

DATV-Express Users Guide

For ODROID ARM “micro-PC” running Lubuntu linux

(based on DATV-Express software release v2.03_ARMhf)

Draft 04

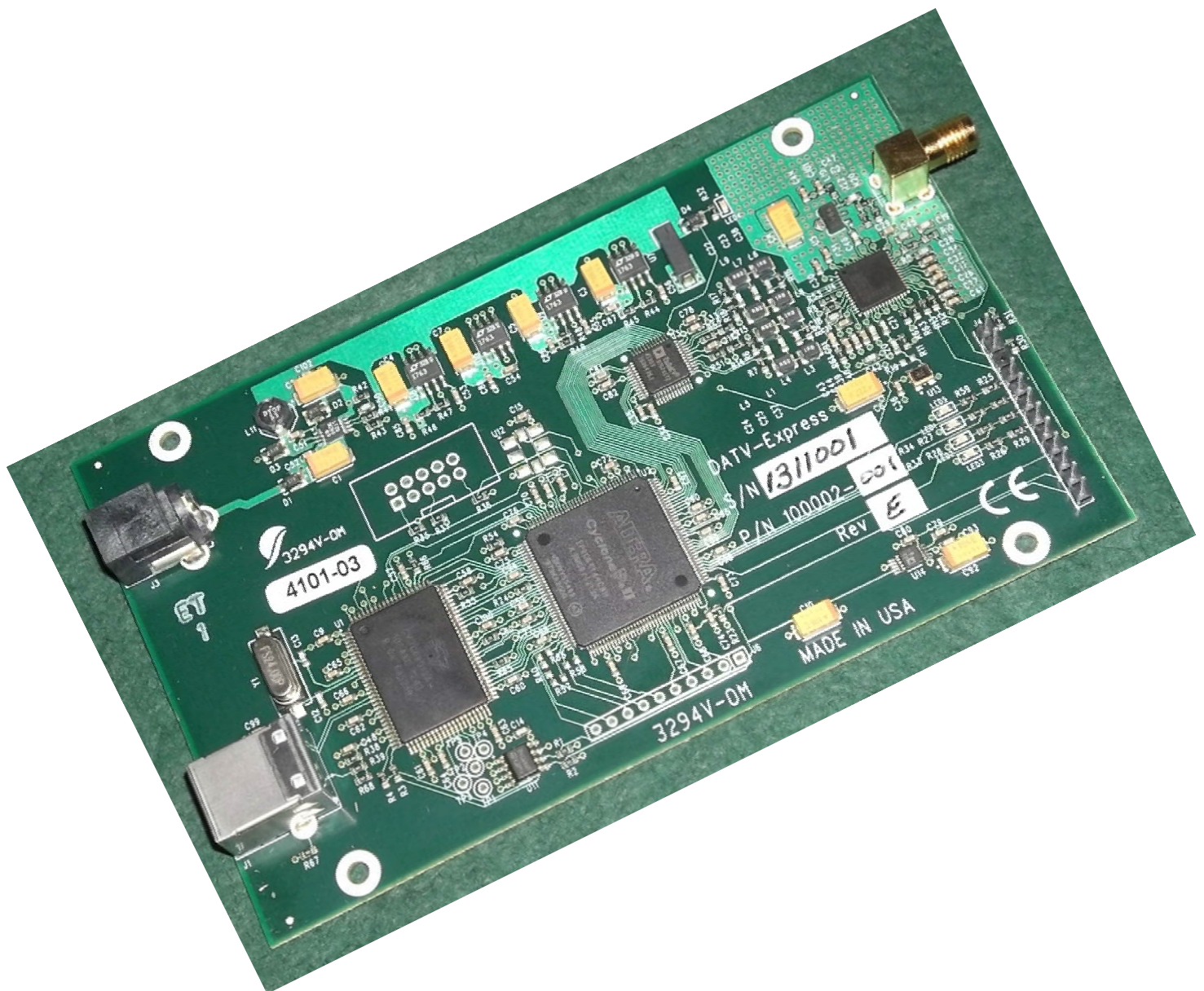


Table of Contents

1.0	– Introduction	5
2.0	– Prepare Lubuntu OS on ODROID.....	5
2.1	Just install the micro-SD memory card on ODROID U3 and boot.....	7
3.0	- Install DATV-Express software package using Debian installer	9
3.1	Using the Software Debian File for First-Time	9
3.2	Verifying USB Access Rights with Lubuntu 14.04 LTS	10
3.2.1	First open a LXTerminal mode window.....	10
3.2.2	Use TERMINAL mode to edit system file	11
3.3	Running DATV-Express Software for First Time	13
3.4	If you have Trouble opening/running the DATV-Express software	13
3.5	Upgrading your installed DATV-Express Software	14
4.0	- Hook-up the DATV hardware and Test	15
4.1	Here is what you need	15
4.2	First test – power up the DATV-Express board by itself	15
4.3	Second test – connect the hardware board and start DATV-Express SW.....	15
4.4	Third test – now connect video-capture to the PC	16
4.5	Fourth test – Transmitting DATV video.....	17
5.0	- DATV-Express GUI Reference Guide	19
5.1	– DVB-S Tab.....	19
5.1.1	Forward Error Correction (FEC).....	19
5.1.2	APPLY.....	19
5.2	– DVB-S2 Tab.....	20
5.2.1	MODULATION	20
5.2.2	CODE RATE (FEC)	20
5.2.3	ROLL OFF	20
5.2.4	FRAME TYPE	20
5.2.5	NULL PACKET DETECTION	20
5.3	– DVB-T Tab.....	21
5.3.1	MODE	21
5.3.2	CONSTELLATION.....	21
5.3.3	GUARD PERIOD	21
5.3.4	FEC RATE	21
5.3.5	CHANNEL.....	21
5.3.6	APPLY.....	21

5.4	– DVB-T2 Tab.....	22
5.5	– SR (Symbol-Rate) Tab.....	22
5.5.1	Symbol Rate (SR).....	22
5.5.2	APPLY.....	22
5.6	– TX Tab.....	23
5.6.1	TRANSMITTER FREQUENCY.....	23
5.6.2	TRANSMITTER LEVEL.....	23
5.6.3	APPLY.....	23
5.7	– PIDs (Packet IDs) Tab.....	24
5.7.1	PMT PID.....	24
5.7.2	PCR PID.....	24
5.7.3	NIT PID.....	24
5.7.4	VIDEO PID.....	24
5.7.5	AUDIO PID.....	25
5.7.6	NETWORK_ID Field.....	25
5.7.7	STREAM_ID Field.....	25
5.7.8	PROGRAM NR Field.....	25
5.7.9	Typical PID Values.....	25
5.7.10	APPLY.....	25
5.8	– SVC (Program INFO) Tab.....	26
5.8.1	SERVICE PROVIDER NAME.....	26
5.8.2	SERVICE NAME.....	26
5.8.3	APPLY.....	26
5.9	– EPG (Electronic Program Guide) Tab.....	27
5.9.1	DURATION (MINUTES) Field.....	27
5.9.2	EVENT TITLE.....	27
5.9.2	EVENT Text.....	27
5.9.4	APPLY.....	27
5.10	– HW (HARDWARE) Tab.....	28
5.10.1	VIDEO CAPTURE DEVICE.....	28
5.10.2	VIDEO INPUT SELECTION.....	28
5.10.3	TRANSMITTER.....	29
5.10.4	ENABLE CALIBRATION (Checkbox).....	29
5.10.5	SERVER IP ADDRESS.....	29

5.10.6	SOCKET NUMBER	29
5.10.7	APPLY.....	29
5.11	– MODE Tab	30
5.11.1	DVB MODE	30
5.11.2	APPLY.....	30
5.12	– MAIN Tab.....	31
5.12.1	TRANSMIT QUEUE	31
5.12.2	NULLS INSERTED	31
5.12.3	TRANSMIT DELAY	31
5.12.4	CARRIER (Checkbox).....	32
5.12.5	TS LOG TO FILE (Checkbox)	32
5.12.6	PTT (Button)	32
5.12.7	Video Bitrate	32
5.13	– Board LEDs	33
5.14	– Optional Si570 Symbol Rate chip	33
6.0	– Useful utilities	34
6.1	DVBInspector for TS files.....	34
6.2	Playing Back TS files.	34
6.3	CPU performance monitor	34
6.4	Tutoune DVB-S analyzer.....	34
6.5	Making backup copy of the HardKernel OS image	35
6.6	Downloading an OS image from HardKernel	36
7.0	– DATV-Express Specifications	38
8.0	– Contacts	43
8.1	E-Mail	43
8.2	Web Site	43
8.3	Product Support	43

1.0 – Introduction

The DATV-Express board is a digital-ATV transmitting exciter that can output around 10 mW (minimum) of RF using DVB-S protocol. With the DATV-Express companion software, the board can currently be used to transmit Standard Definition TeleVision (SDTV) format video. The software is based on a Software Designed Radio (SDR) design and is capable of many forms of modulation and protocols. The initial release of the software has been fully tested with DVB-S DATV protocol. The use of the IQ modulator in the design allows other protocols and modulation technologies to be tried. As an extra bonus, the DVB-T 2K mode DATV protocol has been mostly tested and is included in v2.01 software release. However, we cannot guarantee the performance of that protocol. Caveat Emptor! The hardware board PLL design of is capable of transmitting in any ham radio band between about 70 MHz and 2450 MHz.

This User Guide covers using the ODROID model U3 to run software to drive the DATV-Express Board transmitter. As shown in **Figure 1**, the DATV-Express board is designed to allow it to run from an ARM-based “micro-PC” ODROID. In DVB-S protocol, the ODROID 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 datastreams and modulates using an Analog Devices model ADRF6755 IQ-modulator chip. If using the DVB-T protocol, the ODROID performs the steps of processing the DVB-T protocol and adding the Forward Error Correction (FEC) calculations (instead of the FPGA on the hardware board).

Sections 2.0 through Section 3.0 of this User Guide provide assistance to prepare the PC disk drive, load Ubuntu Operating System, and install the DATV-Express application software. Section 4.0 guides you to conduct some basic tests to confirm that your set-up is running correctly. Section 5.0 is a reference guide for the different settings that can be changed by the user via the DATV-Express users interface.

2.0 – Prepare Lubuntu OS on ODROID

The DATV-Express requires the ODROID and the hardware board to perform all of the DVB-S processing. The ODROID will send the processed TS stream to the DATV-Express hardware board via USB2 connection. See **Figure 1** below for a block diagram of a typical DATV-Express transmitter set-up (shown for DVB-S protocol).

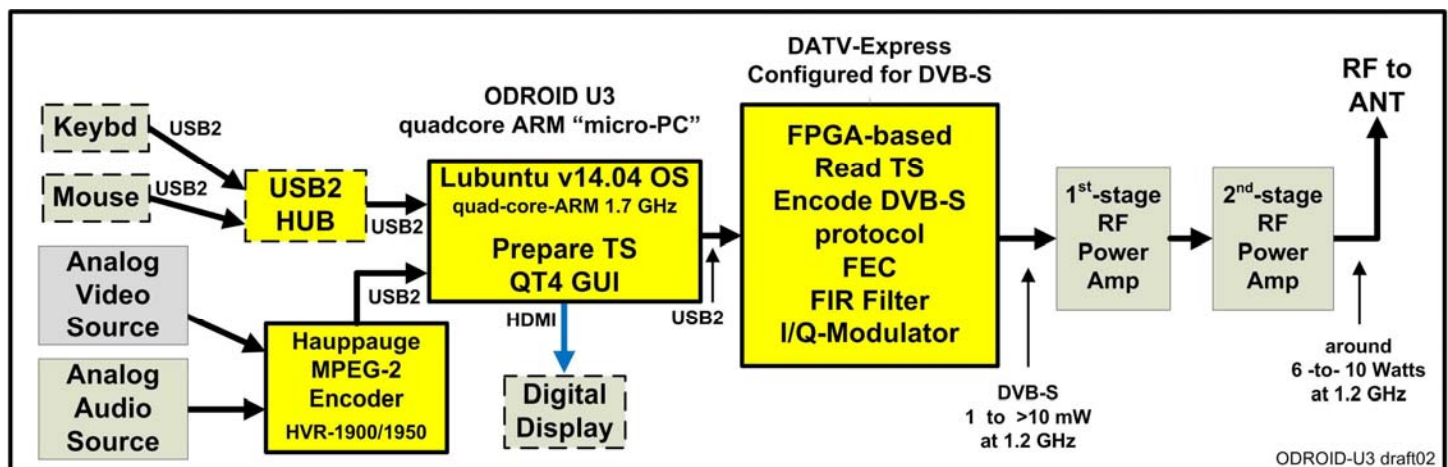


Figure 1 – Block Diagram of typical DATV-Express DVB-S transmitter set-up with ODROID



Figure 2 – Size of quadcore-ARM ODROID-U3 board is about the same size as Raspberry Pi

Currently the DATV-Express software for the ARM-based ODROID only runs on the Ubuntu version 14.04 LTS Operating/System (OS). I recommend that you purchase a micro-SD chip with the Ubuntu already loaded from HardKernel when you order your ODROID U3 computer. Here are a few details to be aware of:

- The micro-SD chip purchased from HardKernel comes ready to use....just a few configuration steps.
- The project team does NOT recommend buying the eMMC memory form factor for use on the ODROID U3. (The adhesive tape used to hold the eMMC module securely in place makes it extremely difficult to remove eMMC module if you want to re-flash it.)
- Section 6.5 guides you to make a backup copy of the HardKernel image that you purchased...in case you ever “brick” the original micro-SD chip. With the backup image file, you can reflash the original micro-SDI, or flash to another micro-SD chip. The micro-SD chip needs to be 8 GB or larger and a “class 10” speed.
- Section 6.6 guides you how to download a Ubuntu flash image file from the HardKernel web site (www.HardKernel.com) so that you can flash it to a new micro-SD card as a spare.

2.1 Just install the micro-SD memory card on ODROID U3 and boot

The micro-SD card does NOT come installed on the ODROID board from HardKernel. Follow these steps to install Lubuntu on the board and to power up and to configure ODROID U3 for the first time.

