

DATV-Express

Users Guide

For running on Windows OS

(based on Express_DVB_Transmitter software v1.25LP11)

Draft 14

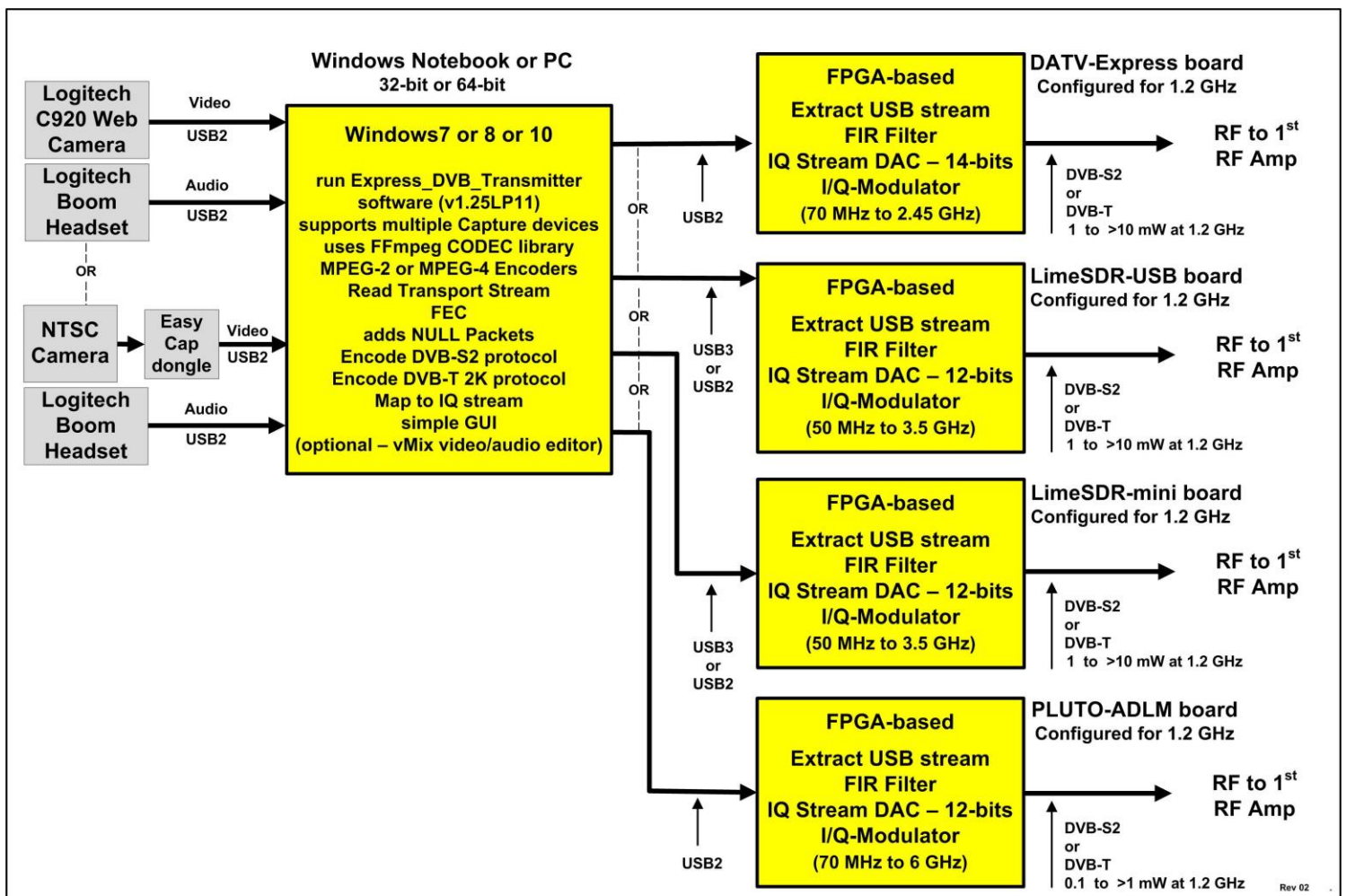


Table of Contents

1.0	– Introduction.....	5
2.0	– Install Express_DVB_Transmitter software package.....	8
2.1	Install the Windows Driver for DATV-Express hardware board	8
2.1.1	You need to have ADMIN privileges on your PC to change drivers.	8
2.1.2	Have the DATV-Express hardware board installed as Unknown Device in the Windows-CONTROL-PANEL.....	8
2.1.3	Change Windows to NOT “download drivers automatically”	9
2.1.4	Start up ZADIG in libusb-win32 mode	9
2.1.5	Recommend editing ZADIG device driver name to "DATV-Express"	9
2.2	Install the Windows Driver for LimeSDR hardware boards.....	10
2.3	Install the Windows Driver for PLUTO hardware board	11
2.4	Install the Express_DVB_Transmitter software package on Windows	13
2.4.1	Download Express_DVB_Transmitter Installer package from DATV-Express.com	13
2.4.2	A quick “test launch” of Download Express_DVB_Transmitter software	14
2.5	Upgrading your installed DATV-Express Software	15
3.0	- Hook-up the DATV hardware and Test	16
3.1	Here is what you need.....	16
3.1.1	Here is what you need to hook up DATV-Express board	16
3.1.2	Here is what you need to hook up either LimeSDR board	16
3.1.3	Here is what you need to hook up PLUTO board	16
3.2	First Test – power up the modulator board by itself	18
3.2.1	First Test – power up the DATV-Express board by itself	18
3.2.2	First Test – power up one of LimeSDR boards by itself.....	18
3.2.3	First Test – power up the PLUTO board by itself.....	18
3.3	Second Test – connect hardware board & start Express_DVB_Trans SW	19
3.3.1	Connect DATV-Express hardware board and start the Express_DVB_Trans SW	19
3.3.2	Connect LimeSDR hardware board & start Express_DVB_Transmitter SW	21
3.3.3	Connect PLUTO hardware board & start Express_DVB_Transmitter SW	22
3.4	Third Test – now connect video-capture to the PC.....	23
3.4.1	Third Test – now connect video-capture to the PC with DATV-Express Board.....	23
3.4.2	Third Test – now connect video-capture to the PC with LimeSDR.....	26
3.4.3	Third Test – now connect video-capture to the PC with PLUTO	28
3.5	Fourth Test – Transmitting DATV video	29
4.0	- Express_DVB_Transmitter Software GUI Reference Guide	31
4.1	FILE Tab	31
4.1.1	Open	31
4.1.2	Save	31
4.1.3	Save As.....	31
4.1.4	Restart	31
4.1.5	Exit	31
4.2	CAPTURE Tab	32
4.2.1	VIDEO Capture.....	32
4.2.2	VIDEO – Device Name field	33
4.2.3	VIDEO – Device Formats field.....	33

4.2.4	VIDEO – Interlaced (checkbox)	34
4.2.5	VIDEO – OK button	34
4.2.6	VIDEO – CANCEL button	34
4.2.7	AUDIO	34
4.2.8	AUDIO – Device Name field	34
4.2.9	AUDIO – OK button	35
4.2.10	AUDIO – CANCEL button	35
4.3	CODEC Tab	35
4.3.1	CODEC – VIDEO Settings	36
4.3.2	VIDEO CODEC – Radio Button Selection	36
4.3.3	VIDEO Bitrate – display	37
4.3.4	GOP (Group Of Pictures)	37
4.3.5	B-Frames Count	37
4.3.6	Performance	38
4.3.7	VIDEO Bitrate twiddle – adjustable field	39
4.3.8	Video Codec – OK button	39
4.3.9	Video Codec – CANCEL button	39
4.3.10	CODEC – AUDIO Settings	39
4.3.11	AUDIO CODEC – Radio Button Selection	40
4.3.12	AUDIO Bitrate – Radio Button Selection	40
4.3.13	Enable AUDIO – checkbox	40
4.3.14	Audio Codec – OK button	40
4.3.15	Audio Codec – CANCEL button	40
4.4	SI TABLES Tab	41
4.4.1	Video PID	41
4.4.2	Audio PID	41
4.4.3	PCR PID	41
4.4.4	PMT PID	42
4.4.5	NETWORK ID	42
4.4.6	STREAM ID	42
4.4.7	SERVICE ID	42
4.4.8	PROGRAM Field	42
4.4.9	Typical PID Values	42
4.4.10	PROVIDER NAME	43
4.4.11	SERVICE NAME	43
4.4.12	EVENT TITLE	43
4.4.13	EVENT DURATION Minutes	43
4.4.14	EVENT TEXT	43
4.4.15	SI Tables – OK button	43
4.4.16	SI Tables – CANCEL button	43
4.5	OPTIONS Tab	44
4.5.1	On Air Format	44
4.5.2	IQ DC OFFSET Calibration	45
4.5.3	NOISE Tool	46
4.6	MODULATOR Tab	47
4.6.1	MODULATOR – Common Settings Tab	47

4.6.2	MODULATOR – DVB-S Tab	50
4.6.3	MODULATOR – DVB-S2 Tab	50
4.6.4	MODULATOR – DVB-T Tab	52
4.7	HELP Tab	54
4.7.1	ABOUT	54
4.7.2	About – OK Button	54
4.8	MAIN Screen.....	55
4.8.1	TRANSMIT QUEUE - indicator.....	55
4.8.2	TRANSMIT Level - indicator	55
4.8.3	TRANSMIT Level – Slide-Bar	55
4.8.4	TS RECORD TO FILE (Checkbox).....	56
4.8.5	CARRIER ONLY (Checkbox)	56
4.8.6	VIDEO IDENT (Checkbox).....	56
4.8.7	TX Mode - display	57
4.8.8	TX Constellation - display	57
4.8.9	TX FREQUENCY - display.....	57
4.8.10	TX SYMBOL RATE - display.....	57
4.8.11	TX FEC - display.....	57
4.8.12	TX BITRATE - display	57
4.8.13	VIDEO BITRATE - display	57
4.8.14	VIDEO CODEC - display	57
4.8.15	AUDIO BITRATE - display	57
4.8.16	PTT (Button).....	57
4.9	DATV-Express Hardware Board LEDs	58
4.10	Optional Si570 Symbol Rate chip	58
5.0	– Useful utilities.....	59
5.1	DVBinspector for TS files	59
5.2	Playing Back TS files.....	59
5.3	CPU performance monitor	59
5.4	Tutoune and MiniTouner and MiniTouner-Express analyzers	59
5.5	vMix Basic Video Mixer	60
5.6	Portsdawn Project Modulator Board	62
6.0	– DATV-Express board for Windows specifications:	63
7.0	– Contacts.....	68
7.1	E-Mail	68
7.2	Web Site	68
7.3	Product Support	68

1.0 – Introduction

The DATV-Express Project began by creating the DATV-Express hardware board as a low-cost (USD300) Digital-ATV SDR-based transmitting exciter that could output around 10 mW of RF using the DVB-S protocol with MPEG-2 encoding and by creating the DATV-Express DVB-S software. Early implementations of DATV-Express software were mainly focused on LINUX Operating System distributions like Ubuntu. Finally, the DATV-Express companion software called (Windows Express_DVB_Transmitter) was ported to the very popular Windows 7, 8, and 10 Operating System. Not only could this software be used to transmit Standard Definition TeleVision (SDTV) format video known as H.262 and also H.264 (HDTV) encoded payload, High Efficiency Video Coding (HEVC) H.265 encoding and even Reduced-Bandwidth-DATV (RB-DATV) where the transmitted RF bandwidth can be between 500 KHz-and-100 KHz.

Beginning in 2017, new powerful SDR-based commercial products from Lime Semiconductor and Analog Devices began to alpha test. Also by 2017/09/27 the DATV-Express Project depleted all inventory of DATV-Express exciter hardware boards. On 11/28/2017 the project team declared an **END OF SALES** policy. The main reason to NOT build more boards is that new DATV products have become available (March 2018) that are SDR-based, both Tx and Rx, and are lower-cost than DATV-Express. Although the DATV-Express hardware board is no longer being sold, the DATV-Express software, (currently v1.25LP11) has continued to expand to support the new lower-cost SDR boards that have recently come to market (thanks to the effort of Charles G4GUO). The current hardware SDR-based boards that are supported are:

1. the DATV-Express hardware Tx-only board (no longer in production)
2. the LimeSDR-USB Tx/Rx board from Lime Micro
3. the LimeSDR-mini Tx/Rx board from Lime Micro
4. the PLUTO-ADALM Tx/Rx board from Analog Devices

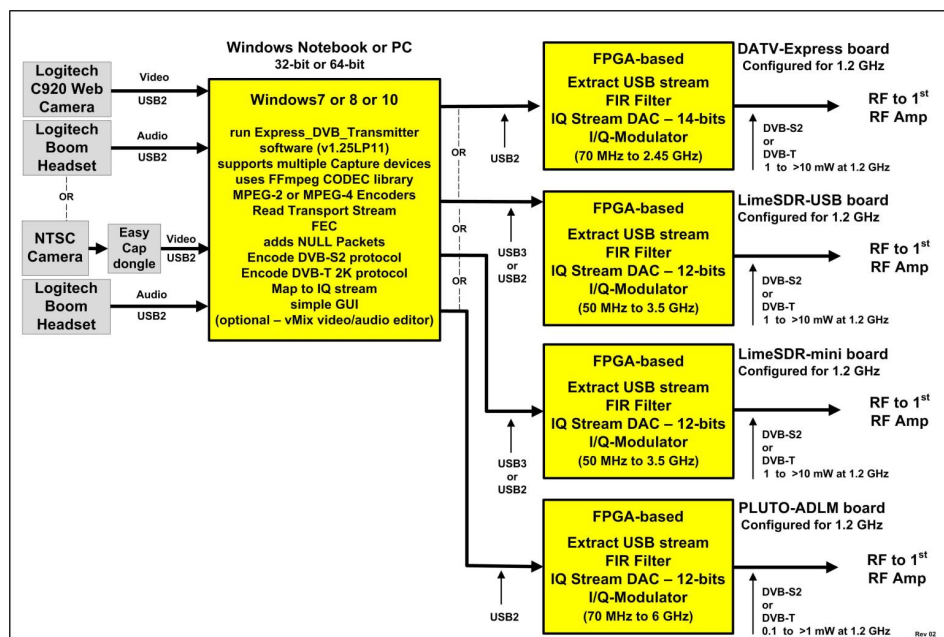


Figure 1 - Block Diagram of v1.25LP11 Express_DVB_Transmitter software with possibilities for running any of four transmitter boards

The DATV-Express Project Team would appreciate any feedback good or bad. If possible please use the BATC forum or DATV-Express yahoo support group (see Section 7.3 for the URL) so your testing information can be shared with others.

This User Guide covers using the Express_DVB_Transmitter software to drive the DATV-Express Board transmitter in both 32-bit or 64-bit Windows environment on Intel-based desktop and notebook computers, as shown in **Figure 1** and **Figure 2**. For preparing the DVB-S protocol, the Windows PC captures the video/audio input stream, uses software-based CODECs for encoding, prepares the Transport Stream (TS) and handles the GUI interface. The hardware board FPGA does most of the hard work for processing the DVB-S protocol, adding the Forward Error Correction (FEC) calculations. The DATV-Express hardware board also shapes the IQ data streams and modulates using an Analog Devices model ADRF6755 IQ-modulator chip.

When running the DVB-S2 protocol, the FPGA on the DATV-Express board is too small to encode the DVB-S2 protocol. The same FPGA restriction is true for the DVB-T protocol. Therefore both the DVB-S2 and DVB-T protocols need to be encoded on the Windows computer (as shown in **Figure 2**). All protocols need to be encoded on the Windows computer for both LimeSDR and PLUTO hardware boards as shown in **Figure 1**.

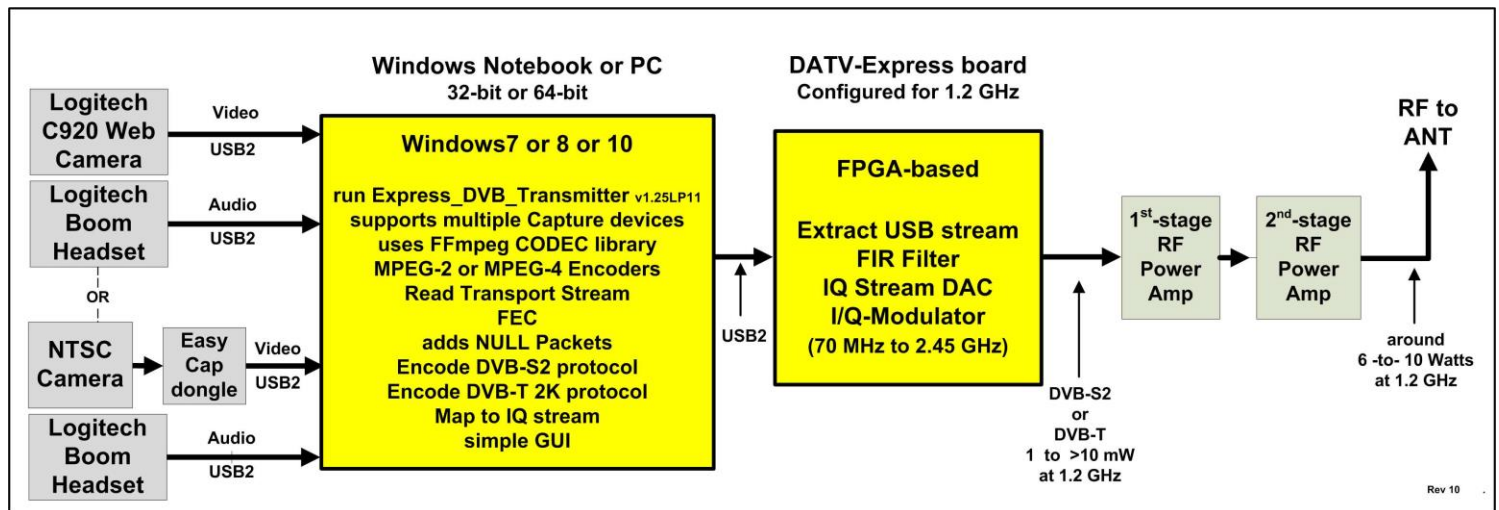


Figure 2 – Block Diagram of typical DATV-Express board set-up with v1.25LP11 software for DVB-S2 protocol or DVB-T protocol. The encoding of DVB-S2 and DVB-T protocol are prepared in Windows PC.

As an added bonus, the DATV-Express board hardware can be used as the modulator board for the BATC Portsdown Project software. The BATC Portsdown Project uses extended RpiDATV software from F5OEO running on an RaspberryPi-3 computer and can be controlled directly from a 3.5-inch or 7-inch touch-screen LCD. See **Figure 3**. This User Guide **DOES NOT** cover operation details for the Portsdown-RpiDATV/RPi-3/DATV-Express set-up. See The BATC Forum for a Portsdown Project User Guide.

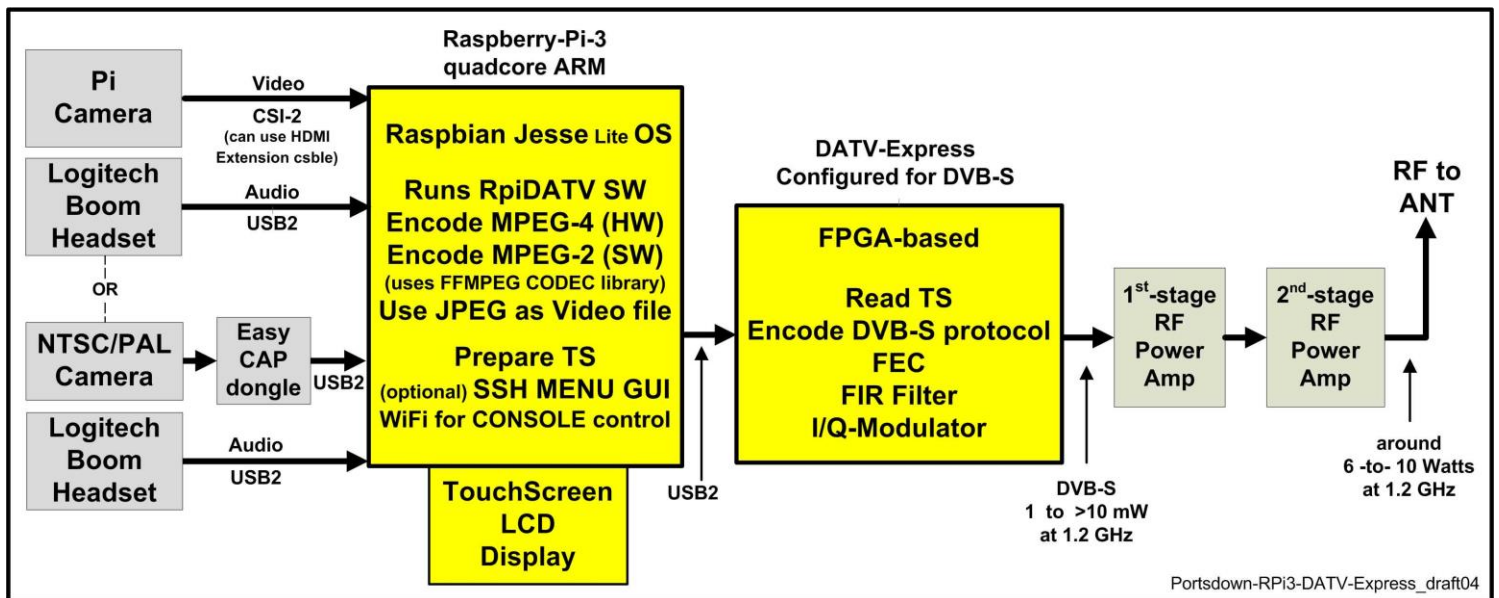


Figure 3 – Block Diagram of typical Portsdown-RPiDATV/RPi-3/DATV-Express set-up for DVB-S.
Portsdown Raspberry-Pi3 now uses the Raspbian Stretch release as OS.

Section 2.0 of this User Guide provides assistance to install the Express_DVB_Transmitter application software using Windows Operating System. Section 3.0 guides you to conduct some basic tests to confirm that your set-up is running correctly. Section 4.0 is a reference guide for the different settings inside the Express_DVB_Transmitter software that can be changed by the user via the software's User's Interface.

2.0 – Install Express_DVB_Transmitter software package

The Express_DVB_Transmitter software requires a Windows desktop/notebook and the hardware modulator board to perform all of the DVB-S processing. Since the Express_DVB_Transmitter software now supports other modulator boards (see **Figure 1**), different drivers need to be installed for each different type of hardware modulator board. The Windows PC will capture the video and audio and then send the processed Transport Stream (TS) datastream to the hardware modulator board via USB2 connection. The FPGA on the hardware board does all the DVB-S protocol encoding. See **Figure 1** (earlier page) for a block diagram of a typical DATV-Express transmitter set-up for the DVB-S protocol (shown configured to transmit on 1.2 GHz).

Currently, the Express_DVB_Transmitter v1.25LP11 software runs only the Vista, Win7, Win8 or Win10 Operating System (OS). (NOTE – sorry, but WinXP does NOT contain the functionality required by Express_DVB_Transmitter software.) First, you will need to install the Windows driver for the hardware modulator board. Second, you will need to install the actual Express_DVB _Transmitter software package.

The Express_DVB_Transmitter software can now run four different DATV exciter boards using the DVB-S or DVB-S2 and DVB-T DATV protocols in a Windows OS environment:

- 1) the DATV-Express hardware board
- 2) the LimeSDR-USB (larger) board
- 3) the LimeSDR-mini board
- 4) the PLUTO board

Installing the drivers is covered in the following four sections

2.1 Install the Windows Driver for DATV-Express hardware board

There is a program called **Zadig** <http://zadig.akeo.ie/> which makes loading Windows drivers easy.

(CAUTION: When downloading Zadig tool from the web site, be careful to use the correct DOWNLOAD button. An incorrect selection will cause many undesirable programs to be installed!)

NOTE - If you already have the software called **DatvExpressServerApp** installed on your machine, then the Windows DATV-Express hardware driver needed for Express_DVB-S/-S2_Transmitter has already been installed and there will be nothing further to do for the windows HW driver.

2.1.1 You need to have ADMIN privileges on your PC to change drivers.

2.1.2 Have the DATV-Express hardware board installed as Unknown Device in the Windows-CONTROL-PANEL

- open the DEVICE MANAGER mode of the Windows Control Panel.
- Attach the DATV-Express board powered-up into USB2 port of Windows machine
- **DO NOT RUN** the inf wizard exe for libusb0
 - ****(does **NOT** show the correct usb device, yet...**JUST ABORT**)
- When you insert the USB cable to the Board from Windows...you will see "unknown hardware do you want to find driver" say **NO**
 - ***IF you are not allowed to abort out of Windows searching the internet, see Section 2.1.3**
- If you are allowed to say NO.... then go to
CONTROL PANEL -> DEVICE DRIVER -> OTHER DEVICES -> UNKNOWN DEVICE

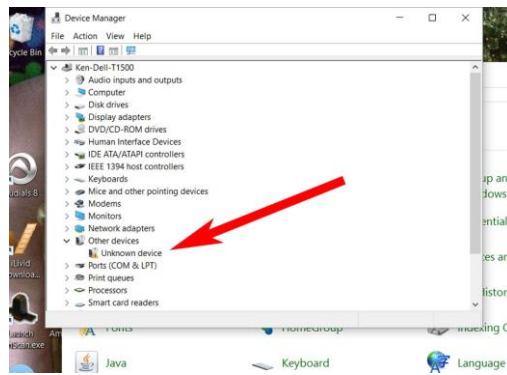


Figure 4 – Before using ZADIG, connecting Hardware Board will result in “Unknown device” driver appearing in DEVICE MANAGER

2.1.3 Change Windows to NOT “download drivers automatically”

If you had trouble with Windows OS insisting on automatically looking for a driver on the internet without giving you an opportunity to ABORT out of that action (perhaps an artifact of old Win7), then follow steps below.

