# Boulder Amateur Television Club
# TV Repeater's REPEATER

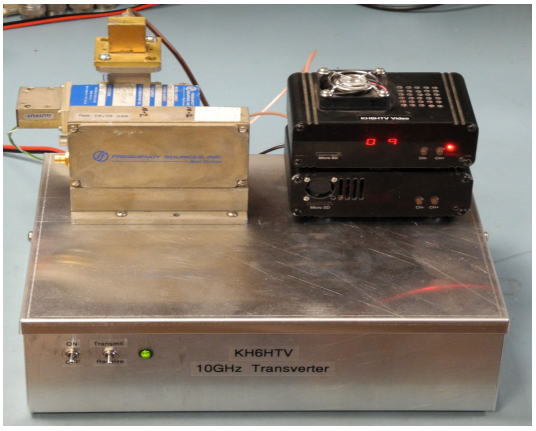
**November, 2021**
**2ed edition, issue #91**

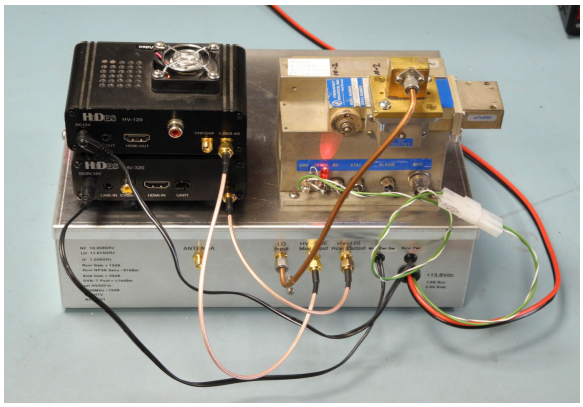
**BATVC web site: www.kh6htv.com**

**ATN web site: www.atn-tv.com**




Jim Andrews, KH6HTV, editor - kh6htv@arrl.net www.kh6htv.com



# A Transverter for 10GHz DVB-T

There is nothing like having a pile of free microwave goodies sitting on the bench to get the home-brew juices flowing. It certainly worked for me. Recently K0RZ cleaned out his ham shack and our BATVC group had a freebie give away. It was advertised earlier this fall here in our newsletter. I picked up a few items myself that would allow me to build a DTV rig for the 3cm (10GHz) band. Now I can report that I have finished assembling and testing it.

I have not tested it yet on the air. The BATVC members had planned a 10 GHz outing yesterday (11/14) to test out several new rigs. It was canceled when we arrived at the test site due to extremely strong winds. It was blowing 30 mph with gusts to 40 mph. Putting up a dish antenna on a tripod in that kind of wind was impossible. If we had tried, our dishes would probably have ended up way over in Kansas !

The complete schematic is shown on a following page. I used the same basic block concept which I used previously building my 5.8 GHz DVB-T Transverter. ( see newsletters #37 & 54 ). The design was driven by what bits & pieces I got from the K0RZ surplus give away, plus what I found in my own microwave junk box. I only had to purchase a couple of items as a result.