- **Figure 3** shows the bottom side of the ODROID U3 computer. The connector slot for inserting the micro-SD card with Lubuntu already on it (see Section 2.0) is on the right-side of the card.
- Install the SD with Lubuntu Ver 14.04 LTS into the connector slot with the micro-SD pins facing towards the ODROID board.
- Before power-up, attach a USB hub into the "vertical USB jack" with mouse and keyboard attached in the hub (see **Figure 4** for location of USB jacks). Powered USB-hubs will probably work best.
- Before power-up, connect a micro-HDMI between ODROID (see **Figure 4**, right-side) and a HDMI display screen.
- It is best to have a 1024 x 768 or 1920x1080 resolution HDMI monitor available for the test below (to allow you to see the enough of the display screen to adjust the ODROID HDMI screen configuration settings in the ODROID Utility tool on desktop, if necessary.)
- Before power-up, attach an ethernet connector (see **Figure 4** for location of RJ-45 jack) or install a USB-based WiFi dongle into the hub. I purchased a power-hog Cisco WiFi USB-unit from HardKernel. But, I prefer to use the tiny WiFi unit purchased from Raspberry Pi. It is tiny, less power, and does not seem to be sensitive to software-failure-by-slight-physical-movements as the Cisco unit.
- Power-up ODROID by inserting the 5V power plug...without DATV-Express HW board connected.
- There is a small "Heart Beat" LED on the top of the ODROID (see right-side of **Figure 4**). It will initially glow a "dim blue" and then change to blinking "bright blue" while the Lubuntu is booting. If the LED does not glow, check that you have inserted the micro-SDI with Lubuntu properly.
- After boot-up is completed, you "may" see a PASSWORD window pop up on initial power-up. Best to leave password blank....If you have already filled in once, this will show up every power-up (this is just a password for log in...not to make you an administrator (aka SU) .)
- Put LXTerminal on the desktop
...go to System Menu -> Accessories -> right-click on LXTerminal
(A friendly aspect of the LXTerminal tool is that it allows the user to select the font size displayed.)

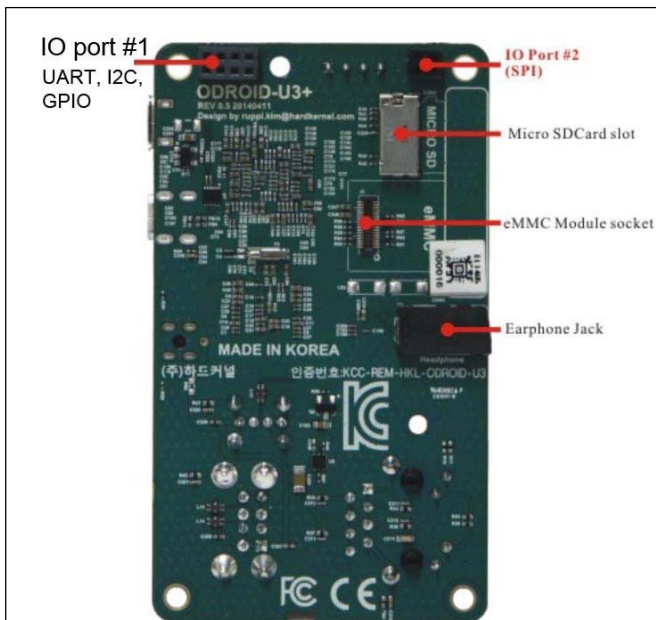


Figure 3 – The bottom side of ODROID U3.
The micro-SDI memory slot is shown on right-side, near the top

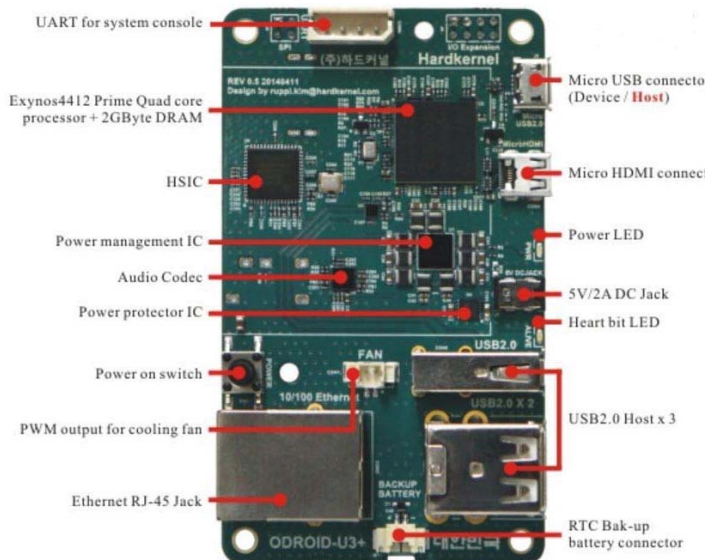


Figure 4 – The top side of the ODROID U3 board.
The Heatsink on top of the Exynos Quad-Core CPU is not shown. Three USB2 connectors are shown on right side, near bottom.

- Connect by either ethernet or WiFi to the internet and make a connection....test by going to Google. See **Figure 5** for enabling a WiFi connection through a near-by Access Point to the internet.

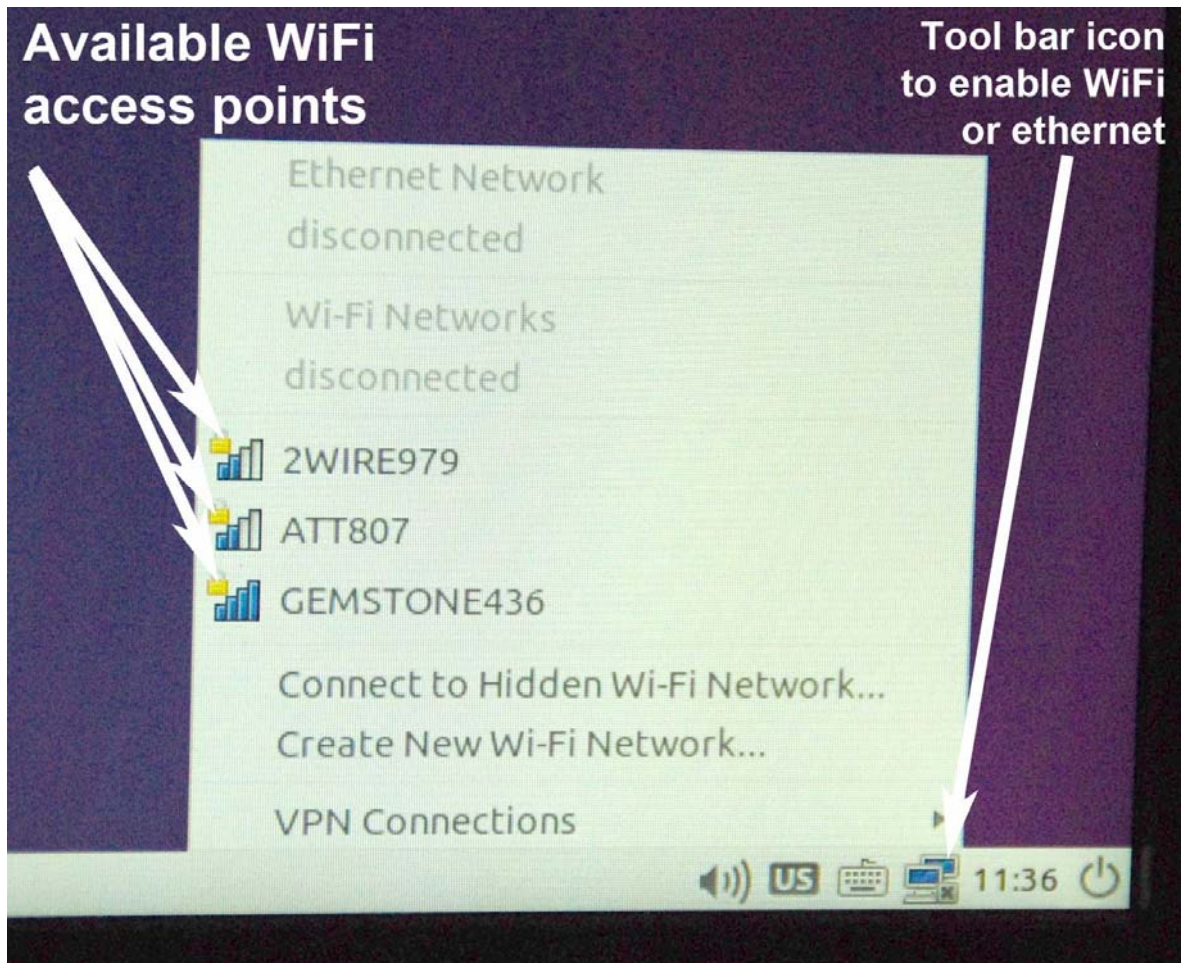


Figure 5 – The Icon to enable the WiFi or ethernet connection to the Internet is NOT obvious

- In the next step (Lubuntu software update), you will need to enter the default administrator password of the ODROID that is found on small 5x7 paper with color photos of the PCBA found in cardboard ODROID box. (password normally is "odroid")
- Allow the Lubuntu OS software do an update....first open ODROID UTILITY (should be on desktop). Exit when the software update that scrolls past the terminal window is done
- Go back and open ODROID UTILITY....select RESIZE ROOT PARTITION. Exit when the **RESIZE** operation is completed.
- Set the time and date on ODROID so that file time stamps are meaningful.
go System Menu -> Sys Tools -> Time-and-Date
(must unlock the window that pops-up.)
- Reboot ODROID (for the flash memory partition RESIZE to get installed)
- Your ODROID U3 with Lubuntu installed should now be ready to use.

3.0 - Install DATV-Express software package using Debian installer

3.1 Using the Software Debian File for First-Time

Debian is the name of a utility to help install the DATV-Express software application package onto Ubuntu. Debian hides much of the tedious complexity from the user during a software install. The name of the Debian utility used by ODROID is GDebi.

- Power-up the ODROID with no DATV-Express connected yet.
- It is **MANDATORY** that the ODROID have WiFi or ethernet access to the internet during the Debian installation. After the Debian install is successful, internet access is optional.
- Please pay attention to **NOTE 1 - Important note on USB access rights....** in Section 3.2. By default a normal Lubuntu user account on Ver 14.04 LTS does not have permission to access a USB device
- Place the ARMhf debian file for DATV-Express software on the desk top (use a USB memory, etc.)
- Double-click on the debian file on the desk top
- The Lubuntu GDebi Package installer utility will open and allow the user to install DATV-Express.
- **NOTE 2 – Different installation messages will appear if you are trying to do a software upgrade instead of a first-time install of software. Go to Section 3.5 for software upgrading.**
- Press the INSTALL PACKAGE button.
- You will be asked to enter your administrator password for Lubuntu to install the software
- A bar will begin to show activity during the INSTALL...called PROGRESS.
- A notice should appear to announce "INSTALL FINISHED".
- When installation is FINISHED...close the GDebi installer window.
- Verify to make sure the installation was successful by looking for "DATV-Express" to be listed in System Menu -> SOUND-and-VIDEO as shown in **Figure 6**.



Figure 6 – The System Menu can show if the DATV-Express is now listed inside the SOUND & VIDEO category

3.2 Verifying USB Access Rights with Lubuntu 14.04 LTS

NOTE 1 - Important note on USB access rights when using Lubuntu 14.04 LTS....

- By default on 14.04 LTS, a normal user account does not have permission to access a USB device.
- So if you are using Lubuntu 14.04 LTS, it is best to just inspect a USB Access Rights system file the first time you are using DATV-Express on Ubuntu by following the steps in Section 3.2.1 and 3.2.2.

3.2.1 First open a LXTerminal mode window

- The linux Terminal mode window might remind DOS users of the old “DOS-box”
- The Lubuntu Terminal window is used to type in OS commands to the operating system...one command at a time.
- The Terminal mode icon does NOT appear automatically on the right hand side of the desktop after you have installed first Lubuntu...you should have placed it on the Desktop during by following the steps in Section 2.1 and dragging it where you want it to be handy.

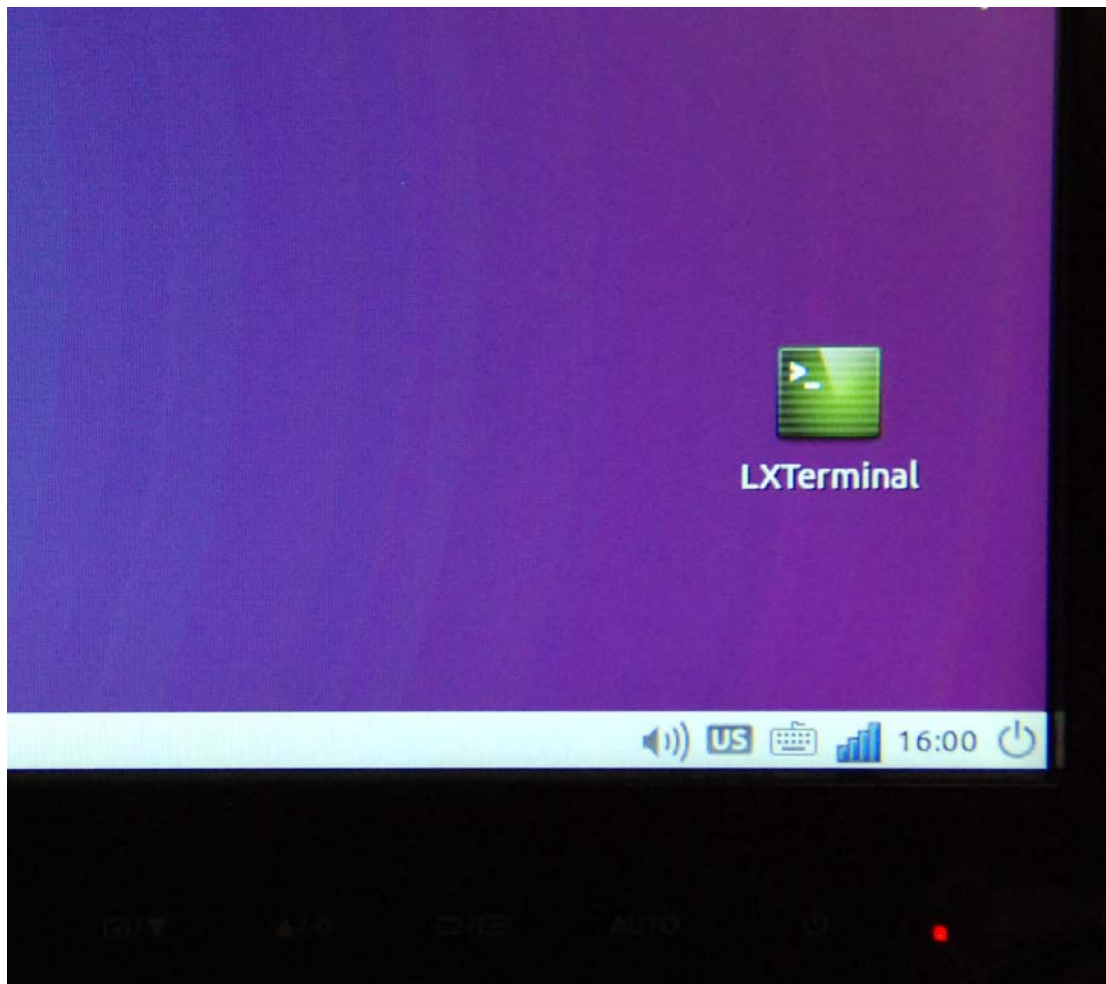


Figure 7 – The Desktop is a good location to keep LXTerminal handy to use for opening the TERMINAL mode.

