



Application Note

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Quad DVB-T Receiver

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This application note gives the details on the design of a Digital TV (DTV) receiver to receive and display simultaneously the DVB-T transmissions from four separate, 70cm, DTV transmitters. It is used by BCARES to provide TV support for local police and fire public safety agencies.



Fig. 1 BCARES TV camera crews at a University of Colorado football game using DVB-T, digital TV transmitters. left to right: George, KA0BSA, Steve, WB0NFQ, Jim, KH6HTV, Ron, K2RAS and William, KD0YYY

The Boulder County, Colorado ARES group, BCARES, has been providing TV coverage since 1995 of the University of Colorado football games for the CU Police Dept. The TV images are not of the game on the field, but of the crowd of up to 50,000 spectators for public safety purposes. BCARES also provides TV coverage for other public safety agencies, including the Sheriff, and various police and fire departments in the county. Other events covered have included: large forest fires, floods, major foot races (50,000 runners), public protests, student riots, and SWAT operations.

When BCARES initially started in 1995 working with the CU-PD, a single TV camera image was provided. It proved so popular with the police command staff, that they soon

asked for even more cameras. This was first done on a single, 70cm, channel by switching on and off separate TV transmitters. Soon the police asked to see all the cameras at the same time. BCARES then drew the line at four cameras as we had run out of available 6 MHz channels in the popular 70cm band. We used channels 57, 58, 59 and 60. This was a technical challenge to accomplish on four adjacent channels without co-channel interference. We were using AM-TV transmitters, originally from PC Electronics and later from VideoLynx. We installed a Spectrum International, inter-digital, 6 MHz, band-pass filter on the output of each transmitter. We also used identical channel filters on the inputs to each receiver. Initially, we provided the images on four separate TV receiver/monitors. However, these took up too much space in the command post. The next improvement was to build a Quad TV Receiver box. We used four separate, commercial grade, cable TV head-end receivers. They were Pico-Macom model MPCD (\$140, available from ATV Research). The composite, NTSC, video outputs from these receivers were then fed into a quad processor which combined the four inputs into a single NTSC, composite video signal with each image displayed in one of the four quadrants on a single video monitor screen. When desired, with the push of a button, a single image could be selected and displayed in full screen mode. This analog system was used successfully for many years by BCARES.

While the analog TV system worked, we were almost never able to provide true, broadcast quality pictures for our public safety agencies. Running low power (1 watt), portable operations, typically from a back pack transmitter with flexible whip antennas, we were always fighting the issues of low signal strength and multi-path with the attendant display issues of "snow" and "ghosting".

In the fall of 2014, Jim, KH6HTV, brought his new digital TV transmitter and receiver to the first CU home football game for a demonstration. His equipment used the European terrestrial DTV standard, DVB-T. The CU-PD police commander was extremely impressed with the performance. Finally BCARES was able to provide absolutely perfect quality TV pictures, with no snow nor ghosting, plus we were able to provide pictures from some parts of the stadium which had never been possible previously. They also had the added bonus of being in true, 1080P High-Definition ! Additional details about this can be found in the June, 2015 issue of **QST**. See pages 42-44, "*DVB-T: A Solution for ARES TV Operations*"

The CU-PD made the decision to fund a complete switch-over from the old analog TV system to the new DVB-T system for the Fall, 2015 season. \$10,000 was allocated in funds for new DVB-T transmitters and a Quad DTV Receiver. New cameras were not necessary as we were already using hi-Def Sony camcorders. The BCARES coordinator for CU-PD, Mark Huff, K0LRS, took the lead to order all necessary parts and assemble the systems. This included Mark designing and building a totally new QUAD-DTV Receiver. Mark has received a lot of technical assistance from Matt Holiday, K0DVB, our local resident DVB-T expert.



Fig. 2 The new BCARES Quad DVB-T Receiver and live, hi-definition images at a CU football game received on channels 57, 58 & 60. Note: ch. 59 is also possible.



Fig. 3 Close up of the front of the new Quad DVB-T Receiver. Key items seen top to bottom are the 2m FM transceiver, the HDMI quad processor, 4 Hi-Des DVB-T receivers, and 4 Spectrum International band-pass, channel filters.

