How to Receive Amateur Digital, DVB-T Television Signals
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The fundamental question is "How can I receive amateur DTV signals?"

The commercial TV broadcast industry began a transition from analog TV to digital TV (DTV) starting in the mid 90s. Several different, DTV systems were developed for different applications, such as over the air terrestrial broadcast, satellite broadcast and cable distribution. Each system had its unique propagation characteristics and as a result, its coding implementation. For amateur DTV, the system adopted should be optimized for terrestrial propagation where "multi-path" is always an issue. TV signals received from satellites, or directly over a CATV network are not subject to multi-path. Thus such DTV systems are less suitable for amateur DTV.

The DTV system adopted by Boulder, Colorado and other Colorado Front Range radio amateurs is called DVB-T, or Digital Video Broadcast - Terrestrial. It is NOT the ATSC (8-VSB) system used in the USA for commercial TV broadcast over the air, nor for transmission in cable TV (CATV). It is the system developed in Europe and used by most of the rest of the world for broadcast DTV. Thus, in the USA, you can NOT use directly your home TV receiver to receive DVB-T. The reasons, we have adopted a European standard rather than an American standard are primarily based upon cost and availability of transmitting equipment and also on the superior multi-path performance of DVB-T over ATSC.

DVB-T includes special digital algorithms to characterize the time varying channel and eliminate the delayed multi-path signal. The result is perfect, digital quality, ghost free, pictures even under extremely strong multi-path conditions. DVB-T also offers a choice of modulation methods of QPSK, 16-QAM and 64-QAM. 64-QAM supports the highest data bit rate, especially important mainly for video with a lot of extremely fast moving events, such as sports. We have found that the simplest QPSK adequately supports high-definition, 1080P video with ordinary video scenes with some motion. Using QPSK gave an almost 20dB (3 S units) improvement in receiver sensitivity over 64-QAM. Broadcast DVB-T stations use bandwidths of either 6, 7 or 8 MHz depending upon the various country's historical channel allocations. Here in the USA, the FCC fixed TV channel bandwidths at 6 MHz. Therefore, all of our DTV activity has been...
done using 6 MHz. The FCC allows radio amateurs to transmit 6 MHz TV signals on the 70cm band and all higher frequency bands.

In the USA, DTV is called ATSC, (Advanced Television Systems Committee). All TV receivers sold in the USA will only receive ATSC signals. To receive amateur DVB-T transmissions will thus require using some auxiliary receiving equipment, such as a set-top box, similar to those supplied by the cable company. The A/V output from the receiver then goes to your TV's rear panel monitor inputs.

Digital TV Receiver Universal "Gotcha" There is a "Gotcha" for almost all digital TV receivers, whether it is a new SONY that you buy at Best-Buy, a set-top box receiver, or a USB dongle. Unlike the old analog TV receivers, we can not simply enter on the remote control any arbitrary channel number and the receiver will automatically tune to that frequency and start working. Due to unfortunate, poor human interface design by DTV engineers, they require that DTV receivers must be "taught" each and every new channel by exposing it to the actual rf signal. This is typically done once when unpacking your TV, connecting it to the cable system or outside antenna and doing an "Auto-Scan". The TV receiver scans all frequencies and memorizes only those on which it found a valid signal. Thus no matter what DTV receiver you are using -- you will have to teach it first to find and memorize a specific frequency (channel). This means you need to either (1) own your own DVB-T modulator, (2) carry your receiver to another ham's house and train it on his modulator, or (3) if you have a really good RF path, have the other ham point his antenna at you and transmit a DTV signal on each frequency of interest.

So -- now back to the original question "How can I see the local amateur DVB-T pictures?" There are a few possible solutions, some simple and some not so simple. They include: 1. buy a TV receiver overseas 2. buy a DVB-T set-top tuner 3. buy a cheap ($10) USB TV tuner dongle for your PC  or 4. The KISS solution from Hi-Des

Off-Shore TV Receiver: This might seem to be the most direct approach for USA amateurs. Namely to actually purchase a TV receiver intended for use in another country where DVB-T is used. However, there are several gotchas. First will be the cost of purchase plus shipping it to the USA. The most important is the fact that it will NOT tune to the amateur 70cm band (420-450MHz). They are already pre-programmed to only tune the standard VHF and/or UHF channels in use in that particular country. Thus to use a standard TV receiver will require you to build/buy a frequency up/down
converter. This is not as simple as it sounds. It turns out that there are very stringent requirements on low phase noise for the local oscillator to function properly with DVB-T signals. The least amount of either FM or phase noise on the LO and the DVB-T receiver will not decode the signal. Also one needs to take care and only purchase a TV set that is capable of receiving 6 MHz bandwidth signals. Most countries use 7 and/or 8 MHz bandwidths.