3.2.2 Use TERMINAL mode to edit system file

- In order to add USB access-control rights, the parameter you may need to modify is the **MODE** parameter Inside the system file `/lib/udev/rules.d/50-udev-default.rules`
- Double-click on the TERMINAL application icon (shown in **Figure 7** after you have dragged the icon to your toolbar on your desktop). Alternatively, the user can right-click on LXTerminal and select OPEN.
- Open this file with LEAFPAD editor tool in terminal by typing in:
`sudo leafpad /lib/udev/rules.d/50-udev-default.rules`
and then press the ENTER key. See **Figure 8**.
- NOTE – for those who are curious:
 - The “SUDO” linux command allows the user to assume the rights of a “Super User” (aka root user) for a single command
 - “LEAFPAD” is a “graphical TEXT editor” tool used by ODROID Lubuntu



Figure 8 – TERMINAL mode command-line window while typing the “sudo leafpad” command

- The “leafpad” editor window will open the system file as shown in **Figure 9**.

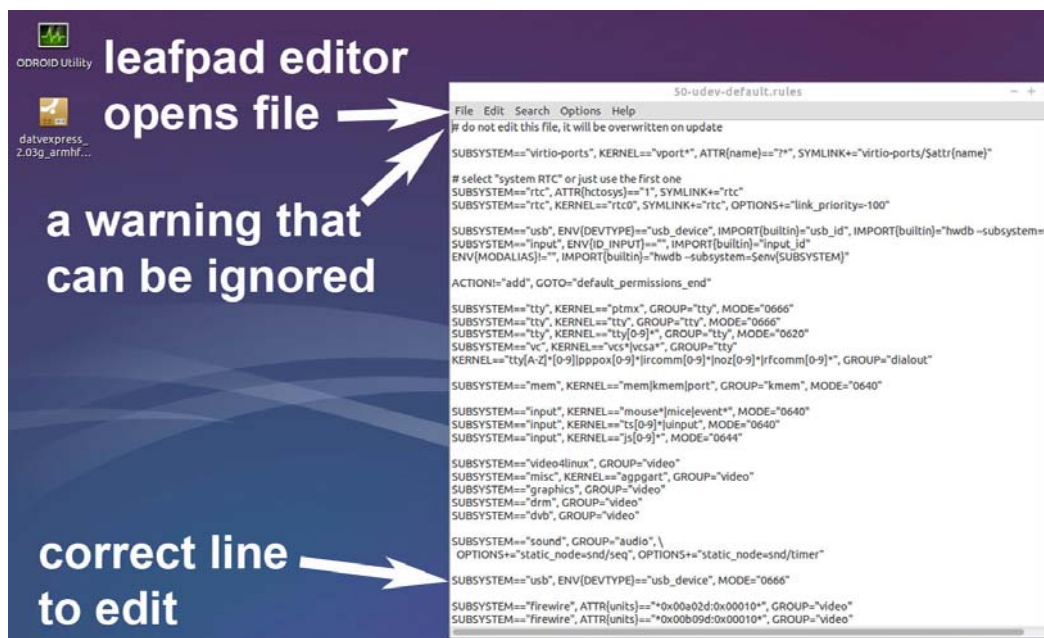
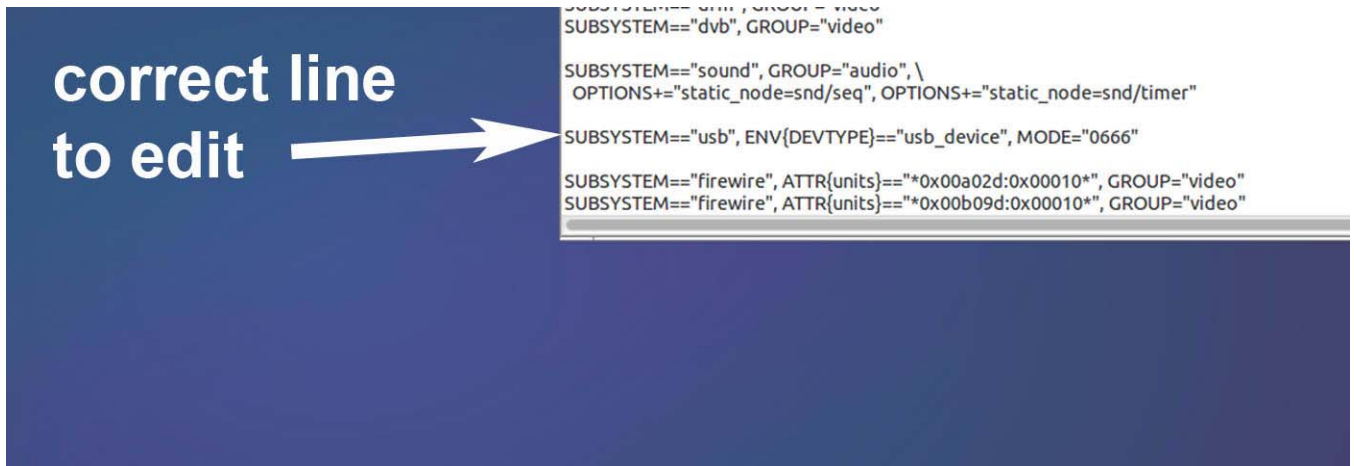


Figure 9 – LEAFPAD tool window showing the open 50-udev-default.rules system file

- Please IGNORE a warning message while saving that says “Do not edit this file. Root is owner. It will be overwritten...” that is shown in **Figure 9**.
- Now edit the **MODE** values to `SUBSYSTEM=="usb", ENV{DEVTYPE}=="usb_device", MODE="0666"` See **Figure 10**.



**Figure 10 – Edit this line so that
value of MODE="0666"**

- Save the `50-udev-default.rules` file after the edit using **FILE -> SAVE**.
- Some error messages you may see when you later connect the hardware board to the PC are similar to “could not open USB device....” and “libusb requires write access to USB device nodes”, or “DEMO Mode – board not connected”,
- Finally, another symptom of improper USB access rights is that most of the LEDs do NOT light up when you finally attach the hardware board and start-up the DATV-Express program in Section 5.4. The additional LEDs do not light because the board software has not been downloaded via USB to the board.

3.3 Running DATV-Express Software for First Time

- At this point you DO NOT connect either board or video-capture card attached to the PC. Without the hardware board or video-capture unit, the DATV-Express software application will start up in the DEMO mode...to tell you it is running.
- Start the DATV-Express software application file by going to the system menu: Sys Menu -> SOUND & VIDEO then single-click of the listing DATV-Express (see **Figure 6**)
- If the software application is working well, the DATV-Express MAIN user window should appear in DEMO mode, as shown below in **Figure 11**.

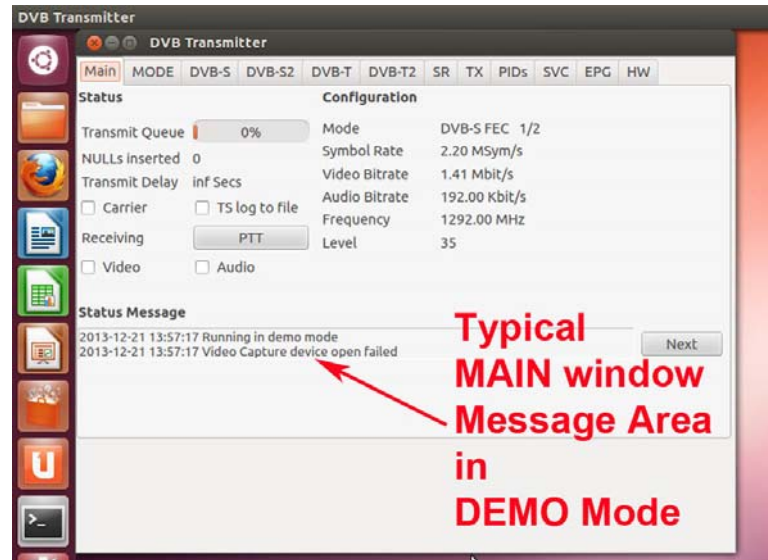


Figure 11 – MAIN user window showing DEMO MODE without either hardware board or video-capture

- If you want to confirm the version number of the DATV-Express binary file that you are running, look in the ABOUT screen. In the open MAIN user window, “mouse-over” cursor along top bar (to the right of the words “DVB Transmitter” until the HELP link appears. Open the HELP link to open the ABOUT screen.
- If everything is working OK...then (1) close the DATV-Express software application, then (2) turn OFF power on ODROID by asking Ubuntu to SHUT DOWN, and finally (3) remove the DC from ODROID.
- Now you are ready to hook-up the hardware and perform initial tests in **Section 4.0**.

3.4 If you have Trouble opening/running the DATV-Express software

NOTE 4 – if you double-click on the DATV-Express software Program binary file on the desktop (in Section 4.3) AND then are **ASKED FOR A PASSWORD**, then you may have started DATV-Express software previously from the TERMINAL box while using SUDO. In that case, you must delete the configuration file **datvexpress.cfg** from the hidden **.datvexpress** directory.

- Complete the following steps:
 - Uninstall the DATVEXPRESS debian installation (using Ubuntu SOFTWARE CENTER)
 - Start up the PCmanFM HOME DIRECTORY graphic file manager tool (to right of Sys Menu)
 - “mouse-over” cursor along top bar until you see VIEW...and click the SHOW HIDDEN FILES entry in pull-down list (you will need to enter root password to see hidden files)
 - Open HOME folder-> open the .datvexpress folder
 - Delete the file called **datvexpress.cfg**
 - Reinstall the v2.03 debian package without using sudo this time....just double-clicking on the desktop v2.03 debian file.]

Another trouble-shooting approach if you launch DATV-Express to start up...but the User Interface in **Figure 11** never appears...is to start the DATV-Express binary in the terminal mode.

- Open the LXTerminal tool shown in **Figure 7**.
- Just type DATV-Express at the command line
- If there are any error messages on starting DATV-Express, they will be displayed in the terminal window and perhaps will suggest the cause of failure.

3.5 Upgrading your installed DATV-Express Software

Occasionally you may want to upgrade your DATV-Express software file to begin using a newly release feature or bug-fix. When newer debian files are available, these upgrades can be downloaded from the **DOWNLOADS** area on the DATV-Express web site (See **Section 8.2**)

- It is MANDATORY that the ODROID provide Wi-Fi or ethernet access to the internet during the Debian installation. After the Debian install is successful, internet access is optional.
- Consider renaming the newer debian file for the software build number...to allow you to keep track of which file is for which version? For example: datvexpress_2.03_armhf.deb
- The best way to remove the existing DATV-Express binary file to trash is to use the REMOVE PACKAGE button in shown in **Figure 12**.
- Then Double-click on the new debian file on the desk top
- The Lubuntu GDebi will open and display that the DVB TRANSMITTER app is installed See **Figure 12**.

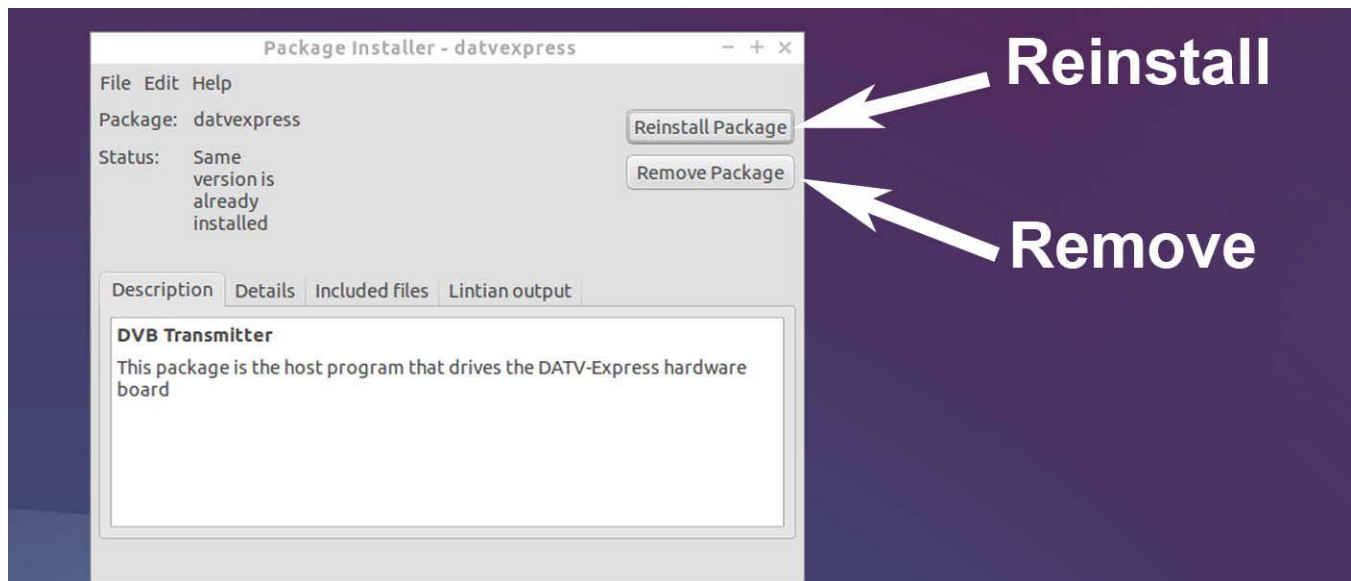


Figure 12 – Lubuntu GDebi Package Installer screen for Upgrading Software

- A pop-up will ask you to enter your administrator password for Lubuntu to install the software
- A wheel will eventually begin to spin in the menu bar to show activity...called PROGRESS.
- A green-checkmark should re-appear to announce “INSTALLED” and the far-right button will now offer REINSTALL as shown in **Figure 12**.
- Close the Lubuntu APPLICATION INSTALLER window.
- The easiest way to launch the DATV-Express package is to Start the DATV-Express software application file by going to the system menu:

Sys Menu -> SOUND & VIDEO then single-click on the listing DATV-Express (see **Figure 6**)

4.0 - Hook-up the DATV hardware and Test

4.1 Here is what you need

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 board
- An ODROID model U3 “micro-PC” with appropriate Ubuntu Operating installed and the necessary 5V/2A DC power supply.
- An HDMI display monitor connected from the ODROID to display by a micro-HDMI adapter cable
- 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 Hauppauge model PVR-350 or HVR-1900/1950 video-capture card (See SPEC in Section 8.0 - Required Computer components)
- A PAL or NTSC video camera
- RCA-type cable to connect the camera to the Hauppauge video-capture unit.
- A Set-Top-Box (STB) connected to some form of display (a TV set or computer) or receiver for the DVB protocol desired. 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 to checkout if the board and software are working as expected.