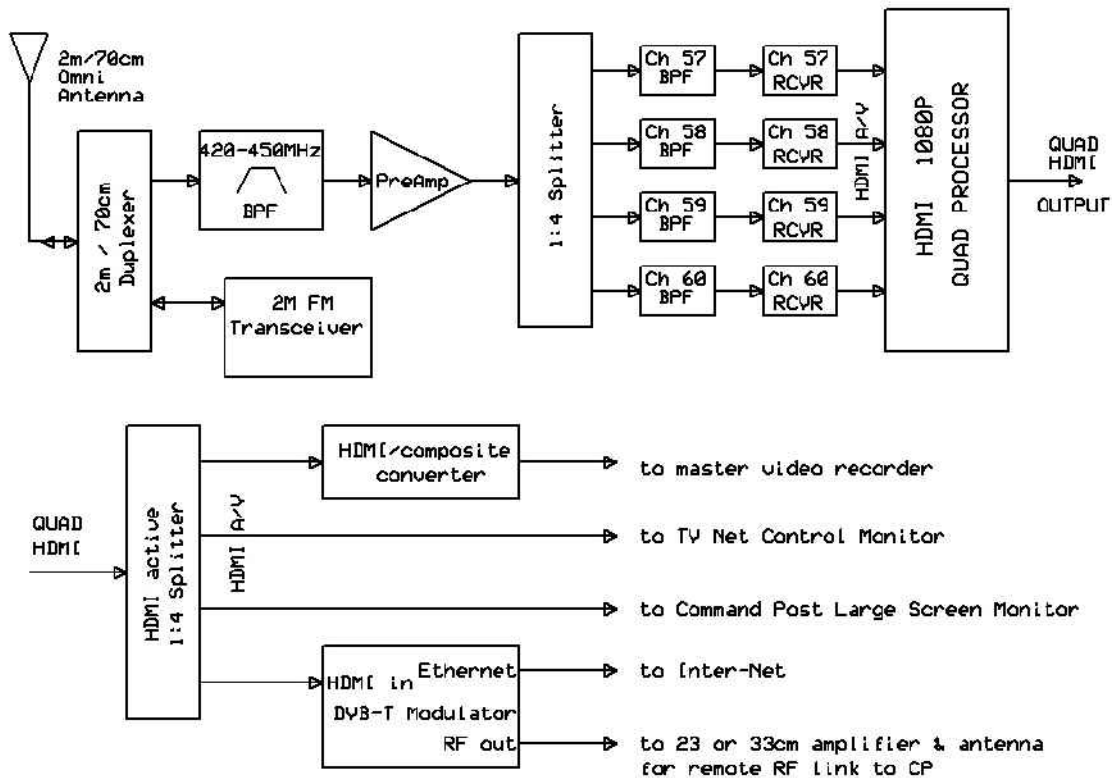


Fig. 4 Block Diagram of BCARES, Quad DVB-T Receiver

Figures 2, 3 & 4 show the new Quad DTV Receiver. Figure 4 is the block diagram of the major components. The key to making the entire system possible is the HDMI Quad Processor. After a search on the inter-net, Mark was able to find one at: <http://www.ambery.com/4hddvispqupi.html> It was called a "4-Channel HDMI DVI Split-Screen Quad PIP Video Matrix Switch", Model: PIPV400H and cost \$1,670.00

The four DVB-T receivers are from Hi-Des Technologies, in Taiwan, www.hides.com.tw They are the model HV-110 and cost \$169 each. To ensure the system works reliably in a high RF, EMI situation, such as a large football stadium, and to minimize co-channel TVI, high-quality, 6 MHz bandwidth, band-pass, channel filters are required on the input of each receiver. The BPFs used were salvaged from the previous BCARES analog quad TV receiver box. They were built by Spectrum International. SI is no longer in business and these filters are now only available on the surplus market. Suitable replacements are now available from Don, N0YE, and marketed by KH6HTV Video, www.kh6htv.com as the model 70-BPF-5P-6BW-XXX (\$325).

The input DTV signals are received on a dual-band (2m/70cm) omni-directional, vertical antenna. We recommend the Diamond X-50N. They first pass through a 2m/70cm duplexer (Diamond MX-72H, \$50). Additional RFI protection filtering is provided by a 70cm (420-450MHz), 30 MHz bandwidth, Spectrum International, band-pass filter. The DTV signals are then amplified in a low noise (0.5dB NF, 18dB gain), GaAsFET pre-amplifier (Advanced Receiver Research, www.advancedreceiver.com, model P432VDG, \$90). The amplified signals are then split four ways (-7dB loss) in an

ordinary CATV, 1 : 4 splitter and sent to the four channel filters and DVB-T receivers. The A/V outputs from the receivers are HDMI. These go to the HDMI quad processor.

The quad processor only provided a single HDMI audio/video output. To provide additional HDMI outputs, a 1 in / 4 out active HDMI splitter was used. These are available on the internet from many sources at low cost (< \$50). An NTSC, composite, quad video signal was provided using an inexpensive HDMI to composite converter. An additional feature of this receiver was the ability to send it's quad video image to other remote locations, either via an RF link and/or the internet. This was provided by using a Hi-Des, model HV-100EH, DVB-T modulator (\$570).

A 2 meter, FM transceiver was included in this quad DTV receiver box. It is used to provide intercom communications between the TV net controller and the remote TV camera crews. It shares the 2m/70cm omni antenna via the duplexer. Other miscellaneous items needed included +12Vdc and +5Vdc power supplies, cables, etc. The entire receiver was packaged in a rugged, portable, 19" rack mount cabinet, Gator model GRR-8L, available for about \$250 from Amazon.com. The overall cost of the entire receiver, excluding labor costs and antenna(s), is approximately \$5,500.