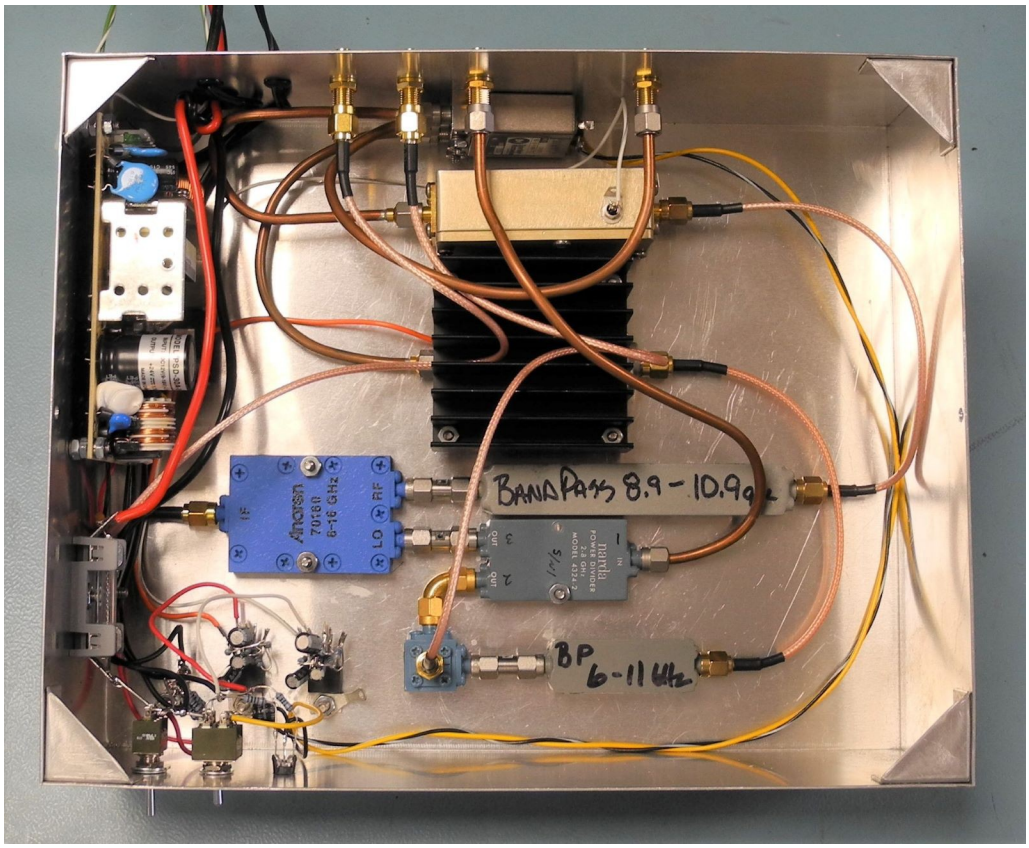
Based upon Don, N0YE's guidance, we here in Boulder have picked 10.359 GHz as our 3cm frequency for DVB-T experimentation. The international SSB frequency is 10. 368 GHz. Don chose 10.359 as being close (9 MHz) to the SSB, but still far enough away for our 6 MHz wide DVB-T signals to not interfere with the weak signal SSB folks. But being only 9 MHz away from 10.368, Don felt that most SSB transverters could be easily modified to work with our TV signals without re-tuning.

I again used a Frequency West brick as the local oscillator. It is the large gold colored module mounted on the top cover. The brick I got from the K0RZ surplus. It's frequency was 11.615 GHz which dictated what my IF frequency would be. With the LO being on the high side of the desired RF, I will be using the lower side-band. It was thus LO - RF = IF = 11.615 - 10.359 = 1.256 GHz. This actually falls in the 23cm band. This IF is not usable with most DVB-T receivers, such as the HV-110, or the generic consumer set-top boxes which top out at the 33cm band, below 1GHz. I still own one of the older Hi-Des model HV-120 receivers which goes up to 2.6GHz so it will be my IF receiver.

Unfortunately, Hi-Des no longer offers for sale the HV-120. Hi-Des does offer their HV-122 receiver which goes up to 2.4GHz, but it is not suitable for microwave transverter use because it can not decode a DVB-T signal if the side bands happen to be inverted. For details, see my app. note, AN-50a "Is DVB-T Sideband Sensitive ?"

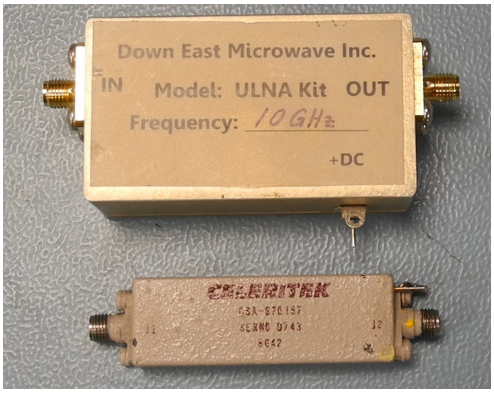
My transverter concept uses a single LO driving two separate mixers. One dedicated for receive and one for transmit. I thus only needed a single SMA coax relay for the antenna switch. I used a 4 - 8 GHz Narda 3dB splitter to drive the LO ports of the mixers. While it was specified for 4-8, I tested it and found it still worked well at 11 GHz for splitting my LO drive equally.

I used two different models of mixers. I had originally planned to use a pair of the Narda 70160s. However upon testing them I found that it really only worked well for down conversion. It's conversion loss really sucked as an up converter. I later found an old spec. sheet from Narda which only advertised it for down converter use. Scrounging thru my junk box I found another small SMA mixer from Aertech. I had zero data on it, nor was I able to find any on-line. But testing it on the bench I found that it worked with a +7dBm LO drive and had decent -8dB up conversion loss at 10 GHz.




Interior view of the new KH6HTV, DVB-T 10GHz Transverter

Now to avoid issues with unwanted side-bands from the mixers, it is always well to include band-pass filters in a transverter design. With an LO of 11.615 GHz and an IF of 1.256GHz, the desired RF signal is 10.359GHz as the LSB. The USB is12.871GHz. Here I lucked out in the K0RZ surplus bins. I found a couple of small, SMA band-pass filters. Testing them on my old Wiltron network analyzer, I found they had great brick wall skirts. I used the 8.9-11GHz filter on the receive side to avoid having USB noise destroy the LNA's performance. I used the 6-11GHz BPF then on the transmit side to eliminate feed-thru of both the LO and USB.