- On the Windows PC, go to Devices and Printers from START.
- Right-Click on the Icon that represents the computer in the next pane.
- Left-Click device installation settings from the menu.
- A window opens “Do you want Windows to download driver software and realistic Icons for your devices?” The default is “**Yes, do this automatically**”, click on the button next to “**No, Let me choose what to do**”.
- Click on the button: “**Never install driver software from Windows Update**”.
- Click on “**save changes**” and it will exit. Then go back and repeat Section 2.1.2 again

2.1.4 Start up ZADIG in libusb-win32 mode

Then start-up Zadig and it will then fill in USB ID automatically and install the drivers as “Unknown Device #1”



Figure 5 – ZADIG tool will install a new driver named “Unknown Device #1”

2.1.5 Recommend editing ZADIG device driver name to "DATV-Express"

- after completing the steps in Section 2.2.4, stay in ZADIG
- double click on UNKNOWN DEVICE
- use the EDIT button in ZADIG screen (next to current name of the Device driver) and change the driver name to “Datv-Express”
- click on UPDATE DRIVER

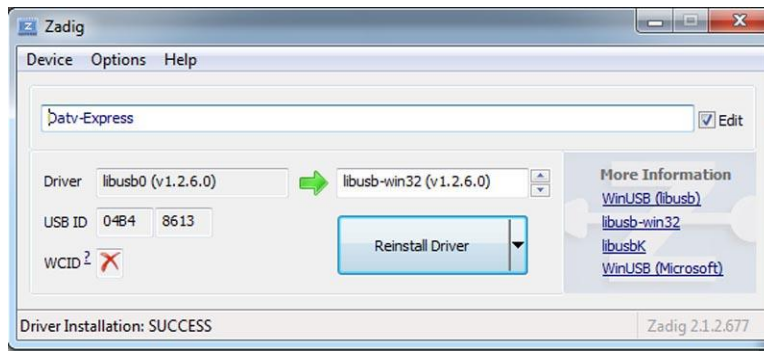


Figure 6 – Use ZADIG EDIT feature to rename the Device driver name

Go back to the Control Panel tab for DEVICE DRIVER and confirm that the renamed driver is now called **Datv-Express** as shown in **Figure 7**.

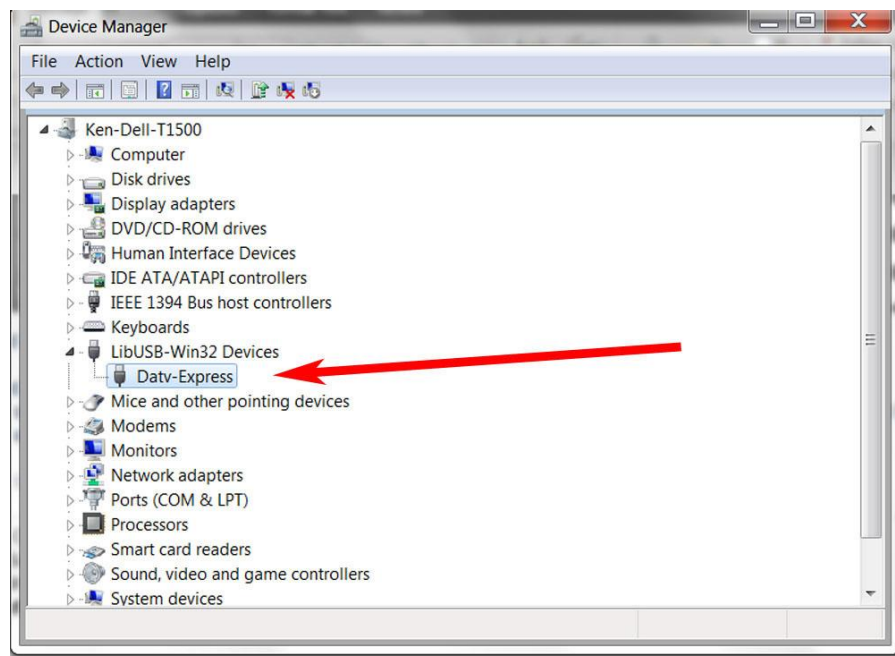


Figure 7 – DEVICE MANAGER shows successful installation of ZADIG driver.

- For further information consult the Zadig webpage and instructions.

2.2 Install the Windows Driver for LimeSDR hardware boards

IF you are installing software for a LimeSDR-USB board (or mini), then:

Connect the LimeSDR-mini to a USB port (I use the USB-3 port) on Windows PC that is connected to the internet.

Do not start the Windows Express_DVB_Transmitter software, yet. Plug-in the LimeSDR-mini to the USB port and wait a few minutes for the LimeSDR to find the drivers on the internet and automatically install. If the driver was automatically installed, Then the LED on LimeSDR-mini will start blinking

between Red and Yellow. If successful, you should see a device called "FTDI FT601 USB 3.0 Bridge Device" in Windows Device Manager under USB controllers (see **Figure 08**).

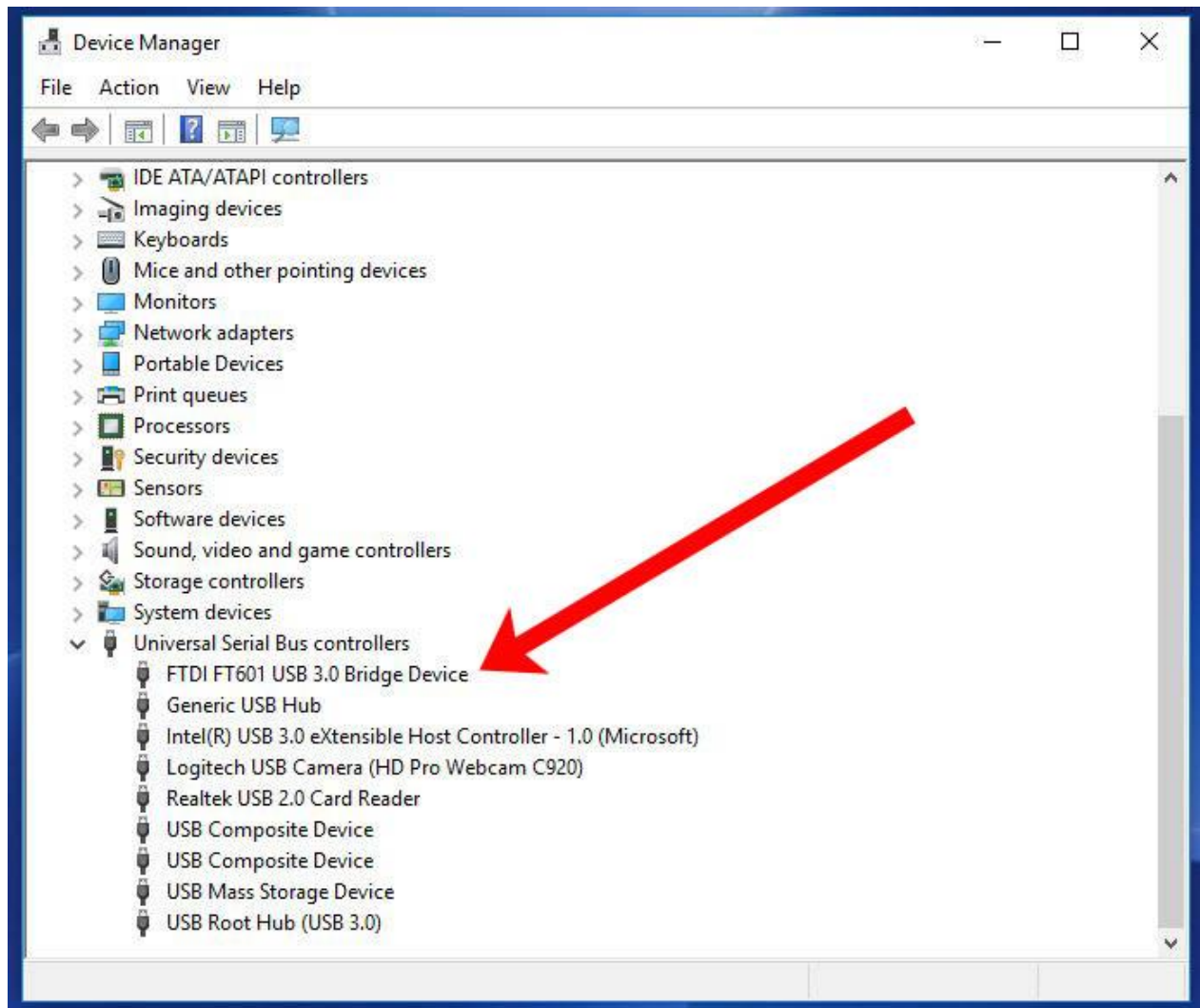


Figure 8 – DEVICE MANAGER on Win10 shows successful installation of LimeSDR-Mini driver.

Note that later in Section 2.4, you may also need to still install Microsoft Redistributable Visual C++ (32-bits) if claims of **"missing dlls"** appear when starting the Windows Express_DVB_Transmitter software.

2.3 Install the Windows Driver for PLUTO hardware board

IF you are installing software for a ADALM-PLUTO board, then:

Before running the Express_DVB_Transmitter software you will need to perform the following steps

(1) Install the Windows drivers for the ADALM-PLUTO which are here

<https://wiki.analog.com/university/tools/pluto/drivers/windows>

(2) Extend the frequency range of the ADALM-PLUTO. Notes on how to do this are here

<https://wiki.analog.com/university/tools/pluto/users/customizing>

(3) Plug-in the PlutoSDR to the USB port and wait a few minutes for the PlutoSDR to find the drivers on the internet and automatically install. If the driver was automatically installed then the READY LED on LIME will glow steady BLUE and the LED1 will then start blinking BLUE. If successful, you should also see a device called "PlutoSDR Serial Console (COM3)" in Windows Device Manager under PORTS (COM & LPT) (see **Figure 09**)

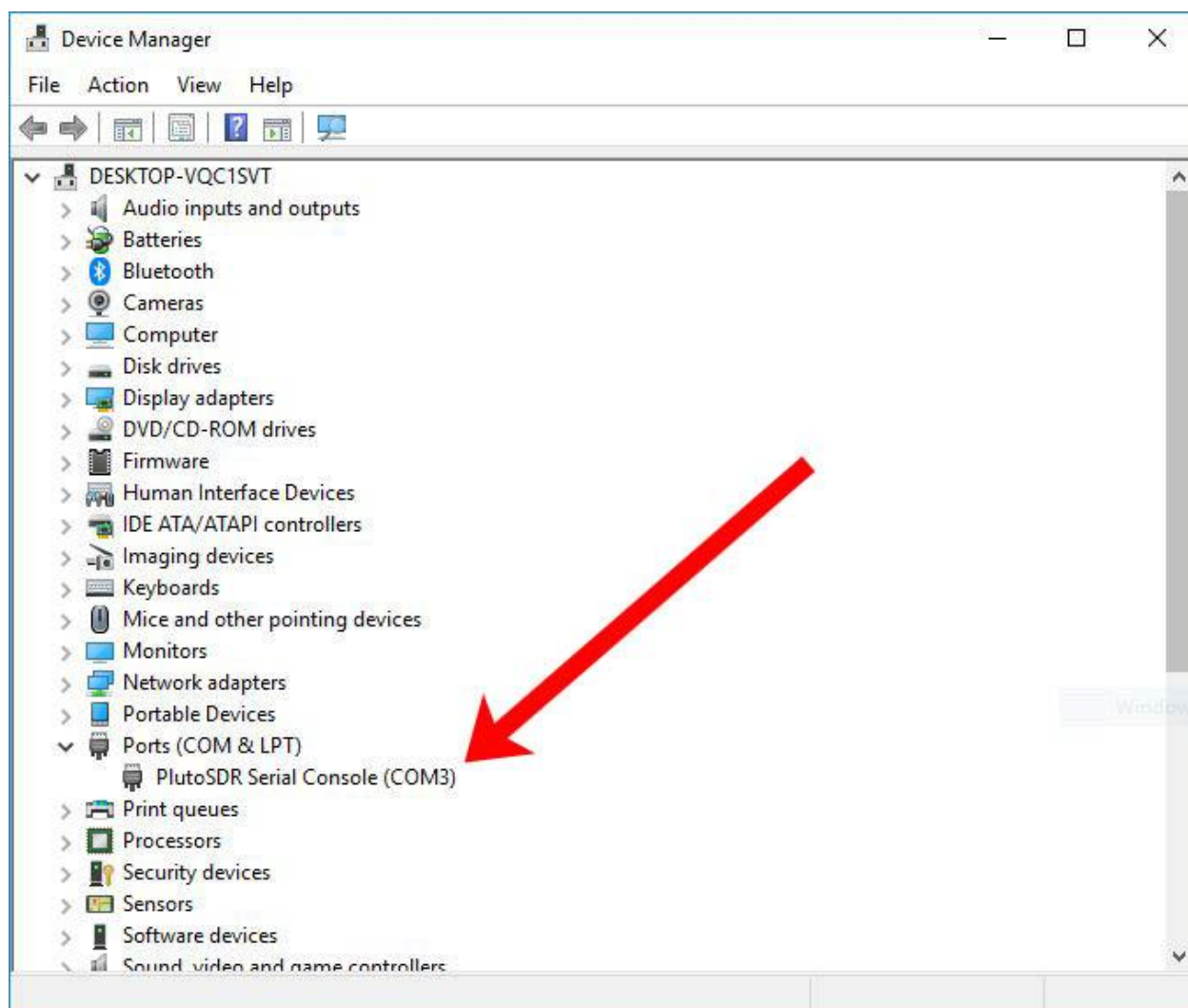


Figure 9 – DEVICE MANAGER on Win10 shows successful installation of ADALM-PLUTO driver.

Note that later in Section 2.4, you may also need to still install Microsoft Redistributable Visual C++ (32-bits) if claims of **"missing dlls"** appear when starting the Windows Express_DVB_Transmitter software. Install the VC++ 2015 re-distributable (32 bit version) to resolve the "missing dlls" issue from <https://www.microsoft.com/en-gb/download/details.aspx?id=48145>

2.4 Install the Express_DVB_Transmitter software package on Windows

The software needed to install the Express_DVB_Transmitter app on Windows is found in an easy-to-use package installer file that was prepared by the **Inno Set-up** utility.

2.4.1 Download Express_DVB_Transmitter Installer package from DATV-Express.com

“Inno Setup” is the name of a utility that helps to install the Express_DVB_Transmitter software application package onto Windows OS. The Express_DVB_Transmitter installer package has already used Inno Set-up to hide much of the tedious complexity for installing software on the Windows OS.

- Download the **Windows_setup_datv_express_dvb-s_transmitter_v1.25LP11.zip** zip file from the www.DATV-Express.com website on the **DOWNLOADS** page.
- Be sure to read the **NOTES .TXT** file for this software, also on the **DOWNLOADS** page.
- SAVE the zip file to whatever directory you like on your Windows PC.
- OPEN the ZIP file and if given a choice...save the contents to a folder called Express-DVB-S_Transmitter

NOTE 1 – you will **NOT** need to run this setup as ADMIN

NOTE 2 – you will **NOT** need internet access during the install

- RUN the SETUP.EXE installer file and allow it to install at the default location...in the ROOT DIRECTORY.

NOTE 3 – I find it convenient to let SETUP create a “shortcut” icon on the DESKTOP

- When SETUP.EXE has finished, the Windows root directory should look like **Figure 10** with a ROOT-directory folder called **DatvExpress** containing the folder for the software that is named **Express-DVB-S_Transmitter**.

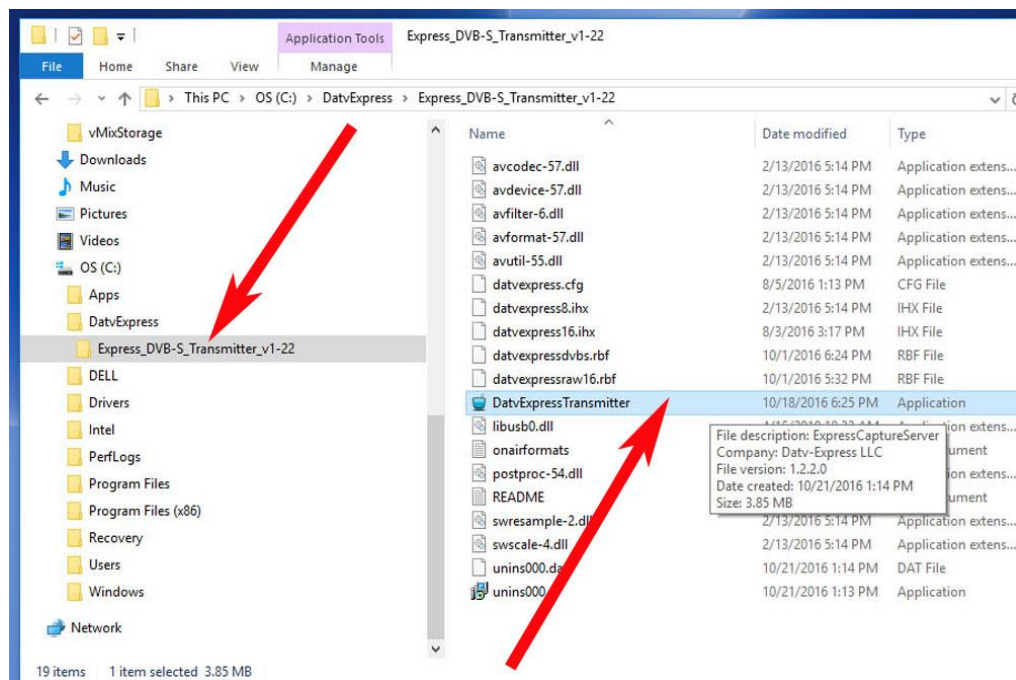


Figure 10 – The SET-UP.exe should be allowed to default to installing software inside a Directory called DatvExpress (see left arrow)

- The new EXE file for the Express_DVB_Transmitter software is the file named “DatvExpressTransmitter.exe” (see right arrow in **Figure 10**).

2.4.2 A quick “test launch” of Download Express_DVB_Transmitter software

You should now have a “short-cut” icon called Express DVB showing up on the Windows OS Desktop. We will now step through a quick launch of the Express_DVB_Transmitter software to make sure that everything seems to be working....before you do more set-up and Testing in Section 3.0

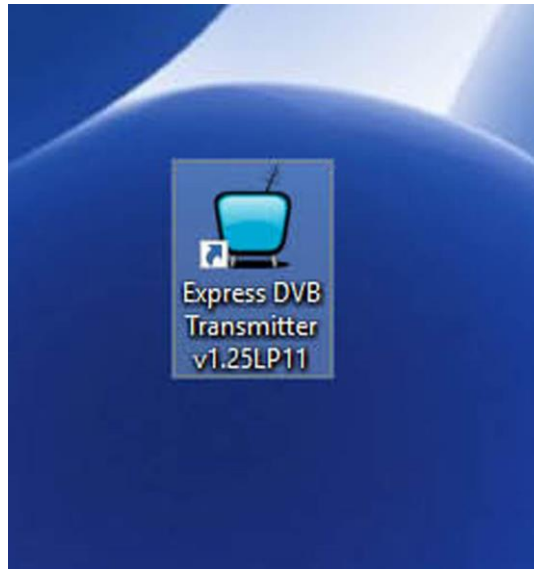


Figure 11 – The Express_DVB_Transmitter app icon should appear on the Desktop

- Attach the camera you plan to use to the Windows computer USB port.
- Also attach the audio input (if different than camera) to the computer USB port.
- Attach the DATV-Express hardware board to a computer USB port.
- **DO NOT power up** the DATV-Express hardware board, yet. (no RF amplifiers are needed at this point.)
- Double-click on the desk-top icon. The main screen of Express_DVB_Transmitter software should open in the DUMMY MODE as shown in **Figure 12**. The PTT button will remain grayed out until the correct board is powered up and saved in Section 3.0).

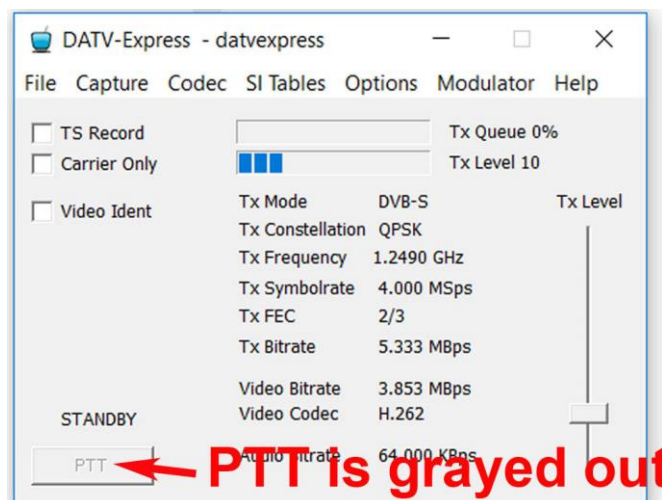


Figure 12 – The initial MAIN screen you should see after set-up is run and when v1.25LP11 is running in the DUMMY MODE.

2.5 Upgrading your installed DATV-Express Software

Occasionally you may want to upgrade your Express_DVB_Transmitter software file to begin using a newly released feature or bug-fix. When newer installation upgrade files are available, these upgrades can be downloaded from the **DOWNLOADS** area on the DATV-Express web site (See **Section 7.2**)

- It is NOT required FOR the Windows PC to provide Wi-Fi or Ethernet access to the internet during the upgrade installation after the upgrade .ZIP file has been downloaded to the target computer.
- Simple - run the installation script file (setup.exe) again. It will replace the old files.

3.0 - Hook-up the DATV hardware and Test

3.1 Here is what you need

Because the v1.25LP11 software supports more than one type of modulator board, this section is broken into three sections to detail three different board manufacturers.

3.1.1 Here is what you need to hook up DATV-Express board

A list of minimum items you need to have your first test of the DATV-Express software and board

- A version E (or later) DATV-Express exciter hardware board
- A PC with appropriate Windows Operating System installed (as used in Section 2.2).
- A 12V DC power supply to run the DATV-Express. By itself, the DATV-Express board will run about 2 Watts (mostly quiescent power in the modulator chip U4).
- A 12V power cable with a 2.54 mm center contact connector at one end to attached to J3 on the hardware board.
- Invest in purchasing a brand-new USB2 cable with a “Type A” connector for PC-end, and a “Type B” connector for the J1 connector on the hardware board.
- A web-camera with USB interface (Logitech model C920 units work well).
- Or a PAL or NTSC video camera with an appropriate video-capture dongle like (EZ-cap)
- RCA-type cable to connect the camera to the Hauppauge or other video-capture unit.
- A receiver/analyzer for the DVB-S protocol like MiniTiouner board with MiniTioune software, or a Set-Top-Box (STB) connected to some form of display (a TV set or computer).
- Optionally, you can use a spectrum analyzer, if you have access to one.
- [NOTE – optionally I use a microwave “directional coupler” unit (cheap on e-Bay) to split the exciter output RF signal to both the spectrum analyzer (the forward signal sample) and to the transmitter antenna.
- A small bent piece of wire to act as a one-quarter-wave vertical antenna for both the DATV-Express exciter board and a second antenna for the DATV STB or stand-alone DATV receiver.
- RF Amplifiers are optional, but are not needed for checkout at this point if the board and software are working as expected.

3.1.2 Here is what you need to hook up either LimeSDR board

- A PC with appropriate Windows Operating System installed (as used in Section 2.2).
- NO external power supply (12V DC, etc) is required. Power is obtained from the PCB USB port.
- Invest in purchasing a brand-new USB-3 cable with a “Type A” connector for PC-end, and a “Type B” connector for the connector on the LimeSDR hardware board.
- A web-camera with USB interface (Logitech model C920 units work well).
- A receiver/analyzer for the DVB-S protocol like MiniTiouner board with MiniTioune software, or a Set-Top-Box (STB) connected to some form of display (a TV set or computer).
- Optionally, you can use a spectrum analyzer, if you have access to one.
- [NOTE – optionally I use a microwave “directional coupler” unit (cheap on e-Bay) to split the exciter output RF signal to both the spectrum analyzer (the forward signal sample) and to the transmitter antenna.
- A small bent piece of wire to act as a one-quarter-wave vertical antenna for both the LimeSDR-USB or LimeSDR-mini exciter board and a second antenna for the DATV STB or stand-alone DATV receiver.
- RF Amplifiers are optional, but are not needed for checkout at this point if the board and software are working as expected.

3.1.3 Here is what you need to hook up PLUTO board

- A PC with appropriate Windows Operating System installed (as used in Section 2.2).
- NO external power supply (12V DC, etc) is required. Power is obtained from the PCB USB port.

- Invest in purchasing a brand-new USB2 cable with a “Type A” connector for PC-end, and with a “Micro-USB” connector for the hardware board.
- A web-camera with USB interface (Logitech model C920 units work well).
- A receiver/analyzer for the DVB-S protocol like MiniTiouner board with MiniTioune software, or a Set-Top-Box (STB) connected to some form of display (a TV set or computer).
- Optionally, you can use a spectrum analyzer, if you have access to one.
- [NOTE – optionally I use a microwave “directional coupler” unit (cheap on e-Bay) to split the exciter output RF signal to both the spectrum analyzer (the forward signal sample) and to the transmitter antenna.
- A small bent piece of wire to act as a one-quarter-wave vertical antenna for both the PLUTO exciter board and a second antenna for the DATV STB or stand-alone DATV receiver.
- RF Amplifiers are optional, but are not needed for checkout at this point if the board and software are working as expected.

3.2 First Test – power up the modulator board by itself

3.2.1 First Test – power up the DATV-Express board by itself

- IMPORTANT NOTE – please take adequate precautions against ESD discharges to the board. A minimum precaution should be to first touch the 12V DC power supply chassis....or the top of the SMA connector, J2, before you handle the board. Components on an exposed DATV-Express board are susceptible to ESD damage if not handled correctly.
- NOTE – do not connect the USB2 cable to the DATV-Express board at this point of testing.
- Connect the 12V power cable to J3 on the DATV-Express board
- Power up the power supply
- If the LED 4 lights (5.5 V on-board DC-to-DC power supply) near the upper-right mounting hole, then the test is successful
- No other LEDs on the hardware board should activate during this test (see Section 4.13 for locations).
- **Note that LED 1, 2, 3, and 5 normally glow very dimly. They are OFF if they are not as bright as LED 4.**
- Power off the power supply.

3.2.2 First Test – power up one of LimeSDR boards by itself

- IMPORTANT NOTE – please take adequate precautions against ESD discharges to the board. A minimum precaution should be to first touch the top of the SMA RF connector, before you handle the board. Components on an exposed LimeSDR board are susceptible to ESD damage if not handled correctly.
- Power OFF the computer
- Now attach the USB-3 connector to the PC and the LimeSDR.
- Now Power ON the PC.
- NOTE – Typically, PC's and Operating Systems take several minutes to fully start-up. Be patient.
- When your operating system is fully running, the LED on the LimeSDR board should be blinking RED/YELLOW.
- If the LED on the LimeSDR board is blinking RED/YELLOW,, then this test is successful.
- NOTE – Do NOT start the Express_DVB_Transmitter software (v1.25LP11) at this point in testing
- Now move to Section 3.3.

