TechTalk116

DigitalATV – Using ODROID with DATV-Express board

by Ken W6HHC

In TechTalk109. I discussed how to use the DATV-Express exciter board with an Intel based Linux PC.

In this follow-up article, I will discuss the next stage of the project, which is replacing the PC with a small, more portable, low powered ARM-based board. In particular, I will concentrate on the ODROID model U3 platform."

Figure 1 – Production DATV-Express hardware board for Digital-ATV

After the main Linux DATV-Express software was released earlier this year, the project team looked at the possibility using the following "micro-PC's" to drive the DATV-Express hardware board:
- Raspberry Pi (single-core-ARM based)
- RikoMagic MK802iv (quad-core-ARM based)
- HardKernel ODROID U3 (quad-core-ARM)

ODROID Model U3

The Raspberry Pi and the MK802iv units that were tested with the DATV-Express hardware board and software…each had problems when with our project. The single-core-ARM Raspberry Pi, running at 700 MHz, was underpowered for our particular use. The MK802iv had issues with the completeness of its software repositories…that prevented easily recompiling the linux kernel software. The small ODROID U3 (see **Fig03**), quad-core-ARM CPU running at 1.7 GHz, was tested and proven to be suitable for meeting our DVB-S goals.

Figure 3 - Size of quadcore-ARM ODROID-U3 board is about the same size as Raspberry Pi

Fig02, below, illustrates a typical transmitter set-up for using the ODROID U3 to drive the DATV-Express board in a typical DVB-S operation. This approach uses a USB2-based Hauppauge model HVR-1900 (PAL) or the HVR-1950 (NTSC) to perform video capture
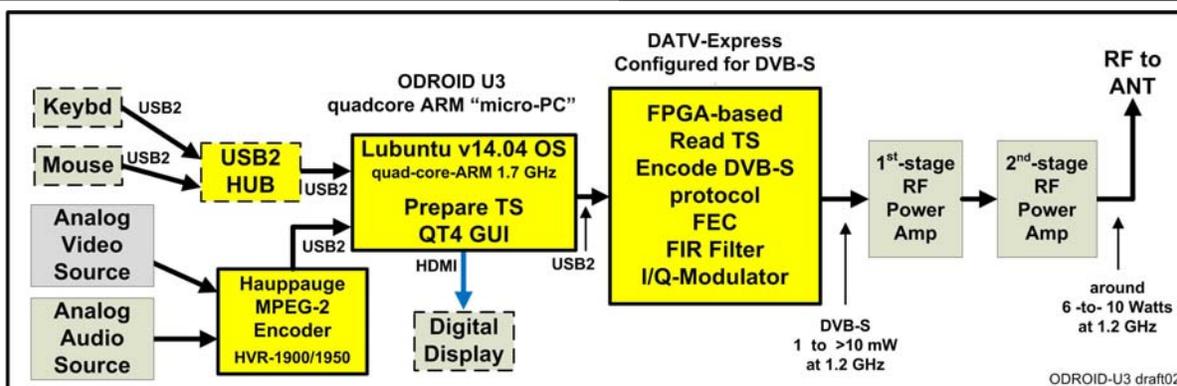

Figure 2 – Typical Block Diagram of ODROID DVB-S transmitter using DATV-Express

and MPEG-2 encoding. The MPEG-2 video and audio elementary streams are sent by a USB2 interface to the ODROID for processing into a Transport Stream (TS).