4.2 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 6.13 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.

4.3 Second test – connect the hardware board and start DATV-Express SW

- NOTE – do NOT connect the Hauppauge video-capture unit during this test
- Power OFF the 12V power supply.
- Connect the USB2 cable between the PC and J1 on the hardware board
- Power ON the ODROID
- After ODROID boots up, power ON the 12V power supply for the DATV-Express board
- LED 4 should light (5.5 V on-board DC-to-DC power supply)
- Start up the DATV-Express software by Sys Menu -> SOUND & VIDEO then single-click on the listing DATV-Express (see Figure 6)

- No additional LEDs should be ON. NOTE an LED is ON if it glows as brightly as LED 4.
- The normal user display window on the ODROID should announce DEMO mode as in photo below.

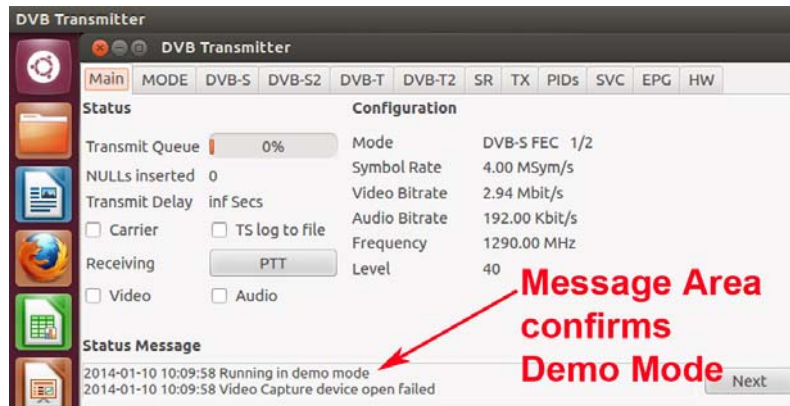


Figure 13 – The MAIN Tab message area confirms that the Software is running in the DEMO Mode

4.4 Third test – now connect video-capture to the PC

- Start by exiting the DATV-Express software, powering OFF the board 12V power supply and the ODROID power...including pulling out the 5V DC plug from ODROID.
- Connect the Hauppauge video-capture unit to the PC by an unused USB2 connector
- Connect the camera cables to the VIDEO and at least one AUDIO jacks on the Hauppauge unit
- Power ON the camera
- Power ON the Hauppauge unit (wall-wart?)
- Power ON the ODROID
- When Ubuntu is displaying the desktop, power ON the 12V power supply
- Start the DATV-Express software application file using the System Menu (See **Figure 6**)
- Go to the HW Tab (see **Section 5.10**) set the Video Capture Device field as in **Fig 25**) and hit APPLY.
- Now in the HW Tab (see **Section 5.10**) also set the Video Input field to “composite” (or whatever you choose to use) and hit APPLY. Exit the DATV-Express software and then restart the software for the video changes to take effect.
- 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.]
- If everything is working OK at this point, the User window on the ODROID display should show a message similar to that shown below....NO LONGER announcing that the software is in the DEMO mode.

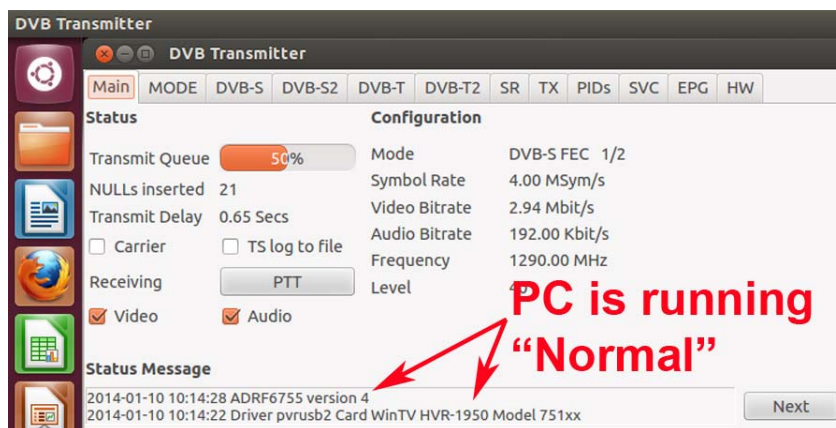


Figure 14 – The MAIN Tab message confirms that Software is no longer running in DEMO Mode

- **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. Check that **NOTE 1** in Section 3.2 has been implemented. Also, perform a list of USB devices command on the PC (lsusb command).
- Open the TERMINAL box and type in the “lsusb” command (that is: “list USB devices”).
- **Figure 15** shows a typical successful list of USB devices.

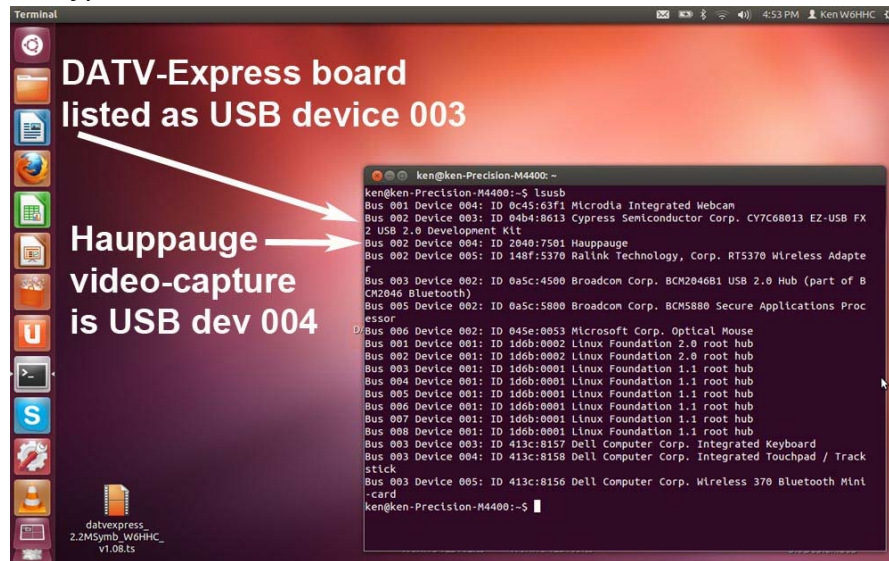


Figure 15 – Terminal mode window showing typical “lsusb” listing that contains both hardware board and Hauppauge video-capture

- If everything is OK...then close the DATV-Express software application, turn OFF power on the 12V power supply , and turn OFF power on ODROID by asking Ubuntu to SHUT DOWN

4.5 Fourth test – Transmitting DATV video

- Choose in your mind, the ham band you want to use, the exact frequency, and DATV protocol (for example: DVB-S or DVB-T) that you want to transmit on.
- Set-up (A) a nearby 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.

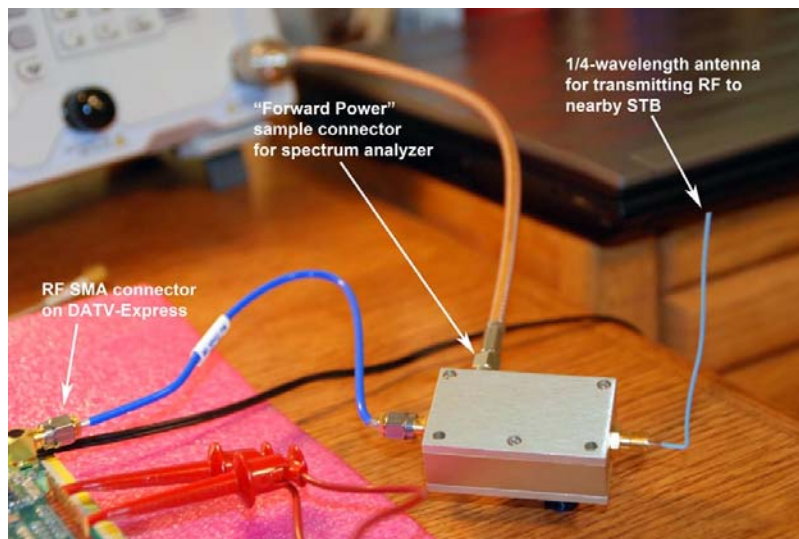


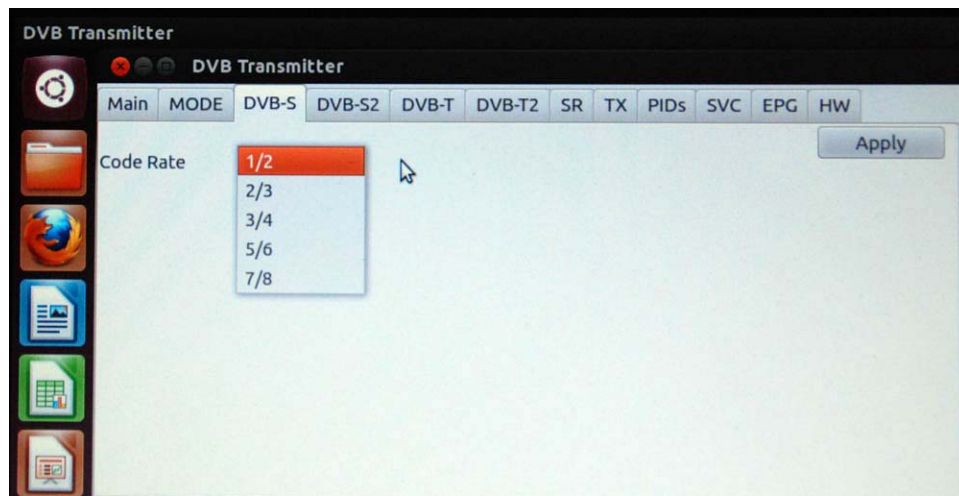
Figure 16 - a microwave “directional-coupler” is used to sample some RF energy for the Spectrum Analyzer (shown antenna is for 1.2 GHz band)

- 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 Hauppauge unit (wall-wart?) and the camera
- Power ON the ODROID
- Power ON the DATV-Express board. Just LED 4 will be light at this point.
- Double-click on the DATV-Express software application file 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 DATV-Express software to the exact protocol that you are using. This manual will walk you through a DVB-S test. Other protocols will differ slightly, but you should be able to see the path of a typical set-up by studying the DVB-S procedure.
- Go to the TX Tab in the DATV-Express program window. (See section 5.6)
 - o Edit the TRANSMITTER FREQUENCY field in the TX Tab window to the exact center frequency you plan to transmit....for example 1292000000 in the 1.2 GHz/23 cm band
 - o Edit the TRANSMITTER LEVEL field to the RF output level you want to try...for example **20**
 - o Click on the APPLY button to send these values to the software
- Go to the SR Tab in the DATV-Express program window. (See section 5.5)
 - o Select the Symbol/Rate that your STB is set to receive?
 - o Choose the radio-button closest to your desired SR
 - o You can place the cursor inside one of the fields and enter a value (if none of the default values are correct).
 - o Click on the APPLY button to send these values to the software
- Go to the MODE Tab in the DATV-Express program window. (See section 5.11)
- Select the correct protocol by selecting the DVB-S protocol (or DVB-T protocol)
- 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, open the MAIN Tab on the computer screen. The TRANSMIT QUEUE should be active between 3% and 90%. Click on the large PTT button...and the RECEIVING mode next to PTT, should change to TRANSMITTING.
- Hopefully you will see an RF signal appear on the receiver or the spectrum analyzer. If you are using a DVB-S STB or DVB-T STB, you will see video...if everything has been set up for your STB correctly.

5.0 - DATV-Express GUI Reference Guide

Section 5 walks the reader through the function of the controls of each of the TABS shown in the user interface window.

5.1 – DVB-S Tab



**Figure 17 – Window for the DVB-S Tab
displaying various FEC settings that can be selected**

5.1.1 Forward Error Correction (FEC)

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

5.1.2 APPLY

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

5.2 – DVB-S2 Tab

[Note that the DVB-S2 protocol is not fully tested in this software release.]

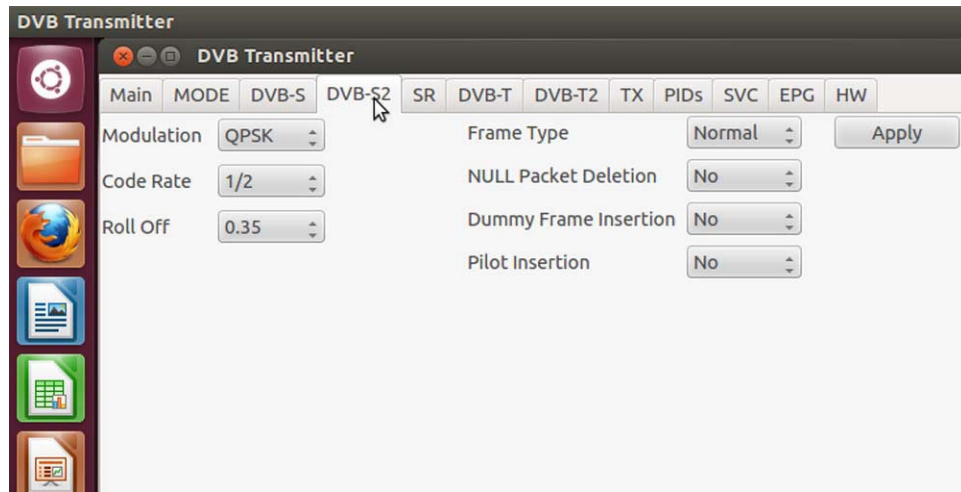


Figure 18 – Window for the DVB-S2 Tab

5.2.1 MODULATION

Choose QPSK, 8PSK, 16APSK, or 32APSK modulation technologies from the pull-down menu.