3.2.3 First Test – power up the PLUTO board by itself

- IMPORTANT NOTE – please take adequate precautions against ESD discharges to the board. A minimum precaution should be to first touch the outer shell of the SMA RF connector, before you handle the PLUTO board.
- Power OFF the computer
- Now attach the USB-3 or short USB-2 cable to the connector to the PC and the LimeSDR.
- Now Power ON the PC.
- NOTE – Typically, PC's and Operating Systems take several minutes to fully start-up. Be patient.
- When your operating system is fully running, the LED1 on the PLUTO-ADLM board should be blinking BLUE and the READY LED should be steady ON..
- If the LED1 on the PLUTO board is blinking BLUE,, then this test is **successful**.
- NOTE – Do NOT start the Express_DVB_Transmitter software (v1.25LP11) at this point in testing
- Now go to Section 3.3.

3.3 Second Test – connect hardware board & start Express_DVB_Trans SW

3.3.1 Connect DATV-Express hardware board and start the Express_DVB_Trans SW

- Disconnect THE USB cable from the hardware board at this point
- Power OFF the 12V power supply for the DATV-Express hardware board.
- Connect the USB2 cable between the PC and J1 on the DATV-Express hardware board.
- Power ON the Windows computer
- After PC boots up, power ON the 12V power supply for the DATV-Express board
- Only LED 4 should light (5.5 V on-board DC-to-DC power supply)
- Start up the Express_DVB_Transmitter software by double-clicking on Express_DVB_Transmitter desktop icon.
- If an error message indicating “PLUTO not found – 1005” as shown in **Figure 13**, then:

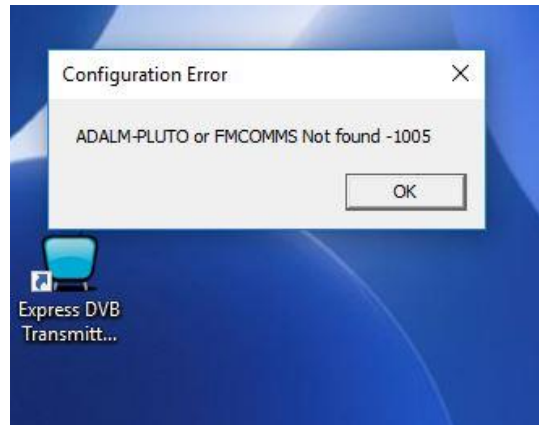


Figure 13 – An Error Message stating “No LimeSDR hardware found” or stating “No PLUTO hardware found”, usually means that the MODULATOR-COMMON settings are not correct

The message in **Figure 13** of “No PLUTO hardware found” is usually indicating that the parameters in the MODULATOR-COMMON are set to the wrong board manufacturer. The **FIGURE 14** shows that you can choose from four different types of hardware modulator boards. If you are trying to TEST a DATV-Express hardware board, then the DATV-Express boards need to be selected in the MODULATOR-COMMON tab. Correct the setting to select DATV-Express hardware and SAVE the settings in the FILE Tab.

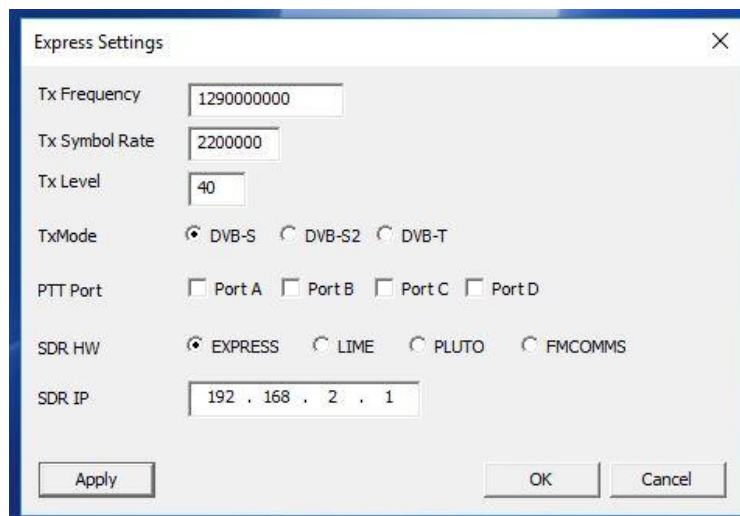


Fig 14 – The MODULATOR-COMMON Tab setting needed for testing a DATV-Express hardware board.

After correcting the settings in the MODULATOR-COMMON tab and saving them in FILE Tab, then restart the V1.25LP11 program.

It is then NORMAL for an error message indicating an “Invalid Video Capture Device” as shown in **Figure 15** to appear.

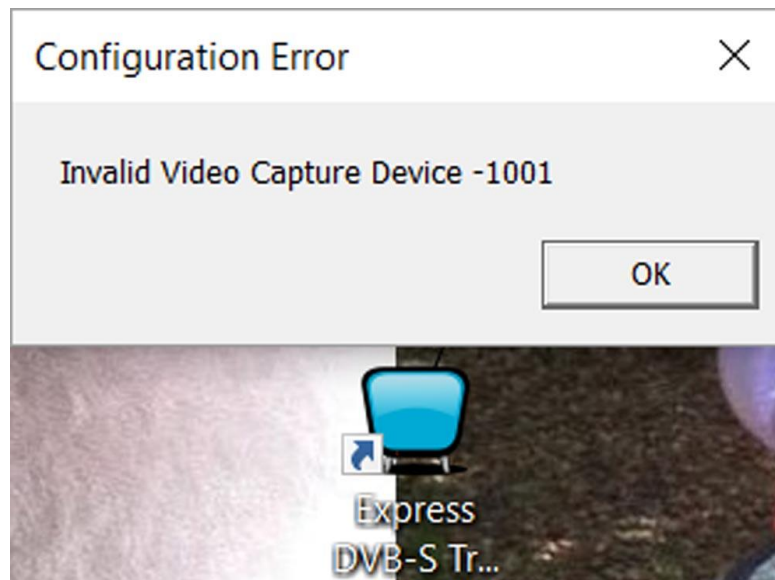


Figure 15 – An error message appears because the camera (video-source) is not connected or selected

- Say **OK** to the error message.
- Now, the MAIN user display window on the Windows PC should appear in a DEMO mode as in photo in **Figure 16**.

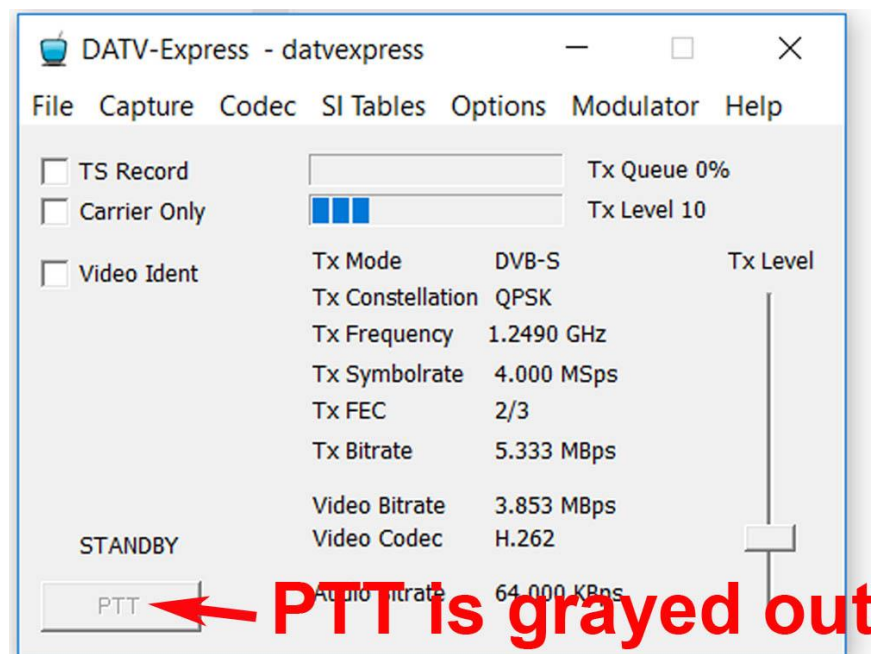


Figure 16 – The MAIN window confirms that the software is running in the DEMO Mode with PTT button “grayed out”

If you see **Figure 16** OK, then you have completed these steps successfully. Proceed to Section 3.4.1

3.3.2 Connect LimeSDR hardware board & start Express_DVB_Transmitter SW

- Make sure the PC is powered OFF at this point
- Connect the USB-3 cable between the PC and J1 on the LimeSDR hardware board.
- Power ON the Windows computer
- Wait until the PC Operating System boots up completely
- Start up the software by double-clicking on Express_DVB_Transmitter desktop icon.
- If an error message indicating “DATV-Express hardware not found – 1005” or “PLUTO hardware not found” appears similar to shown in **Figure 17**, then:

The message in **Figure 17** of “No “DATV-Express hardware not found” error is usually indicating that the parameters in the MODULATOR-COMMON tab are set to the wrong board manufacturer. The **FIGURE 18** shows that you can choose from four different types of hardware modulator boards. If you are trying to TEST a LimeSDR hardware board, then the LimeSDR board first needs to be selected in the MODULATOR-COMMON tab. Correct the setting to LimeSDR hardware and SAVE the settings in the FILE Tab.



Figure 17 - An Error Message stating “DATV-Express hardware not found” or stating “No PLUTO hardware found”, usually means that the MODULATOR-COMMON settings are not correct for LimeSDR

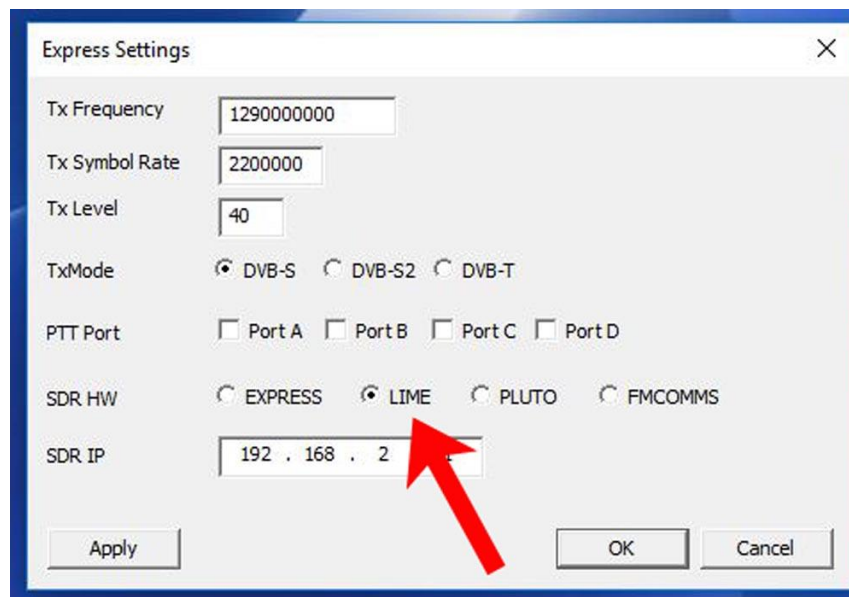


Figure 18 - Screen Capture of MODULATOR-COMMON tab set up to use either the LimeSDR-USB (the larger board) or LimeSDR-mini in the v1.25LP11 software.

After correcting the settings in the MODULATOR-COMMON tab and saving them in FILE Tab, then restart the V1.25LP11 program.

It is then **NORMAL** for an error message indicating an “Invalid Video Capture Device” as shown back in **Figure 15** to appear.

- Say OK to this error message.
- Now, the MAIN user display window on the Windows PC should appear in a DEMO mode (because the video/audio selections have not been properly made, yet) as in photo in **Figure 19**. The PTT button on the MAIN screen is still “grayed out” and can NOT be activated yet.
- If you see **Figure 19** OK, then you have completed these steps successfully. Proceed to Section 3.4.2.

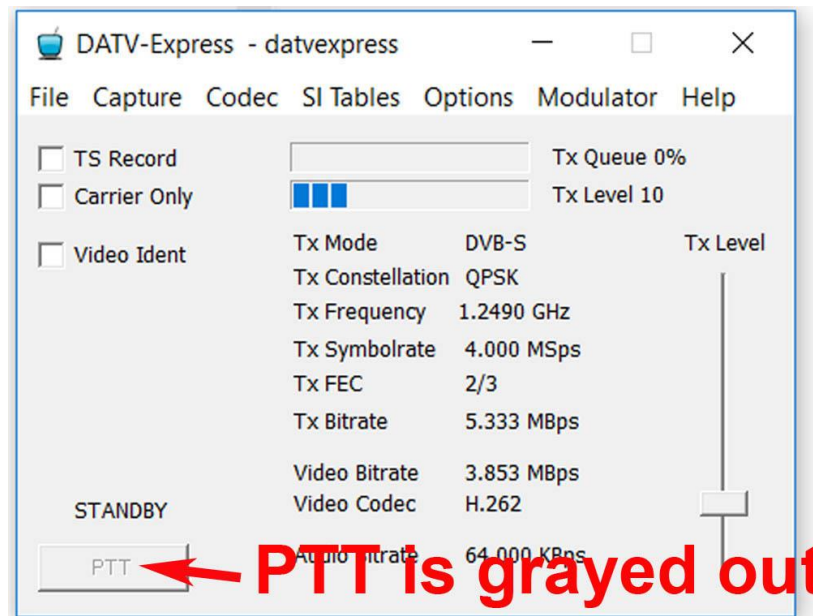


Figure 19 - The MAIN window confirms that the software is running in the DEMO Mode with PTT button “grayed out” (because the video/audio selections have not been made)

3.3.3 Connect PLUTO hardware board & start Express_DVB_Transmitter SW (This Section is still under construction)

3.4 Third Test – now connect video-capture to the PC

3.4.1 Third Test – now connect video-capture to the PC with DATV-Express Board

- Start by exiting the Express_DVB_Transmitter software, then powering OFF the board 12V power
- Connect the video-capture camera to the PC by an unused USB connector
- Also attach the audio input (if different than camera) to the computer USB port.
- Attach the DATV-Express hardware board to a computer USB port.
- Now power up the hardware board. (no RF amplifiers are needed at this point.)
- Start the Express_DVB_Transmitter software application file by double-clicking the desktop icon.
- LED lights 3, 4, 5 on the hardware board should be lit...with the second from bottom blinking, LED2.
- First we need to configure a valid video input and a valid audio input...before the software will really run.
- Select the CAPTURE Tab on the Main screen that is shown in Figure 23
- Now select VIDEO
- The VIDEO CAPTURE Settings screen as shown in **Figure 20** should appear.

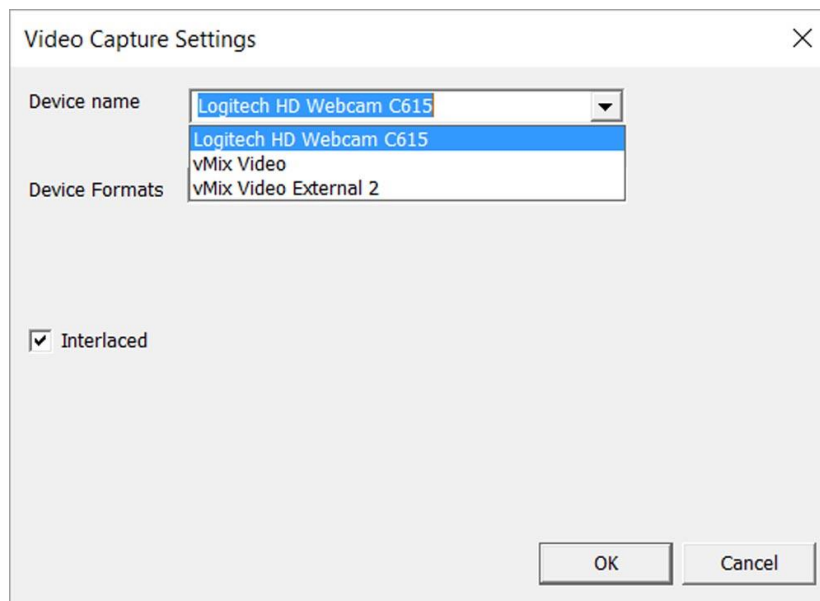


Figure 20 – The Video Capture screen allows you to select your camera if plugged in.

- Select the desired Camera from the DEVICE NAME field's pull-down menu.
- Click OK
- Now pull down the menu from the Video DEVICE FORMATS field as shown in **Figure 21**. Note that not all formats shown will be supported by a specific camera.

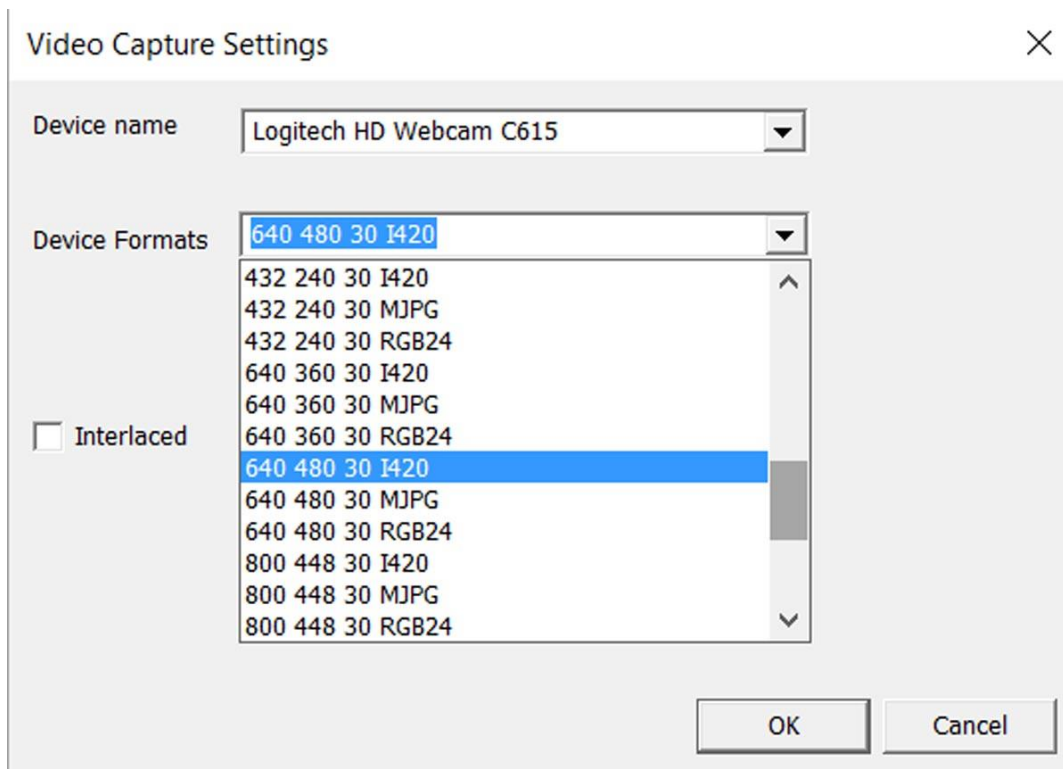


Figure 21 – The DEVICE FORMATS menu allows a number of possible values

- Select a Device Format setting
- Click OK
- Then click the INTERLACED box and again say OK
- Go to the FILE TAB on the MAIN MENU and select SAVE
- Go back to the FILE TAB on the MAIN MENU and select RESTART
- Select the CAPTURE TAB on the Main screen
- Now select AUDIO
- The AUDIO CAPTURE Settings screen shown in **Figure 22** should appear.

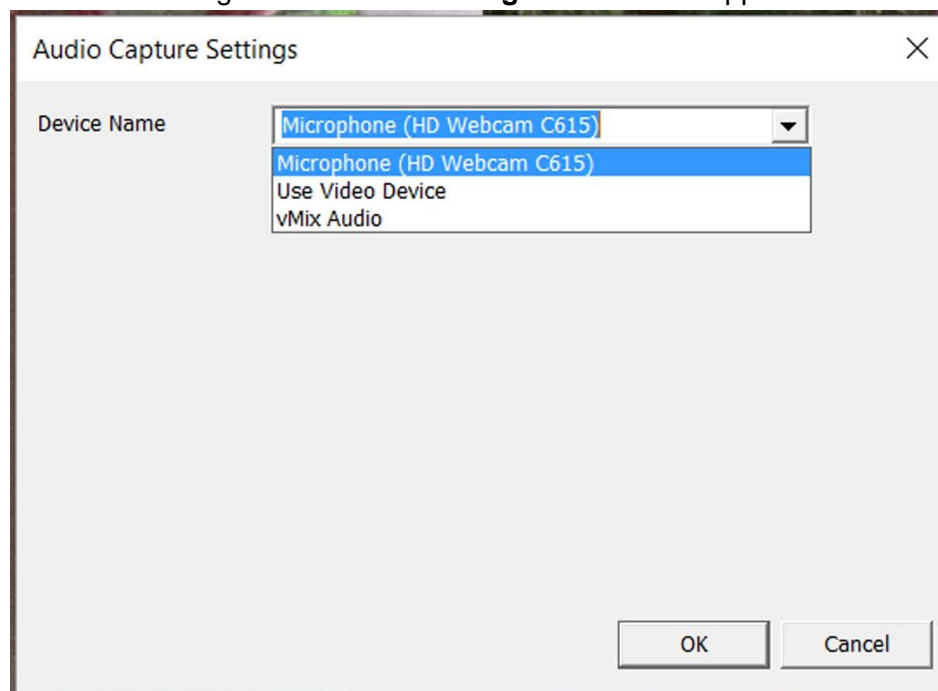


Figure 22 – The AUDIO Capture screen allows you to select the Audio device.

- Select the desired source of AUDIO from the DEVICE NAME field's pull-down menu.
- Click OK
- Go to the FILE TAB on the MAIN MENU and select SAVE
- Go back to the FILE TAB on the MAIN MENU and select RESTART
- You are going to power-OFF the computer at this point.
- Go to the FILE TAB on the MAIN MENU and select EXIT.
- Turn the Power-OFF to the DATV-Express hardware board.

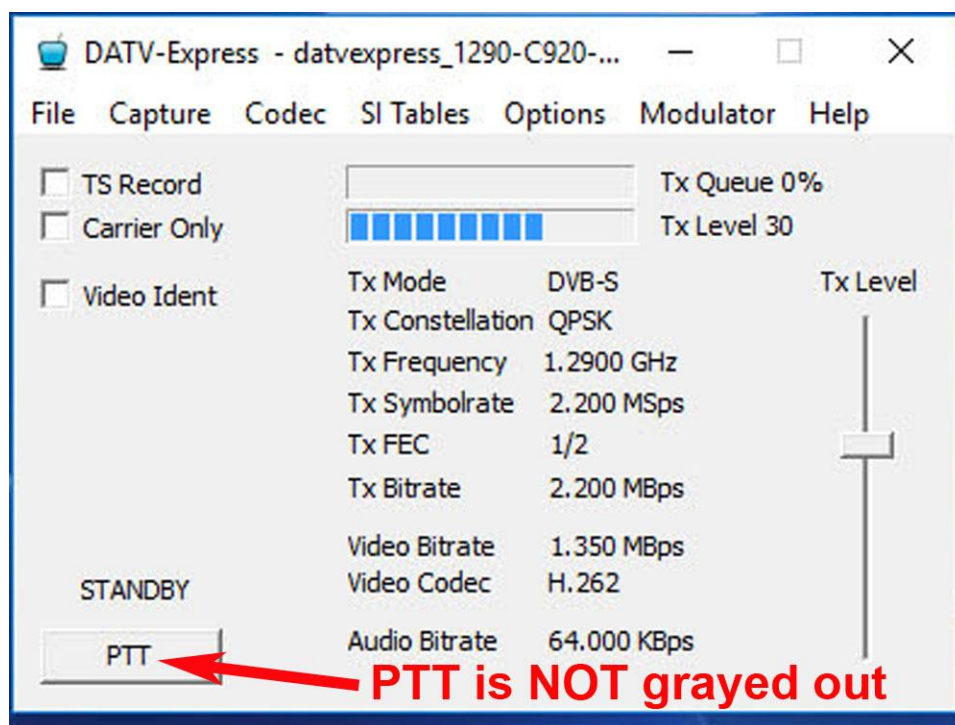


Figure 23 – The "NORMAL" MAIN screen confirms that Software is no longer running in DEMO Mode

- If in the MAIN screen you see still has the PTT button "grayed out", then perhaps you did not yet successfully complete the steps in Sections 2.2.2 and 2.2.3? Go back and complete those steps again?
- **If the FPGA does NOT light the new LEDs (LED 5, LED3, and LED2) on the board**, that probably means that the code did not download to the board FPGA for some reason.

Test the PTT Button

If everything in Section 2.2.2 worked correctly, then the PTT button will be allowed to work properly, (and PTT will NO LONGER be "grayed out").

- Now power up the hardware board. (no RF amplifiers are needed at this point.)
- Double-click on the desk-top icon. The main screen of Express_DVB_Transmitter software should open.
- First check to see if your VIDEO and AUDIO selections were correctly saved using the CAPTURE TAB
- If everything is correct...select the CANCEL button to escape back to the MAIN screen
- Finally press PTT. If everything is working the MAIN screen should display that you are in the TRANSMIT mode in RED.
- If the PTT button the MAIN screen turns RED...then this step is successful.
- If everything is OK...then close the DATV-Express software application, then turn OFF power on the 12V power supply , and finally turn OFF power on the computer.
- Proceed to Section 3.5.1

3.4.2 Third Test – now connect video-capture to the PC with LimeSDR

- Restart the v1.25LP11 software.
- The LED on the LIME hardware board may still be blinking Red/Yellow
- First we need to configure a valid video input and a valid audio input...before the software will really run.
- Select the CAPTURE Tab on the Main screen that is shown back in **Figure 23**
- Now select VIDEO
- The VIDEO CAPTURE Settings screen similar to shown in **Figure 24** should appear.

