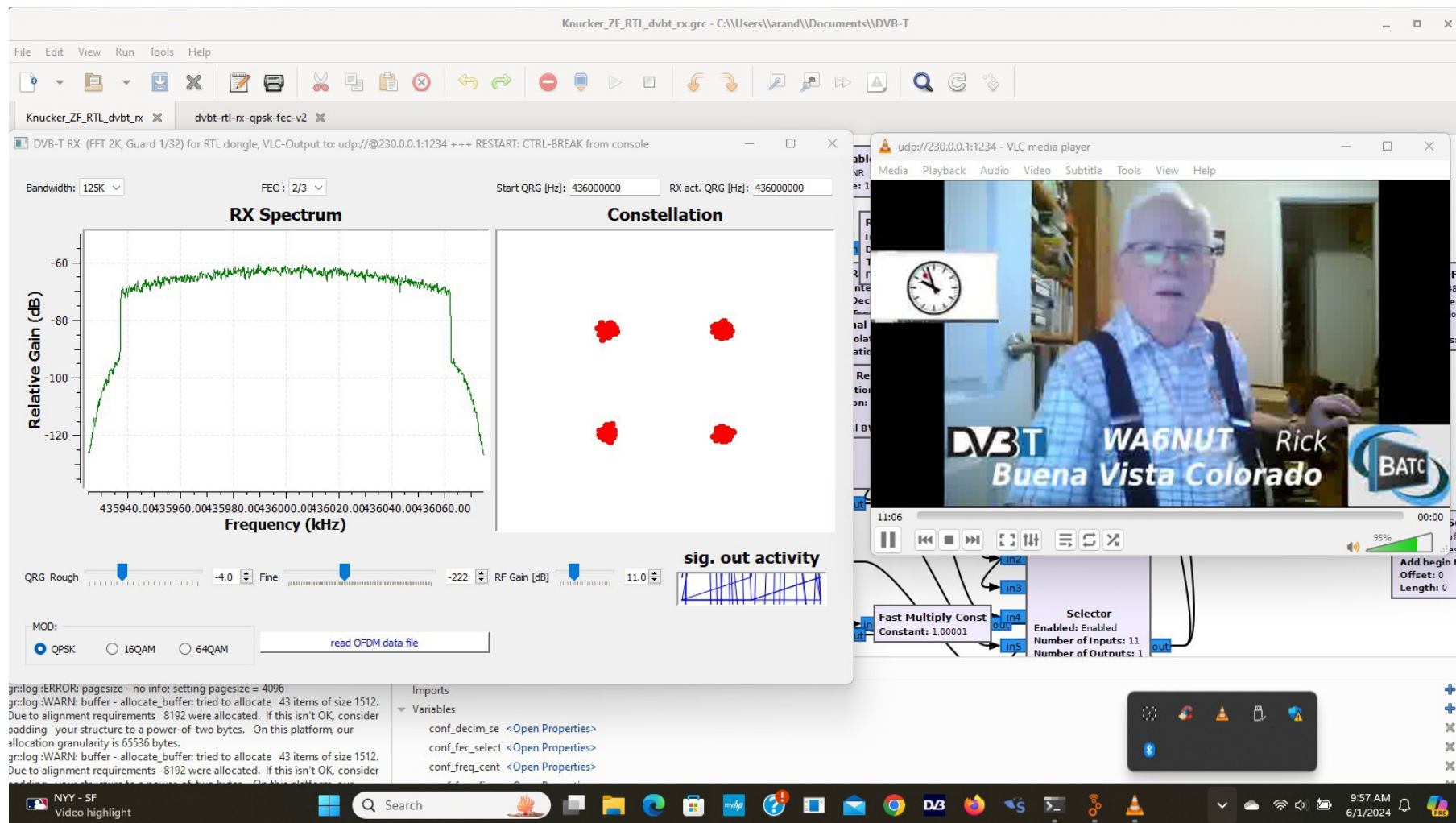


Figure 5: DVB-T Receive Setup Screenshot: Receiving 125K s/sec, 15 fps, 640x360 resolution signal. From left to right: DDØCW “Knucker” receiver (note the “sig. out activity” window), VLC Media Player, with GNU Radio Companion in the background.

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