The first step that project-member Charles G4GUO took to get ready for allowing the software program to work with the "micro-PC" ARM computers was to move the DVB-S protocol processing into the FPGA coding, in order to off-load the processing on the ODROID. The quad-core-ARM is not as powerful as an equivalent Intel quad-core i5 or i7 CPU.
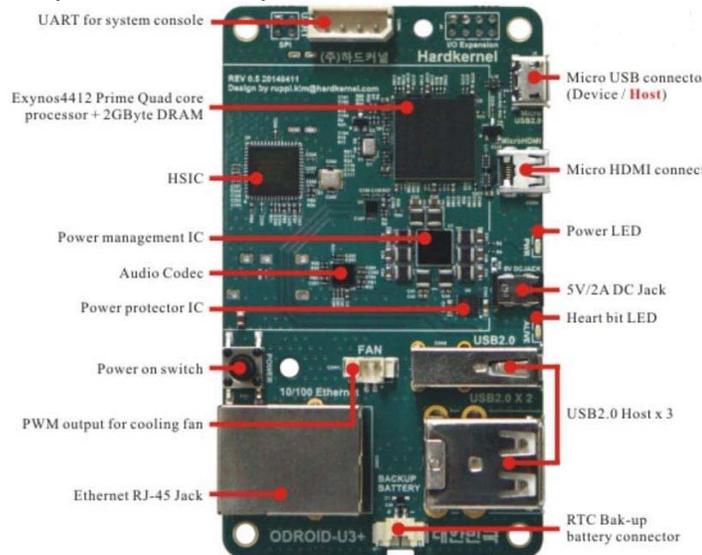

Figure 4 – The top side of the ODROID U3 board. The Heatsink on top of the Exynos Quad-Core CPU is not shown. Three USB2 connectors shown on right side, near bottom.

The ODROID U3 runs with a light-weight version of Ubuntu 14.04 LTS operating system that is called Lubuntu 14.04 LTS. Lubuntu uses a small desk-top-environment called LXDE. It is recommended that the image of the Lubuntu 14.04 LTS OS be placed on a micro-SD memory chip, not the available eMMc memory module. You either need to: (a) purchase a micro-SD from HardKernel with the OS installed …or… (b) just purchase a "class 10 speed" 8 GB (or larger) micro-SD chip from your local computer store, down load the OS image from HardKernel (no cost) and burn the OS image onto the micro-SD chip. Plug the micro-SD memory chip into the slot shown in **Fig05**.

Running ODROID with DATV-Express
The first steps to operate the ODROID are to attach the WiFI or Ethernet connection for the ODROID, leave off the hardware board & Hauppauge cables,
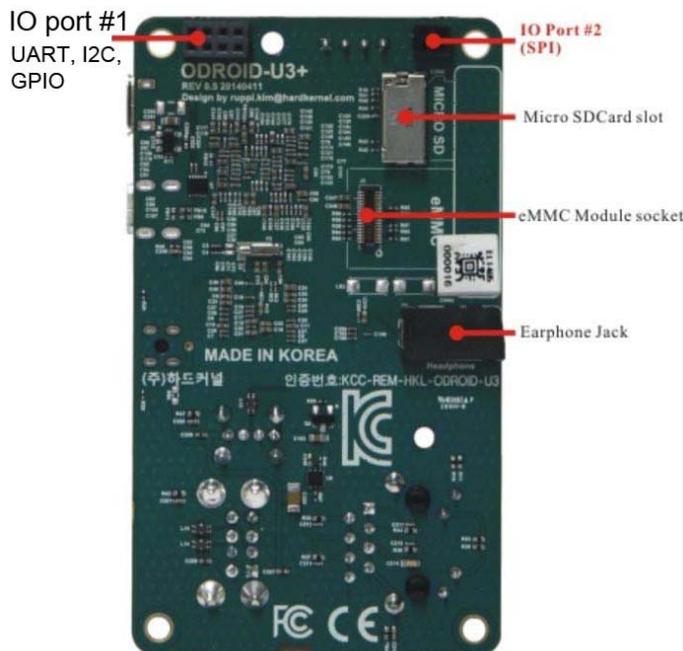
Figure 5 – The bottom side of ODROID U3. The micro-SD memory slot is shown on right side near the top

connect the micro-HDMI-adapter-cable to a display, and connect the power-adapter (wall-wart) to the ODROID to power-up. You should see the ODROID boot-up on the display (with a blinking blue-LED on the ODROID board). At this point it is necessary to enable the WiFi or Ethernet connection to internet. More detailed instructions will be available in the DATV-Express User Guide for ODROID (coming soon to the www.DATV-Express web site.