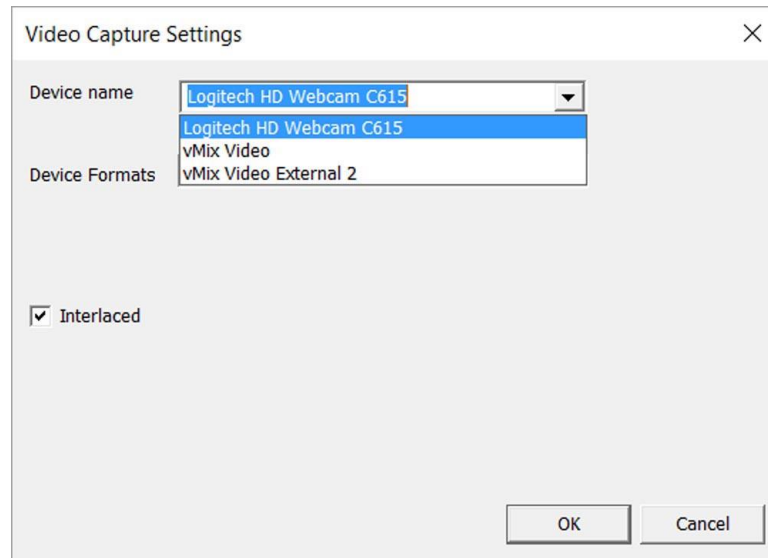


Figure 24 – The Video Capture screen allows you to select your camera if plugged in

- Select the desired Camera from the DEVICE NAME field's pull-down menu.
- Click OK
- Now pull down the menu from the Video DEVICE FORMATS field as shown in **Figure 25**. Note that not all formats shown will be supported by a specific camera.

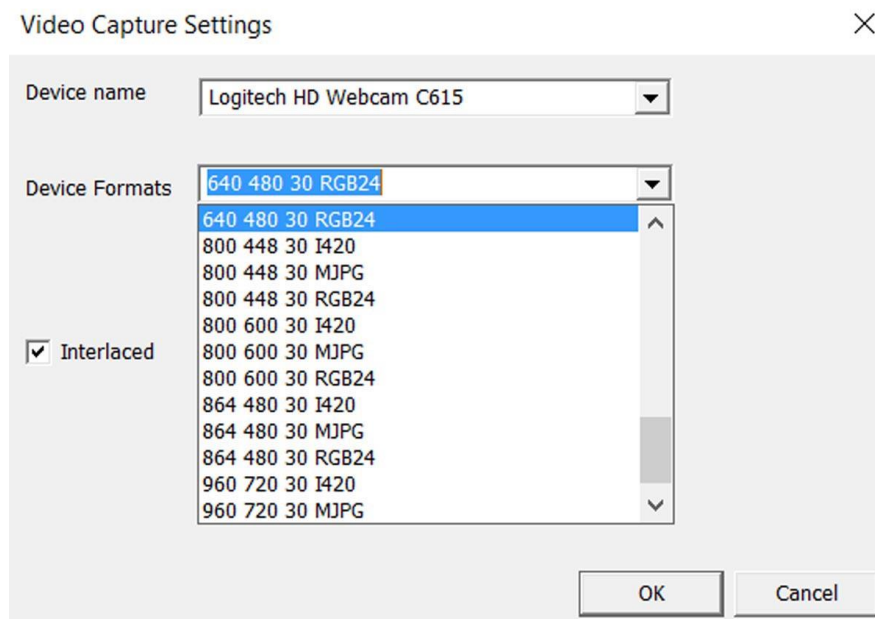


Figure 25 – The DEVICE FORMATS menu allows a number of possible values

- Select a Device Format setting
- Click OK
- Then click the INTERLACED box and again say OK
- Go to the FILE TAB on the MAIN MENU and select SAVE
- Go back to the FILE TAB on the MAIN MENU and select RESTART
- Select the CAPTURE TAB on the Main screen
- Now select AUDIO
- The AUDIO CAPTURE Settings screen shown in **Figure 25** should appear.

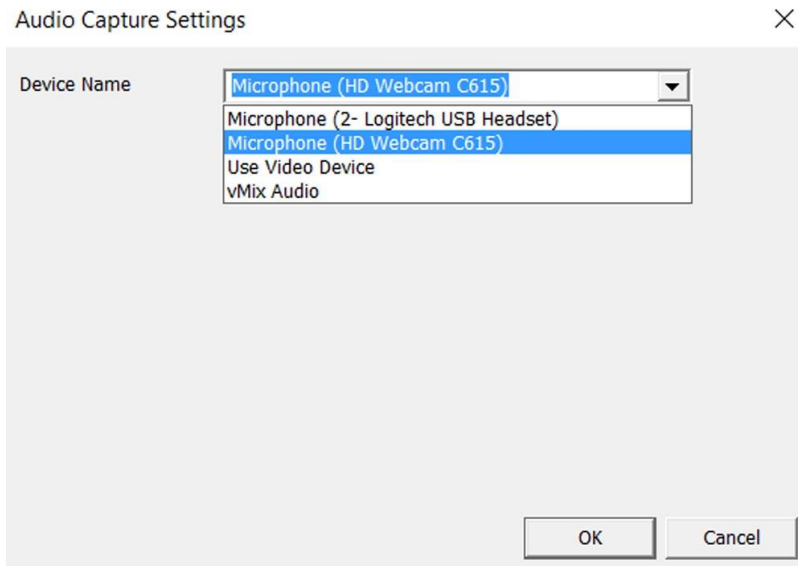


Figure 25 – The AUDIO Capture screen allows you to select the Audio device.

- Select the desired source of AUDIO from the DEVICE NAME field's pull-down menu.
- Click OK
- Go to the FILE TAB on the MAIN MENU and select SAVE
- Go back to the FILE TAB on the MAIN MENU and select RESTART
- You are going to power-OFF the computer at this point.
- Go to the FILE TAB on the MAIN MENU and select EXIT.
- Turn the Power-OFF to the DATV-Express hardware board.

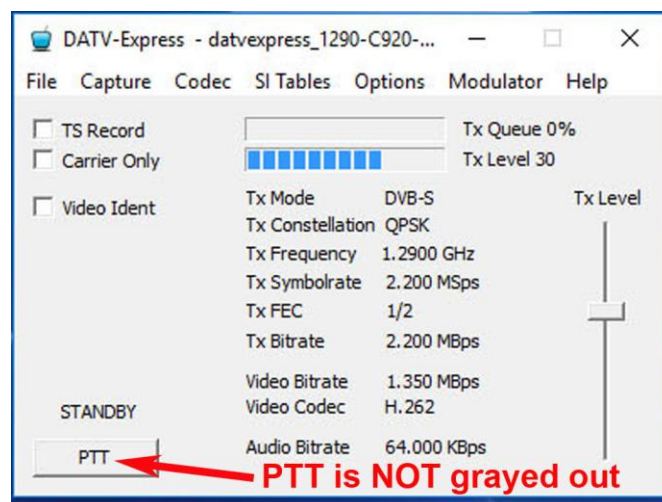


Figure 26 – The "NORMAL" MAIN screen confirms that Software is no longer running in DEMO Mode

- If in the MAIN screen you see still has the PTT button “grayed out”, then perhaps you did not yet successfully complete the steps in Sections 2.2.2 and 2.2.3? Go back and complete those steps again?

Test the PTT Button

If everything in Section 2.2.2 worked correctly, then the PTT button will be allowed to work properly, (and PTT will NO LONGER be “grayed out”).

- Now power up the hardware board. (no RF amplifiers are needed at this point.)
- Double-click on the desk-top icon. The main screen of Express_DVB_Transmitter software should open.
- First check to see if your VIDEO and AUDIO selections were correctly saved using the CAPTURE TAB
- If everything is correct...select the CANCEL button to escape back to the MAIN screen
- Finally press PTT. If everything is working the MAIN screen should display that you are in the TRANSMIT mode in RED.
- If the PTT button the MAIN screen turns RED...then this step is successful.
- If everything is OK...then close the Express_DVB_Transmitter software application, and finally turn OFF power on the computer.
- Proceed to Section 3.5.2

3.4.3 Third Test – now connect video-capture to the PC with PLUTO

(This section is still in construction!!)

3.5 Fourth Test – Transmitting DATV video

- Get ready to plan for the ham band you want to use, the exact frequency, DVB-S Symbol-Rate, and the FEC setting you want to use.

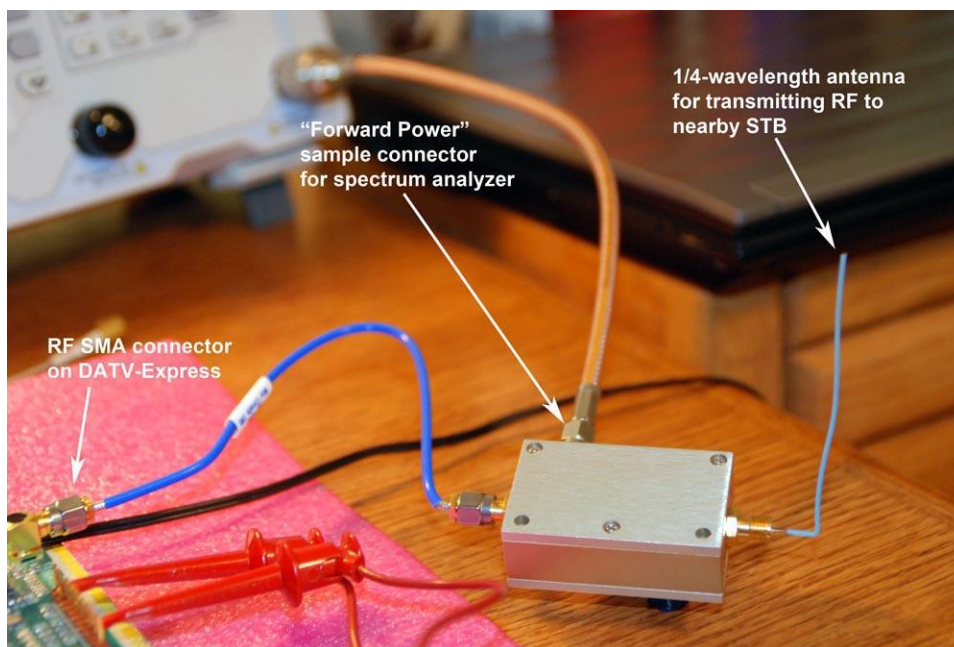


Figure 28 - a microwave “directional-coupler” is used to sample some RF energy for the Spectrum Analyzer (shown antenna is for 1.2 GHz band)

- Set-up (A) a nearby MiniTiouner, MiniTiouner-Express, or SetTopBox (STB) as a receiver for the protocol, and all the DVB settings that the receiver needs to know. Alternatively you could just look on a (B) spectrum analyzer or (C) using an RF “splitter” or microwave directional-coupler, sample the exciter RF output to the spectrum analyzer and connect the RF output to an antenna to be received by a nearby STB.
- I suggest you will have the best results if you can preprogram the receiver to the channel you plan to transmit on. “Blind scans” can work to allow the STB to find transmitted DATV signals, but many things can go wrong to cause the STB to not lock on the signal during scanning. The PAT/PMT table sequence is sometimes transmitted in DATV applications NOT often enough. If the STB does NOT pick up that PAT/PMT table information in it’s “scan dwell period”, then the STB will skip to the next channel in the search scan.
- Place a small bent piece of wire to act as a one-quarter-wave vertical antenna in the SMA connector of the DATV-Express exciter board for the planned transmission band/frequency.
- If you will be using a nearby-STB or receiver to display the video, then connect another small bent piece of wire to act as a one-quarter-wave vertical antenna for the receiver (see **Figure 16**).
- Power ON the STB receiver and/or the spectrum analyzer and set it to the desired pre-programmed channel.
- Power ON the DATV-Express board. Just LED 4 will be light at this point.
- Double-click on the Express-DVB-S_Transmitter software application icon on the desk top
- By the time that the GUI window opens up on the PC display, LED 5 and LED 3 should light up and LED 2 should blink if the PC has loaded the FPGA on the hardware board. [See section 6.13 for LED details.]
- You will need to set-up the Express-DVB-S_Transmitter software to the exact protocol that you are using. This manual will walk you through setting up for a DVB-S test.
- Go to the **MODULATOR** Tab in the Express-DVB-S_Transmitter program window. (See section 4.6)
 - Edit the TRANSMITTER FREQUENCY field in the MODULATOR Tab window to the exact center frequency you plan to transmit....for example 1292000000 in the 1.2 GHz/23 cm band
 - Edit the Symbol-Rate field in the same Tab to the value you desire...for example 4000000
 - Edit the FEC setting to the value you desire...for example 7/8
 - Edit the TRANSMITTER LEVEL field to the RF output level you want to try...for example try **20**
 - Click on the OK button to send these values to the software
 - Go to the FILE TAB and select SAVE.

- Go to the FILE TAB and select RESTART.
- Go to the **CODEC** Tab in the Express-DVB-S_Transmitter program window. (See section 4.3)
 - Select the Video encoding technology that your STB is set to receive...the simplest is H.262 (aka MPEG-2)?
- Click on the OK button to send these values to the software
- Go to the FILE TAB and select SAVE.
- Go to the FILE TAB and select RESTART.
- If you are trying to view video on an STB, then the configure video on the DATV-Express software. It is then necessary to go to the HW Tab and set up your video-capture device (see section 5.10).
- At this point, click on the large PTT button...and the STANDBY mode next to PTT, should change to TRANSMIT.
- Hopefully you will see an RF signal appear on the receiver or the spectrum analyzer. If you are using a DVB-S STB receiver or if you have a MiniTiouner analyzer, you will see video...if everything has been set up for your STB correctly.

4.0 - Express_DVB_Transmitter Software GUI Reference Guide

Section 4 walks the reader through the function of the controls of each of the TABS shown in the user interface window.

4.1 FILE Tab

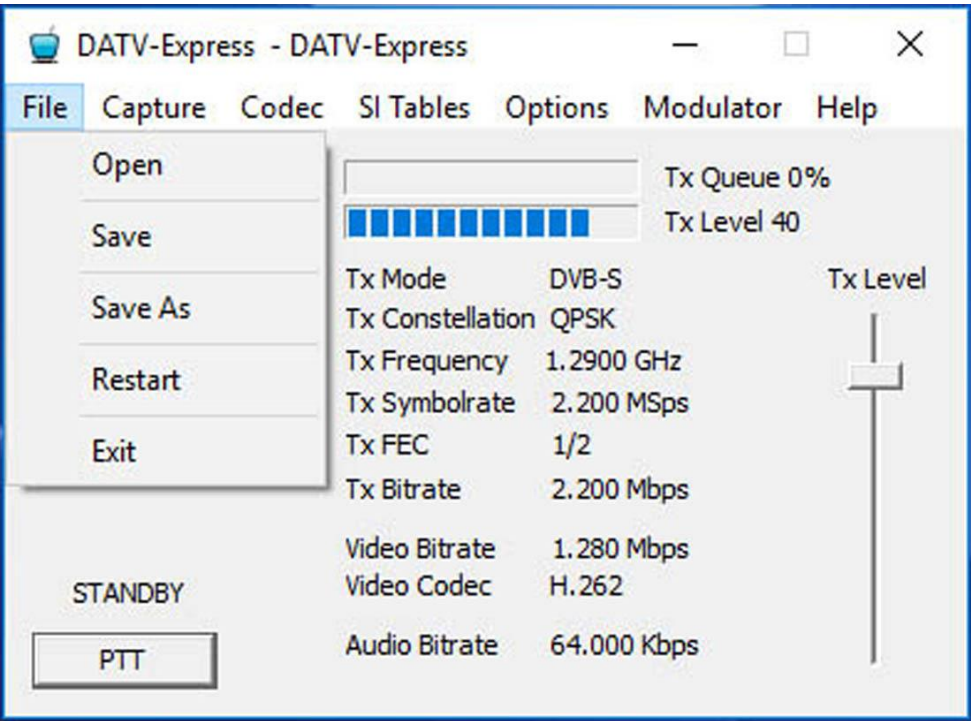


Figure 29 – Window for the FILE Tab displaying various configuration file actions that can be selected

4.1.1 Open

This selection allows the user to select from previously stored preset values for Frequency and CODECs, etc., in the files ending in **.CFG** . For example, a file named `datvexpress_23cm_H.262.CFG` could store the users normal settings for the 23 CM band for H.262 operations.

4.1.2 Save

This selection allows the user to **SAVE** any recently changed values back to the currently used **.CFG** file.

4.1.3 Save As

This selection allows the user to **SAVE** any recently changed values back to a new **.CFG** file for a different band. For example, a file named `datvexpress_70cm_H.262.CFG` could save settings to be used on the 70 CM band.

4.1.4 Restart

After saving the latest changes to configuration settings, use the **RESTART** selection to assure that the software is using these latest changes.

4.1.5 Exit

This selection will immediately shut down the Express software program..

4.2 CAPTURE Tab

The CAPTURE TAB allows you to select either Video-capture devices-and-settings or Audio-capture devices-and-settings.

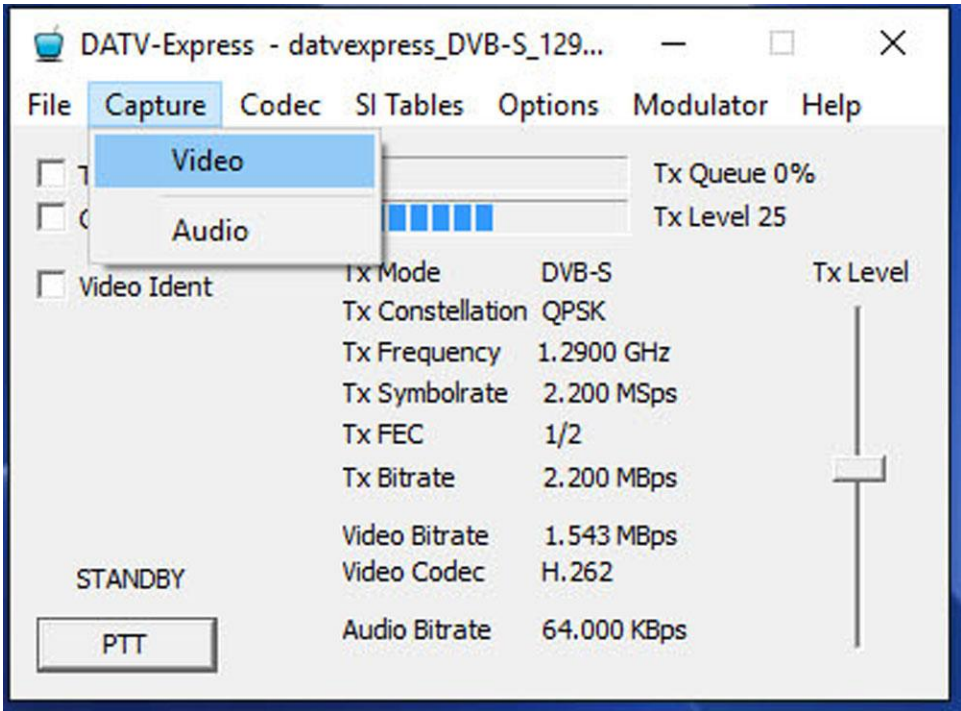


Figure 30 – Window for the CAPTURE Tab selecting Video

4.2.1 VIDEO Capture

The Video Capture Settings screen in **Figure 31** allows you to select the desired video-capture device and choose the Device Format for that device and to choose if you want to interlace the video display lines.

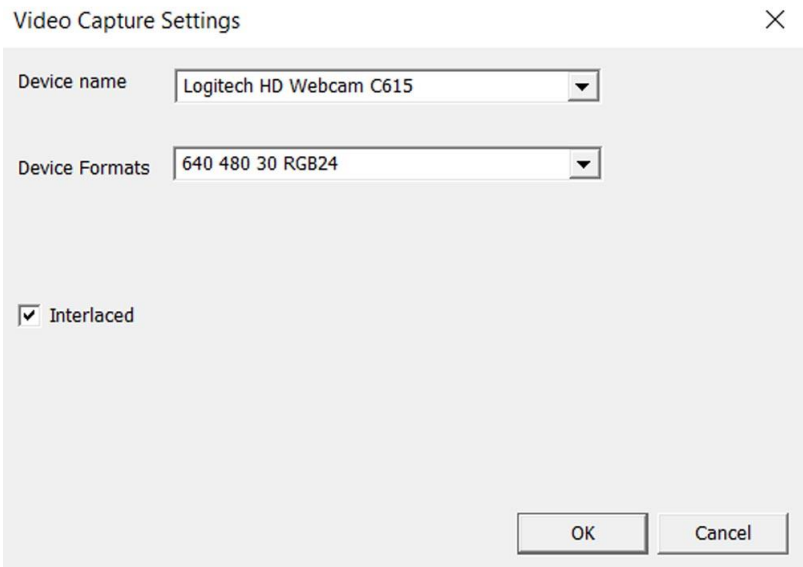


Figure 31 – Window for the VIDEO CAPTURE selection

4.2.2 VIDEO – Device Name field

The pull-down menu on the DEVICE NAME field shows the valid devices that are installed on your Windows computer (see **Figure 32**). Just select the one you plan to use. Then press OK

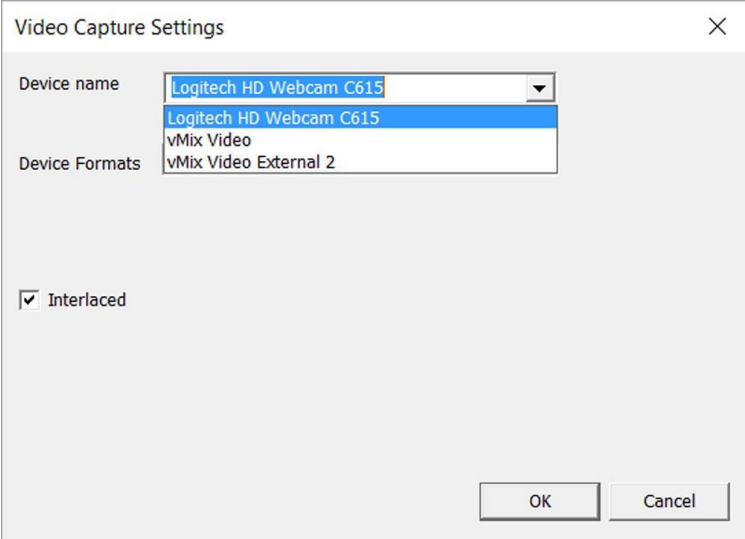


Figure 32 – Window for selecting the Video-source device

4.2.3 VIDEO – Device Formats field

The pull-down menu on the DEVICE FORMATS field shows many “possible” choices. When selecting a Video capture device, make sure you select a format. Only analogue formats can be used such as YUV, RGB, etc. Not all shown format values are allowed. The software includes all the “possible” formats for debugging. A good selection for a Logitech C920 camera is **640 480 30 RGB24**. Some frame rates will not be supported by your video capture device. Also, some older cameras can not output 30 frames-per-sec,

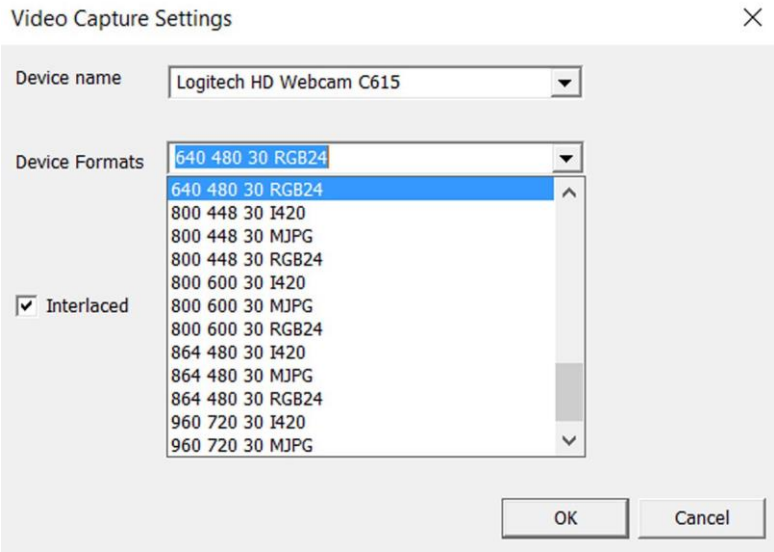


Figure 33 – Window for selecting the Video input format from camera

In Windows, it is a good idea to use Logitech install program when you install a camera. G4GUO has noticed that Windows default drivers and manufacturers own drivers support different formats. The Express application only supports a limited number of formats. Those formats it does not support are not displayed. That may explain why in some cases - vMix can see the camera...but Express software can not see that camera.

[NOTES on some video formats and their impact. MJPG is motion jpeg, a compressed format. So the application has to decompress the MJPG into YUV420, then compress it into MPEG2/MPEG4 so it is doing extra work. “Extra work” typically results in additional video delays (aka video latency). However, If MJPG is all that is available, then use it.

I420 is in fact YUV420 so no decompression is required. RGB24 is 24 bit Red Green Blue (8 bits per colour/color) which has to be converted into YUV420 where Y is the luminance information and UV the chrominance information. The 420 bits specify the Luminance to chrominance resolution ratio.]

4.2.4 VIDEO – Interlaced (checkbox)

The “interlaced” function was brought over straight from the FFmpeg library and is associated with the capabilities of the video-capture device. Always monitor your own transmissions and see what effect occurs with and without the Interlaced (check box) enabled.

4.2.5 VIDEO – OK button

Click on the OK button when all of the settings have been correctly configured.

4.2.6 VIDEO – CANCEL button

Click on the CANCEL button if you want to escape from any selections you may have changed,

4.2.7 AUDIO

The CAPTURE Tab allows you to select the source for AUDIO that you plan to use.

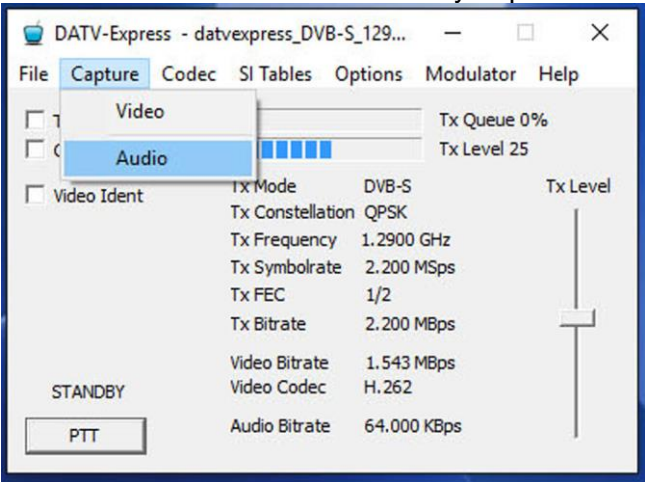


Figure 34 – Window for the CAPTURE Tab selecting Audio

4.2.8 AUDIO – Device Name field

The pull-down menu on the DEVICE NAME field shows the valid audio devices that are installed on your Windows computer (see Figure 35).

