



Application Note

AN-23

June, 2015

DVB-T Television Repeater

Jim Andrews, KH6HTV

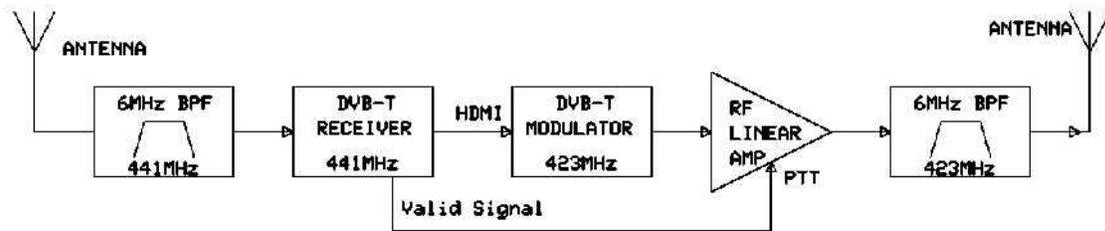


Fig. 1 A 70cm, Digital TV Repeater, block diagram.

The FCC allows licensed amateur radio operators to transmit wide bandwidth, fast-scan, video on the 70cm (420-450MHz) band and all higher microwave bands. On the 70cm band, the ARRL national band plan [1] calls for TV repeater inputs to be on Ch 60 (438-444MHz) and outputs to be on Ch 57 (420-426MHz) with TV simplex operations on Ch 58 (426-432MHz).



Fig. 2 Typical, 70cm, Inter-Digital Band-Pass Filter. Shown with top cover removed.

To build an in-band, 70cm, Television Repeater, Fig. 1, very high selectivity, band-pass filters (BPF) are mandatory on both the transmitter and receiver. On the 70cm band, 6 MHz channels are used and the typical spacing between the input and output is only 18

MHz. The purpose for the BPF on the receiver input is to prevent fundamental overload of the receiver's front end by the extremely strong, near-field signal from the transmitter. The purpose of the BPF on the transmitters' output is to prevent any out of band spurious spectrum from polluting the RF environment of adjacent channels and especially the receiver's channel. The BPFs used are typically of the Inter-Digital BPF design, Fig. 2, as described in application note, AN-22 [2].

Most 2m and 70cm, narrow-band (15kHz), FM voice repeaters typically use a single antenna for both transmit and receive. A duplexer is typically used between the antenna and the transmitter and receiver. On 2 meters, the frequency separation typically used is 600 kHz, or a ratio of $600/15 = 40:1$. On 70 cm, the frequency separation typically used is 5 MHz, or a ratio of $5000/15 = 333:1$. For TV signals with bandwidths of 6 MHz, the ratio of transmit/receive separation to bandwidth is only $18\text{MHz} / 6\text{MHz} = 3:1$.

With this close separation of only 3:1, it is very difficult to build an effective duplexer for TV repeater service. Thus, usually TV repeaters do not use a single common antenna for both transmit and receive, but two separate antennas as shown in Fig. 1. If omnidirectional antennas are used, they should be positioned on the same supporting mast, directly one above the other so that they are sitting in the null position of each other's antenna pattern to achieve the maximum isolation. For portable repeaters using directional antennas, there is definitely a right and a wrong way to position your antennas ! See Fig. 3 below.