Place the correct DATV-Express .deb file (for ARMhf) on the ODROID desktop…and double-click the file to install the DATV-Express software. You will need to modify one system file for access rights for USB (same as PC versions) and then you can remove the internet connection and attach the hardware board and Hauppauge video-capture unit.

Testing DATV-Express with ODROID
The DATV-Express software binary can be launched from the System Menu in the lower left-hand corner of the Lubuntu desktop. As shown in **Fig06**, the DATV-Express application is listed in the SOUND & VIDEO area in the system menu. Just click on it and it launches the app.   The DATV-Express graphic user

Figure 6 – The DATV-Express application can be launched from the System Menu of the Lubuntu Desktop

interface (GUI) looks essentially the same (see **Fig07**) as the GUI that displays on the Ubuntu PC installations. The set-up and configuration is also essentially the same….except most operating will use EXPRESS-AUTO mode (in HW Tab) to offload processing from the ODROID for DVB-S operations.
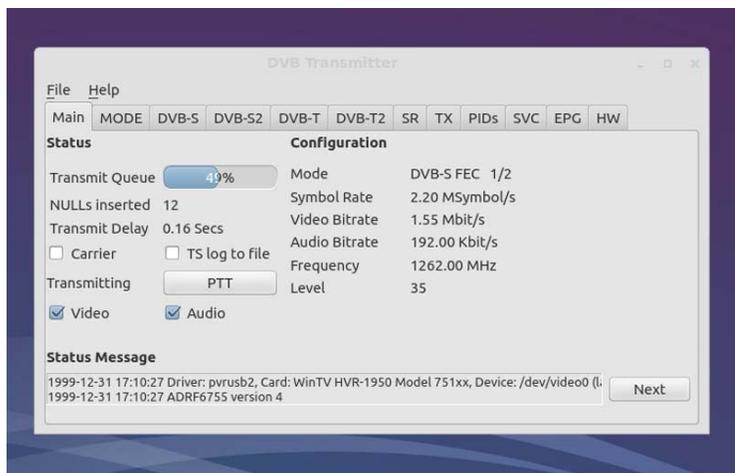

Figure 7 – The DATV-Express GUI for ODROID looks essentially the same as when installed on Ubuntu on a PC

Fig08 shows the ODROID set-up to operate and drive the DATV-Express board (not shown - off to the right). A non-powered USB-hub can be seen to the right of ODROID for connecting a mouse and keyboard. The Cisco USB WiFi unit, purchased from HardKernel, can be seen lying unconnected on the desk to the left of ODROID.
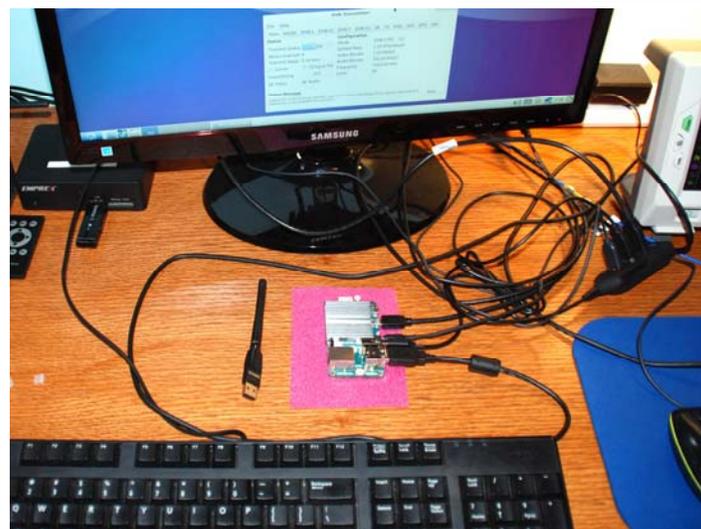

