

Bill Ress, N6GHZ
n6ghz@amsat.org

This article describes testing that was performed on three DVB-S receivers costing less than \$32 that can be used to receive the HAMTV signal from the International Space Station (ISS).

Now that the HAMTV video transmitter has been successfully launched to the ISS and is waiting commissioning, the attention is now focused on the equipment needed by Amateurs to receive this new Amateur digital TV signal from space. One key component is the DVB-S receiver. The receiver needs to receive and demodulate the DVB-S QPSK signal format (data rate) of 1.3 MegaSamples/second (Ms/s) with a forward error correction (FEC) of $\frac{1}{2}$.

The DVB-S QPSK signal format is also used by the free-to-air (FTA) satellite signals currently transmitted from several Ku band geostationary satellites. The direct-to-home (DTH) satellite industry has spawned many receivers available throughout the web. Most of the receivers have specified receive modulation capabilities of 2 to 45 Ms/s. This leads to the question whether they will work at 1.3 Ms/s. By the way 1.3 Ms/s was chosen because it has a narrower bandwidth of approximately 1.4 MHz compared to higher data rates which have higher signal bandwidths. So the key criteria for choosing a receiver is will it lock onto (receive) the data rate from HAMTV at 1.3 Ms/s?

In addition to determining if the receiver you chose from the many options out there receives the HAMTV data rate, you also need to determine the form factor for your choice. There are three:

- USB
- Plug-in PC cards (none exist for the Mac - to my knowledge)
- Standalone.

For testing, I chose a USB and a standalone receiver purchased on eBay and the legacy high end receiver I have been using for years for my FTA receiving.

Why not evaluate a DVB-S PC plug-in card receiver?

While there are several good ones on the market, they tend to be \$80 and higher, and frankly I'm cheap. Additionally they require that you get into your PC, install the card and then the software/drivers. For many (me included) this can become frustrating if it

doesn't go right, and also as noted above, they exclude the Mac user.

A word about the DVB-S receiver testing

One of the problems that will be encountered is testing the HAMTV receiving setup in the absence of the HAMTV signal from the ISS. A low cost 2.4 GHz QPSK test source doesn't currently exist. I was fortunate to borrow the expensive 2.4 GHz, 1.3 Ms/s test source built by Kerry Banke, N6IZW. This uses the Digilite PCB, a PLL up converter to 2.4 GHz and a video test pattern.

Using a DVB-S receiver intended for the FTA applications for HAMTV at 2.4 GHz

All FTA/DTH DVB-S receivers are designed to work with a Ku band satellite block down converter (Low Noise Block - LNB). The LNB converts the Ku band satellite signal (11.7 to 12.2 GHz) to a frequency in the 950 to 2150 MHz (L band) region. This is the input frequency for the DVB-S receivers. So, when configuring your receiver, you need to know the L band IF frequency of your 2.4 GHz down converter. You should note that HAMTV can transmit on one of four possible frequencies. We will use 2.422 GHz in our example. Some 2.4 GHz converters on the market, using a 916.5 MHz Local Oscillator, (such as those made by Kuhne and High Sierra Microwave) will output the 2.422 GHz HAMTV signal at 1.5055 GHz. Your DVB-S receiver is configured, using its software, to receive a signal from the "phantom" Ku band LNB at 1.5055 GHz.

An example would be to configure the DVB-S receiver to be working with a Ku band LNB that uses a 10.6 GHz LO. The Ku band satellite transponder that would give you an L band output of 1.5055 GHz would have a frequency of 12.1055 GHz. This frequency is used for configuring the system when setting up the receiver software. The software will also allow you to input the modulation which, for HAMTV, is 1.3 Ms/s with a FEC of $\frac{1}{2}$. Each receiver will accomplish this differently depending on the software it uses. Since the Banke HAMTV test source outputs a 2.400 GHz signal, the L band IF output for the 2.4 GHz down converter used is 1.4835 GHz since the down converter I used in the tests had an LO at

916.5 MHz.

The USB DVB-S Receiver Tested

This receiver is available from several eBay vendors for around \$32. Some offer free or low cost shipping. Just search "DVB-S USB TV Receiver" in the eBay "Satellite TV Receivers" category. Like all receivers in this category, it is intended for the FTA/DTH satellite market.



USB DVB-S Receiver

The receiver was run from my Dell notebook using Windows 7. It comes with a version of BlazeDTV 6.0 software which is used to control the receiver. This software can also capture an image or record the streaming video. Software/driver installation was uneventful. I used the "phantom" Ku band setup described above to enable the receiver to work with the 2.4 GHz down converter's IF output.