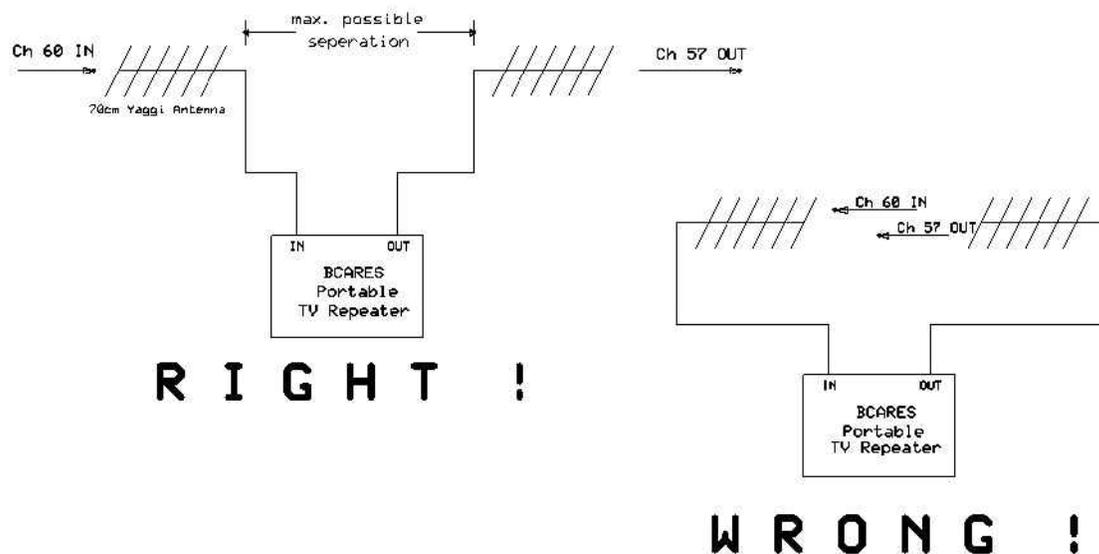


Fig. 3 Portable TV Repeater using Yaggi Antennas. The secret to a repeater is high isolation between the transmitter and the receiver.

CROSS-BAND TV REPEATERS: Repeaters can also be built as "Cross-Band", meaning the input and output frequencies are not on the same bands. Oftentimes, assembling a cross-band repeater is much simpler than building an in-band

repeater because of the extreme separation in input/output frequencies. In some cases, the special band-pass filters can even be eliminated. Then it is a simple matter of patching the output of the receiver into the transmitter and you are on the air repeating. Especially easy is when the input frequency is on a band lower than the output frequency. If the output frequency is however on the lower band, then much more care is required. One must first consider the selection of frequencies. One should especially avoid choosing frequencies where the receive frequency is on one of the harmonics of the transmitter frequency. If this is unavoidable, then extra low-pass filtering will be required on the transmitter's output.

DVB-T REPEATER: It is a very straight forward matter to assemble a DVB-T repeater, especially when one uses the modulators and receivers from Hi-Des Technologies in Taiwan [3]. The recommended receiver is the Hi-Des model HV-110 and the modulator is the Hi-Des model HV-100EH. For automatic operation of a repeater, one only wants it to be transmitting when it is receiving a valid incoming signal. At all other times the transmitter needs to be disabled. Disabling is easily accomplished using the PTT (Push-To-Talk) line on the RF amplifiers. KH6HTV VIDEO RF Linear Amplifiers are all equipped with the ability to use a PTT control line. They typically have PTT On/Off ratios of >90dB.

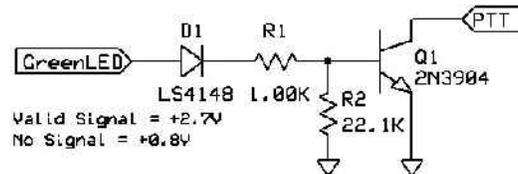


Fig. 4 Simple circuit modification to obtain "Valid Signal" from HV-110 receiver.

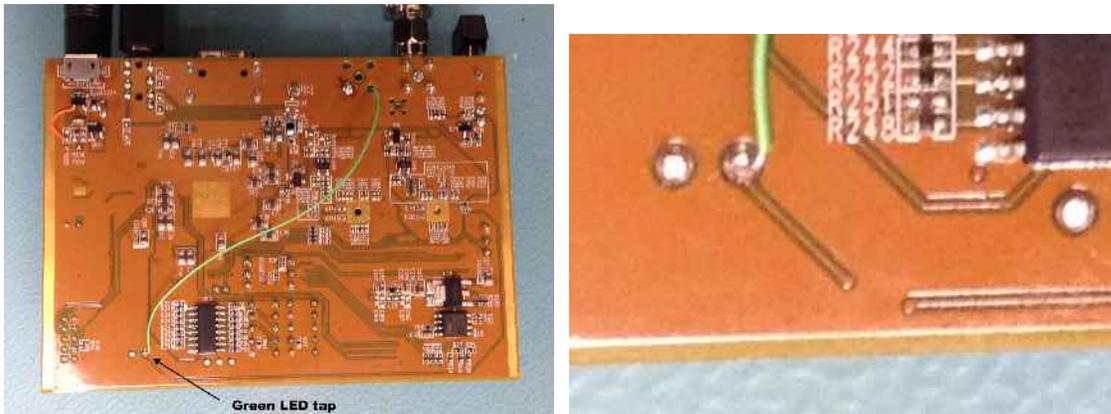


Fig. 5 View of underside of HV-110 pc board showing location of Green LED tap.