Figure 8 – Set-up to use ODROID U3 to test with DATV-Express board at QTH of W6HHC

Fig09 shows the normal DVB-S "haystack" during "barefoot" testing as displayed on a Spectrum Analyzer. This test was operated on 1262 MHz with a 3 MHz bandwidth (**BW$_{allocation}$**) using 2.2 MSymb/sec Symbol Rate (SR).
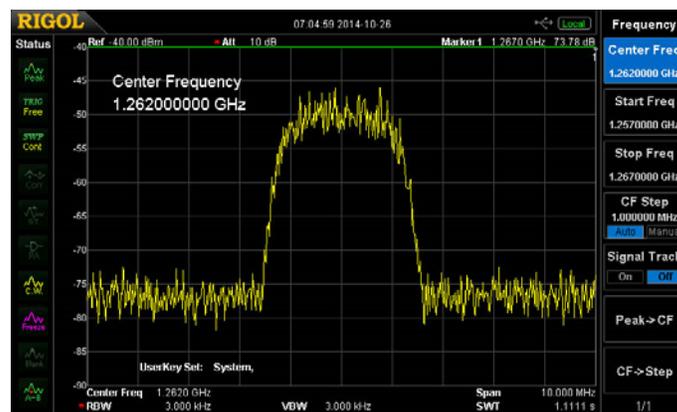
Figure 9 – Spectrum Analyzer display of "Barefoot" testing of DATV-Express exciter board using DVB-S on 1.2 GHz band.

The RF coming from the DATV-Express hardware board driven by the ODROID should not be any different than when the board is being operated with a full-size PC. To confirm this, I hooked up a model MKU-P1301A first-stage RF Power Amp made by Kuhne (in Germany). This RF amp is rated at 1 W (FM) and is the same amplifier that I used to bench test the DATV-Express board driven by a PC. As expected, **Fig10** shows that same reasonably shaped DVB-S "haystack" that was also produced when testing with Ubuntu on a PC.
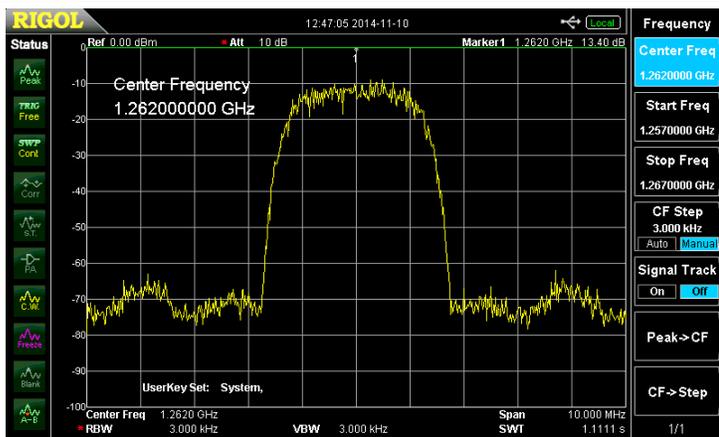
Figure 10 – Spectrum Analyzer display of DATV-Express driving a Kuhne 1.2 GHz RF Power Amp rated at 1W (FM)

The average output power measured in **Fig10** was about 40 mW…enough to easily drive my DownEast second-stage RF PA (30 W FM) on the 1.2 GHz to about 6–to–8 W average power out.