5.2.2 CODE RATE (FEC)

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

5.2.3 ROLL OFF

Etc.

5.2.4 FRAME TYPE

Etc.

5.2.5 NULL PACKET DETECTION

Etc.

5.3 – DVB-T Tab

[Note that not every feature of the DVB-T protocol implementation has been fully tested.]

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 will not be further supported.

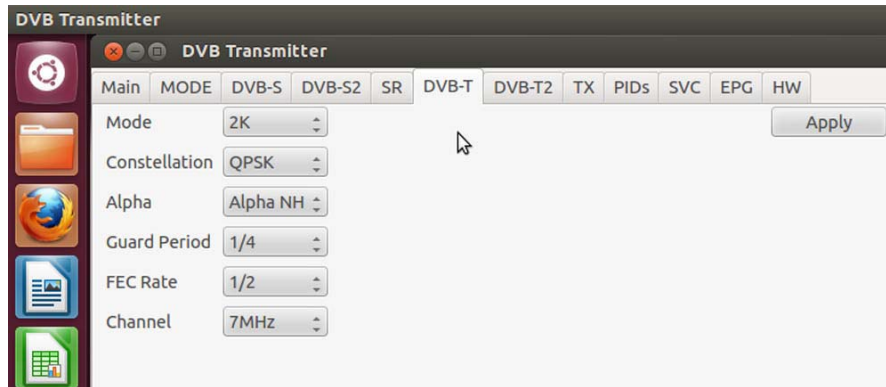


Figure 19 – Window for the DVB-T Tab

5.3.1 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 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 will not be further supported.

5.3.2 CONSTELLATION

Choose QPSK, 16QAM, or 64QAM modulation technologies from the pull-down menu.

5.3.3 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.

5.3.4 FEC RATE

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

5.3.5 CHANNEL

Allows choosing the RF bandwidth of the desired channel that you desire from the pull-down menu. Although the menu says that you can choose from 8, 7, 6, 4, 3, 2, or 1 MHz bandwidths. **The current DATV-Express V2.03 software for ODROID is currently only capable of running in the 1 MHz channel bandwidth mode.** When selecting 2 MHz bandwidth or higher, at least one of the quad-cores of the CPU will go into saturation and not be able to keep up with the required workload.

5.3.6 APPLY

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

5.4 – DVB-T2 Tab

(This tab is reserved for future software implementation)

5.5 – SR (Symbol-Rate) Tab

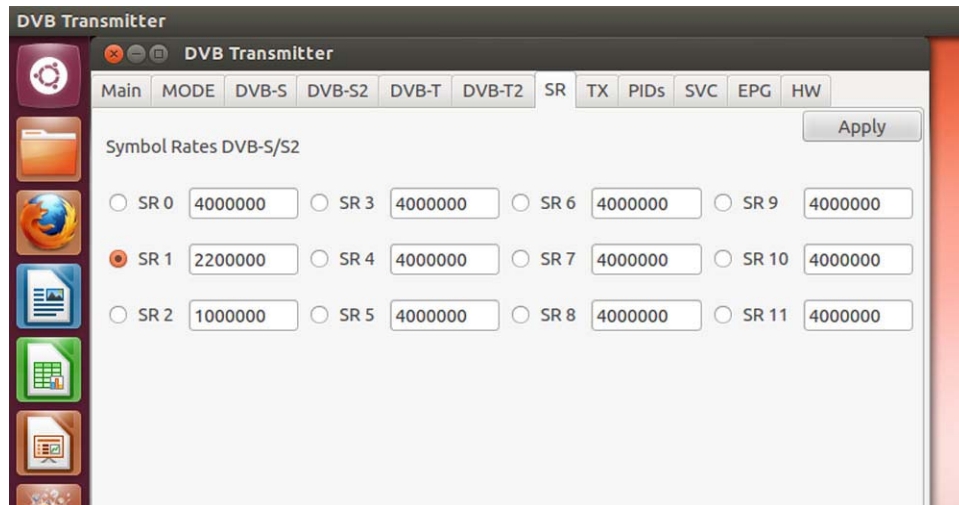


Figure 20 – Window for the Setting Symbol-Rate

5.5.1 Symbol Rate (SR)

Select the RADIO BUTTON that contains the Symbol Rate that is closest to what you plan to use. You can edit that SR field to the exact Symbol Rate that you plan to use on your STB or Receiver.

5.5.2 APPLY

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

5.6 – TX Tab

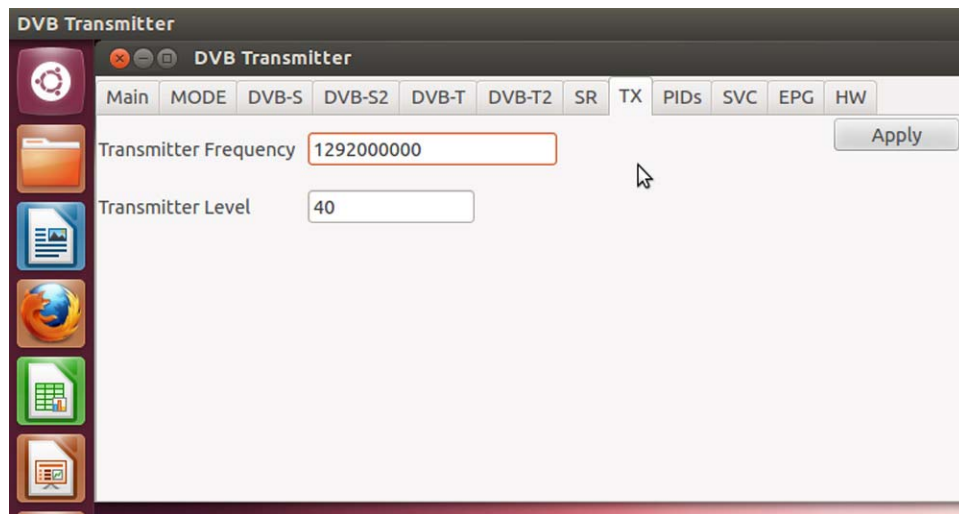


Figure 21 – Window for the TRANSMITTER Tab

5.6.1 TRANSMITTER FREQUENCY

Enter the desired frequency for the transmitter. The units in this field are Hz.

5.6.2 TRANSMITTER LEVEL

The DATV-Express PC software program allows values from 0-through-47 to be entered in this field to control 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 17 dBm. Some boards show a little distortion (spectral regrowth, aka "shoulders") occurring at output level values set to higher than 35-to-40.

5.6.3 APPLY

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

5.7 – PIDs (Packet IDs) 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.

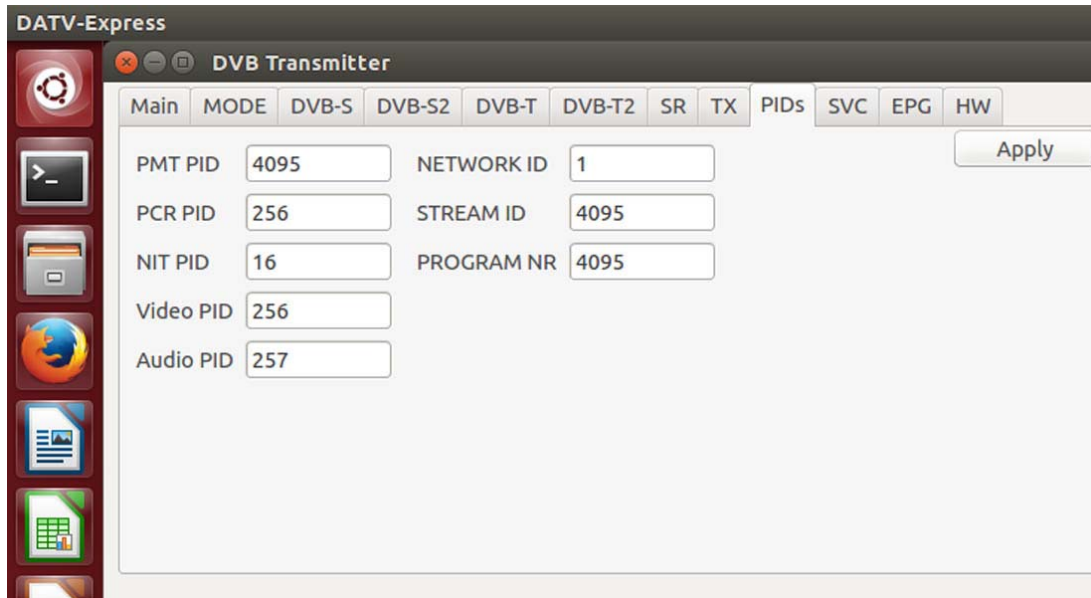
The image shows a software window titled "DATV-Express" with a sub-tab "DVB Transmitter". The window has a sidebar on the left with icons for various functions. The main area contains the "PIDs" tab, which is active. It features several input fields for configuring PIDs: PMT PID (4095), NETWORK ID (1), PCR PID (256), STREAM ID (4095), NIT PID (16), PROGRAM NR (4095), Video PID (256), and Audio PID (257). An "Apply" button is located in the top right corner of the main area.

Figure 22 – Window for PIDs Tab

5.7.1 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 APPLY button to save the new value.

5.7.2 PCR PID

The PCR PID is the Packet ID associated with the Program Clock Reference (PCR) field that is carried as a separate stream to help synchronize audio and video. The PCR PID is typically set to the same value as the Video PID. The default value is 256 (decimal).

5.7.3 NIT PID

The NIT PID is the Packet ID associated with the Network Information Table (NIT). The Network Information Table is specified in the MPEG-2 standard (ISO/IEC 13818-1), section 2.4.1, as an optional Program Specific Information (PSI) table, but the syntax of the NIT is left for others to specify. The default value is 16.

5.7.4 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 APPLY button. 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.

5.7.5 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 APPLY button.

5.7.6 NETWORK_ID Field

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.

5.7.7 STREAM_ID Field

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).

5.7.8 PROGRAM NR 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. The default value is 4095 (decimal).

5.7.9 Typical PID Values

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

5.7.9.1 DATV-Express Recommended PIDs

- PMT PID 4095 (decimal).
- VIDEO PID 256
- AUDIO PID 257
- PCR PID 256 (DATV-Express v2.01 automatically sets this PID to equal same as Video)
- NIT PID 16
- NETWORK_ID 1
- STREAM_ID 4095
- PROGRAM NR 4095

5.7.9.1 BATC Forum DigiLite Suggested PIDs

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

5.7.10 APPLY

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

5.8 – SVC (Program INFO) Tab

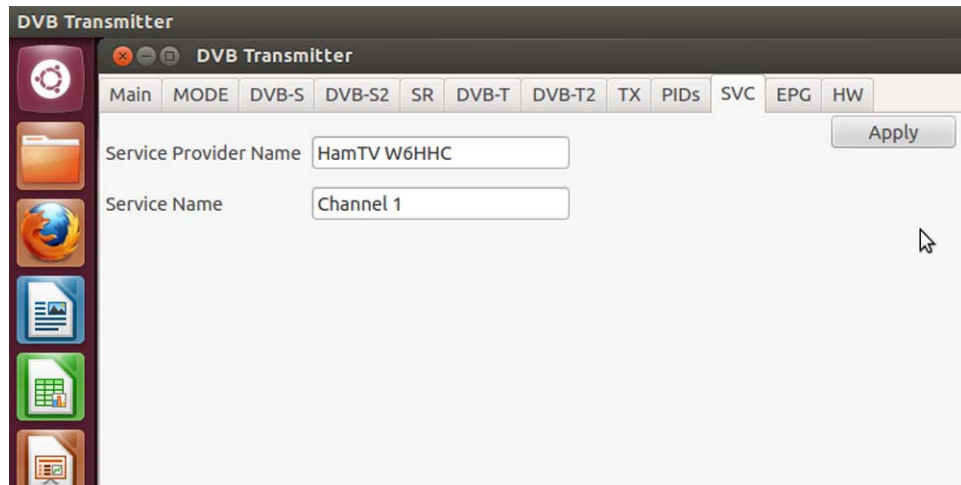


Figure 23 – Window for the SVC Tab

5.8.1 SERVICE PROVIDER NAME

The name of the ham station or organization providing the content is entered in this field.

5.8.2 SERVICE NAME

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

5.8.3 APPLY

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

5.9 – EPG (Electronic Program Guide) Tab

DVB Electronic Program Guide information typically are available for commercial television transmissions and consist of a digitally displayed, non-interactive menu of broadcast programming scheduling information shown by a satellite TV provider to its viewers on a dedicated channel. The Electronic Program Guide (EPG) feature of DVB transmissions provides receiving DATV stations with the ability to see what programs are planned for the channel they are watching. [Note – you should confirm how your STB displays time. A default for STBs appears to be displaying the UTC time zone. Edit the UTC offset or enter your local time to achieve the STB displaying your local time zone.]

