Digital ATV Repeaters

Assembling a repeater for digital TV is easier than you think.

Jim Andrews, KH6HTV

Amateur television (ATV) is an often-overlooked part of Amateur Radio. The FCC allows live fast-scan TV on the 70-centimeter, 33-centimeter, and 23-centimeter bands, and on all of the microwave bands. ATV groups have put up ATV repeaters on these bands. The ARRL *Repeater Directory* no longer lists ATV repeaters separately, so I have recently compiled a directory of US ATV repeaters.[1]

Hams have been transmitting live TV pictures almost since the birth of television in the late 1930s, but as the commercial broadcast TV industry has transitioned from analog to digital TV (DTV), many ATV hams and repeaters have started using digital-ATV (DATV). Most DATV activity in the US uses the European terrestrial broadcast TV standard called DVB-T.[2]

Most DVB-T amateurs in the US are using low-cost, off-the-shelf modulators and receivers from commercial outlets like HiDes.[3] With this equipment, ATV amateurs are now able to transmit broadcast-quality digital video in high definition (up to 1080p) with CD-quality audio.

Assembly

A basic TV repeater for DVB-T is far easier to assemble than a typical FM voice repeater or an older National Television System Committee (NTSC) analog TV repeater. The basic elements required for a cross-band repeater, plus the appropriate antennas, are just the DVB-T receiver, the DVB-T modulator, and an RF linear power amplifier (see Figure 1). However, if any other features are added to the repeater, such as multiple receivers, dual-mode, extra video sources, etc., then it becomes a complex engineering project.

If assembling an in-band repeater, then band-pass filters (BPF) are also required on the input and output. These BPFs need to be wideband to match the channel bandwidth — in the usual case, 6 MHz. They also need to be low loss and have very steep skirts. Most TV repeaters use interdigital BPFs, as shown in Figure 2. I give details on how to build your own online.[4]

Receive and Transmit

Most FM voice repeaters use a single common antenna for receive and transmit, which requires an expensive duplexer to separate the signals and isolate the transmitter from the receiver. For TV signals with bandwidths of 6 MHz, the ratio of transmit/receive separation to bandwidth on the 70-centimeter band is only 18 MHz/6 MHz, or 3:1. A duplexer would provide sufficient isolation for such a condition but is very difficult to build.

Thus, for TV repeaters, we typically use two separate antennas for receive and transmit. Isolation is achieved by separation of the antennas. The best arrangement is for the antennas to be mounted vertically on a common axis. As an example, two 70-centimeter vertically polarized antennas mounted vertically on the same common axis separated by 10 feet have an isolation of 54 dB. If they are instead horizontal from each other, it would require a separation of 100 feet to achieve the same isolation. For cross-band repeaters, additional isolation is provided by the frequency selectivity of the antennas.

Note that the interconnection in Figure 1 consists simply of an HDMI cable between the receiver and modulator, coax cables for the RF circuits, and one single logic data wire (valid signal) from the receiver to the power amplifier. If this is a local, manually controlled repeater, simply set up on the fly for an emergency situation. However, this wire is not

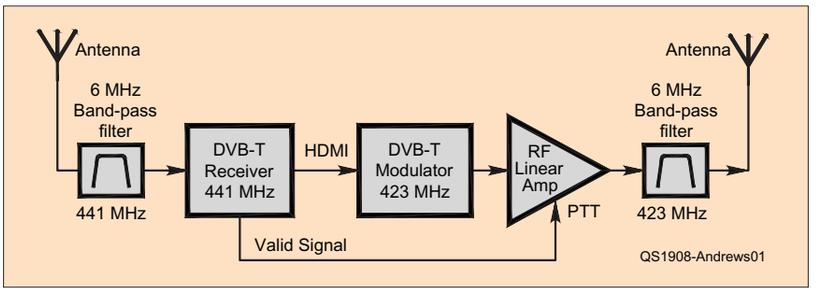

Figure 1 — Block diagram of a DVB-T repeater.

needed — just the control operator operating the power amplifier's **ON/OFF** switch.

For automatic repeater operation, we do need the valid signal control line. Most DVB-T receivers include an LED front panel indicator that changes from red to green when the receiver is receiving a valid DVB-T signal. Thus, we need to get inside the receiver, remove the LED drive signal from the circuit board, and buffer it with a simple transistor circuit to provide an open collector-to-ground logic output. This is then used to connect to the push-to-talk (PTT) input on the RF linear power amplifier to key the repeater's transmitter on and off.

Putting it to Use

You may be worried about meeting the FCC's requirement to identify transmissions at least every 10 minutes, but this is simple. With DVB-T, you are automatically identifying your signal, not every 10 minutes, but with every frame of video. The digital data stream includes a header of metadata describing the modulation parameters used and the call sign of the transmitter to the DTV receivers, satisfying the FCC's requirement to ID. This is similar to how pushing the **INFO** button on the remote control puts a display of the channel number, station call sign, resolution, and program description onto your TV screen — it's using information from the DTV's metadata header.

Figure 3 shows a 70-centimeter DVB-T repeater built by Matt Holiday, KØDVB. It is small and compact, and all the components fit within a rugged container for portable operation. This DATV repeater is used by the Boulder, Colorado, ARES group (BCARES) in support of the local sheriff, police, and fire agencies. It is stored in the BCARES equipment cache in the county Emergency Operations Center/911 dispatch center, along with portable DATV transmitters and TV cameras.

Figure 2 — An interdigital band-pass filter for 70 centimeters. The top cover is removed to show construction. [Jim Andrews, KH6HTV, photo]

Figure 3 — A portable 70-centimeter DVB-T repeater built by KØDVB. [Matt Holiday, KØDVB, photo]

Notes

[1]J. Andrews, KH6HTV, "USA ATV Repeater Directory — Application Note AN-47," Jan. 2019, **https://kh6htv.com/application-notes/**.

[2]J. Andrews, KH6HTV, "DVB-T: A Solution for ARES Television Operations," *QST*, June 2015, pp. 42 – 44.

[3]HiDes, Taipei, Taiwan, supplier of DVB-T equipment, **www.hides.com.tw**.

[4]J. Andrews, KH6HTV, "Interdigital Band-Pass Filters — Application Note AN-22b," July 2015, **https://kh6htv.com/application-notes/**.

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