The DATV-Express board was originally designed to just run DVB-S protocol. But, the project team is always curious if it can also run DVB-T. One of the first tests I ran on the ODROID U3 was to try the new 1 MHz bandwidth mode for DVB-T that was added in the v2.03 release of software.
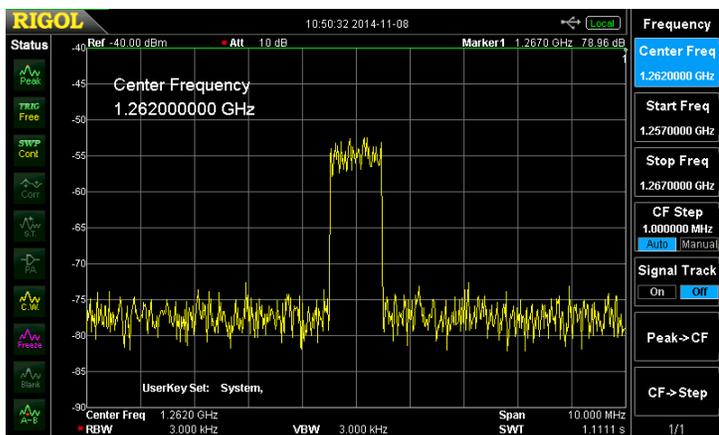
Figure 11 – Spectrum Analyzer of the ODROID driving the Hardware Board in the 1 MHz BW mode with DVB-T protocol. The SA display span is 10 MHz.

Fig11 was taken using QPSK modulation and FEC=1/2. I do NOT have a DVB-T receiver, so I can not view the video quality. With that modulation and FEC setting, the GUI reported the video data rate at about 0.3 Mbps, which would only support a slow video display frame-rate.   If I change the FEC setting to 7/8, then the GUI reports the video data-bit-rate increased to about 0.7 Mbps. Of course, the modulation for the

1 MHz bandwidth mode could be changed to use QAM-16 in order to support a higher video datarate (although with some loss of signal robustness introduced by the increased-modulation-complexity). I also tested DVB-T with QPSK in the 2 MHz BW mode. Using an alpha-test build of the software, one of the four ODROID CPUs was **NOT** able to keep up with the required processing load for the 2 MHz BW testing. Charles G4GUO suspects that further DVB-T load-reduction improvements could possibly be done by rewriting parts of the software in assembly language (but, will not occur soon).

Release of ODROID SW for DATV-Express
The project team plan for ODROID release is to:
1. need to complete the test of the resulting v2.03 installation on ODROID-U3 to make sure that all features work well.
2. A stand-alone ODROID-version of the USER GUIDE needs to be prepared (many Lubuntu screens look different)

My current expectation is that these tasks will all be completed, released, and available on the DATV-Express web site by the end of November.

Possible Future Roadmap with ODROID
The DATV-Express project team recognizes that currently, the Hauppauge approach for video-capture creates two large problems for our project:
(1) The timing on the Hauppauge PCR with a linux driver seems to be very jittery. G4GUO has retimed the PCR and re-stamped the packets, but not perfectly.
(2) Hauppauge has come out with two new HVR models; HVR-1905 (PAL) and HVR-1955 (NTSC) but have not yet come out with the Linux drivers - - creating a DATV-Express problem for buyers of those new models.

Alex OZ9AEC has been experimenting with a Logitech web camera, that outputs the video stream with H264 (aka MPEG-4) encoding. The Logitech model C920 web camera is small and even has mounting for a tripod.