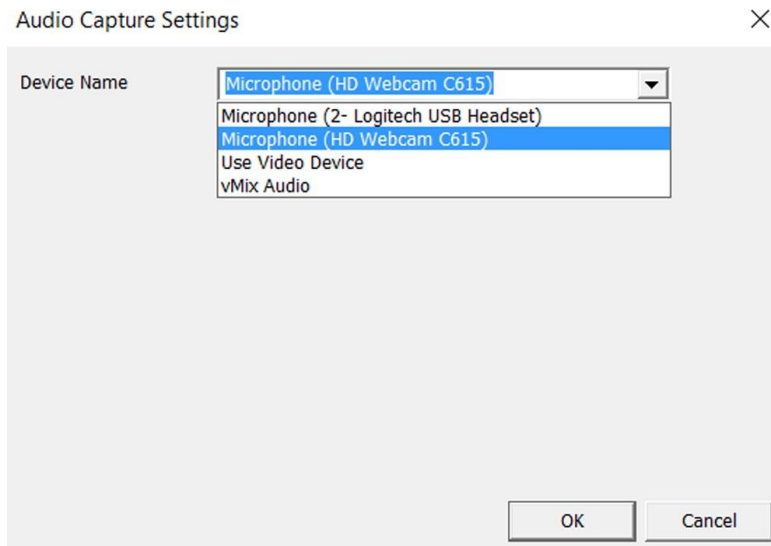


Figure 35 – Window for selecting the Audio-source device

4.2.9 AUDIO – OK button

Click on the OK button when all of the settings have been correctly configured.

4.2.10 AUDIO – CANCEL button

Click on the CANCEL button if you want to escape from any selections you may have changed,

4.3 CODEC Tab

A CODEC is a compression algorithm that can ENCODE or DECODE the video and audio data streams. The CODEC Tab will allow you to choose a VIDEO encoder and an AUDIO encoder.

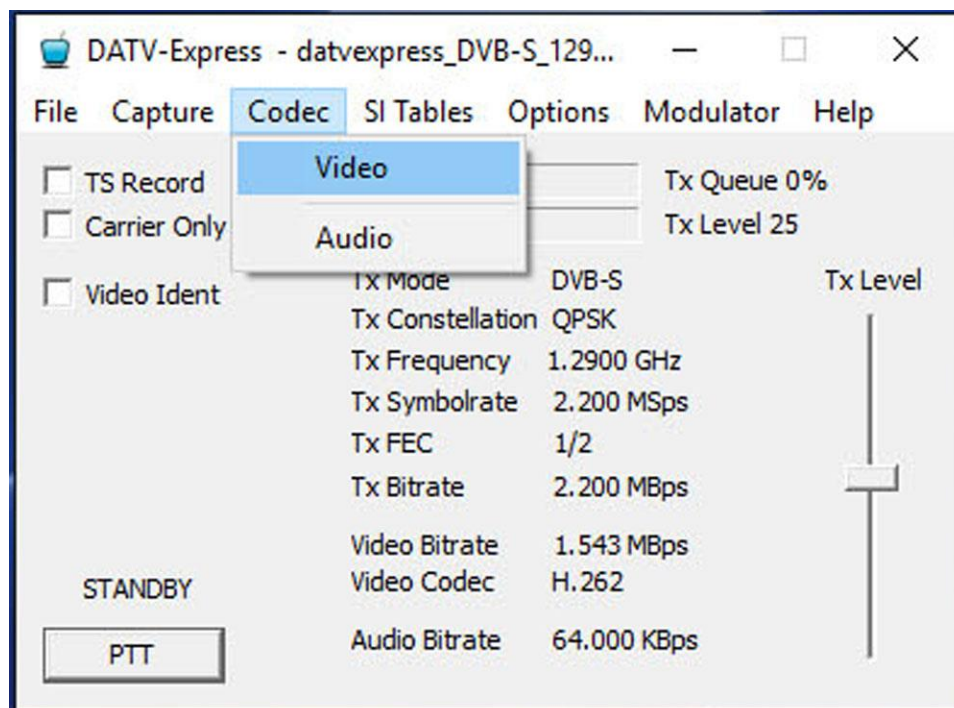


Figure 36 – Window for selecting VIDEO or Audio encoders

4.3.1 CODEC – VIDEO Settings

The Video Codec Settings windows are shown in **Figure 37** and in **Figure 38**. It allows choosing the CODEC technology, adjusting some compression parameters, controlling how much CPU is to be used when using H.264 and H.265, and tweaking the Video Bitrate if needed,

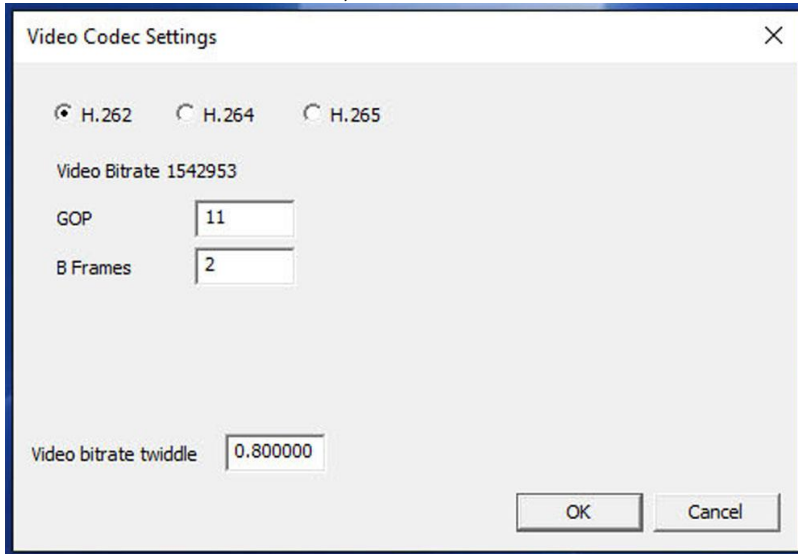
The image shows a 'Video Codec Settings' dialog box. At the top, there are three radio buttons: 'H.262' (selected), 'H.264', and 'H.265'. Below them, the 'Video Bitrate' is set to '1542953'. There are two input fields: 'GOP' with the value '11' and 'B Frames' with the value '2'. At the bottom left, 'Video bitrate twiddle' is set to '0.800000'. At the bottom right are 'OK' and 'Cancel' buttons.

Figure 37 – Window for selecting Video Codec Settings (for H.262)

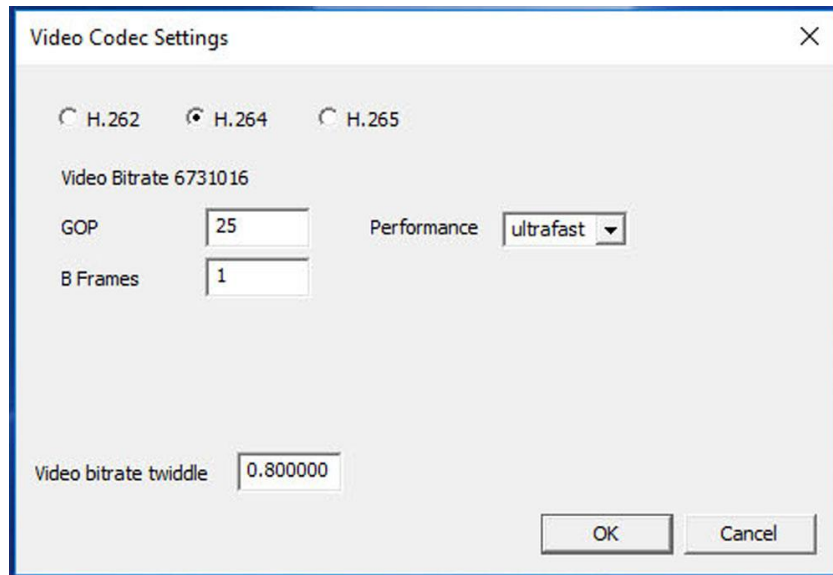
The image shows a 'Video Codec Settings' dialog box. At the top, there are three radio buttons: 'H.262', 'H.264' (selected), and 'H.265'. Below them, the 'Video Bitrate' is set to '6731016'. There are two input fields: 'GOP' with the value '25' and 'B Frames' with the value '1'. To the right of these is a 'Performance' dropdown menu set to 'ultrafast'. At the bottom left, 'Video bitrate twiddle' is set to '0.800000'. At the bottom right are 'OK' and 'Cancel' buttons.

Figure 38 – Window for selecting Video Codec Settings (for H.264 and H.265)

4.3.2 VIDEO CODEC – Radio Button Selection

The radio buttons along the top of the Figure 25 and Figure 26 windows allow you to select one of three different CODEC VIDEO encoding technologies for your transmission.

- **H.262** is the standard MPEG-2 video encoding that is used by commercial DVB-S DTV transmissions. It works well but does not compress as efficiently as H.264 or H.265. H.262 is more compatible on older SetTopBox receivers (such as FTA before MPEG-4 was introduced).
- **H.264** is the newer MPEG-4 video compression that is used by commercial DVB-S2 and DVB-T2 HDTV transmissions. H.264 encoding provides higher bit stream compression efficiency than H.262, but may have a little longer latency (video delay) than H.262. The good news is that H.264 CODEC can be used as the “payload” video stream inside the DVB-S protocol...as long as the receiver is capable of receiving both

DVB-S and H.264...such as a DVB-S2 STB. Another advantage of the H.264 CODEC is that it works better (than H.262) in low Symbol-Rate (less than 1.0 MSymb/sec) environments for RB-DATV (Reduced Bandwidth – DATV). The smoother (less broken) video seen on the receiver is due to H.264 design using a more suitable macro block size.

One caution is that if you insist on using HDTV quality video as an input, then the video bitrate will be very large and may require a 6 MHz Bandwidth on the spectrum to receive that quality. Hams can tweak the video capture format and SR and frame-rate (FPS) to achieve acceptable BW and video quality as the RB-DATV hams do on 2 Meters where reduced bandwidth is required. RB-DATV is also very useful to reduce DATV bandwidth spectrum requirements on other ham bands like 70 CM and even 10 GHz.

- **H.265** is a more recent video compression encoder that is also known as High Efficiency Video Coding (HEVC) can encode 4Kp60/10-bit video in real-time (with hardware encoder). H.265 can compress 480-line video with 50% more reduction and 1080-line video is reduced by 60% (both compared to H.264 CODEC). H.265 is very computer intensive - typically results in latencies nearly 10 seconds on slow CPUs.

4.3.3 VIDEO Bitrate – display

The Video Bitrate displayed below the radio buttons is the calculated bitrate from the software that is left over for the video data stream after all the other overheads are subtracted. The software calculated value can then be adjusted by the twiddle factor in Section 4.3.6.

4.3.4 GOP (Group Of Pictures)

The GOP (Group Of Pictures setting) is one of the compression parameters that affects the compression efficiency and also affects the video delay (latency). GOP value is equal to 16 (length between two I frames) in this example **IBBBPBBBBPBBBBPBBBBIBBBPB...** GOP value is equal to 7 in Figure26. The GOP length is also known as the N parameter. GOP is an advanced topic, outside the scope of this guide but is provided to those advanced hams who need to adjust it. I suggest you use the default value of 10. If you insist on tweaking this parameter, or want to learn more...try Googling for it as “GOP (Group Of Pictures) “. One recommended resource for MPEG-2 video encoding concepts is an article called TechTalk85 , available at www.W6ZE.org/DATV/ under the “DATV Articles” link. Google has wealth of detailed info including:

<https://ffmpeg.org/doxygen/2.8/structAVCodecContext.html#a3e5334a611a3e2a6a653805bb9e2d4d4>

4.3.5 B-Frames Count

A B-Frame is a type of compressed video frame that contains only information to describe the changes from the I-Frame and the P-Frame. The number of B-frames between I and P frames or length between two consecutive P Frames is also known as the M parameter. The B setting (B-Frames count) is another one of the compression parameters that affects the compression efficiency and also affects the video delay (latency). The number of B-frames used to obtain determines how much compression will be obtained by comparing differences to I-frames and P-frames. This parameter sets the maximum number of B-frames between non-B-frames. Note: The video output will be delayed by max_b_frames+1 relative to the input. **Figure 39** shows the concept.

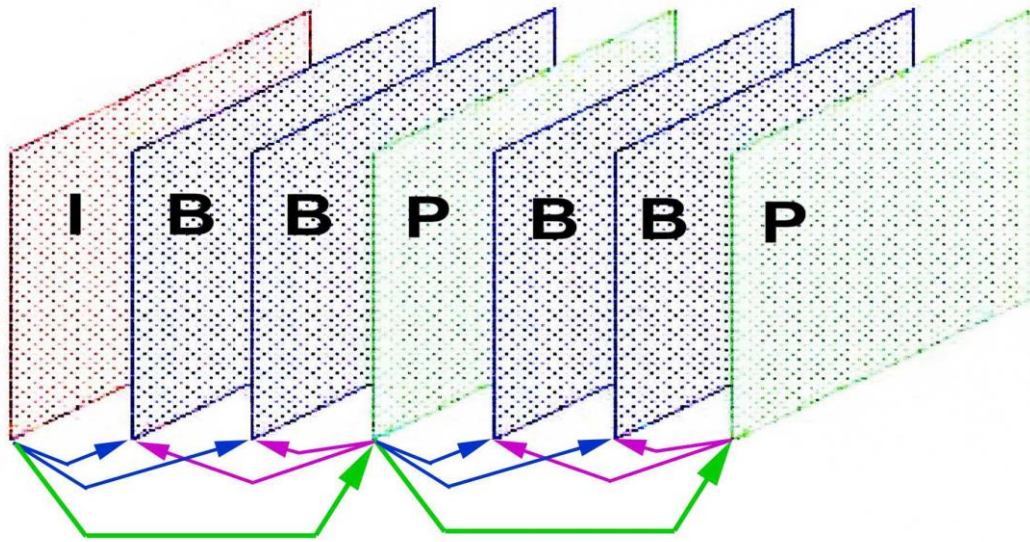


Figure 39 - A diagram of a Sequence of Compressed Frames (using the GOP mode called IBBP) that is: the B-Frames count is 2 (with GOP set to 7) (courtesy of TechTalk85)

- **I-Frame** This type of video frame contains ALL the necessary information to display a whole picture frame (low JPEG-like compression). That is: I-frames are coded without reference to other pictures (frames).
- **B-Frame** This type of compressed video frame contains only information to describe the changes from the I-Frame and the P-Frame.
- **P-Frame** This frame is a resulting Predicted Picture that can use the previous I-frame or P-frame for motion compensation and may be used as a reference for further prediction.

B-Frames settings is an advanced topic, outside the scope of this manual....but is provided to those advanced hams who need to adjust it. I currently suggest you use the value of 2 (with GOP set to 10) for low latency to start with. Using GOP=10 and B-Frames=2 will result in the frame pattern **IBBPBBPBBPIBBP...** Also, experiment trying to receive different settings from your transmitter.

Another beta tester using an i5 laptop with USB composite capture card and Vmix - uses

H.262	between 1.5 to 4+ MSymbols/sec – GOP (N) = 15 and B-frames (M) = 5
H.264	below 1.5 MSymbols/sec – GOP (N) = 20 and B-frames (M) = 3

4.3.6 Performance

The **PERFORMANCE** setting (the field pull-down menu is shown in Figure 26 and 28) determines how much CPU performance will be allocated to perform the H.264 and H.265 video encoding. NOTE that this setting is only active when using the H.264 CODEC. This field allows you to tell the Codec how much effort to make when analyzing the video frame. The faster the option the less CPU required. (for example: **Ultrafast** means “do **NOT** use much of CPU resources in video encoding”.) These commands are sent directly to the Codecs themselves. If you set the CPU resource allocation too high (for example: perhaps by using the setting called SLOW) some software running on this PC may crash, because you have maxed-out of available CPU cycles (all were consumed at some point....CRASH). One beta tester reported that his fairly fast i5 machine seems happy with the “**very fast**” setting, but a slower machines should apparently be set to “**ultrafast**”.

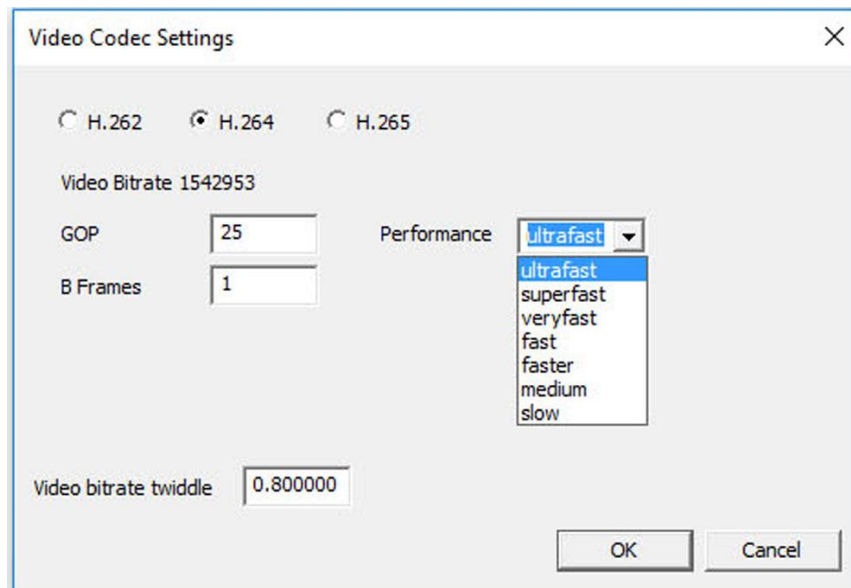


Figure 40 – Pull-Down Menu for selecting Codec Performance for H.264

4.3.7 VIDEO Bitrate twiddle – adjustable field

At both high and low symbol rates the program does not correctly estimate the available bit rate well (displayed as **VIDEO Bitrate** value in Section 4.3.3 and also on the Main screen, It may be necessary to adjust the VBITRATE twiddle factor. It simply multiplies it's estimate by the twiddle factor in this field.

The **VIDEO BITRATE** twiddle factor adjustment has significant effect - this allows fine tuning of the encoder buffer and is dependent on video bit rate and content. One beta tester has found that this should be adjusted on each symbol rate to give an indication of around 1 - 5% on the Tx queue bar graph on the Main Tab (see section 4.8.1) - No indication on the Tx Queue graph means the buffer is under running and the TS will be stuffed with null packets. Higher than 5% on the graph means the buffer seems to eventually fill up with waiting packets and will crash the receiver. As you make changes, you can see the video bit rate display change.

4.3.8 Video Codec – OK button

Click on the OK button when all of the settings have been correctly configured.

4.3.9 Video Codec – CANCEL button

Click on the CANCEL button if you want escape from any selections you may have changed,

4.3.10 CODEC – AUDIO Settings

The Audio Codec Settings page allows you to select the CODEC and the audio bitrate to be used.

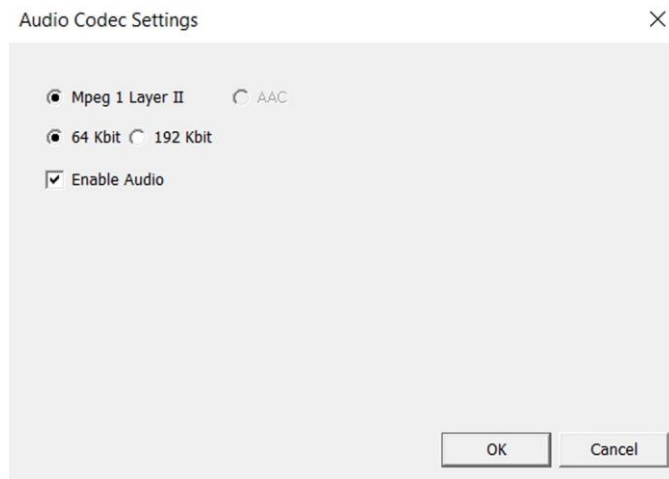


Figure 41 – Window for selecting Audio Codec Settings

4.3.11 AUDIO CODEC – Radio Button Selection

The radio buttons along the top currently only allow choosing the Mpeg-1 Layer II audio Codec. The AAC (aka Dolby audio Codec) is reserved to be implemented in the future.

4.3.12 AUDIO Bitrate – Radio Button Selection

The second row of radio buttons allows choosing between data bitrates for audio:

- **64 Kbit** – a low bitrate stream for audio capture that has good quality, but is non-standard in the DVB-S protocol. It is very useful to trim down the bitrate budget for audio in low Symbol Rate applications, such as 2 Meter RB-DATV where bandwidth is critical. But, some receivers are not expecting 64 Kbps audio and produce audio distortion.
- **192 Kbit** - this bitrate selection for audio is the default setting used by the commercial television world DVB-S protocol with MPEG-2.

4.3.13 Enable AUDIO – checkbox

This checkbox will remove audio from the Transport Stream and transmission if not selected (“checked”). Some RB-DATV hams prefer to use all possible bandwidth for the video stream in low Symbol-Rate transmissions, by relying on separate FM transmissions for the audio.

4.3.14 Audio Codec – OK button

Click on the OK button when all of the settings have been correctly configured.

4.3.15 Audio Codec – CANCEL button

Click on the CANCEL button if you want escape from any selections you may have changed,

4.4 SI TABLES Tab

Packet ID's (PIDs) play an important role in the DATV Transport Stream (TS). Each table or elementary stream in a transport stream is identified by a 13-bit packet ID (PID). A Transport Stream specifies a container format encapsulating Packetized Elementary streams, with error correction and stream synchronization features for maintaining transmission integrity when the signal is degraded during DATV terrestrial transmissions. Program streams are created by combining one or more Packetized Elementary Streams (PES), which have a common time base, into a single stream. A Transport Stream may carry multiple programs. Service Information describes the delivery system, content and scheduling/timing of broadcast data streams etc. The Service Information Table is a container for organizing the many DVB-S Packet ID's and is then inserted into the Transport Stream.

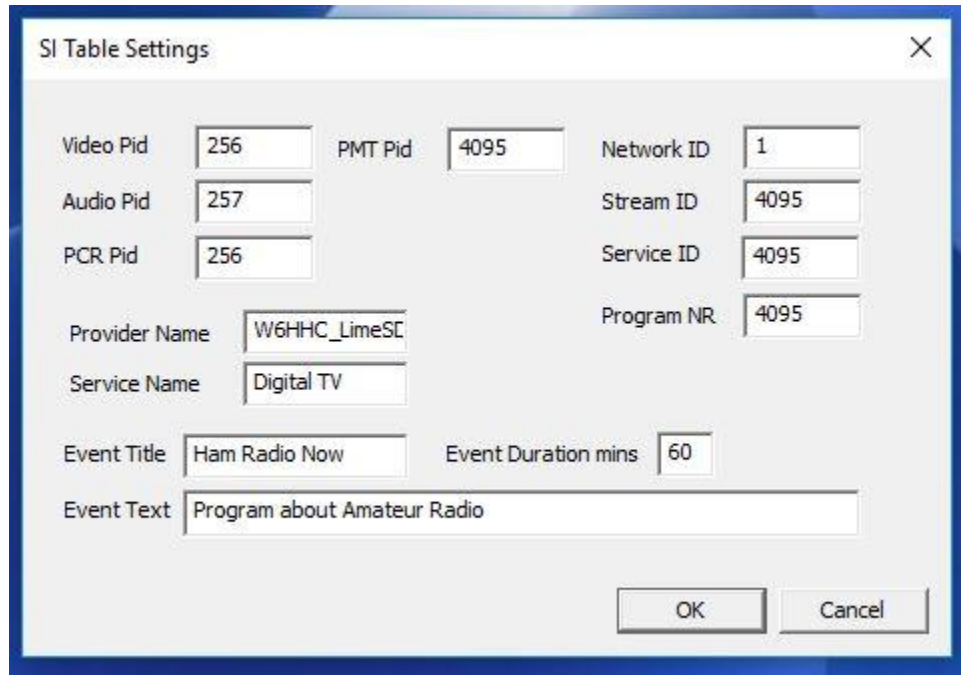
A screenshot of a software window titled "SI Table Settings" with a close button (X) in the top right corner. The window contains several input fields for configuring service information. The fields are arranged in two columns. The left column includes: Video Pid (256), Audio Pid (257), PCR Pid (256), Provider Name (W6HHC_LimeSC), Service Name (Digital TV), Event Title (Ham Radio Now), and Event Text (Program about Amateur Radio). The right column includes: PMT Pid (4095), Network ID (1), Stream ID (4095), Service ID (4095), Program NR (4095), and Event Duration mins (60). At the bottom right, there are "OK" and "Cancel" buttons.

Figure 42 – Window for selecting settings for the SI TABLES

4.4.1 Video PID

The VIDEO PID is the Packet ID associated with the video Elementary Stream (ES). An ES contains only one kind of data, e.g. audio, video, or closed caption. An Elementary Stream is often referred to as "elementary", "data", "audio", or "video" bitstreams or streams. The default value is 256 (decimal). To edit the value, place the cursor inside the VIDEO PID field, edit the desired value, and press the OK button.

4.4.2 Audio PID

The AUDIO PID is the Packet ID associated with the audio Elementary Stream (ES). An ES contains only one kind of data, e.g. audio, video or closed/data caption. An Elementary Stream is often referred to as "elementary", "data", "audio", or "video" bitstreams or streams. The default value is 257 (decimal). To edit the value, place the cursor inside the AUDIO PID field, edit the desired value, and press the OK button.

4.4.3 PCR PID

The PCR PID is the Packet ID associated with the Program Clock Reference (PCR) field and is automatically set to the same value as the Video PID.

4.4.4 PMT PID

The PMT PID is the Packet ID associated with the Program Map Table (PMT). The PMT table contains PID numbers of elementary streams associated with the program and it has information about the type of these elementary streams (video, audio, etc.). The default value is 4095 (decimal). To edit the value, place the cursor inside the PMT PID field, edit the desired value, and press the OK button to save the new value.

4.4.5 NETWORK ID

A DVB network is defined as a “collection of MPEG 2 Transport Stream (TS) multiplexes transmitted on a single delivery system”, e.g. a specific Network_ID is associated with each major transmission point. The NETWORK_ID field is the part of the DVB-SI (Service Information) table. The default value is 1.

4.4.6 STREAM ID

The STREAM_ID (Transport_stream_ID) field is used inside the NIT packet and the EIT packet. This field appears to be the same as the PROGRAM NUMBER field. These two field values (STREAM ID and PROGRAM NUMBER) must be both set to have the same value. The default value is 4095 (decimal).

4.4.7 SERVICE ID

The Service Info Table ID field contains the Packet ID for the Service Info Table??? The default value is 4095 (decimal).

4.4.8 PROGRAM Field

The PROGRAM NUMBER field and the STREAM ID...although having different names...appear to refer to the same thing. So these two field values must be both set to have the same value. Default value is 4095 (decimal).

4.4.9 Typical PID Values

There currently is no DATV standard for hams using PID values, yet.