It is a very simple matter to obtain a "Valid Signal" logic signal from the Hi-Des model HV-110 receiver. The receiver has a front panel bi-color LED which indicates the status. When it is red, no signal is being received. When it is green, a valid signal is present. Thus, connecting a wire to the green LED provides the necessary "Valid Signal". A simple buffer circuit is shown in Fig. 4 to convert this signal into a suitable open collector

transistor switch to drive a PTT line. Fig. 5 shows where to find the green LED tap point. Fig. 6 shows the installation of the "Valid Signal" circuit.

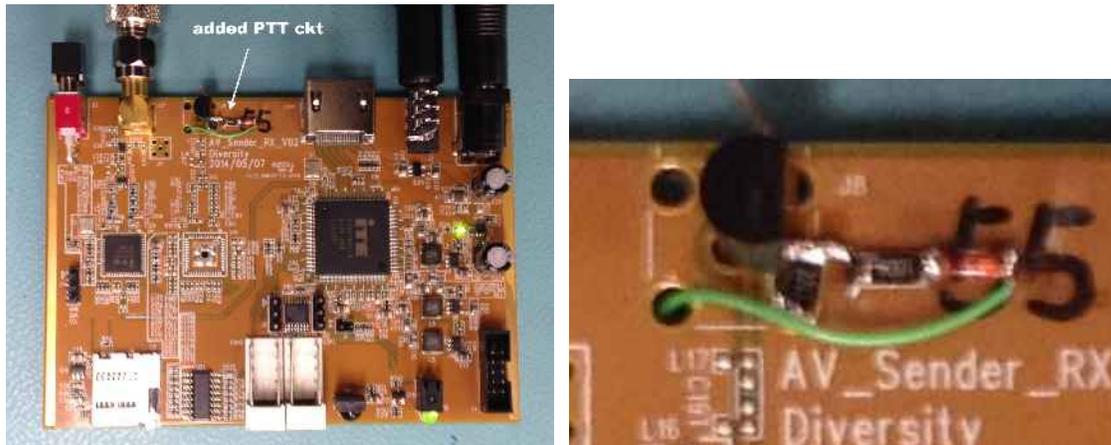


Fig. 6 View of topside of HV-110 pc board showing installation of "Valid Signal" circuit modification.

FCC ID & Control: The FCC requires that all amateur radio transmissions be identified at least once every ten minutes. Using a Hi-Des DVB-T modulator, identification can be automatic and we never have to do it manually or with extra circuitry. In the original design of the DVB-T system, identification of the "Service Name" is included in the outgoing DVB-T digital data stream. By programming your own call sign (such as KH6HTV) as the Service Name, your transmissions are continuously identified automatically. They will appear on the screen of a receiving station.

The FCC also requires that a control operator maintain positive control over a repeater in the event of malfunction, or malicious usage. For a repeater in one's own home, or a manned portable repeater on an ARES operation, this is a simple matter of the operator turning off the master power switch. For an unmanned, remote base repeater, control must be maintained either via a land-line or radio link on a separate control frequency. This will necessitate the installation of additional circuitry in the transmitter's PTT line.

Other Features: Obviously, repeaters can grow to have much more exotic capabilities than the simple one shown in Fig. 1. A repeater might have multiple receiver inputs, both multiple bands, and multiple modes such as VUSB, FM, DVB-S, DVB-T, etc. A repeater might also have multiple transmitters on multiple bands with multiple modes. A nice feature to have on a repeater is a "Beacon" mode. This allows a user to activate the repeater transmitter to be turned on without an incoming signal. This is very useful to allow users to optimize their home receiving stations with a known signal from the repeater. In the Beacon mode, the video source would be generated locally at the repeater site. It could be a tower mounted TV camera. Another useful source is to have a DVD player at the repeater site playing a continuous loop slide show of information about the repeater, the sponsoring club, etc. Each slide should carry the repeater's call sign for identification.

REFERENCES:

1. ARRL Band Plan, <http://www.arrl.org/band-plan>
2. "Inter-Digital Band-Pass Filters", Jim Andrews, KH6HTV VIDEO Application Note, AN-22, May, 2015
3. Hi-Des Technologies, Taiwan, www.hides.com.tw