The only issue with this nice and affordable web camera is that the audio has not been encoded by MPEG-4. My personal suspicion is that Logitech may be attempting to avoid paying a license fee for AC3 (a licensed CODEC by Dolby), the normal audio for H.264? So one approach could be - to encode the C920 camera audio processing a CPU CODEC for MPEG-4 or MPEG-2 on the ODROID?
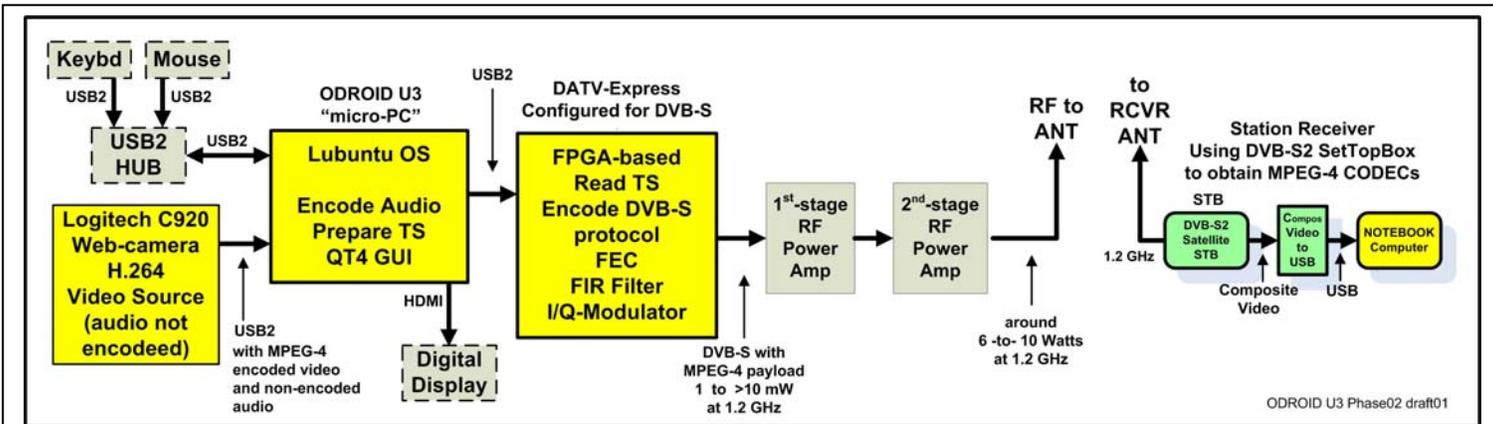
Figure 12 – Possible "concept" Block Diagram of ODROID DVB-S transmitter using C920 Web camera that outputs H.264 encoded video stream

Fig 12 is a concept block diagram of ODROID U3 using the Logitech C920 web camera to transmit H.264 video with DVB-S DATV protocol. The receiver is required to be a DVB-S2 STB receiver or DVB-S2 USB-dongle-receiver that is also capable of receiving legacy DVB-S protocols. Note that this is not a normal commercial protocol. Also note that Logitech does not supply linux drivers …but do support the UVC standards supporting cameras in linux distributions. So there may be an issue with the Lubuntu distribution? But, the project team thinks this might work for DATV??

The team plans to take some time to investigate and sort out these potential C920 issues.

Conclusion
The ODROID U3 "micro-PC" works very well with the DATV-Express DATV exciter board, especially for the DVB-S protocol. It makes the use of a DATV-Express transmitting station more portable by eliminating a large PC or a bulky notebook computer. The ODROID U3 is fairly affordably priced at US$65 (70 Euro) plus plastic-case, 5V/2A power adapter (wall-wart) and shipping.

Useful URLs

- ATCO - Amateur Television of Central Ohio – see **www.ATCO.tv**
- British ATV Club - Digital Forum – see **www.BATC.org.UK/forum/**
- CQ-DATV online (free monthly) e-magazine – see **www.CQ-DATV.mobi**
- DATV-Express Project for Digital-ATV (User Guide and downloads) – see **www.DATV-Express.com**
- HardKernel web site for ODROID U3 – see **www.hardkernel.com/**
- HardKernel USA Sales for faster shipping – see **www.ameridroid.com**
- HardKernel web site for free ODROID Magazine – see   **http://Magazine.Odroid.com**
- OZ9AEC discussions on using Logitech model C920 web camera
  – see **www.OZ9AEC.net/index.php/gstreamer/473-using-the-logitech-c920-webcam-with-gstreamer**
- Orange County ARC entire series of newsletter DATV articles and DATV presentations
  – see **www.W6ZE.org/DATV/**
- Yahoo Group for Digital ATV - see **groups.yahoo.com/group/DigitalATV/**