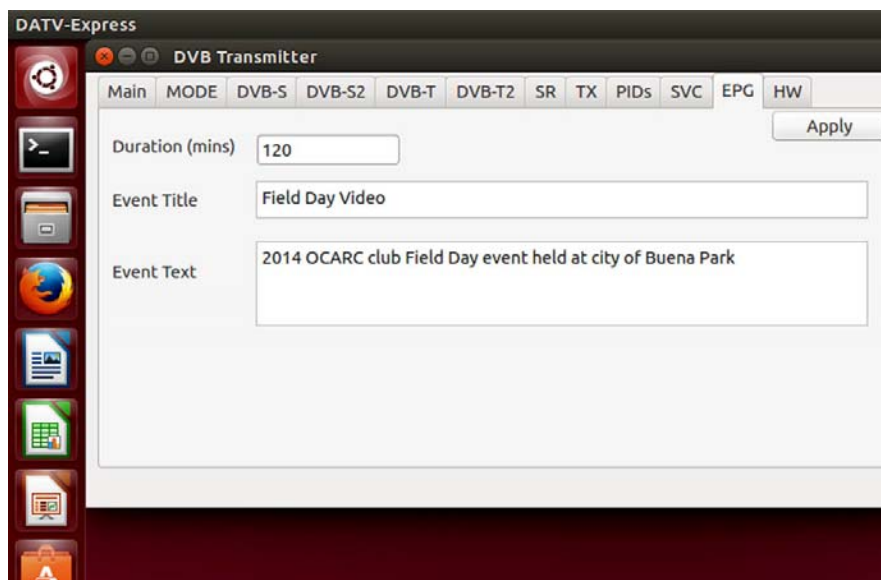


Figure 24 – Window for EPG Tab

5.9.1 DURATION (MINUTES) Field

The DURATION field sets the times shown for an EVENT in the GUIDE (EPG) listing shown by the STB. 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.

5.9.2 EVENT TITLE

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

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

5.9.2 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:

“2014 OCARC club FD was held in the city of Buena Park”

5.9.4 APPLY

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

5.10 – HW (HARDWARE) Tab

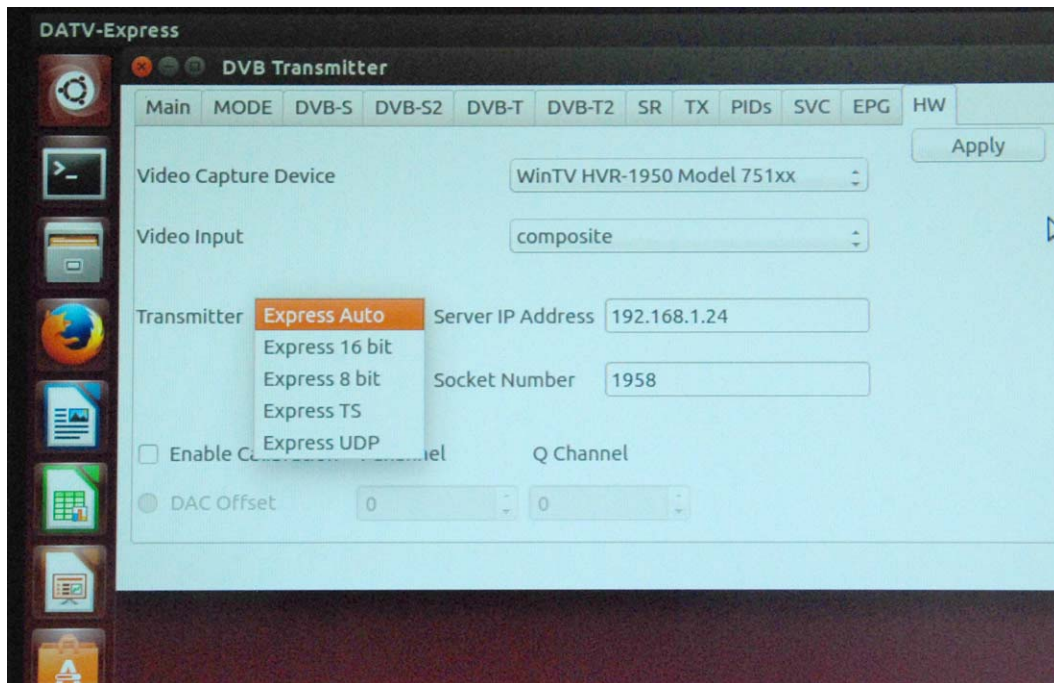


Figure 25 – Window for the HARDWARE Tab

5.10.1 VIDEO CAPTURE DEVICE

This field is intended to identify your video capture card for the DATV-Express board. The Ubuntu operating system will probably default to Dev 0 device number which may be a web camera, etc. Use the pull-down menu to find the video-capture card you want to use. In **Figure 25**, the **WinTV HVR-1950 Model 751zz** driver is being correctly displayed. If needed, you can perform a list devices command (i.e. **ls /dev** from your home directory) using the Ubuntu TERMINAL box to obtain a list of all devices. If the wrong video device is selected here, you will most likely see “Demo Mode” and “CAP” errors (video capture errors and audio capture errors) listed in the MAIN window message area.

5.10.2 VIDEO INPUT SELECTION

Selects among the ports output streams on the Hauppauge device composite input, TV input. The most important choice normally for the HVR-1900/1950 USB2-based video-capture unit (listed below) are to set the VIDEO INPUT selection to “1” for the composite-video of your PAL/NTSC camera.

- **0 = Television Tuner input**
- **1 = Composite-video input**
- **2 = S-Video input**

The PCI-card models of Hauppauge, such as PVR-150, PVR-300, PVR-350, and PVR-500 are not compatible with the ODROID U3...no PCI connector is available.

5.10.3 TRANSMITTER

This pull-down menu allows you to choose between **EXPRESS-AUTO**, **EXPRESS 16-bit**, **EXPRESS-8-bit**, **EXPRESS-TS**, and **EXPRESS-UDP** selections.

- **EXPRESS-AUTO** allows the software to choose the best setting to use. Novices should always use the AUTO mode, only experts should use the TS or 8/16 bit modes. AUTO is the default mode.
- **EXPRESS 16-bit** provides IQ samples is normally selected to when sending IQ samples to the board.
- **EXPRESS 8-bit** IQ samples can be selected to reduce the load on the USB interface by 50% and is good enough for DVB-S and DVB-S2
- **EXPRESS TS** selects the Transport Stream format for the USB interface, and only works with DVB-S to allow the FPGA chip coding on the DATV-Express board will do the entire DVB-S encoding function. This mode must NOT be selected for DVB-T or DVB-S2.
- **EXPRESS UDP** outputs UDP packets (not fully implemented yet)

5.10.4 ENABLE CALIBRATION (Checkbox)

This check box enables the DAC OFFSET adjustment below. The CARRIER SUPPRESSION feature requires an external narrow band receiver (for example FM), or spectrum analyzer, or an external directional-coupler that is connected to the board RF output and sampling a rectified signal back to connector J4, pins 11 and 12.

5.10.4.1 CARRIER SUPPRESSION ADJUSTMENT

Differences in component values used in the I stream can be slightly than those in the Q stream, and also the gains between the I gain and the Q gain in the modulator IC can have differences. These differences can result in an unwanted carrier being transmitted (rather than suppressed). By adjusting the DAC OFFSET, the differences can be minimized.

- 1) it does not matter what mode is set on MAIN Tab
- 2) Go to Hardware Tab and select **ENABLE CALIBRATION** check box and the **DAC GAIN** checkbox. As soon as you select **ENABLE CALIBRATION** checkbox, the board goes into calibrate mode, there is **NO NEED to click APPLY or to use the PTT.**
- 3) Tune a nearby NB receiver (e.g. FM) or a spectrum analyzer to the frequency set in MAIN Tab
- 4) Measure the S-meter signal strength of the carrier??
- 5) Adjust the DAC GAIN settings a bit...hit APPLY(?) and observe change in signal level on the receiver
- 6) Repeat step 5 until you obtain the lowest signal strength on the receiver.
- 7) When you uncheck the ENABLE CALIBRATION check box, the calibration values are saved.

5.10.5 SERVER IP ADDRESS

The DATV-Express software has a built-in server that waits for network input from a client that can provide a Transport Stream (TS). The **SERVER IP ADDRESS** field allows you to select the IP address that you want the server to operate on to work across a network.

5.10.6 SOCKET NUMBER

This field allows you to enter the socket number you want to associate with the SERVER IP ADDRESS in order to send a TS to the board.

5.10.7 APPLY

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

5.11 – MODE Tab

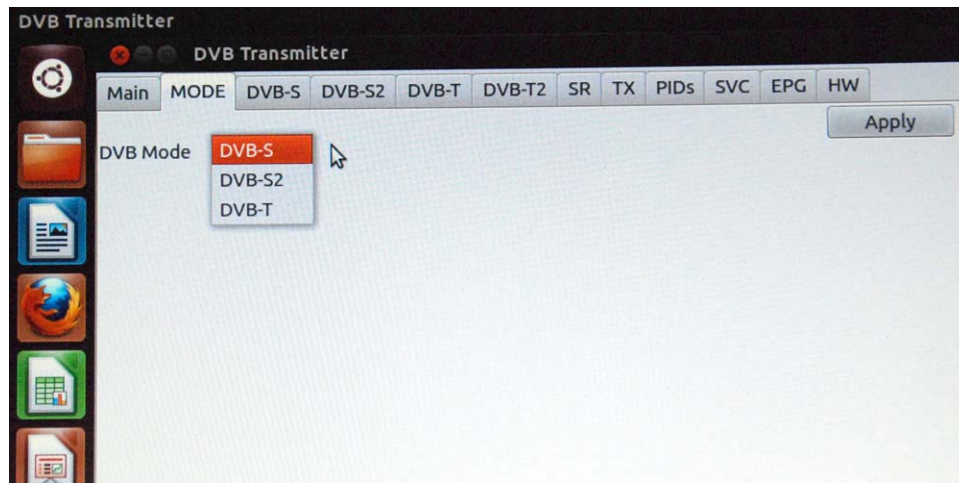


Figure 26 – Window for the MODE Tab

5.11.1 DVB MODE

This pull-down menu currently allows you to select either DVB-S, DVB-S2, or DVB-T protocols.

5.11.2 APPLY

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

5.12 – MAIN Tab

The MAIN window is where you will operate your transmitter once all of the modes and configurations have been set-up in other GUI windows. The MAIN window displays the set-up values, provides a PTT button as well as has a message window.

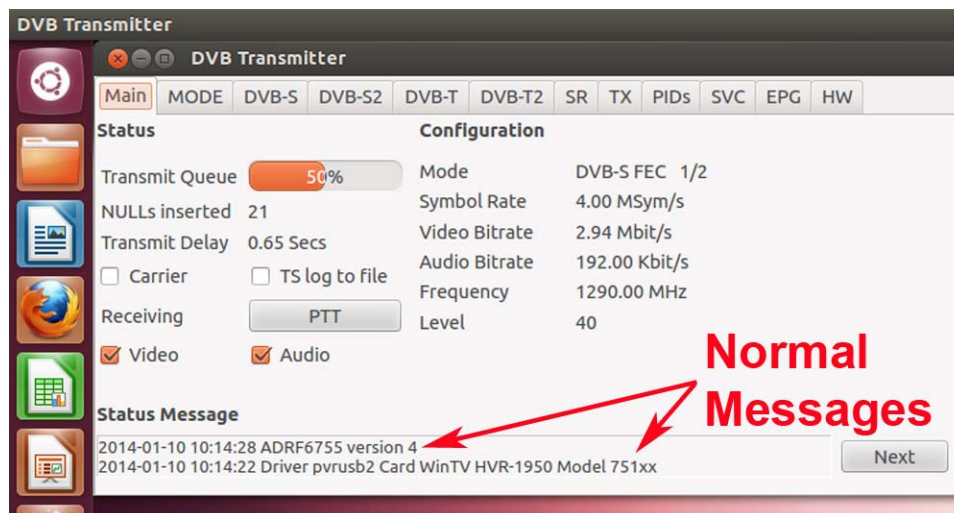


Figure 27 – Message area of MAIN display showing normal running

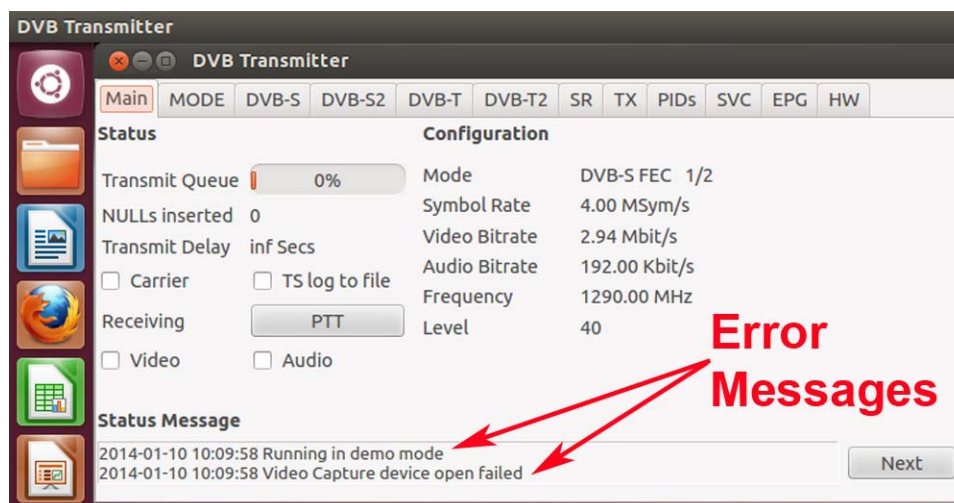


Figure 28 – Message area of MAIN display showing error-condition messages
(The Video-Capture card is not plugged into USB port.)

5.12.1 TRANSMIT QUEUE

5.12.2 NULLS INSERTED

5.12.3 TRANSMIT DELAY

Etc.

5.12.4 CARRIER (Checkbox)

The CARRIER check box can be enabled to transmit an unmodulated carrier signal instead of a DATV signal. If the CARRIER 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.

5.12.5 TS LOG TO FILE (Checkbox)

Whenever this check box is clicked, the DATV-Express software immediately begins to capture the Transport Stream (TS) to a disk drive .ts file. The TS file will be logged independent of the PTT function. The .ts file is called “datvexpress.ts” and will be found in your computer HOME Folder.