4.4.9.1 DATV-Express Recommended PIDs

- PMT PID 4095 (decimal).
- VIDEO PID 256
- AUDIO PID 257
- PCR PID 256 (Express_DVB-S/-S2_Transmitter automatically sets this PID to equal same as Vpid)
- NETWORK_ID 1
- STREAM_ID 4095
- PROGRAM NR 4095

4.4.9.2 BATC Forum DigiLite Suggested PIDs

- PMT PID 4095
- VIDEO PID 256
- AUDIO PID 257
- PCR PID 256

4.4.9.3 BATC DTX1 Manual Default PIDs

- PMT PID 4095
- VIDEO PID 256
- AUDIO PID 257

4.4.9.4 BATC Portsdown Project Manual Default PIDs

- PCR PID 256
- VIDEO PID 256
- AUDIO PID 257

4.4.10 PROVIDER NAME

The Service Provider Name field is the name of the ham station or organization providing the content is entered in this field. Typically enter your call letters and the call letters will be overlaid on the video transmission if the Video IDENT field is checked on the MAIN SCREEN (see Section 4.8).

4.4.11 SERVICE NAME

Enter the name you want to apply to the SERVICE NAME that is displayed by the STB into this field.

4.4.12 EVENT TITLE

This field allows you to enter a title name of an event that will appear in the displayed EPG on the STB when your transmission is tuned in. For example, you could enter TITLES such as:

- CLUB NET
- W6HHC Test Pattern
- Field Day Video
- Etc.

4.4.13 EVENT DURATION Minutes

The EVENT DURATION field sets the times shown for an EVENT in the GUIDE (EPG) listing shown by the STB receiver. The starting time for the event will be when you started the DATV-Express software. The ending time shown for the EVENT listing will be (starting time + DURATION). The DURATION setting has no effect on the actual transmissions of the RF...just the information displayed in EPG by the STB.

4.4.14 EVENT TEXT

This field allows you to enter more detailed descriptive text in the displayed EPG on the STB when your transmission is tuned in. For example the text could say:

“2018 OCARC club FD was held in the city of Buena Park”

4.4.15 SI Tables – OK button

Click on the OK button when all of the settings have been correctly configured.

4.4.16 SI Tables – CANCEL button

Click on the CANCEL button if you want escape from any selections you may have changed,

4.5 OPTIONS Tab

The OPTIONS Tab allows three areas of selection:

- OUTPUT FORMAT
- IQ DC OFFSET CALIBRATION
- NOISE TOOL

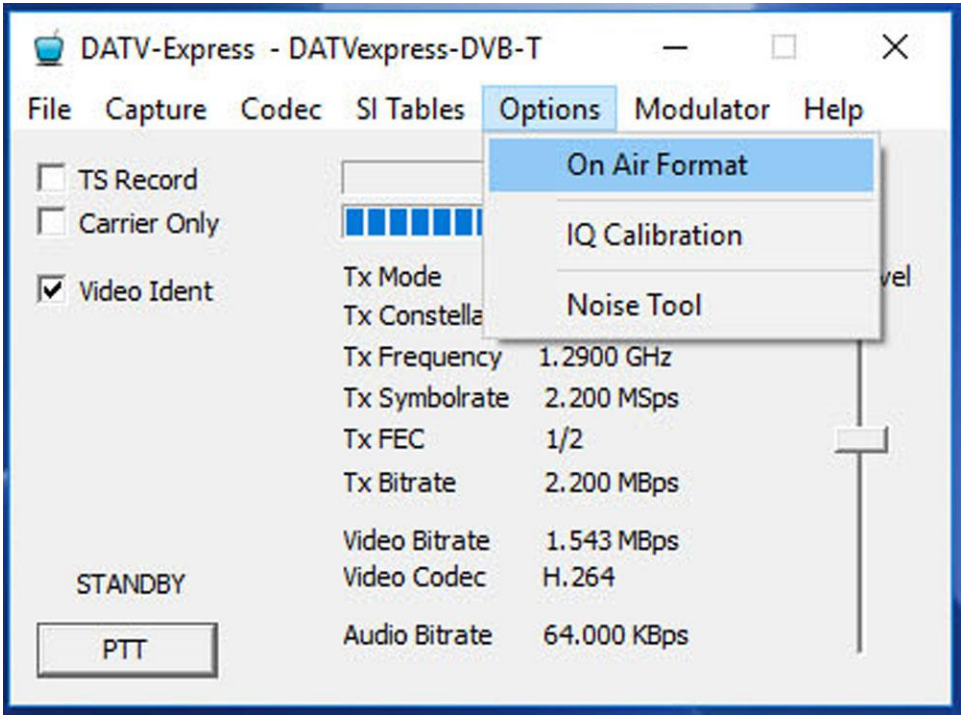


Figure 43 – Window for OPTIONS Tab menu

4.5.1 On Air Format

This OUTOUT FORMAT screen will appear and allow the user to select the format of the transmitted video.

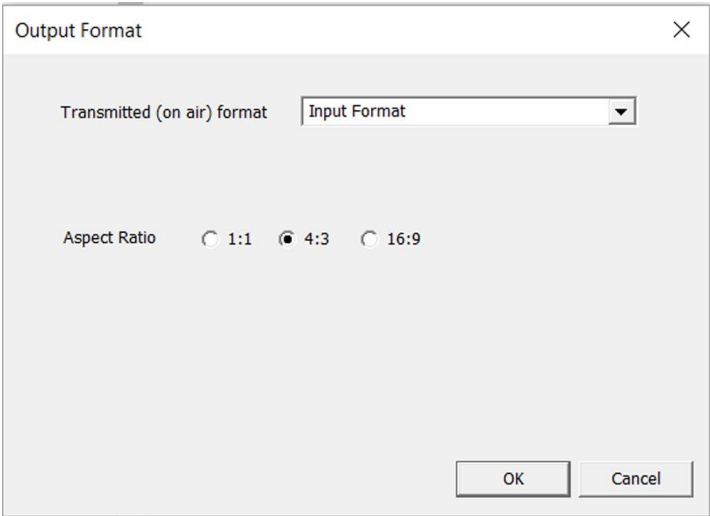


Figure 44 – Window for OPTIONS – On Air Output Format Tab

4.5.1.1 TRANSMITTED (on air) Format

The pull-down menu for the TRANSMITTED (on air) FORMAT field allows you to select either using the same format as you selected for the video-capture device input (See Section 4.2.3) or to select one of the formats shown in the pull-down list. NOTE: The Transmitted video frame rate MUST be <= to the video captured frame rate.

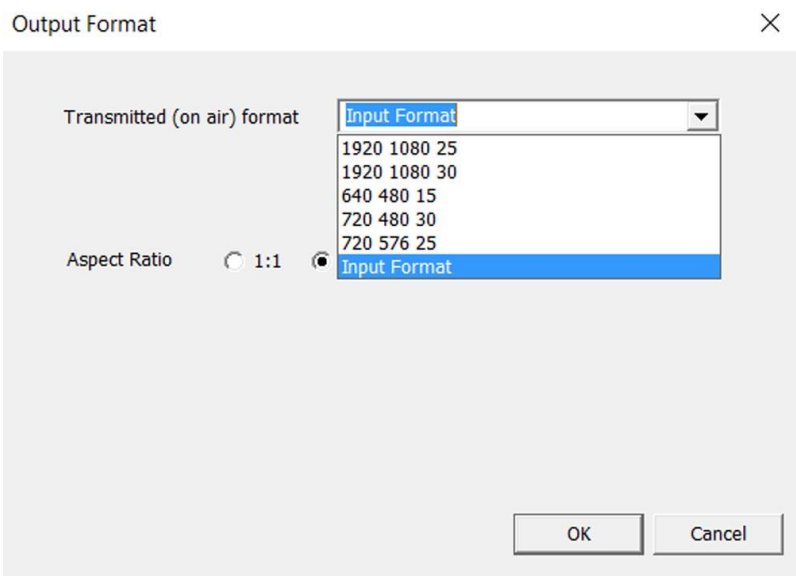


Figure 45 – Window for selecting Transmitted Format

4.5.1.2 ASPECT RATIO – Radio Buttons

The Aspect Ratio radio-buttons allow you to choose a transmitted video aspect ratio of 1:1 , 4:3 , or 16:9 as shown in **Figure 45**. As a note...16:9 aspect ratio is not restricted to MPEG-4/H.264 (as I had long suspected) and can be used with H.262 encoding.

4.5.1.3 Output Format – OK button

Click on the OK button when all of the settings have been correctly configured.

4.5.1.4 Output Format – CANCEL button

Click on the CANCEL button if you want escape from any selections you may have changed,

4.5.2 IQ DC OFFSET Calibration

Screen for adjusting DC-offset of the IQ signals.

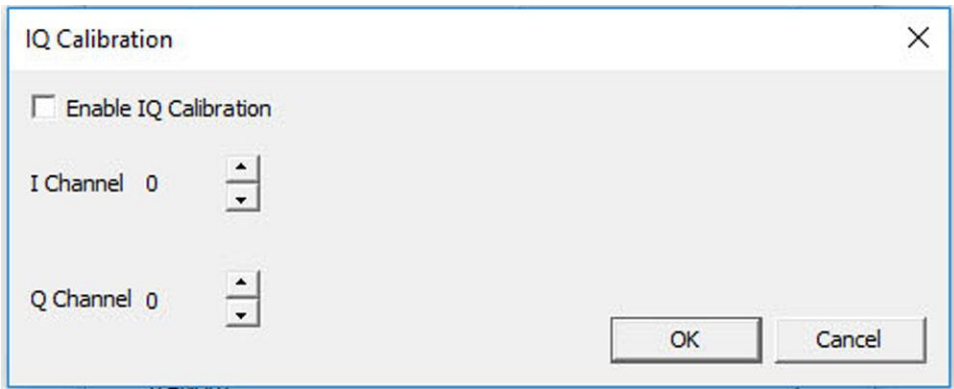


Figure 46 - Screen for adjusting DC Offset Calibration of the IQ signals

If a particular hardware board has a poor balance between the DC bias of the I signal and the Q signal, this condition can result in a “carrier-like” signal appearing at the middle of a “haystack” transmission waveform on a spectrum analyzer.

While the software has put Hardware board into the standby mode (no need to transmit a protocol during this test and adjustment), just tune a spectrum analyzer or FM receiver to the selected frequency and check the Enable IQ Calibrator box. You should be able to see a carrier (perhaps small) or see a S-Meter reading appear. Adjust the I Channel value and the Q Channel value until the carrier becomes smaller.

4.5.3 NOISE Tool

A DVB-S2 noise tool has been added. When the ENABLE NOISE box is checked, this tool will inject a set amount of gaussian noise into your transmitted DVB-S2 (only) signal. This tool provides a good way to check the robustness of a signal being remotely received (at the other end), without changing the power level at the transmitter end.

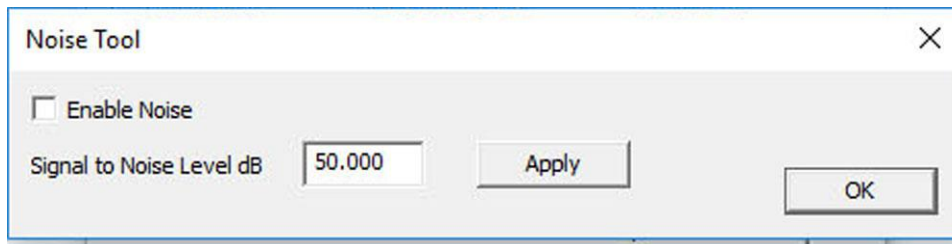


Figure 47 – The NOISE Tool feature allows injecting noise into your DVB-2 Transmitted Signal

4.6 MODULATOR Tab

The MODULATOR Tab allows you

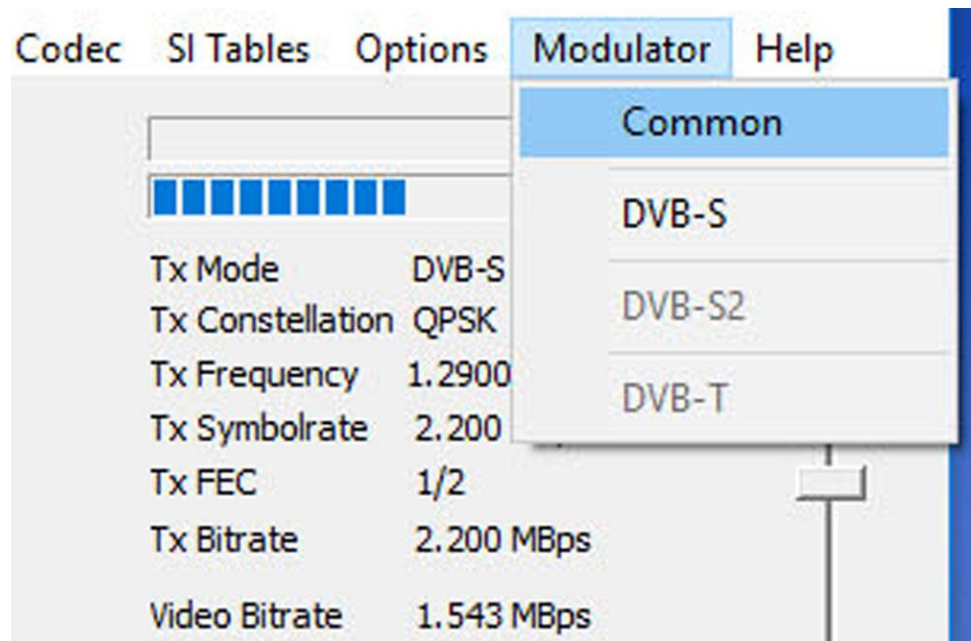


Figure 48 – MODULATOR Tab allows selecting COMMON or specific settings for three Protocols

4.6.1 MODULATOR – Common Settings Tab

The MODULATOR Tab allows you to set the frequency, Symbol-Rate, Forward-Error-Correction value, the RF output power level on the DATV-Express hardware board, and also activate a set of ports to work with different RF amplifiers.

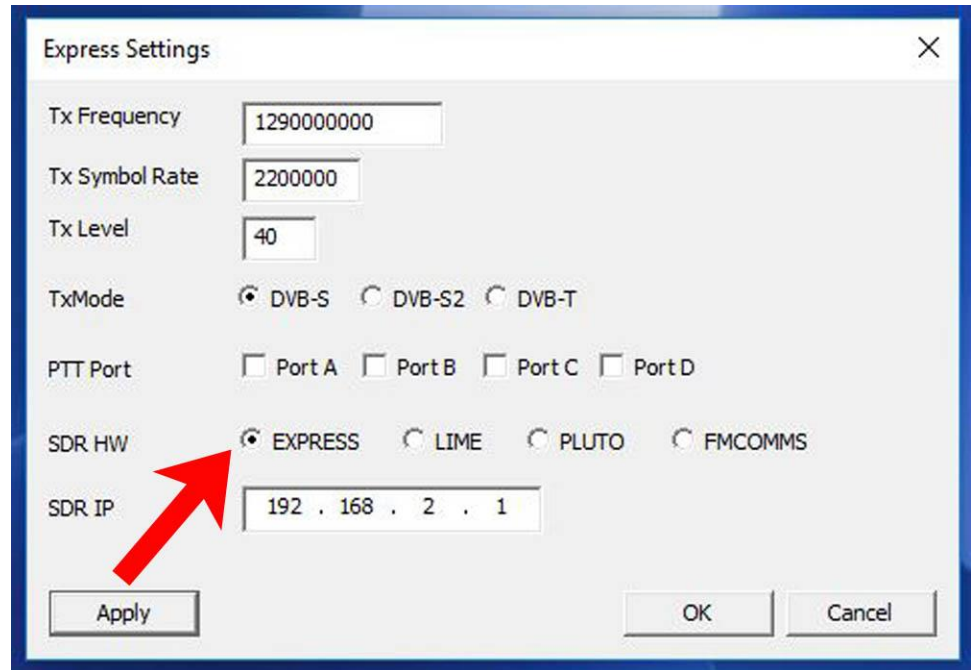


Figure 49 – Settings for the MODULATOR - COMMON Tab for DATV-Express board

4.6.1.1 TRANSMITTER FREQUENCY

This Tx Frequency field allows you to type in the frequency to transmit in Hertz. The setting shown in **Figure 49** is 1.290 GHz (aka 1290 KHz). After you have typed in the desired frequency, click on the OK button.

4.6.1.2 TRANSMIT Symbol-Rate

This Transmit Symbol-Rate field allows you to select the Symbol-Rate you need for transmitting the DVB-S protocol. You can edit that SR field to the exact Symbol Rate that you plan to use on your STB or Receiver or DATV-Repeater. Express_DVB_Transmitter software will allow you to select between 125 KSymbols/sec and 8 MSymbols/sec. Be aware that many commercial receivers do not work below a SR of 1.5 MSymbols/sec. MiniTiouner receiver/analyzers are recommended for Reduced-Bandwidth-DATV (RB-DATV) operations and testing.

4.6.1.3 TRANSMITTER RF LEVEL

This Tx RF Output Level field lets the software program set values from 0-through-47 to be entered for the RF output level on the DATV-Express hardware board. Each value represents a 1 dB difference in the RF output strength. The maximum output of the board's RF buffer amplifier design is somewhere between +10 dBm and +12 dBm. Some boards show a little distortion (spectral regrowth, aka "shoulders") occurring at output level values set higher than 35-to-40. For those who are curious, the reason for 0-to-47 steps is...that is how many levels of RF attenuation Analog Devices designed into the RF modulator chip being used.

4.6.1.4 TRANSMITTER Protocol (TxMode) – Radio Buttons

This TxMode field radio-buttons allows the user to select any of the standard DVB Protocols provided by the DATV-Express software: DVB-S, DVB-S2, or DVB-T. Note - that you can only select the individual protocol settings in Sections 4.6.2 (DVB-S), Section 4.6.3 (DVB-S2), or Section 4.6.4 (DVB-T) if you have clicked the corresponding Protocol in **Figure 49** (COMMON settings) and then pressed the **OK** button.

4.6.1.5 PTT PORTS

NOTE; These PORT checkboxes are currently only active with the DATV-Express hardware board. The PTT Port checkboxes enable the Port output signals selection in the MODULATOR menu to select/drive amplifiers or Relays. There tends to be some confusion in using the name "**PTT**" in PTT PORTS. When a port checkbox is enabled...the enabled port signal will be continuously asserted on the corresponding J6 pin for **BOTH** Tx and Rx. That is: the PORT pins are active high on both transmit and receive. Basically, it is better to think of these PTT PORTS as **FREQ** PORTS to change over the correct antennas and amplifiers when you change bands.

Port A = J6 pin 5, Port B = J6 pin 6, Port C = J6 pin 7, Port D = J6 pin 10

Pin 1 is the pin closest to the J6 label and is a ground pin (see J6 pin-out in Section 6.0).

IMPORTANT - These output pins are connected directly to the FPGA with no protection - you have been warned! The output must not exceed 20 mA and is at 3v3 logic levels. Optical isolation is recommended. (See the "DATV-Express Specifications" pages inside Section 6.0 for further information). J6 has no connector installed. If these optional connections are made, the user must provide a connector or solder directly to the connector pad holes.

There is a Chinese high-impedance opto-coupled relay-board available on eBay (actually loads of them). It's a bit unclear who makes them. G8GTZ suggests he uses an opto-isolator / relay-board similar to ebay part number 291566724157 directly on to the DATV-Express I/O pins. G4GUO suggests that if you want to use the same 12v supply to drive the relay board as you use to drive DATV-Express hardware you might consider one of the 12v opto-isolator boards. As far as wiring them up is concerned, that all depends on what the end-user wants to do with them. I think it is possible to get the schematic from one of the eBay sellers.

4.6.1.7 SDR HARDWARE – Radio Buttons

There are four boards that can be selected;

EXPRESS should be selected if the DATV-Express hardware board is going to be used.

LIME should be selected if either the LimeSDR-USB hardware board (larger board) or the LimeSDR-mini is going to be used.

PLUTO should be selected if the PLUTO-ADLM hardware board is going to be used.

FMCOMMS should be selected if you are going to use FMCOMMS hardware board. NOTE – the FMCOMMS is a fairly expensive specialty hardware board from Analog Devices that is not covered by this manual.

4.6.1.8 SDR IP – IP Address Field

That SDR IP field is for using the Analog Devices FMCOMMS4 board which needs to be connected via Ethernet.

4.6.1.9 SETTINGS – OK button

Click on the OK button when all of the settings have been correctly configured.

4.6.2 MODULATOR – DVB-S Tab

When selecting the DVB-S menu item from the MODULATOR Tab, the following FEC (Forward Error Correction) configuration setting are available. Note - the DVB-S protocol only allows QPSK digital modulation technology to be used.

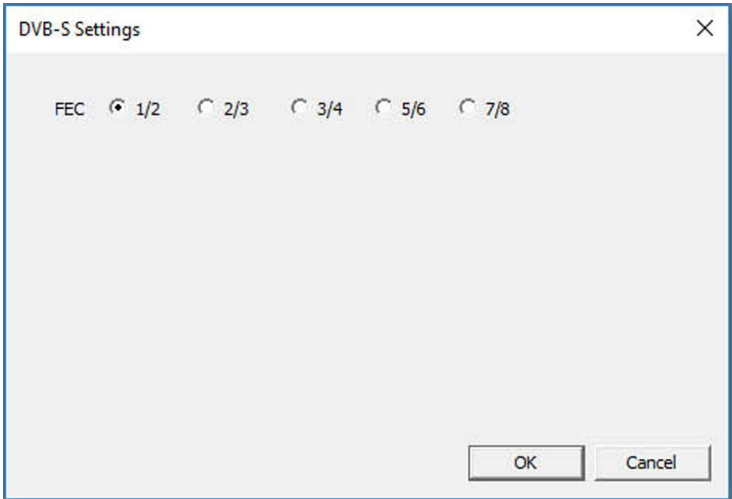


Figure 50 – Settings for the MODULATOR – DVB-S Tab

4.6.3 MODULATOR – DVB-S2 Tab

When selecting the DVB-S2 menu item from the MODULATOR Tab, the following configuration setting are available: Constellation (aka modulation technology), Roll-Off, FEC, and Pilot Symbols. One deviation from the commercial implementations for the Express_DVB_Transmitter beta DVB-S2 code is that only a Roll-Off factor of 0.35 is coded. The FPGA on the hardware board is not large enough to also implement the Roll-Off factors of 0.25 or 0.20.

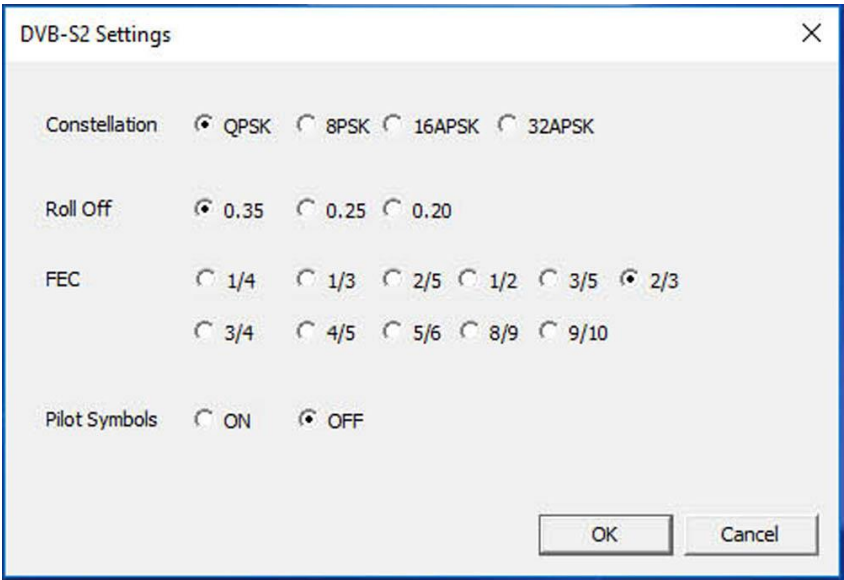


Figure 51 – Settings for the MODULATOR – DVB-S2 Tab

4.6.3.1 Constellations (Modulation Technology) – Radio-Button Selection

This implementation of the product supports all four modulation technologies offered for DVB-S2 protocol. As the modulation technology complexity increases from simple QPSK to the most complex 32APSK...the robustness of the received signal decreases. That is 32APSK requires the highest C/N ratio (signal to noise ratio). The complexity of the modulation technologies allow more data-bits to be included in each symbol-transition as listed below:

Modulation Technology	data-bits per Symbol
• QPSK	2
• 8PSK	3
• 16APSK	4
• 32APSK	5

4.6.3.2 Roll-Off Factor

As mentioned earlier, the Express_DVB_Transmitter beta DVB-S2 software code only implements a Roll-Off factor of 0.35. The FPGA on the hardware board is not large enough to also implement the Roll-Off factors of 0.25 or 0.20.

4.6.3.3 FEC – Radio-Button Selection

Select the FEC setting that you plan to use on the STB or Receiver from the radio-button menu. The radio-buttons for selecting FEC for QPSK modulation are shown in **Figure 39** and **Figure 40**. Other modulation technologies (aka constellations) will “grey out” FEC choices that are not available in a chosen modulation.

4.6.3.4 Pilot Symbols

The DVB-S2 protocol uses Pilot Symbols to end more info to a receiver and thereby help the receiver to more quickly train an adaptive equalizer. Without Pilot Symbols...the receiver needs to scan a blind scan to attempt to parse out settings or use trial and error...it will just take longer to capture the signal..

4.6.4 MODULATOR – DVB-T Tab

Note that not every feature of the DVB-T protocol implementation has been fully tested. This protocol release of DVB-T should be considered as **EXPERIMENTAL**. The DATV-Express board was designed to be a great DVB-S exciter. The DVB-T protocol is pushing the limits of what is possible with this hardware design. The testing has found 2K mode of DVB-T to give more consistent results than 8K DVB-T using the hardware. Individual results may vary. DVB-T 8K mode has been found to exceed the performance limits of the board design, and is NOT supported. The most significant feature of the PC CPU is the size of the on chip processor cache as most of the algorithms require continual accesses of the same memory locations, so fast processors with large caches are ideal for DVB-T. When selecting the DVB-T menu item from the MODULATOR Tab, the following configuration settings are available: confirming 2K mode, Channel Bandwidth desired (only 1 MHz and 2 MHz work well), Constellation (aka modulation technology), FEC, and Guard Period.

