



Application Note
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Reception of Amateur TV

Jim Andrews, KH6HTV

www.kh6htv.com

Note: The original AN-12 was written in 2012 and the cable TV modulation method of 64-QAM was used for digital TV. Since then, the author has discovered the European Digital Video Broadcast - Terrestrial, DVB-T, modulation scheme. It has been found to be far superior for over-the-air transmissions than CATV 64-QAM, particularly in terms of receiver sensitivity and tolerance of multi-path. The reader of this app. note is also encouraged to read about DVB-T in application note, AN-17.

The purpose of this application note is to attempt to clear up a lot of miss-conceptions about receiving amateur, fast-scan, television signals. Most fast-scan ham TV activity is on the amateur radio 70 cm band (420-450 MHz). This is the lowest frequency ham band that the FCC allows fast-scan TV. Most of the comments in this app. note pertain to the 70cm band.

In the past, in the USA, broadcast TV was an analog transmission using Vestigial Upper SideBand (VUSB) modulation and required a 6 MHz wide channel. It meet NTSC standards and had 480i resolution with live, full color pictures and stereo audio. Our analog TV system dates from the 1930s. More recently, the FCC mandated that all commercial TV broadcast must discontinue the old analog NTSC, VUSB system and use the newer, digital, ATSC 8VSB system. The FCC did however allow low powered, TV translators (i.e. repeaters) to continue to use the old, analog NTSC, VUSB system. The new ATSC 8VSB Digital TV (DTV) still retains the same channels as before with 6 MHz channel widths. ATSC is capable of broadcasting high-definition video at either 720p or 1080i resolution and 5.1 digital audio in a single 6 MHz channel. Alternatively, several, separate, standard definition (480i) TV programs can also be broadcast simultaneously in a single 6 MHz channel which previously would only support a single, analog 480i picture. USA broadcast TV operates in three different frequency bands. Channels 2 - 6 are in VHF Low-Band from 54 to 88 MHz. Channels 7 - 13 are in VHF High-Band from 174 to 216 MHz. Channels 14 - 75 are in the UHF band from 470 to 842 MHz. The original TV channel One (44 - 50 MHz) was just below the ham 6 meter band and is no longer authorized for TV service.

Cable TV systems (CATV) today provide most TV viewers with their TV entertainment. CATV systems are completely closed, wired systems which do not radiate their signals over the air. As a matter of fact, they are very closely monitored by the FCC to insure that they do not radiate. They are very heavily fined by the FCC if they are caught

radiating any RF which causes interference to licensed users of the spectrum. TV signals on a CATV system are a mixture of analog and digital. The analog signals are still the old NTSC, 480i system. The digital signals are NOT the same as found on broadcast TV. They use a different, digital, modulation scheme called Quadrature Amplitude Modulation (QAM).

CATV also uses standard 6 MHz TV channel spacings. CATV systems operate over a much broader frequency range than broadcast TV. CATV signals range from 5.75 MHz up to 1 GHz. CATV uses a different channel numbering scheme compared to broadcast TV. This alone is one of the major causes of confusion among potential ham TV viewers. Cable channels 2 through 13 are identical with broadcast TV. From there on, all higher numbered **CATV channels are NOT the same as broadcast TV channels**. For example, CATV #57 is 420 - 426 MHz, while Broadcast #57 is 728 - 734 MHz. For a table of the complete CATV / Broadcast TV frequencies go to:

http://www.picomacom.com/_pdfs/Frequency-Charts.pdf

As hams, we are fortunate that some of the CATV channels directly overlay our 70 cm band. They are: 57 (420-426 MHz), 58 (426-432 MHz), 59 (432-438 MHz), 60 (438-444 MHz) and 61 (444-450 MHz). For more details, see KH6HTV Video Application Note AN-10, "70cm, 33cm, & 23cm TV Frequencies".

What is Required to Receive Ham TV ? ----- Simple -- your own home TV receiver ! As long as your local TV ham is transmitting on the 70cm band, on a designated CATV channel, with either NTSC analog TV or QAM digital TV, you can receive his signal directly on your own TV receiver with no extra converter box required.

For reception of DVB-T digital TV signals, an extra set top converter box is required. We recommend the Hi-Des model HV-110 DVB-T Receiver. It is available over the internet from the manufacturer Hi-Des Technologies in Taiwan (www.hides.com.tw) for \$169. It tunes from 170 to 950 MHz and thus covers both the 70cm and 33cm amateur bands. It provides both hi-definition HDMI and std. definition composite video outputs. See AN-17 for more details. (rev. 10/14)

But, don't I have to be connected to the cable system to receive the CATV channels ? --- Wrong ! The TV receiver doesn't care whether you have a CATV coax feed or a coax coming from an antenna. It doesn't know the difference.

Analog Reception is Simple ---- It is extremely simple to receive the older, NTSC, analog TV. Connect an antenna to the rear panel F connector where you normally have your CATV coax connected. Use your remote control to access the setup menu and tell the TV receiver you want "Cable". (NOT broadcast, over-the-air, antenna, or what ever other choice is offered). Then simply punch into the remote the desired channel number of the ham TV transmission. If you have a good antenna, with proper polarization and orientation, and a line-of-sight path to your local TV ham, you should now be seeing his video.