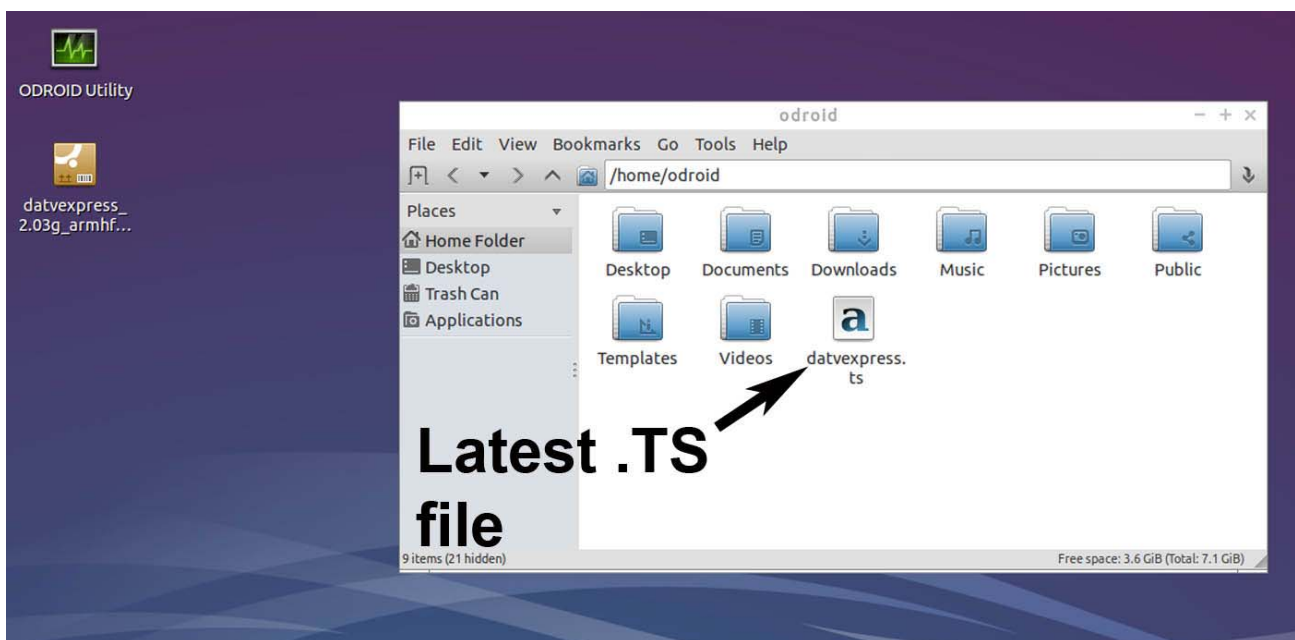


Figure 29 – The latest TS file will be stored in the HOME directory as seen here using the PCmanFM file manager

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 LOG. The file can then be moved or copied to your desktop.

You can watch the TS file played back using a program like GNOME MPlayer on Lubuntu (look in the Sys Menu under SOUND & VIDEO) or Windows Media Player on Windows. The details of the TS file can be inspected using an analyzer like DVBinpector (free). NOTE that VLC is not yet available for ARM-based computers like ODROID with Lubuntu.

5.12.6 PTT (Button)

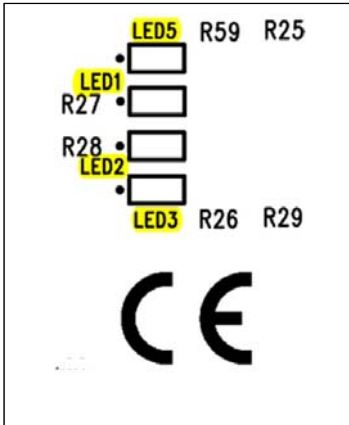
The PTT button can be clicked to alternate between RECEIVING and TRANSMITTING modes.

5.12.7 Video Bitrate

The Video Bitrate value displayed on the MAIN Tab confirms what rate the DATV-Express software has requested from the video capture unit.

5.13 – Board LEDs

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



**Figure 30 – identification of the four LEDs
in lower-right hand corner of PCBA**

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

LED 5 – is ON when the FPGA has been loaded and is successfully performing flow control

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

5.14 – Optional Si570 Symbol Rate chip

The 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 will 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.

6.0 – Useful utilities

6.1 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.

6.2 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 the GNOME Mplayer as the TS player on Lubuntu. The GNOME Mplayer comes installed on Lubuntu 14.04 LTS. NOTE – the VLC player is not yet available for ARM-based computers like ODROID.
- Use Windows Media Player as the TS player on Win7

6.3 CPU performance monitor

There are several free CPU performance monitoring utilities that you can find on the internet for Ubuntu. Try SYSTEM MONITOR or my favorite SYSTEM LOAD INDICATOR that can be found at <https://launchpad.net/indicator-multiload> I usually adjust my monitor to be about 100 pixels wide.

6.4 Tutioune DVB-S analyzer

Tutioune is a new software utility that has been specially developed to provide radio amateurs and DVB technicians with a tool that allows Digital ATV (DVB-S) to be measured precisely. With Tutioune 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 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.

Tutioune 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 Tutioune can be used with a number of DVB-S PCI 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:

- Tutioune1600 for TT S2-1600 you can find it here :
www.vivaDATV.org/viewtopic.php?f=60&t=214
- Tutioune3200 for TT S2-3200 you can find it here :
www.vivaDATV.org/viewtopic.php?f=60&t=276

6.5 Making backup copy of the HardKernel OS image

I find it is a good practice to make a back-up copy of the Lubuntu OS image that I purchased from HardKernel at the same time that I purchased my ODROID U3 board onto a micro-PCI flash memory chip. This way I do NOT have to purchase another micro-SD card from HardKernel if I "brick" my OS (that is: crash the Operating System beyond repair) or just corrupt the OS. By having a copy of the original Lubuntu image file on my Windows computer, I can burn as many copies of the file as I want to either the original micro-SD or a fresh micro-SD chip that I purchased at my local computer store.

A good article on making OS images for the ODROID U3 can be found in the May 2014 issue of the free ODROID Magazine at <http://Magazine.Odroid.com> .

- The speed for the micro-SD cards must be "class 10"
- The HardKernel OS image will be around 6 GBytes. So purchase a new micro-SD card that is at least 8 GB (I have also used 16 GB and 32 GB...but these take a longer time to read and write during this back-up process.)
- Download the ODROID recommended **Win32DiskImager** SD formatter tool from the SourceForge website...onto your Windows 32-bit computer
<http://sourceforge.net/projects/win32diskimager/>
- **CAUTION – I have observed that the Win32DiskImager copy tool CRASHES my Win7 operating system (classic "blue screen of death") about 50% of the time when I try to start a copy operation!! Please shut down all other applications on your Windows computer BEFORE you launch a Win32DiskImager copy operation...to protect those applications from data corruption. If you experience a crash....the windows "Blue Screen" will eventually allow you to automatically restart your PC. You can start up other Applications after the Win32DiskImager is copy step is running normally.**
- Place the original HardKernel micro-SD chip into a USB-Reader for SD and micro-SD memory chips
- Plug the SD reader into a USB port on your Win32 computer
- You will need ADMIN privileges on the Windows PC to run the Win32DiskImager utility
- Run Win32DiskImager utility
- In the open Win32DiskImager screen, point the utility to where you want to save the OS image that is on the micro-SD card. I use the following file name for the target file on Win32 diskdrive:
ubuntu-14.04.1lts-lubuntu-odroid-u_gold-std-bkup.img
- In the open Win32DiskImager screen, point the utility to the USB SD-reader device that is plugged into your Windows computer.

- Press the **READ** button to copy yyy.img file on the micro-SD chip to your WinPC.
- **NOTE - the WRITE button copies a yyy.img file from your WinPC to the micro-SD chip. Using WRITE now would writeover the real image on micro-SD...a BAD THING**

Now you can WRITE the yyy.img file on your PC disk to a new micro-SD memory chip.

- Place the new target micro-SD chip into a USB-Reader for SD and micro-SD memory chips
- Plug the SD reader into a USB port on your Win32 computer
- **CAUTION – I have observed that the Win32DiskImager copy tool CRASHES my Win7 operating system (classic “blue screen of death”) about 50% of the time when I try to start a copy operation!!**
- **Please shut down all other applications on your Windows computer BEFORE you launch a Win32DiskImager copy operation...to protect those applications from data corruption.**
- You will need ADMIN privileges on the Windows PC to run the Win32DiskImager utility
- Run Win32DiskImager utility
- In the open Win32DiskImager screen, point the utility to the OS image file *on the PC drive you want to copy to micro-SD. You may be named the file something like:

ubuntu-14.04.1lts-lubuntu-odroid-u_gold-std-bkup.img

- In the open Win32DiskImager screen, point the utility to the containing the fresh micro-SD module.
- Press the **WRITE** button to copy yyy.img file on the WinPC to your USB-Reader device
- When the copy operation and the verify operation is completed, you can remove the USB-Reader from the WinPC and then carefully remove the micro-SD chip from the USB-Reader
- On an unplugged ODROID, insert the newly copied micro-SD and power-up to see if it boots exactly like the original image.

6.6 Downloading an OS image from HardKernel

It is also possible to download a back-up copy of the Lubuntu OS image from the HardKernel web site. Once you have downloaded the Lubuntu OS image file onto your Windows computer, you can burn it to a blank (or even previously used) micro-SD flash memory card in the same way as described in **Section 6.5**. As a reminder, a good article on making OS images for the ODROID U3 can be found in the May 2014 issue of the free ODROID Magazine at <http://Magazine.Odroid.com> .

- Download the CHECKSUM tool is md5sums-1.2.zip from ODROID website at:
www.pc-tools.net/win32/md5sums/
- Download the compressed ODROID Lubuntu OS image file (called yyy.img.xz) to a new folder on your Windows-32 machine from
http://dn.odroid.com/4412/Linux/ubuntu-u2-u3/
- The actual file name of compressed image you are looking for will have a filename similar to:
ubuntu-14.04.1lts-lubuntu-odroid-u-20140814.img.xz
- Check the MD5 checksum of compressed .img.xy file to make sure the download is perfect.
- Compare the check sum of compressed file by just opening and the dragging the compressed file onto **md5sums-1.2.exe**
- Extract the yyy.img file from yyy.img.xy compressed file using 7-ZIP utility obtained at:
http://www.7-zip.org/
- Place the uncompressed yyy.img file into a folder where you want to save back-up image files.

Now you can WRITE the yyy.img file on your PC disk to a new micro-SD memory chip.

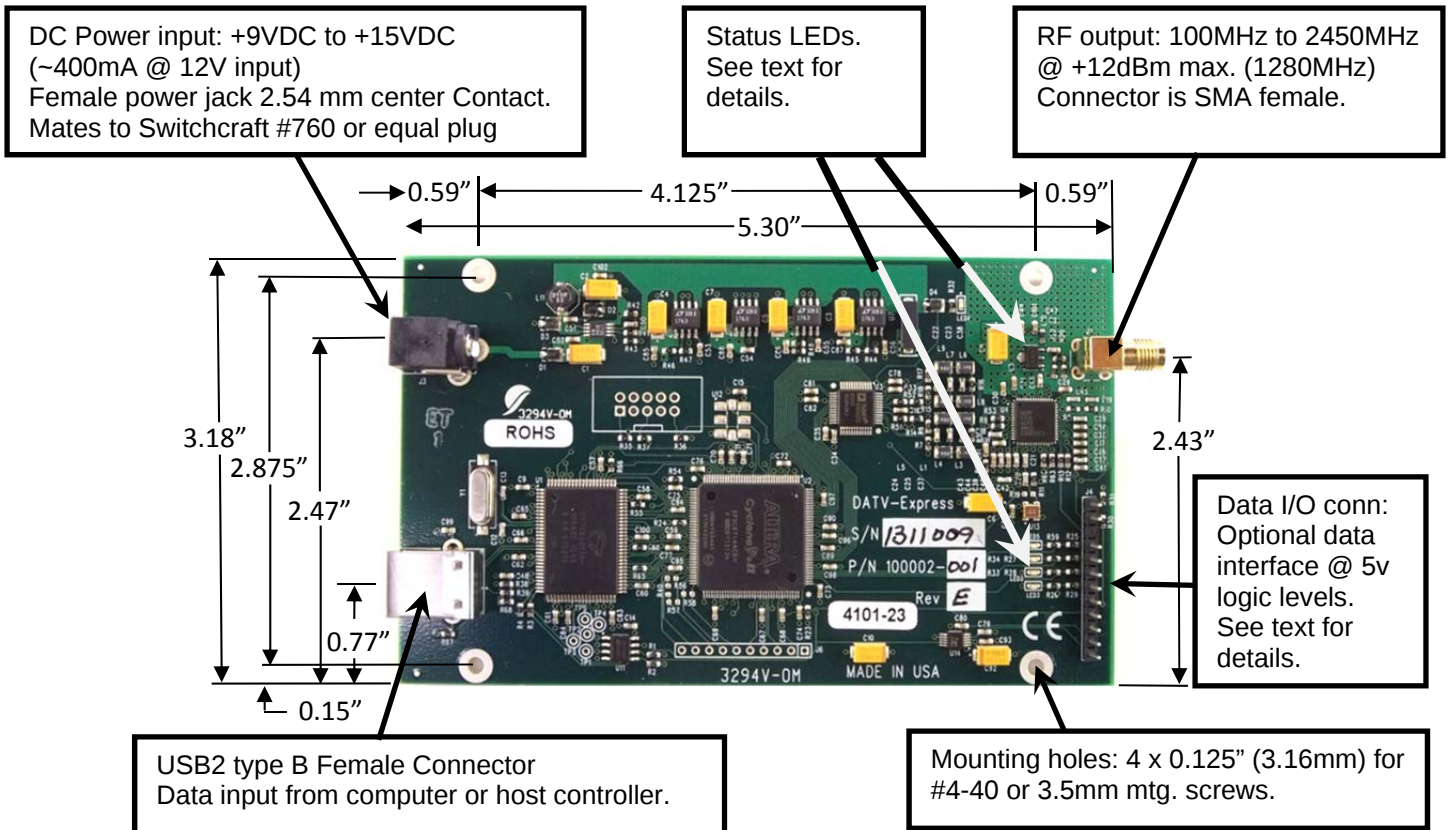
- Place the new target micro-SD chip into a USB-Reader for SD and micro-SD memory chips
- Plug the SD reader into a USB port on your Win32 computer
- **CAUTION – I have observed that the Win32DiskImager copy tool CRASHES my Win7 operating system (classic “blue screen of death”) about 50% of the time when I try to start a copy operation!!**
- **Please shut down all other applications on your Windows computer BEFORE you launch a Win32DiskImager copy operation...to protect those applications from data corruption.**
- You will need ADMIN privileges on the Windows PC to run the Win32DiskImager utility
- Run Win32DiskImager utility
- In the open Win32DiskImager screen, point the utility to the OS image file *on the PC drive you want to copy to micro-SD. Your downloaded image file on WinPC should be named something like:

ubuntu-14.04.1lts-lubuntu-odroid-u-20140814.img

- In the open Win32DiskImager screen, point the utility to the containing the fresh micro-SD module.
- Press the **WRITE** button to copy yyy.img file on the WinPC to your USB-Reader device
- When the copy operation and the verify operation is completed, you can remove the USB-Reader from the WinPC and then carefully remove the micro-SD chip from the USB-Reader
- On an unplugged ODROID, insert the micro-SD with the download image and power-up to see if it boots up to the Lubuntu Desktop.
- More info is coming soon.....!!