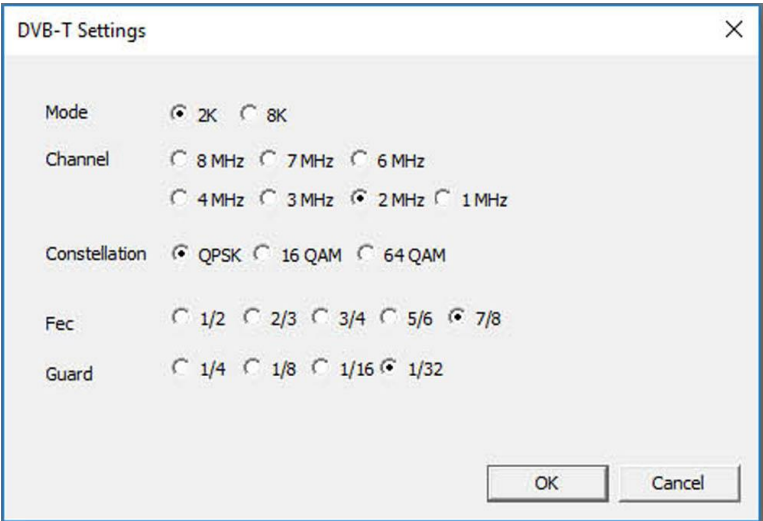


Figure 52 – Settings for the MODULATOR – DVB-T Tab

4.6.4.1 MODE

The COFDM modulation technology used by the DVB-T protocol can be chosen for 1,705 sub-carriers called the 2K packet length mode, or chosen for 6,816 sub-carriers, called the 8K packet length mode. Ham radio DATV currently only uses the 2K mode of DVB-T protocol. Select 2K or 8K length of packets from the pull-down menu. Again, be aware that the DVB-T 8K mode has been found to exceed the performance limits of the board design, and is NOT supported.

4.6.4.2 CHANNEL (RF Bandwidth)

Choose the RF bandwidth of the desired channel that you desire from the pull-down menu. Choose from 8 to 2, and 1 MHz bandwidths. Because of the high Windows CPU consumption and aliasing filtering-problems, DATV-Express V1.23 software is only able to support 2 MHz and lower channel-bandwidths. When trying to run more traditional DVB-T bandwidths like 7 MHz....large undesirable spikes from aliases appear nearby in the spectrum as illustrated in **Figure 53**. The current software is able to operate correctly for 2 MHz and 1 MHz channel-bandwidths to achieve an acceptable RF signal in the spectrum.

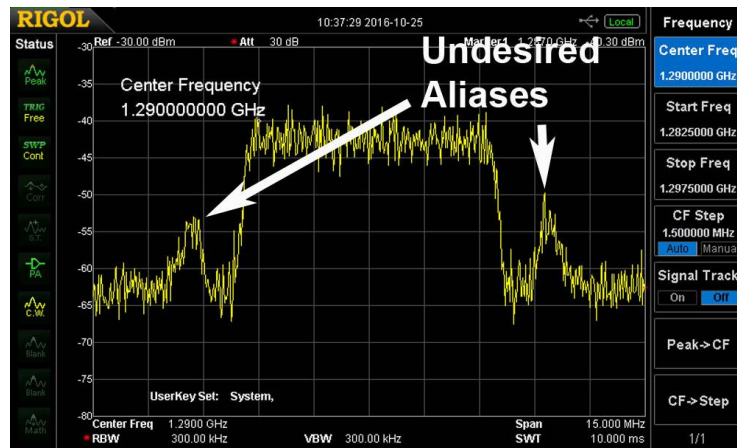


Figure 53 – With 7 MHz Channel selected, Spikes from improperly filtered aliases appear in the spectrum when DVB-T Channel-Bandwidth not operating at 2 MHz or 1 MHz.

4.6.4.3 Constellations (Modulation Technology) – Radio-Button Selection

This implementation of the product supports all three modulation technologies offered for DVB-T protocol. As the modulation technology complexity increases from simple QPSK to the most complex 64QAM...the robustness of the received signal decreases.

4.6.4.4 FEC RATE

Select the FEC setting that you plan to use on the STB or Receiver from the pull-down menu.

4.6.4.5 GUARD PERIOD

The purpose of the guard interval is to introduce immunity to propagation delays, echoes and reflections, to which digital data is normally very sensitive. In COFDM, the beginning of each symbol is preceded by a guard interval. As long as the echoes fall within this interval, they will not affect the receiver's ability to safely decode the actual data, as data is only interpreted outside the guard interval. Longer guard periods allow more distant echoes to be tolerated. However, longer guard intervals reduce the channel efficiency.

4.7 HELP Tab

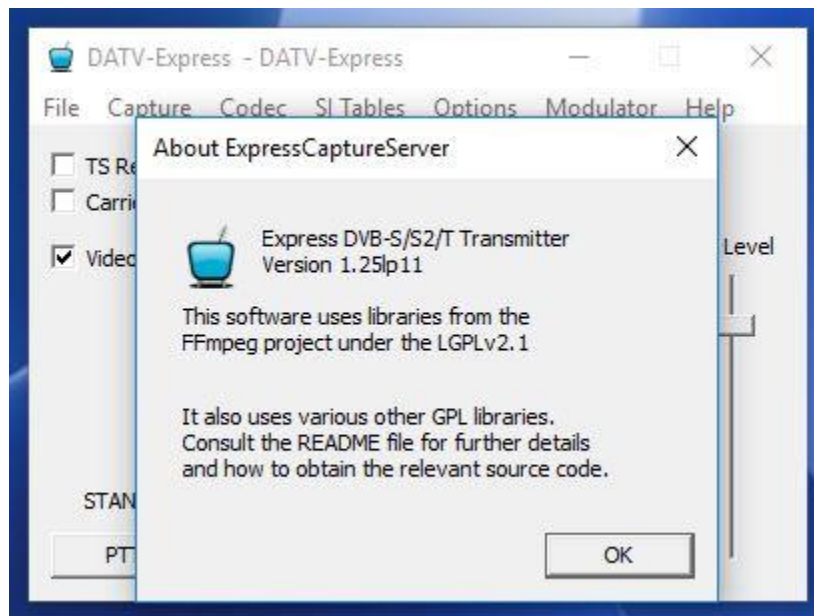


Figure 54 – Window for the HELP - ABOUT window

4.7.1 ABOUT

Selecting ABOUT on the HELP Tab allows you confirm what version of Express_DVB _Transmitter software you are running, as shown in **Figure 54**.

4.7.2 About – OK Button

Click on the OK button when you want to exit the ABOUT screen.

4.8 MAIN Screen

The MAIN window is where you will operate your transmitter once all of the capture-devices, protocol, CODECs and configurations have been set-up using the other GUI tab windows. The MAIN window displays the set-up values and provides a PTT button.

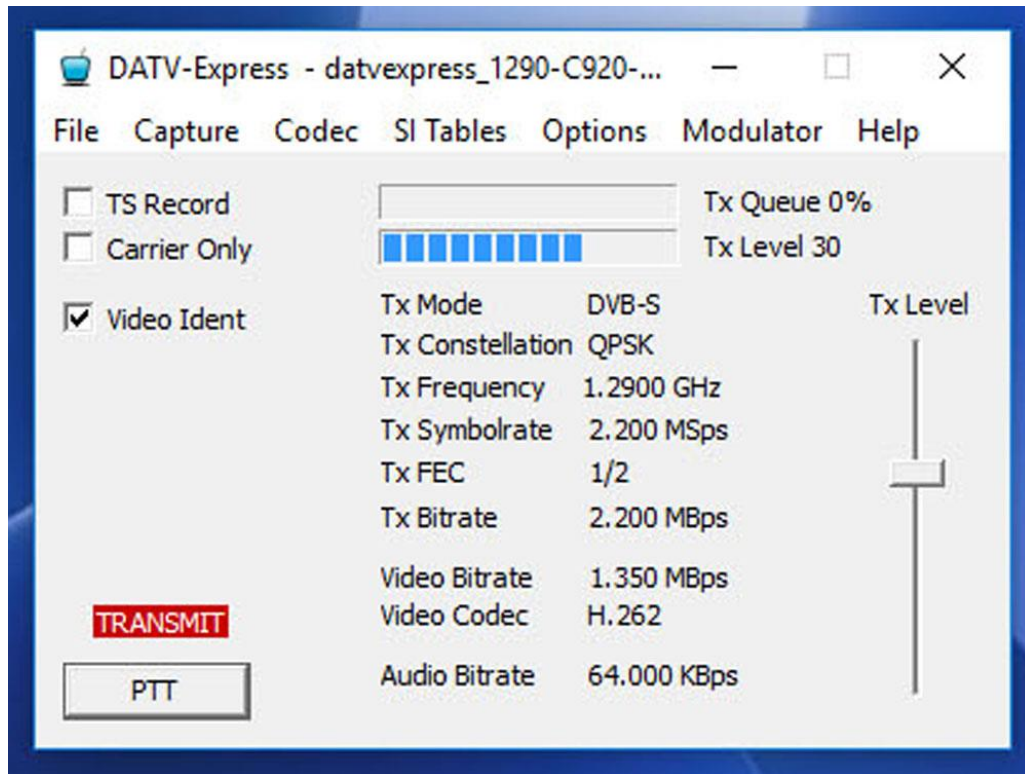


Figure 55 – The MAIN display showing normal running in TRANSMIT mode

4.8.1 TRANSMIT QUEUE - indicator

The TX Queue graphic indicator shows the number of video packets and NULL packets available in the Queue buffer waiting to be processed. The display may miss a few packets still in the queue buffer because it only gets updated every 100 msec. G4GUO explains that the most important aspect is whether the Tx Queue value is monotonically increasing or not. (see the graphs on the right side of the page at https://en.wikipedia.org/wiki/Monotonic_function for what Charles means). In testing by W6HHC, he found the Tx Queue is typically empty (0 %), with only an occasional packet going into the buffer and flickering the display. See Section 4.3.7 for some hints on how to fine tune the Tx Queue using the VIDEO BITRATE parameter.

4.8.2 TRANSMIT Level - indicator

This field displays the RF power out setting that was configured in the MODULATOR - Common Settings Tab (Section 4.6.1.3 TRANSMITTER RF LEVEL). In addition, you can control the value of TRANSMIT Level by moving the slider-control on the right-side of **Figure 55**.

4.8.3 TRANSMIT Level – Slide-Bar

You can also change the RF power out TRANSMIT value by grabbing the slider-control on the right-side of **Figure 55** with your mouse. Finally, if you “mouse over” the slider-bar, you can use the mouse roll-wheel to increment or decrement the TRANSMIT level in 1 dB changes.

4.8.4 TS RECORD TO FILE (Checkbox)

Whenever the TS Record check box is clicked, the Express_DVB_Transmitter software immediately begins to capture the Transport Stream (TS) to a disk drive .ts file. However, the TS file ONLY works correctly with the CODEC running during the TRANSMIT function of the PTT button. The .ts file is called “datvexpress.ts” and will be found in your computer HOME Folder.

I suggest renaming the .ts file immediately to something like “datvexpress_G4xyz_4MSYM.ts”, so the file will not be overwritten the next time you use the TS RECORD. The file can then be moved or copied to your desktop.

You can watch the TS file played back using a program like Windows Media Player on Windows. The details of the TS file can be inspected using an analyzer like DVBinpector (free). It is important to understand that the format of the TS file video will be according to the video-capture input settings (CAPTURE Tab) and not the On-The-Air settings of OPTIONS Tab (like Aspect Ratio, etc.).

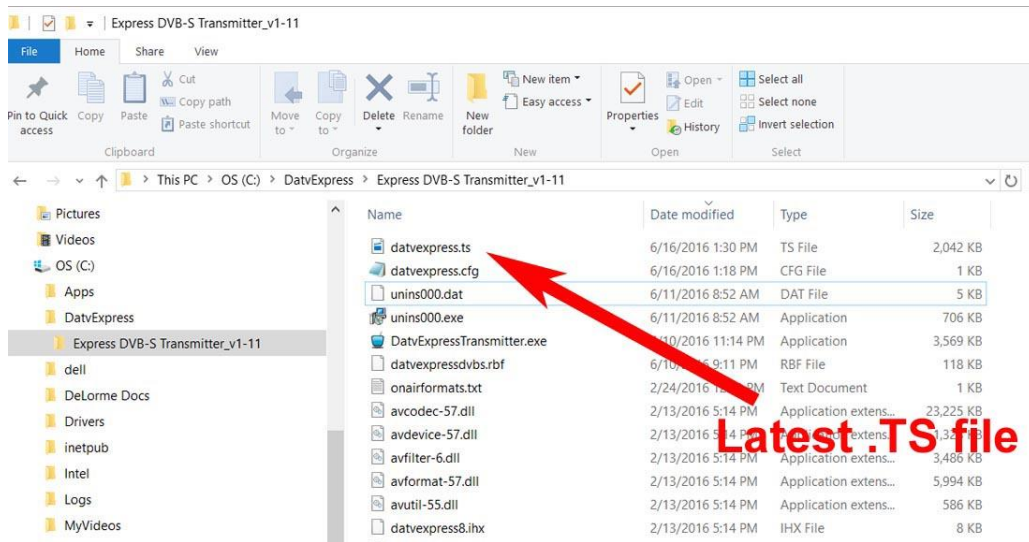


Figure 56 – The latest TS file will be stored in the Express_DVB_Transmitter (home) Directory as seen here using the Windows file manager

4.8.5 CARRIER ONLY (Checkbox)

The CARRIER ONLY check box can be enabled to transmit an unmodulated carrier signal instead of a DATV signal. If the CARRIER ONLY is checked, then the signal will be transmitted whenever the PTT button is in the TRANSMITTING mode.

NOTE – Currently the RF power level of the carrier is NOT the maximum output level that can be achieved by the design. It is NOT the “key down” output that would be produced by a CW transmitter at maximum gain. The output value is currently set mathematically (somewhat arbitrarily) to just provide a good beacon for antenna pointing, etc. Do NOT try to measure the power output level capability of the board or amplifiers using the CARRIER feature.

4.8.6 VIDEO IDENT (Checkbox)

The Video Ident check box enables the text (such as call letters) entered in SI TABLES Tab (Section 4.4.10 PROVIDER NAME) to be overlaid on the video transmission.

4.8.7 TX Mode - display

The TX Mode display field indicates what protocol mode was selected in Section 4.6.1 (MODULATOR – Common Settings Tab)

4.8.8 TX Constellation - display

The TX Constellation display field indicates what constellation (modulation technology) is associated with the DVB protocol you have selected (as displayed in Section 4.8.7).

4.8.9 TX FREQUENCY - display

The TX FREQUENCY display field value confirms the frequency setting entered in the MODULATOR Tab (Section 4.6.1 TRANSMITTER FREQUENCY).

4.8.10 TX SYMBOL RATE - display

The TX SYMBOL RATE display field value confirms the symbol-rate setting entered in the MODULATOR Tab (Section 4.6.2 TRANSMITTER Symbol-Rate).

4.8.11 TX FEC - display

The TX Forward-Error-Correction (FEC) display field value confirms the FEC setting entered in the MODULATOR Tab (Section 4.6.3 TRANSMITTER Forward Error Correction).

4.8.12 TX BITRATE - display

The TX Bitrate display field value is the calculation of the net payload data bit rate after the overhead of the selected FEC is removed.

4.8.13 VIDEO BITRATE - display

The Video Bitrate display field value is the calculation of how much of the Tx Bitrate is available for video bitrate after the audio bit rate is subtracted and the overhead of SI Tables is subtracted.

4.8.14 VIDEO CODEC - display

The Video CODEC display field value confirms the CODEC selected in the CODEC Tab (Section 4.3.2 VIDEO CODEC – Radio Button Selection).

4.8.15 AUDIO BITRATE - display

The Audio Bitrate display field value confirms the audio bit-rate setting selected in the CODEC Tab (Section 4.3.11 AUDIO CODEC – Radio Button Selection).

4.8.16 PTT (Button)

The PTT button can be clicked to alternate between STANDBY (receiving) and TRANSMIT modes.

4.9 DATV-Express Hardware Board LEDs

The main cluster of four LEDs is located in the lower right hand corner of the DATV-Express hardware PCBA near the CE “mark”.

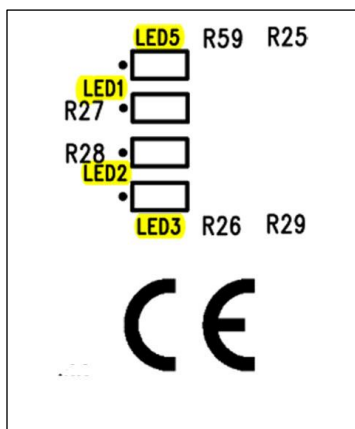


Figure 57 – identification of the four LEDs
in lower-right hand corner of DATV-Express board

LED 4 – +5.5V Power supply is operational (upper right-hand corner of board near mounting hole)

LED 5 – TS Flow Control is ON when the FPGA is successfully receiving TS from the host and performing flow control. If OFF, there is a setup or hardware malfunction.

LED 1 – does a short blink when there is activity with I2C interface on the board

LED 2 – Counter using Symbol-Rate clock – constantly blinks slowly to show that FPGA is running in RCV mode. The XMT blinking rate is three times as fast as RCV. The rate of blinking will increase as the SR setting is increased.

LED 3 – PLL Lock is ON when modulator reports lock status via I2C buss to FPGA.

4.10 Optional Si570 Symbol Rate chip

The DATV-Express hardware PCBA has been designed with an etch “foot print” for an Si570 Symbol Rate PLL chip at position U12. If the Si570 is soldered onto the board, then the software will detect the chip and allow the Si570 to control the Symbol Rate setting with more precision. If U12 is not soldered in, then the FPGA will control the creation of the Symbol Rate flow.

Anyone adding one of these Si570 chips to their board will have to use the 570CAC000121DG part from the Digi-Key distributor. The reason being that the software needs to know the factory-default start up frequency of the chip before it can calculate the calibrated reference oscillator frequency which it needs when programming the chip to other frequencies. The 570CAC000121DG is a CMOS device with a default start up frequency of 100 MHz and an I2C address of 55 hex.

5.0 – Useful utilities

5.1 DVBInspector for TS files

DVBInspector is a free Windows software program that can analyze various aspects of Transport Stream (TS) files. DVBInspector offers five different views of a transport stream;

- tree view (for logical analyzes),
- EIT view (fast overview of EIT information),
- bitrate view (to see bitrate alter over time),
- bar view (summary of average/minimum and maximum bitrates) and
- grid view (to see how different PIDs are distributed over time).

Go to www.digitalekabeltelevisie.nl/dvb_inspector/ to download the utility software.

Go to www.digitalekabeltelevisie.nl/dvb_inspector/usermanual.shtml for the manual.

5.2 Playing Back TS files.

The DATV-Express software can now create a Transport Stream (TS) file of your transmission (see the MAIN Tab in Section 5.12 for details on creating a TS file). If you want to play back and listen to the video on the TS files, there are listed below two utility programs that can play back TS file on your computer.

- Use Windows Media Player as the TS player on Windows OS
- Use the GNOME Mplayer as the TS player on Ubuntu. The GNOME Mplayer comes installed on Ubuntu 14.04 LTS. NOTE – the VLC player is not yet available for ARM-based computers like ODROID.

5.3 CPU performance monitor

It is easy to use the Windows TASK MONITOR for CPU performance monitoring. Perform the Windows “three finger salute” (CTL – ALT – DEL) and choose:

TASK MGR → PERFORMANCE Tab → CPU

5.4 Tutioune and MiniTiouner and MiniTiouner-Express analyzers

Tutioune (older) and MiniTiouner (current) are a software utility that has been specially developed to provide radio amateurs and DVB technicians with a tool that allows Digital ATV (DVB-S and DVB-S2) to be measured precisely. With MiniTutioune you will no longer have the frustration of seeing only “level” and “quality” information from standard satellite receivers including STBs; basic quality guidance that fails to satisfy technical users.

Technical DVB-S and DVB-S2 users want to measure the received transmission characteristics exactly, so they can improve their systems and debug problems that may be encountered. Digital transmissions

are not really "all or nothing", in between there are many things that can happen; it's important to be able to observe and define the various stages.

Tutoune is a software solution for making these measurements. This free Windows software utility was developed by F6DZP Jean Pierre Courjaud. The software can be downloaded from www.vivaDATV.org/viewtopic.php?f=60&t=214 Tutoune can be used with a number of DVB-S PCI-based satellite receiver cards such as the TechnoTrend TT-S2-3200 board (€80 new and possibly less on eBay) or the best: TT S2-1600 board. For these two families of card there are now two versions of software:

- Tutoune1600 for TT S2-1600 you can find it here : www.vivadtv.org/viewtopic.php?f=60&t=352
- Tutoune3200 for TT S2-3200 you can find it here : www.vivaDATV.org/viewtopic.php?f=60&t=276

MiniTiouner is a USB-based hardware DVB-S tuner that runs essentially the same analyzer software to make measurements. Details on the hardware product and the free version of software needed for MiniTiouner can found at:

- www.vivaDATV.org

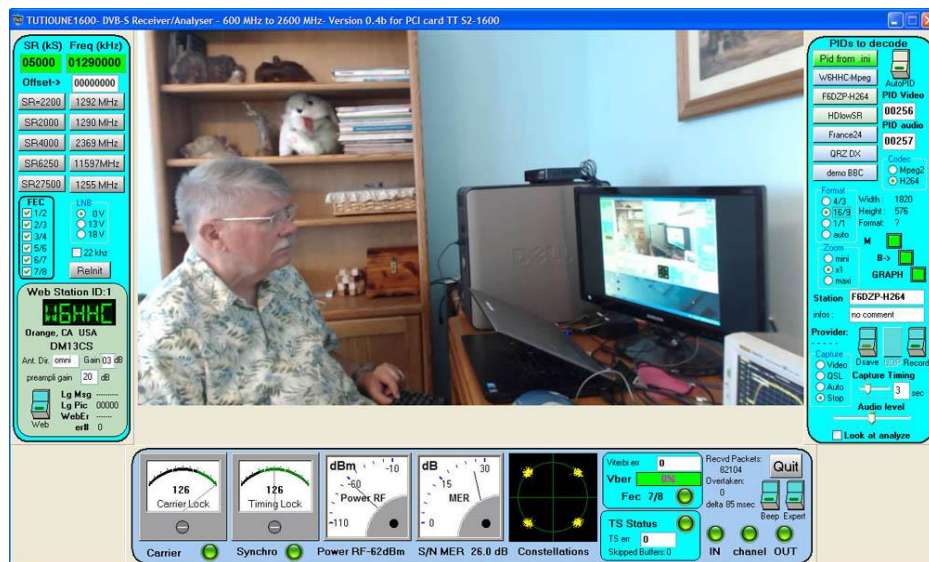


Figure 58 – Displaying H.264 video transmission in 16:9 Aspect Ratio using MiniTioune Analyzer Software

5.5 vMix Basic Video Mixer

vMix is a great optional companion software tool to use with Windows DATV-Express. vMix Basic is an free video-mixer-editor software package for SDTV format video (Standard Definition) that is available from vMix.com. There are more-professional HDTV products that are available for sale, including the vMix Basic HD for US\$60. See **Figure 59** for array of vMix products. The download you want is called **vMix 17** (for the version number).

Important Note:

Please visit the [Download](#) page and try out vMix using our **FREE 60 Day Trial** before purchasing to ensure vMix supports your computer hardware.

vMix is available in six editions. Each purchase does not expire and includes [Free Version Updates for one year](#) from the date of purchase. Please visit our [Knowledge Base](#) for answers to common questions, including: [Which edition of vMix do I need?](#)

Click the button below to pay via Credit Card, PayPal, Bank Transfer or Purchase Order

Buy Now
by FastSpring

	Basic	Basic HD	SD	HD	4K	Pro
	FREE	\$60 USD	\$150 USD	\$350 USD	\$700 USD	\$1200 USD
Total Inputs	4	4	1000	1000	1000	1000
Camera / NDI Inputs	2	3	1000	1000	1000	1000
Maximum Resolution	768x576	1920x1080	768x576	1920x1080	4096x2160	4096x2160
Overlay Channels	1	1	4	4	4	4

Figure 59 – The array of vMix products – including free vMix BASIC

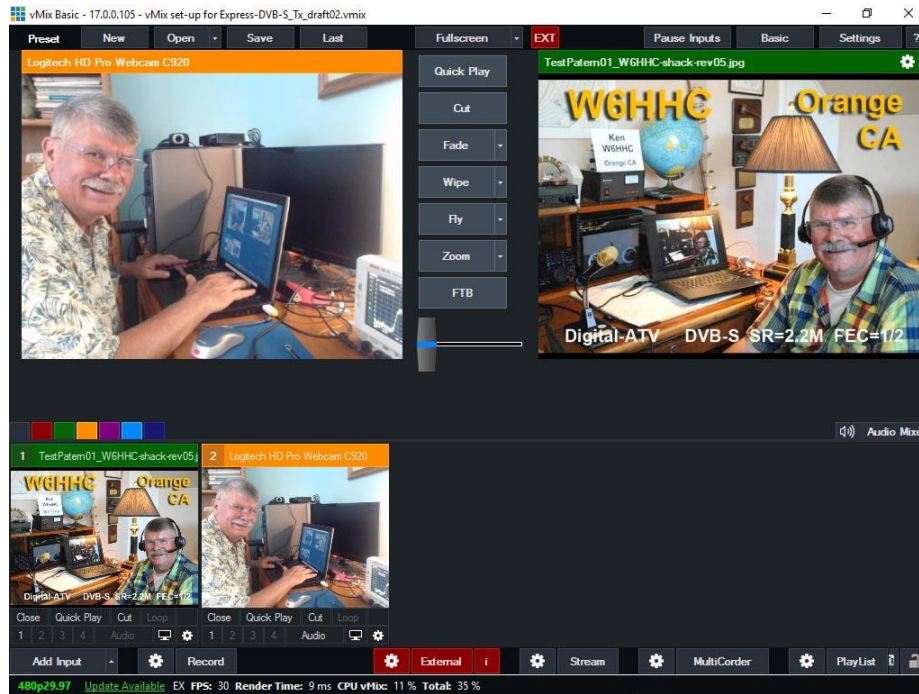


Figure 60 – An example of running vMix Basic video software with one camera and a “Test Pattern” JPEG

The free video-editing software allows you to:

- 1) support one or two USB-cameras
- 2) use a JPEG file as a “Test Pattern” video source
- 3) switching between the two video sources (see **Figure 49**)
- 4) adding a better-looking call-letters-overlay
- 5) try “green-screen” video tricks.

