How to Receive Amateur Digital Television
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By now Boulder Amateur Radio Club (BARC) members are probably quite aware of some of your fellow club members', high-definition, digital television (DTV) activities. We have been using the club's 146.70 MHz, NCAR repeater for our TV intercom frequency for our weekly Thursday afternoon TV nets and also for DTV propagation experiments lately. We have also been publishing articles here in BARC's Bark. Plus Don, N0YE, and Jack, K0HEH, have given live DTV "demos" at the club's November "Show and Tell" evening and also at the recent Boulder County Amateur Radio Emergency Services (BCARES) annual meeting. This has generated interest among members that have inquired "How can I also see your DTV pictures?"

The DTV system adopted by local, Boulder and Colorado Front Range hams is called DVB-T, or Digital Video Broadcast - Terrestrial. It is NOT the 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, 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 performance. In the USA, DTV is called ATSC, Advanced Television Systems Committee. TV receivers sold in the USA will only receive ATSC signals.

Over the air, USA broadcast DTV uses the 8-VSB modulation method. CATV uses either 64-QAM or 256-QAM modulation. Both use standard 6 MHz bandwidth TV channels. The ATSC technology is patented and very difficult to obtain without paying very high license fees. The cost of an 8-VSB modulator is extremely expensive and well beyond most hams' budgets. In 2011, Jim, KH6HTV, found a digital CATV modulator for $1,200 (the cost of a decent HF rig). It produced 64-QAM or 256-QAM for up to 1080i video. Note: modulators only put out low power, typically about 0dBm or less, and need a high power linear amplifier to make a complete DTV transmitter. Over the air, propagation experiments with the CATV modulator showed that it could be used, but only in situations where multi-path was essentially non-existent (almost never ! ! ). Also DTV receiver sensitivity for 64-QAM was very poor at about -80dBm and even worse for 256-QAM. Thus, the use of 64-QAM never really took off for amateur DTV.
A year ago, the amateur TV magazine, ATV Quarterly, (www.atvquarterly.com) published some articles about DVB-T and also had an advertisement from a new company, Hi-Des Technology, (www.hides.com.tw) in Taiwan which was offering for sale reasonably priced DVB-T modulators and receivers. Jim, KH6HTV, purchased a modulator and receiver set and immediately found the performance to be far superior to that of CATV 64-QAM. Soon thereafter other local TV amateurs got their own DVB-T equipment and started experimenting also. At present, their are Colorado DVB-T amateurs in Boulder County, Douglas County and El Paso County. Most all of the DVB-T activity has so far been on the amateur 70cm band. The longest DVB-T DX here in Colorado has been 77 miles from Cheyenne, Wyoming to Boulder.

DVB-T was designed particularly for the multi-path issues always found in terrestrial RF propagation. Multi-path is not an issue for satellite paths nor especially in cable systems, thus other DTV methods are used for these services. 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 Hi-Des DVB-T equipment supports 6, 7 and 8 MHz and also supports using lower bandwidths of 2, 3, 4 & 5 MHz. Some DTV hams elsewhere have been experimenting using narrower bandwidths down to 2 MHz. High-Definition TV (720p or 1080i) will not work at 2 MHz. However, standard-definition, 480i video will work with 2 MHz bandwidth.

So -- back to the original question "How can I see the local DTV pictures?" There are a couple of easy solutions. Either with a "turn-key" $169, set top box -- or -- a really inexpensive ($10), USB, TV tuner dongle.

**EASY SOLUTION:** The easiest solution is to buy from Hi-Des, their Model HV-110, DVB-T Receiver. It costs $169. It has an SMA antenna input connector. Video output is either via digital HDMI or analog, composite (480i only). It requires +5Vdc power.
An AC power supply is included. It is controlled via a supplied IR remote control. The HDMI or composite video can then be connected directly to your home TV receiver/monitor via the rear panel video input connectors. The receiver is frequency synthesized to any frequency between 170 and 950 MHz. It works with all bandwidths from 2 MHz to 8 MHz.

**LOW COST ( $10 ) SOLUTION:** The really low cost approach is to buy a DVB-T TV Tuner USB dongle for your PC computer. They are found from several sources on [www.ebay.com](http://www.ebay.com) It should be mentioned that Hi-Des also sells USB dongles, but they are quite expensive, in the $150-$250 price range. The model RTL2832 PC dongle (the $10 ebay special) comes with a modest antenna, remote control and a CD containing the software. The antenna is not used because it is too small. The antenna jack is a MCX connector. This unit came with software by Blaze Video. [www.blazevideo.com](http://www.blazevideo.com) Hopefully there are other options for software to run this dongle. The good news is this dongle and associated software works for DVB-T, 6 MHz bandwidth, amateur DTV purposes. The picture and audio are quite good. The picture can be sized to fill the screen. The picture quality will depend on the PC monitor. There are controls for adjusting color, brightness and other video properties. The side by side comparison of the receiver sensitivity with the Hi Des receiver is comparable. Most hams are not using MCX 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.

The PC software that came with the dongle receiver is a teaser. It works but would not be acceptable for a normal TV viewing experience. An upgrade software version is available online for $50. The supplied software is acceptable for ATV purposes. The price is right. The driver and the feature software need to be loaded from the CD, in that order. It should be noted that not every ham trying to use these dongles was able to successfully make them work. It did not work on computers with Windows 8. It works on most XP machines, but we have encountered a couple of older XP computers that wouldn't work. These tuner dongles will only work with standard broadcast bandwidth of 6 MHz.

**DIGITAL TV RECEIVER "GOTCHA"** There is a "Gotcha" for all digital TV receivers, whether it is a new SONY that you buy at Best-Buy, the Hi-Des receiver, or the 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 whether you are using the Hi-Des set-top receiver box or the USB tuner dongle -- 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.

**ANTENNAS:** Most all present DTV activity is on the 70cm band. Thus, use the best 70cm antenna you have and put it up as high as possible. All DTV activity is using vertical polarization.

**DETAILED SETUP PROCEEDURE:** 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.