7.0 – DATV-Express 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 if possible. 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 the 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 Computer components

Host computer with at least (2) USB2 I/O ports available for DATV-Express

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

Software support requirements

- for DVB-S, Pentium 4 running 2.4 GHz or better, 2GB available hard drive
- for DVB-T narrow bandwidths (2 & 3 MHz), dual-core CPU running 2.0 GHz should be adequate
- for DVB-T 2K mode to use all of the bandwidths, the CPU needs to be a quad-core i7

Operating system - 32 bit or 64 bit Ubuntu (Linux) – Version 14.04 LTS (or 12.04 LTS). Download at www.ubuntu.com/download

Hardware video capture card

- Hauppauge external USB models HVR-1950, HVR-1900, PVR-USB2
- Hauppauge internal PCI-card models PVR-150, PVR-250, PVR-350, PCR-500

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

100MHz to 2450 MHz

Symbol Rate(MSymbols/sec)

Select SR from 1.00 to 9.99 in 0.01steps. (Design is optimized for 2-6 MS/sec). There are 12 preset configurable combinations.

Note: Symbol rates >8.00MS/sec show increased 12MHz sidebands on each side and 35 dB down from center carrier because I/Q low pass anti-aliasing filters are optimized for 2-6 MS/sec. Below 1.5 MS/sec there could be some undesired aliases spurs (also +/- 12 MHz which is the Nyquist sampling frequency), if an interdigital bandpass filter is not used. Video displays will appear to be normal in either case.

FEC

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

Signal quality data

EVM (Error Vector Magnitude) - 2.4%.

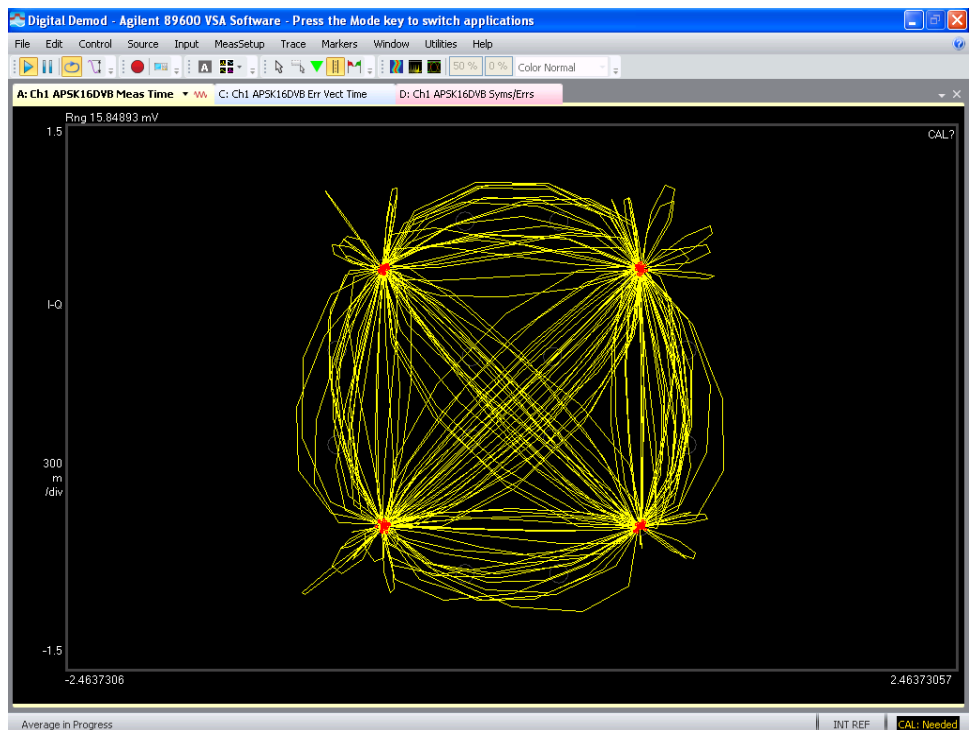
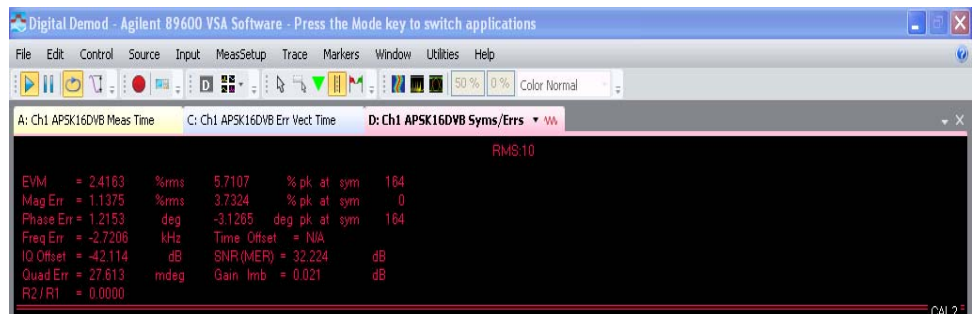
(Measured with Agilent EXA N9010A Signal analyzer – software VSA 89600B).

(≤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 downstream 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 identification

LED1 – I²C activity - BLINK
LED2 – Symbol Rate Counter
LED3 – FX2 OK - ON
LED4 – +5V power - ON
LED5 – PLL locked - ON

Blinks quickly 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.
ON if the USB controller is OK.
ON when +5.5VDC is present.
ON for all normal operation. If OFF, there is a FPGA loading malfunction.

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 50 Ω 1/4w resistor	
2	Tx disable (Gnd to turn Xmit OFF)	(Floats to +3.3V thru 100 Ω for Xmit ON condition).
3	Key (no pin)	
4	PLL locked (LED5)*	(*This data is + true to 3.3V for function indicated. The
5	I ² C activity (LED1)*	outputs are in parallel with LEDs thru a 100 Ω resistor).
6	Symbol Rate (LED2)*	
7	FX2 OK (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	FPGA I/O pin97
4	FPGA I/O pin 96
5	FPGA I/O pin 95
6	FPGA differential -output pin 72
7	FPGA differential +output pin 71
8	FPGA differential - input pin 70
9	FPGA differential + input pin 69
10	FPGA I/O pin 67

Transport Stream

A “transport stream” feature is incorporated in the software to enable signal analysis. When the” **TS log to file**” button 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 log 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: 100MHz 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)

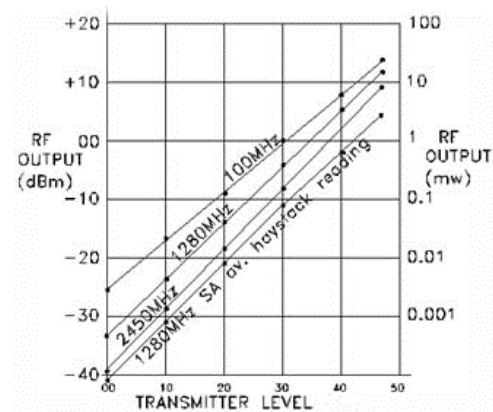
-35dBm to +12dBm in 1dB steps (1280MHz)

-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)

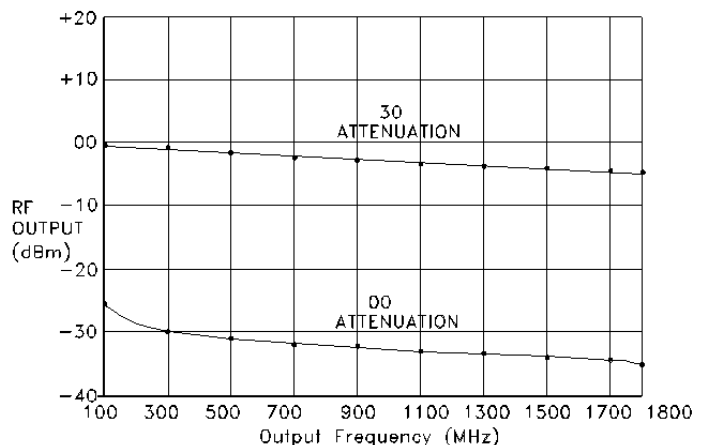
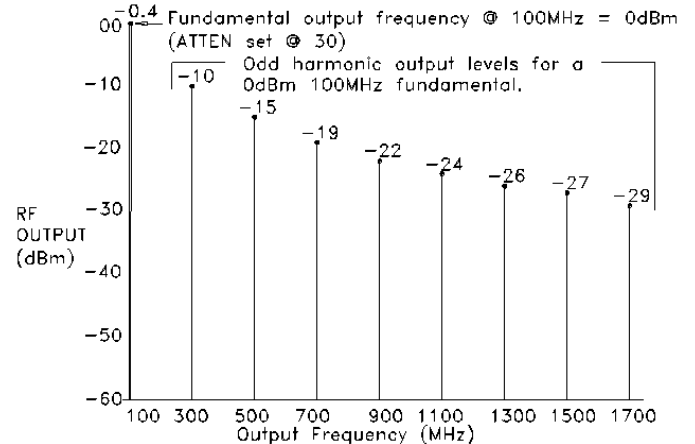


The table above illustrates the RF signal level at 100, 1280 and 2450MHz frequencies verses the internal software controlled RF output settings. An RF output setting of “00” produces the minimum level of RF output from the board and a setting of “35” is the maximum RF level out with no detectable signal 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 in 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:

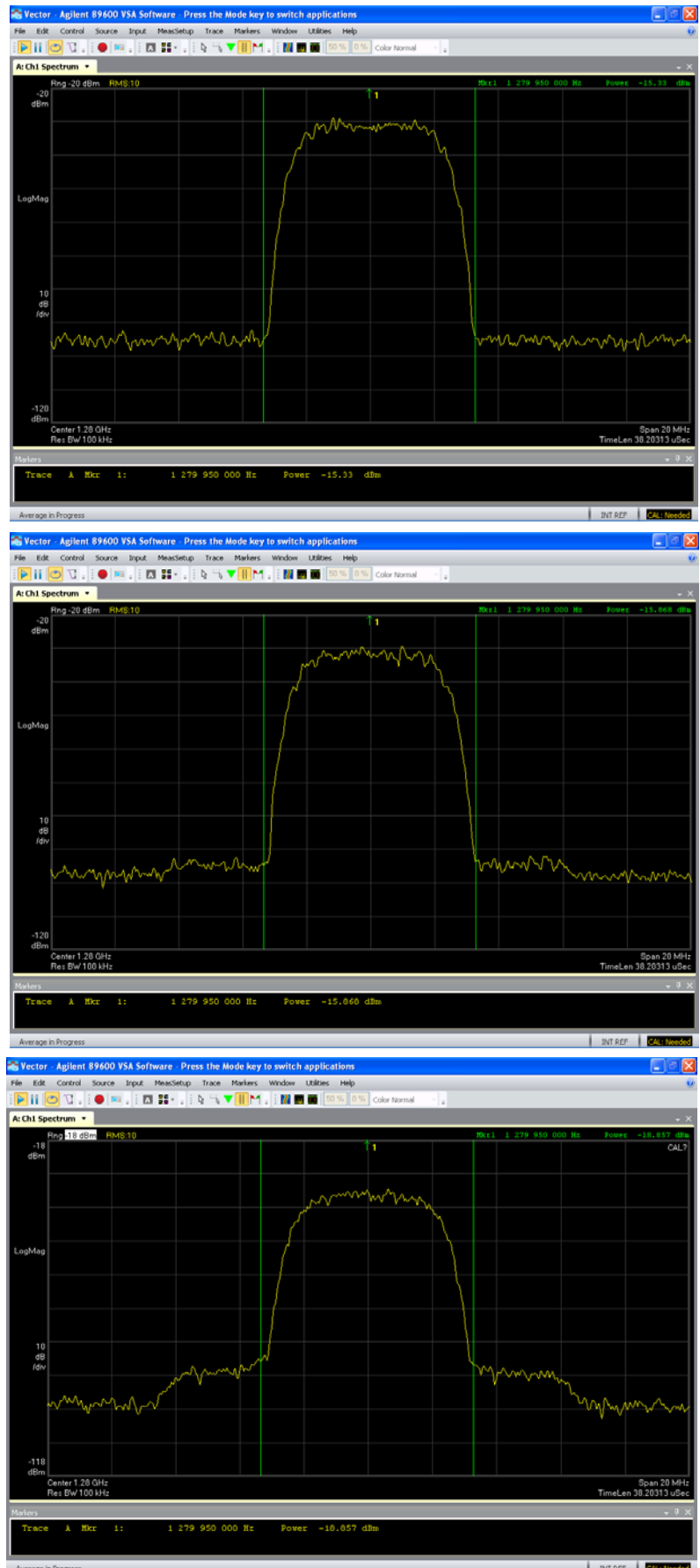
Since the spectral regrowth becomes noticeable when the attenuator output is greater than about 35, the graphs below show the RF output change as it passes through those points. From software-controlled RF output setting 00 to about 35, the regrowth is practically non-existent.

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. Remember, any post signal amplification and (or) filters will tend to add distortion and decrease the overall signal quality.



8.0 – Contacts

8.1 E-Mail

- Art Towslee – WA8RMC Towslee1@EE.net
- Charles Brain – G4GUO G4GUO@ARRL.net
- Ken Konechy – W6HHC W6HHC@ARRL.net
- Tom Gould – WB6P Gould@Gekco.com

8.2 Web Site

www.DATV-Express.com

WebMaster – Bob Tournoux – N8NT

8.3 Product Support

Yahoo Groups Support Forum for DATV-Express

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

You can subscribe by sending an email to:

datv-express-subscribe@yahoogroups.com