Digital QAM-TV Reception is not so Simple --- Modern, current production TV receivers sold in the USA are required to receive analog NTSC, broadcast digital ATSC 8VSB, and cable digital QAM TV signals. These TVs can be purchased at any local electronics store, such as Best Buy, etc. Unfortunately, the designers of our modern analog/digital TV receivers made the use of these receivers difficult for non-ordinary, ham TV viewers. They figured they only needed to do a one time, initial set-up, for your cable or broadcast viewing the first time you opened the shipping carton. For ham DTV, you will still need to connect an outside antenna and then in the menu tell the set you want "Cable". Then you will need to perform an auto scan for the TV receiver to search each and every TV channel to attempt to locate your friend's ham TV signal. Not a simple process ! If the TV doesn't find it on it's scan, it will then lock out that channel from it's memory. Most all modern TV receivers do not allow us the ability of random access from our remote control to any arbitrary DTV channel, such as 57.1. I did however find that a USB TV-tuner stick called an Elgato Eye TV Hybrid for my Apple MacBook Pro laptop computer does allow random access for DTV. Most TV receivers only allow access to those channels they previously located during an Auto Scan. The most reliable way to accomplish the "training" of the TV receiver is to physically take it to your ham TV friend's QTH and feed a strong, known, good QAM-DTV signal into the set and then do the Auto Scan. A royal "Bummer" ! For more details, see KH6HTV-Video Application Note, AN-2, "DIGITAL TV -- the Good, the Bad & the Ugly".

Weak Signal Reception ---- How weak of a TV signal can I receive ? Tests have been run on an assortment of typical TV receivers. For a P2 picture with NTSC, VUSB-TV, the typical receiver sensitivity is about -89 dBm. Note: for VUSB, power is measured the same as for a single side band transmitter as peak envelope power (PEP). On a TV transmission, the peak power occurs on the sync tips. A P2 picture is a weak signal with a black & white picture (no color or sound) and a lot of snow. See App. Note AN-5 for a description of TV reporting P ratings. For reception of QAM-64 DTV, the typical receiver sensitivity is about -78 dBm. Note: for DTV, power is measured as the average power.

Reception of DVB-T is much easier than for CATV 64-QAM due to better sensitivity and also enhanced tolerance of multi-path. For details, see AN-17 (rev. 10/14)

To enhance your ability to receive ham TV pictures there are three areas in which improvements can be made: (1) antenna, (2) coax and (3) pre-amp. Obviously the better the antenna, the better are your chances of getting a picture. Plus, putting it up as high as possible and clear from any obstructions is always a plus. See app. note AN-4 for more details on suitable antennas for ham TV. It is also important to use low-loss coaxial cable for the run from your antenna to the ham shack. The other area that hams often overlook is the improvement that can be made with the addition of a good pre-amplifier. Our recommendation of an excellent pre-amp for the 70 cm band is the Advanced Receiver Research model P432VDG. (www.advancedreceiver.com) It is a GaAs FET preamp with 0.5 dB noise figure and 17 dB gain. It sells for \$80. Adding this preamp in front of a typical TV receiver improves the NTSC, VUSB-TV threshold from -89 dBm to -97 dBm and improves the QAM-64 DTV threshold from -78 dBm to

-85 dBm. This 7 to 8 dB improvement can be very significant. For additional discussion on the effects of transmitter power, coax loss, antennas, and receiver sensitivity, see app. note AN-7 on TV Propagation.

Non-Standard TV Frequencies ---- It should be noted that in some regions of the US, TV hams are using non-standard, 70cm frequencies, such as 426.25 MHz and 434 MHz, for their TV transmissions. With much older TV receivers, this was not much of a problem. They either had a manual fine tuning adjustment control and/or a wide range AFC circuit which could pull in the off-channel TV signal. Modern TV receivers are designed with synthesized local oscillators and very sharp SAW IF filters and must work on crowded CATV systems with a strong signal on each and every channel. I have found that they do not work well when the ham TV signal is not exactly centered on it's assigned 6 MHz channel. If you live in one of these regions, you will need to use a tunable down-converter.

Higher Ham TV Bands ---- Hams are also transmitting TV pictures on the higher, microwave ham bands. The most popular is the 23cm band (1240-1300 MHz). On these bands, they are using several different modulation methods, including: AM, VUSB, FM, digital (many formats), etc. For receiving these ham TV signals, you will need specialized down converters for AM or VUSB or completely separate video receivers for the other modes.

TV Demodulators --- For fixed installations in facilities such as an Emergency Operations Center (EOC) or police Mobile Command Post (MCP), the Boulder County ARES group (BCARES) uses specialized analog TV receiver modules designed for rack mount use in cable TV head-ends. They are called Demodulators. They require +5V & +12Vdc power. They are frequency synthesized with a SAW IF filter and provide a baseband, composite video output along with a mono audio output. These A/V signals can then be routed through a video distribution amplifier (VDA) and sent to several video monitors. In a typical BCARES EOC or MCP installation four of these receivers are used set to 70cm channels 57, 58, 59 and 60 along with a quad processor. The output from the quad processor then presents the video from all four channels in each of four quadrants on a single monitor screen. A common antenna is used along with a low noise pre-amp and a four way signal splitter. These TV Demodulators are made by several CATV suppliers, including Pico-Macom, Holland Electronics, Blonder-Tongue, and R.L. Drake. A good source for these and other video equipment is ATV Research, www.atvresearch.com