This USB receiver will allow completely portable operation since it is run by the computer and the USB DVB-S receiver can also provide power to the 2.4 GHz down converter. This power would be 13 to 18 volts (on its LNB port), assuming the down converter draws less than 400 mA. This is the configuration I prefer.

The test results looked good. The specification for this receiver is for a minimum signal of -65 dBm and a minimum data rate of 2Ms/s. Using the Banke HAMTV 2.4 GHz test source, this receiver, however, locked onto the L band IF signal around -70 dBm. The 2.4 GHz down converter I used (made by High Sierra Microwave) had a 40 dB conversion gain, making the signal -110 dBm at 2.4 GHz.

The Standalone DVB-S Receiver

This category of receiver requires connection to the AC mains and outputs the video/audio signal to a separate monitor, but does not require a PC to just view the HAMTV signal. To capture HAMTV video, it will require a piece of hardware/software like the USB EasyCAP connected in place of the monitor to record the video/audio on the PC or Mac. The receiver I obtained on eBay was the X2-FTA DVB-S Mini Digital Satellite Receiver available for around \$24.00 and free shipping.



X2-FTA DVB-S Mini Digital Satellite Receiver

The setup/control software for the receiver is internal firmware, and using an external monitor, setup went without issues. I also installed the USB EasyCAP in place of the monitor and ran the HAMTV video to my



Viewsat VS2000 ULTRA Receiver

PC where it was captured and stored.

RF testing was done the same way as with the USB receiver. This receiver also provided an L band sensitivity of approximately -70 dBm and locked to the 1.3 Ms/s HAMTV signal without issues even though it also has a minimum data rate specification of 2 Ms/s.

The Legacy Standalone FTA Receivers

For years I have been using a full featured FTA receiver, the Viewsat VS2000 Ultra, in my FTA satellite setup. Since it was produced some years back, I wondered how it would configure and perform for HAMTV. These receivers, and many like it, are often available used on eBay at very attractive prices. At the time of this writing, several of these models were available for under \$20 on eBay.

Again, using the 2.4 GHz HAMTV test source, it locked to the 1.3 Ms/s signal at just under -65 dBm and the internal setup software allowed the required “phantom” transponder and HAMTV modulation to be configured.

Summary

Receiving the HAMTV signal from the ISS will provide the Amateur with interesting new technical challenges. For many, it will be their introduction to Amateur digital TV, a format being used on more and more “TV repeaters” throughout the world. Tracking the fast moving ISS with a 2.4 GHz antenna will also provide challenges. So with this brief introduction to your “low cost” DVB-S receiver options, your receiver choice might be made easier, allowing you to concentrate on the other blocks needed in your HAMTV receiving system.



November 2013 NASA ELaNa Minotaur Launch Satellite Summary		
Satellite	Sponsor/Owner Institution	Downlink Frequency (MHz)
Black Knight-1	United States Military Academy	437.345
CAPE-2	Cajun Advanced Picosatellite Experiment	145.825; 437.325
ChargerSat-1	University of Alabama in Huntsville	437.405
COPPER	Saint Louis University Parks College	437.290 9600bps
CSIP	Technology Cubesat	
DragonSat-1	Drexel University	145.870
Firefly	Goddard Space Flight Center	
Ho'oponopono-2	University of Hawaii at Manoa	427.220 9600bps FSK/GMSK
KYSat-2	Kentucky Space LLC	437.405
Lunar Orbiter/ Lander CubeSat	University of Vermont Vermont Technical College	
NPS-SCAT	Naval Postgraduate School	2401.200 - 2447.600; 437.525
ORSES	US Army Space and Missile Defense Command	
ORS Tech-1,2	Johns Hopkins University	
ORS-3	United States Air Force	
PhoneSat-v2	NASA Ames Research Center	2401.200 - 2431.200; 437.425
Prometheus-1,2,3,4	Los Alamos National Laboratories	
Rampart	Morehead State University	
SENSE-1,2	United States Air Force	
STARE-B	Lawrence Livermore National Laboratories	
STPSat-3	USAF Space Test Program	
SwampSat	Gator Amateur Radio Club University of Florida	437.385
TetherSat-1,2	Naval Research Laboratory	(1) 437.100 (2) 437.305 9600bps AX.25
TJ3Sat	Thomas Jefferson High School	437.320
Trailblazer-1	University of New Mexico	437.425
Vermont Lunar Cubesat	Vermont Technical College	437.305 9600bps

Note: Refer to JE9PEL's web page for additional mission information: <http://www.ne.jp/asahi/hamradio/je9pel/minotaur.htm>