You can capture any video that you can get to your Windows computer via USB, Firewire, ASI, or HDMI (while using an HDMI-USB capture card), and your old NTSC/PAL home camera (while using an EasyCAP USB video-capture dongle). vMix will be displayed as one of the available devices under CAPTURE – Video Devices and CAPTURE – Audio Devices.

This DATV-Express Users Guide does not cover set-up and running vMix in detail, since there are tons of YouTube tutorial videos describing how to set-up and use the vMix third-party product. That being said, the project team will offer one very non-intuitive step for those hams who just want to push buttons instead of follow a tutorial. In order to get the output video stream being sent to the Express_DVB-S_Transmitter software, you must configure and activate the EXTERNAL button at very bottom of the vMix screen (see RED button in **Figure 60**).

5.6 Portsdown Project Modulator Board

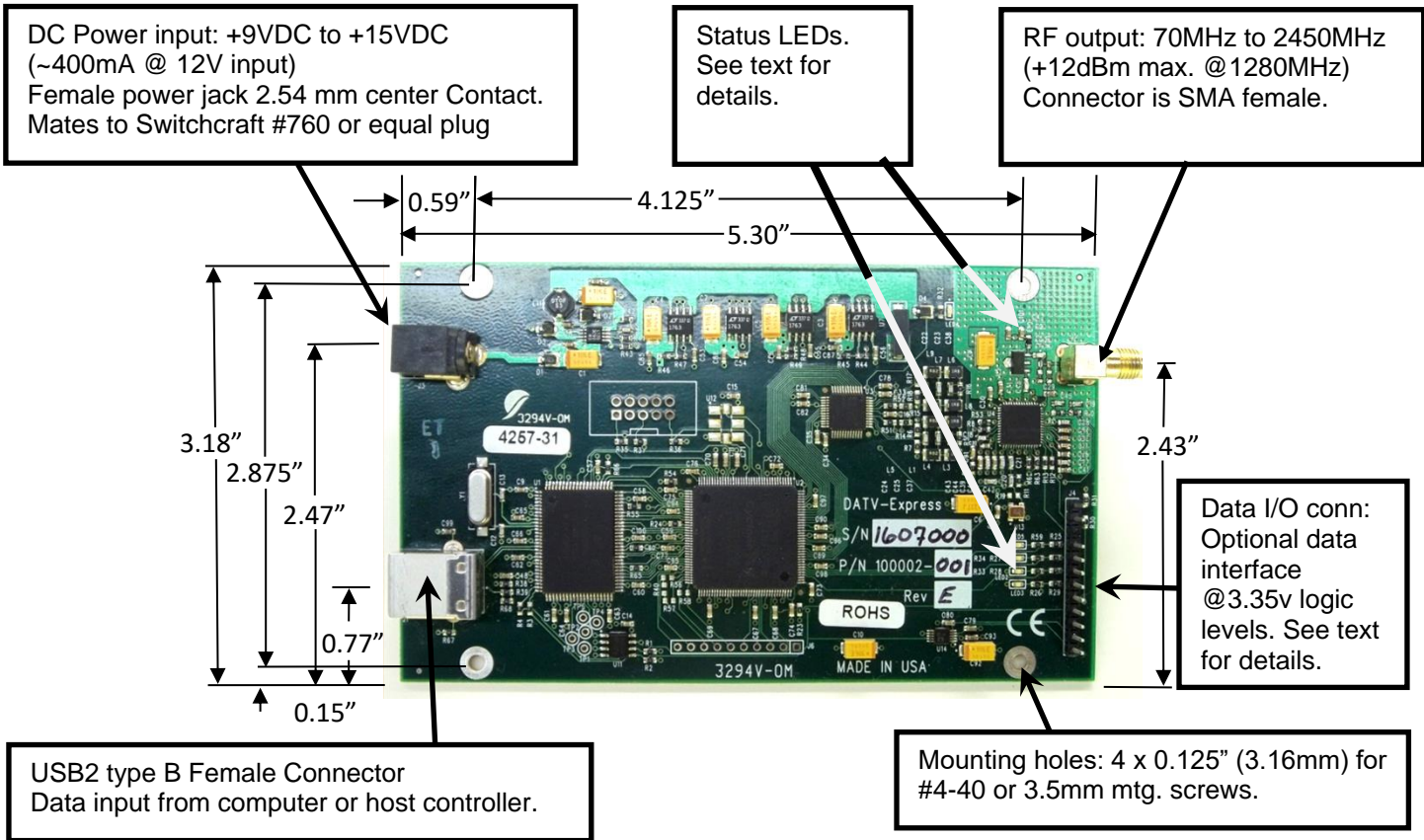
The DATV-Express hardware can be used as the modulator board for the BATC Portsdown Project software. The BATC Portsdown Project uses RpiDATV software from F5OEO (that has been extended by the BATC Portsdown team) running on an RaspberryPi-3 computer and can be controlled directly from a 3.5-inch touch-screen LCD or a larger 7-inch touch-screen LCD. See **Figure 61**. This User Guide does **NOT** cover operation details for the Portsdown-RpiDATV/RPi-3/DATV-Express set-up. **Figure 3** in the Introduction Section shows a typical Block Diagram for using the DATV-Express as the modulator board with Portsdown. The Portsdown Project software allows you to change settings in the field using only the LCD touch-screen display (called TOUCHSCREEN mode)...or use an external PC via SSH (called CONSOLE MODE) to do detailed configuration settings. See the BATC Forum for a Portsdown Project User Guide that covers set-up details and operating details.



Figure 61 – Using the DATV-Express board as the modulator for the BATC Portsdown Project software running on a RaspberryPi-3

6.0 – DATV-Express board for Windows specifications:

Physical details:



It is recommended that the board be placed in an enclosure of some type, preferably of metal construction. The board mounting holes mate to a (5.6" x 4.3" x 1.8") Bud Industries or DigiKey part number #CU-387 plastic enclosure and may be used from an economy standpoint. The input and output connector holes must be added by the user. If a metal enclosure is used, it is helpful for heat distribution purposes to use metal mounting standoffs. The modulator IC gets very warm during normal operation so using a metal standoff here will help sink heat away from it. Ventilation holes in either enclosure around the vicinity of the output connector is desired for elevated temperature environments.

Environmental Details:

Temperature – 0 to +30°C (32-86°F)

Humidity - +10 to 95% non-condensing

Electrical Details:

Required Windows Computer components

Host computer with at least (2) USB2 I/O ports.

USB interface cable – USB type "A" connector at computer, USB type "B" connector at DATV-Express.

Software support requirements – Pentium 4 or better, 2GB available hard drive.

Operating system - 32 bit or 64 bit Windows Vista, 7, 8 or 10.

Hardware video-capture (Hauppauge) NOT required – Most Windows supported video capture devices are supported by the FFmpeg software CODEC library. Including a laptop webcam, Logitech C615 and C920 web cameras, EasyCap USB dongle with NTSC / PAL hand-cam, and optional Vmix video mixing software.

Input voltage requirements

+9 to + 15VDC (400 ma@12vdc). Input is polarity protected but not fuse protected. External 1 amp slo-blo fuse is required by user for safe operation.

Frequency Range

70 MHz to 2450 MHz

Symbol Rate (Symbols/sec)

Select SR from 100000 to 8000000 in steps of one Symbol/second. (Design is optimized for 0.10-to-8 MS/sec). There are 12 preset and automatic configurable combinations to adjust for adequate aliasing adjustments.

FEC

Combinations: 1/2, 2/3, 3/4, 5/6, 7/8 for DVB-S protocol.

Signal quality data

EVM (Error Vector Magnitude) - 2.4%.

(Measured with Agilent EXA N9010A Signal analyzer – software VSA 89600B). ($\leq 3\%$ is acceptable for commercial broadcast).

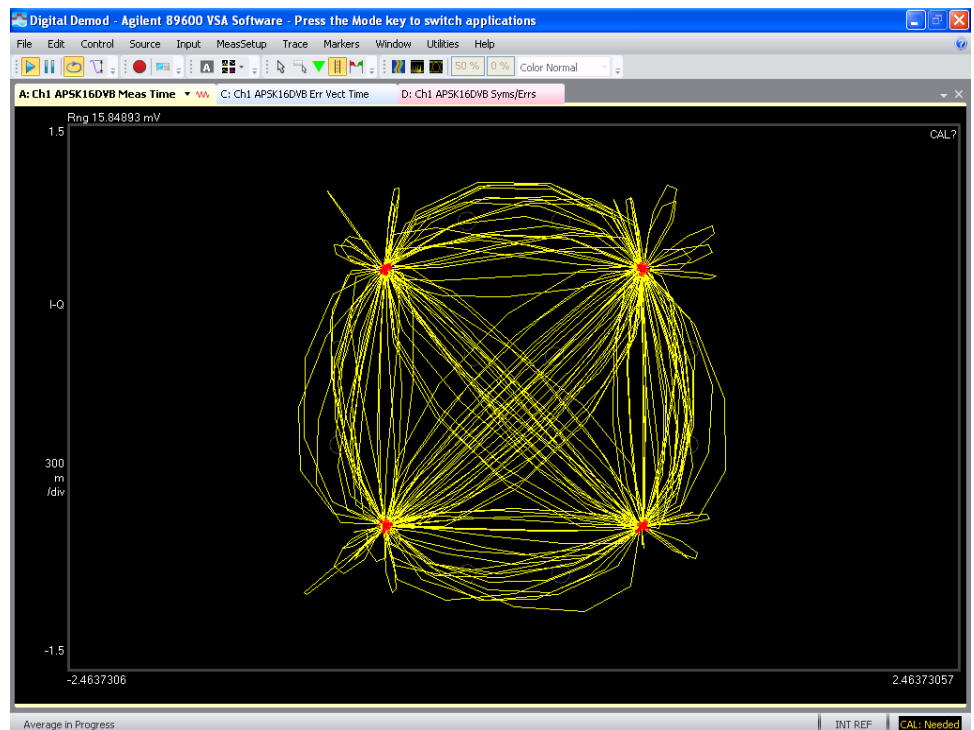
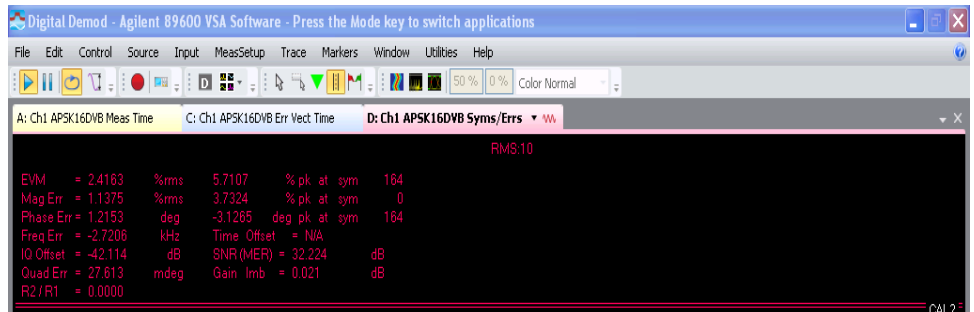
EVM is the percentage away from the ideal symbol landing spot in the signal constellation. This data is normally measured at the receiver and takes into account the combined effects of transmitter and receiver Carrier or Signal to Noise ratios (CNR or SNR).

MER (Modulation Error Ratio) - 32dB.

Minimum recommended down-stream MER = 12-13dB for QPSK and 27dB for 64QAM including 3-4dB headroom for reliability. It's calculated as: $10\log(\text{average symbol power} / \text{average error power})$.

Video – Determined by capture card specs. Hauppauge model HVR1950 will accept 1V P-P 75 ohm NTSC or PAL video.

Audio – Determined by capture card selection. Compression: MPEG1



LED Function

- LED1 – I²C activity - BLINK
- LED2 – Symbol Rate Counter
- LED3 – PLL locked - ON
- LED4 – +5V power
- LED 5 – TS Flow Control

Description

- Quick blink during I²C communication. It's a very short blink and hard to see.
- Constant FLASH. Slow for RCV. X3 for XMT. Higher symbol rates = faster flashing.
- is ON if the USB controller is OK.
- is ON when +5.5VDC is present.
- is ON when the FPGA is successfully receiving TS from the host and performing flow control. If OFF, there is a setup or hardware malfunction.

(Note: LEDs glow very dimly when in OFF state)

Connector details

USB2 type “B” connector (J1) - Standard USB2 connections to/from host computer.

RF output connector (J2) – SMA female.

DC power connector (J3) - Female DC connector, 2.54mm center pin. Mates to Switchcraft #760 or equal plug

Data I/O connector (J4)

1	+5.2vdc thru 50Ω 1/4w resistor	
2	PTT (non-delayed) output (+3.3V Tx & GND Rx.	Limit sink current to 10mA.)
3	Key (no pin)	
4	TS Flow Control (LED5)*	*This data is + true to 3.3V for function indicated. The outputs are in parallel with LEDs thru a 100Ω resistor. Limit sink current to 10mA. (when LEDs are OFF)
5	I ² C activity (LED1)*	
6	Symbol Rate (LED2)*	
7	PLL Locked output (LED3)*	
8	I ² C buss SDA	Reserved for future data communication/expansion and testing analysis.
9	I ² C buss SCL	Reserved for future data communication/expansion and testing analysis.
10	Ground	
11	Analog input 1	These inputs are reserved for forward and reverse power output signals through a dual directional coupler. VSWR reporting and some linearization is possible with this data.
12	Analog input 2	

Expansion connector (J6)

1	Ground
2	Key (no pin)
3	Delayed-PTT output (goes + delayed 200 msec from C/O) Limit sink to 10mA FPGA output pin97
4	Change/Over (C/O) output (+ when PTT is TRANSMIT for enabling amplifiers & relays FPGA pin96
5	PORT A output on Windows OS - FPGA I/O – output pin 95
6	PORT B output on Windows OS - FPGA differential - output pin 72
7	PORT C output on Windows OS - FPGA differential +output pin 71
8	FPGA differential – input pin 70
9	FPGA differential + input pin 69
10	PORT D output on Windows OS - FPGA I/O – output pin 67

NOTE: Port A-D outputs are +3V when respective Modulator Tab box is checked. They’re active during Rx and Tx and intended to signal external circuitry of a given band selection. They’re mutually inclusive so all or none may be selected allowing up to 16 combinations. Optical isolation recommended – max 10Ma sink current.

Transport Stream

A “transport stream” feature is incorporated in the software to enable signal analysis. When the “**TS Record to file**” checkbox is checked, the computer will collect the active signal in a continuous datvexpress.ts data stream in the default Home directory. The data will continue to collect as long as the “**TS Record to file**” button is checked at the rate of about 20-30 MB/minute. The file can then be played back with Windows Media Player or equal software to view the video. The transport stream captured is the same one sent to the DATV-Express board in normal operation. (It is NOT the actual transmitted RF signal).

Example: Your friend has a computer program with video analysis capability. You can Email the datvexpress.ts file to him so he can analyze your signal details as the video plays.

RF output

Frequency range: 70MHz to 2450MHz.

Resolution: 100 Hz Accuracy: $\pm 2\text{KHz}$

Frequency stability: $\pm 100\text{ PPM}$

Output Impedance: 50 ohms

Level: -34dBm to +13dBm in 1dB steps (100MHz)

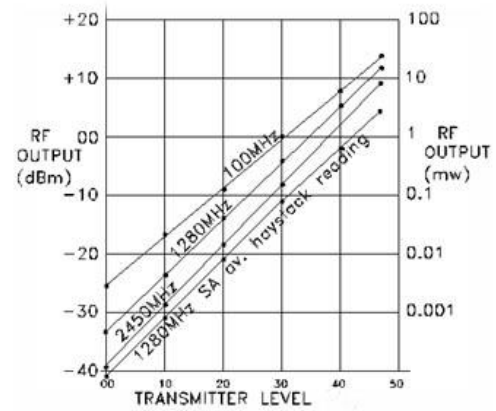
-35dBm to +12dBm in 1dB steps (1280MHz)

-39dBm to +8dBm in 1dB steps (2450MHz)

Spectral regrowth: -60dBc (RF output settings 00 to 35)

-50dBc (RF output settings 36 to 47)

Software controlled RF output: 00 to 47 in 1 dB steps
(00 is lowest level)

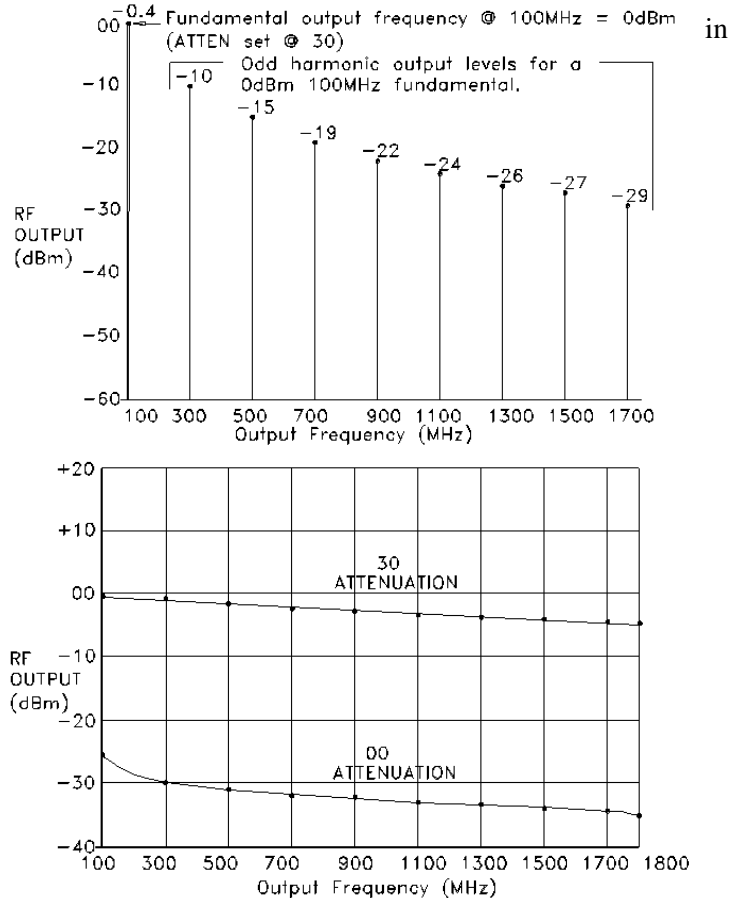


The table above illustrates the RF signal level at 100, 1280 and 2450MHz frequencies versus the internal software controlled RF output settings. An RF output setting of “00” produces the minimum level of RF output from the board and a setting of “35” is the maximum RF level out with no detectable signal distortion (spectral regrowth). Above a setting of 35, some sideband regrowth becomes noticeable on a spectrum analyzer as the power level increases due to slight compression in the RF MMIC amplifier. The 100MHz carrier is given to establish a reference point. It is below what a QPSK signal is allowed on the Amateur radio frequencies. **!CAUTION! DO NOT ATTEMPT TO TRANSMIT A SIGNAL OUTSIDE THE ALLOWED HAM FREQUENCIES?**

The 100MHz and 1280MHz graph lines represent the true average power output for either the single carrier or QPSK signal. The 1280 SA graph line is included to show how the signal amplitude at “top of haystack” on a standard scalar Spectrum Analyzer compares to the true average power. The true power is actually close to 10dB greater than the SA reading! Note: A thermal milliwatt meter such as the Hewlett Packard model 432A, which has a bolometer probe does, in fact, indicate true average power for both “carrier only” and complex QPSK signals. Use that data to predict post amplifier maximum input requirements.

The graph at the right illustrates the harmonic content expected the RF output signal. **It MUST pass through a filter of some type in order to suppress unwanted harmonics.** Since all unwanted frequencies are **above** the fundamental, a simple low pass filter may be all that is needed. The graph was created with a 100MHz signal to illustrate that the harmonic content extends many times beyond the fundamental. Only odd harmonics are produced. Even harmonics are below the SA measurable limit. If operation is planned for the 70cm band (420-450MHz), a third harmonic at ~1290MHz will be present about 26dB below the fundamental. **DO NOT use an interdigital filter here as that type of filter passes the third harmonic with almost no added loss!** Low pass filters are easy to construct and should be placed **between** the DATV-Express board and power amplifier, not after the PA. For low pass filter design examples go to www.CalculatorEdge.com/.

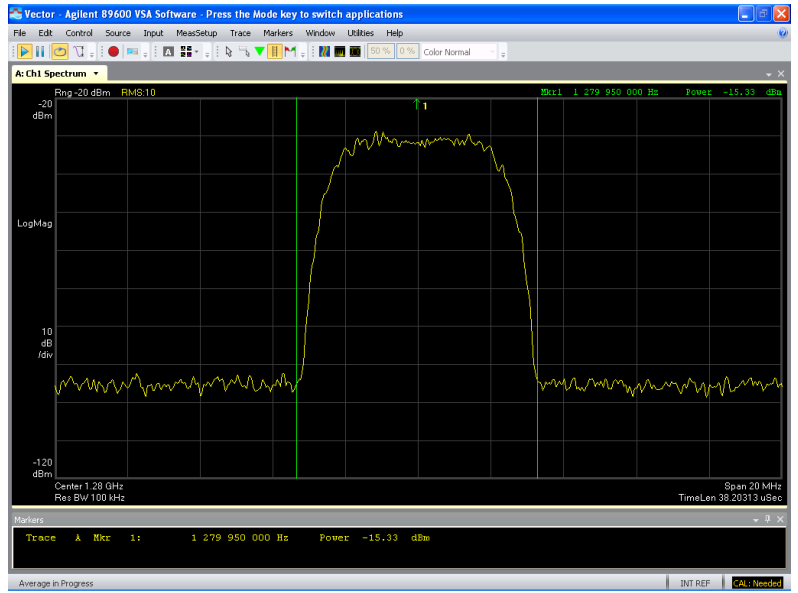
The graph at the right illustrates how the RF output decreases as the output frequency increases. At software-controlled RF output setting = 30, a 100MHz 0dBm signal reduces to about -5dBm at 1800MHz, everything else remaining the same.



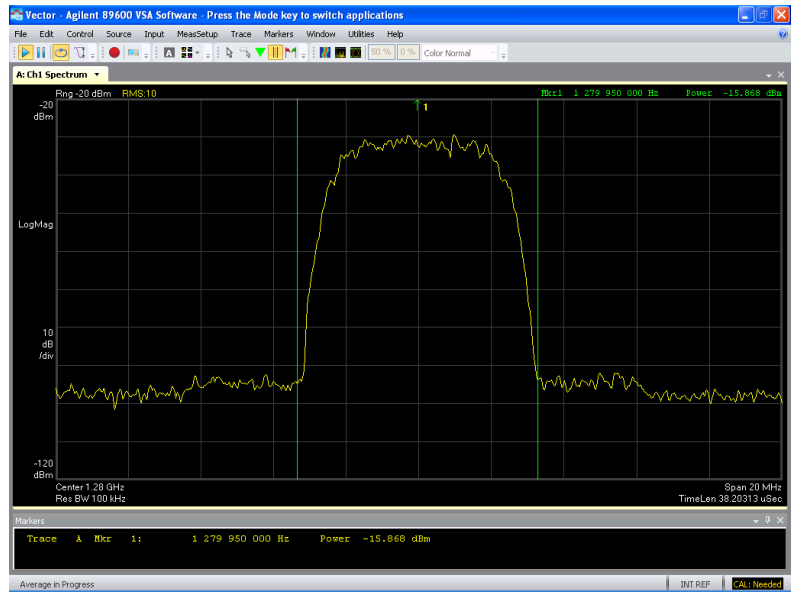
QPSK Analysis:

Since the spectral regrowth becomes noticeable when the attenuator output is greater than about 35, the graphs below show the RF output change as it passes through those points. From software-controlled RF output setting 00 to about 35, the regrowth is practically non-existent.

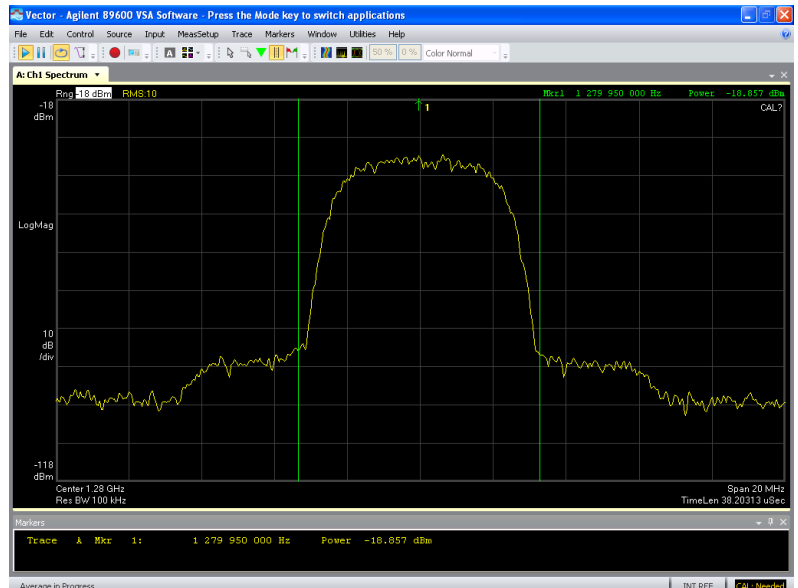
The graph at the right was taken with attenuator = 30 on an Agilent EXA analyzer and external 10dB attenuator in place between the DATV-Express board and analyzer. It shows a “top of the haystack” signal of about -30dBm which equates to true power = -15.3dBm between the 6MHz green markers. (Signal level is lower here than in earlier references due to added cable length and external attenuator). The noise floor is about -95dBm. This represents the noise being about a 65dB below the main signal.



The middle graph, taken with the software controlled output = 40 and external 20dB attenuator, shows slightly visible regrowth on each side of the main signal. It raises the noise floor up about 5dB resulting in distortion being down 60dB. This is still very good.



The bottom graph, taken with RF output setting = 47 (highest RF output) and external attenuator, shows higher regrowth sidebands. Regrowth is now about 10dB above the -95dB noise floor but still well within acceptable transmission limits. Here the spectral regrowth is down ~ 50dB.



The distortion and spurs on a QPSK DATV transmitter signal should be down at least 30 dB or more from the main signal on the “after amplifier” signal. Remember when looking at the DATV-Express RF output, any post signal amplification and (or) filters will tend to add distortion and decrease the overall signal quality.

7.0 – Contacts

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7.3 Product Support

Yahoo Groups Support Forum for DATV-Express

<https://groups.yahoo.com/neo/groups/DATV-Express/info>

You can subscribe to the DATV-Express Project Support Forum by sending an email to:

[**datv-express-subscribe@yahoogroups.com**](mailto:datv-express-subscribe@yahoogroups.com)