DVB-T Set-Top Receiver: This is a potentially low cost ($30) solution. Doing a Google search on the internet for "DVB-T Receivers" will bring up a lot of "hits". Some with very attractive prices in the $30 to $100 range. I found the one shown in the photos above for only $30. It was advertised to receive frequencies from 48 to 862MHz with bandwidths of 6, 7 or 8 MHz. It worked and produced excellent video up to 1080i resolution on my monitor with it's HDMI output. It also was extremely simple to operate. However, it's major drawback was that it did NOT tune the amateur 70cm
band. It only tuned the standard broadcast TV channels. One had to select a particular country and then it used a lookup table for the standard frequencies and bandwidths for that country. For a 6 MHz bandwidth, I had to choose Taiwan, Philippines or Panama. Thus to be able to use this DVB-T Tuner for any amateur bands, would require an additional low phase noise down-converter. This is the same "gotcha" as buying a complete DVB-T receiver.

**LOW COST ($10) SOLUTION:** The really low cost approach is to buy a DVB-T TV Tuner USB dongle for your PC computer. Most of the "hits" from a Google search for DVB-T receivers will in fact be these dongles. They are found from many sources on [www.ebay.com](http://www.ebay.com) and [www.amazon.com](http://www.amazon.com) among others. Most of these seem to use the same basic design with an R820T DTV tuner IC ([www.rafaelmicro.com](http://www.rafaelmicro.com)) and an RTL2832U DVB-T COFDM demodulator IC with a USB interface ([www.realtek.com](http://www.realtek.com)). The tuner's frequency range is 42 to 1002MHz with a 3.5dB noise figure. These same dongles have been used by amateurs as generic software defined radio (SDR) receivers for many other RF applications with appropriate software. These dongles typically come with a small mag. mount whip antenna, remote control and a mini-CD disc with TV tuner software. The RF connectors vary and sometimes are not what are shown in the internet advertisement. The antenna connector is usually an MCX or the European TV antenna connector, called the Belling-Lee (IEC 61169-2). Most USA amateurs are not using MCX or Belling-Lee connectors. We have made our own adapters by simply cutting off a connector pigtail from the supplied mini antenna and installing another connector of our own choice on the other end of the pig-tail. Suitable coax adapters are also available on the internet.

All of the USB TV tuner dongles seem to come with free TV tuner software by Blaze Video ([www.blazeyvideo.com](http://www.blazeyvideo.com)). It only runs on Windows PC computers. It is not very good. It seems to be supplied as a "teaser" and they really want you to purchase their $50 upgrade software. The good news is this dongle and associated software works for DVB-T, 6 MHz bandwidth, amateur DTV purposes on the 70cm band. The picture and audio are acceptable. The software is extremely slow in responding. There is a major "gotcha" in the supplied Blaze software. It has a built-in "time bomb". After operating for a few weeks, it stops functioning, at which point they try to upgrade you to their $50 software. It should be noted that not every amateur trying to use these dongles was able
to successfully make them work. It did not work on computers with Windows 8 or 10. It works on most XP machines, but we have encountered some older XP computers that wouldn't work. If you do elect to use the supplied Blaze software, the driver and the feature software need to be loaded from the CD, in that order. Appendix I gives more details on using the Blaze software.

**VLC Works!**  Steve, WB0NFQ, has discovered that the general purpose video processing software called **VLC** ([www.videolan.org](http://www.videolan.org)) works great with these USB TV Tuner dongles. **VLC** is a free and open source cross-platform multimedia player. **VLC** is available for Windows, Mac OS X, Linux and Unix. The Windows version does work with these dongles. The Mac version does not support these cheap, generic dongles. It only supports expensive Eye TV tuner dongles. Several Boulder, CO amateurs are using **VLC** successfully on older Windows PCs. I personally have not been able to get it to work with a Windows 10 PC.

To use **VLC** with a TV tuner dongle, first attach the dongle to a USB port. Attach an antenna to the dongle and make sure it is close to a strong DVB-T signal on the desired frequency. Next, launch the **VLC** program. On the upper task bar, click on "Media" and select "Open Capture Device". This will open the above page. For Capture Mode,
select "TV - digital". For Tuner Card, select "0". For Delivery System, select "DVB-T". Under Options, enter the desired frequency and bandwidth. Frequency is to be entered in kHz and must be the center frequency of the desired channel. For the example shown above, the channel was 58 (426-432MHz) with a center frequency of 429MHz (429000 kHz). Note: VLC is nice in that any arbitrary frequency within the tuning range of the R820T tuner IC is acceptable. This is an extremely nice feature of VLC. It is the equivalent of the old "random access" with analog TV. VLC does not have to be "trained" (auto scanned) like most DTV receivers. VLC offers a wide selection of bandwidths from 5 to 10MHz, plus an Auto search mode. It is best to not use Auto as it takes a lot longer to find a signal. Select "6 MHz" bandwidth. Do not use any of the Advanced Options. The final step is to click on the "Play" button at the bottom of the page. If a DVB-T signal is present at the antenna input on the desired frequency, you should now see a live video picture complete with audio. The photo below is an example of VLC receiving an amateur DVB-T signal on 429MHz.
**KISS SOLUTION:** The real KISS (Keep It Simple Stupid!) solution to receiving amateur DVB-T on both the 70cm and 33cm bands is to purchase the Model HV-110, set-top, DVB-T receiver directly from Hi-Des in Taiwan (www.hides.com.tw). It costs $169 which includes shipping. It is extremely easy to setup and operate. It can be trained to receive any arbitrary frequency from 170 to 950 MHz, including the amateur 70cm and 33cm bands.

The HV-110 has an SMA antenna input connector. Video output is either via digital HDMI or analog, composite (480i only). It has selectable video resolution up to 1080P. The HDMI or composite video can then be connected directly to your home TV receiver/monitor via the rear panel video input connectors. It requires +5Vdc power. An AC power supply is included. It is controlled via a supplied IR remote control. The receiver is frequency synthesized to any frequency between 170 and 950 MHz. The
receiver is quite sensitive. The DTV threshold has been measured at -97dBm for a QPSK, 6 MHz signal.

The Hi-Des HV-110 supports commercial broadcast bandwidths of 6, 7 and 8 MHz and also supports using lower bandwidths of 2, 3, 4 & 5 MHz. Some DTV amateurs elsewhere have been experimenting using narrower bandwidths down to 2 MHz. High-Definition TV (720p or 1080p) will not work at 2 MHz. However, standard-definition, 480i video will work quite well with 2 MHz bandwidth.

Another nice feature of the Hi-Des HV-110 receiver is the available On Screen Diagnostics (OSD) as seen in the above live photo. In the lower left corner is the call sign of the transmitting station. In the upper left corner is the center frequency and the bandwidth. In the lower right corner is the signal to noise ratio of the received signal. In the upper right corner is the actual signal strength in dBm of the signal at the antenna input. This rf power meter has been found to be extremely accurate (within ±1dB from -10 to -90dBm)

It should be noted that Hi-Des also supplies other DTV receivers, including USB dongles. They have not been evaluated. The prices of their dongles were not inexpensive, but were comparable to the HV-110. It was felt by the author that the true KISS solution would avoid the necessity of including a PC computer in the setup with all of it's inherent driver, software bug, etc. issues.
APPENDIX I -- Detailed Setup Procedure for Blaze Video HDTV Player Software

For the USB DVB-T Tuner Dongle, this is the detailed procedure Don, N0YE, has developed. When scanning for 70cm DVB-T channels do the following:

1. Push the scan button in the lower right of the control panel. A separate box appears with options to select.
2. Set the Country to Universal
3. Enter the Frequency range from 423000 to 447000. Set the starting frequency to the frequency of the channel to be trained. For example if 435 MHz is to be trained, set the range to start at 435000.
4. Set the Bandwidth to 6 MHz
5. Leave the Advanced settings to NOT SET.
6. Push the OK button to begin the scan.
7. The scan will go to completion. It is probably best to let the scan go to completion. If for some reason you want to stop the scan you can do so without losing any channels found to that point.
8. The channels found are listed in a Play List. The Play List can be displayed by pushing the small box in the upper right of the control panel. This button has an arrow pointing northwest.
9. Channels found are listed in the order found. The frequency of the found channel is listed along with the call sign. By clicking on a channel in the Play List, that channel will be tuned in. There are options displayed for managing the Play List.
10. New channels found are added to the Play List. It is not clear how to manage channels listed in the Play List. This version of software does not allow channels in the list to be deleted or moved although those options are listed in light grey.
11. To scan an additional channel, the application program has to be terminated and restarted. When the program is restarted, the Play List is remembered.
12. It appears the Play List cannot be deleted.
13. Sometimes the application is slow to very slow. To change channels for example takes over 5 seconds. Some other actions take longer. On occasion the response is much quicker. Blaze Video has probably done this intentionally as an inducement for you to pay $50 for their advanced software.
14. The remote control works but the software appears to always be slow. Only the obvious buttons on the remote were tested. Interestingly the remote has an ON/OFF button that turns off the software. This button did not turn the software on.