The amplifiers used in the transverter. Top is the LNA. Bottom is the power amp.

I did need to purchase amplifiers. I found a suitable transmit amplifier at my favorite microwave surplus dealer, Western Test Systems in Wyoming ( www.westerntestsystems.com ) It was a small SMA module made by Celeritek. It was specified to cover 6-11 GHz with 33dB gain, +22dBm and work on 12Vdc. I tested it and found at 10.25 GHz it had 36dB gain, P(-1dB) = +22dBm and P(max) = +25dBm. It pulled 480mA at 12Vdc and got quite hot. It thus needed a good heat sink. In the interior view photo, this amplifier is sandwiched under the black heat sink.

For my receiver LNA, I purchased a 10G-LNA kit from Down-East Microwave. I have previously written my review of it in the September newsletter, issue #87. I tested it and found the gain to be 20dB with a 1.06dB noise figure.

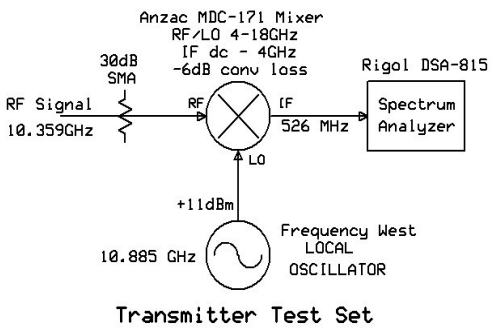
For DC power, the transverter is designed to work off of +13.8Vdc. The Frequency West brick LO requires -20Vdc. Bill, AB0MY, had previously found a low cost isolated DC/DC converter suitable for powering these bricks. It was the MeanWell model PSD-30A-24. See newsletter issue #57. Bill got his from Jameco for only $13, but they were sold out. I was able to find one on Amazon for about 2X what Bill paid.

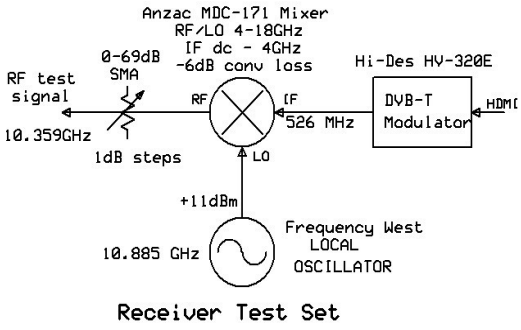
I power the Hi-Des receiver directly with 13.8Vdc and I leave it on all the time. When I am in the transmit mode, there is sufficient leakage thru the SMA coax relay and the receive chain that I get a weak, but usable signal to the IF receiver that I can monitor my transmitter output. I measured the DVB-T leakage signal to be -76dBm.

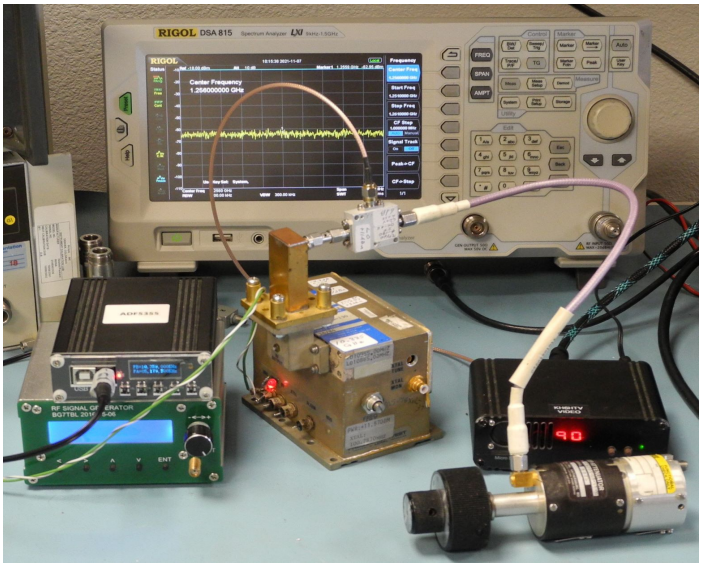
My front panel T/R switch powers up the Hi-Des HV-320E modulator only when I am in the transmit mode. When transmitting, I remove power from the LNA and apply power to the Celeritek amplifier. I power both of these amplifiers from regulated +11.8Vdc supplied by low drop-out, linear LM2941 regulators, U2 & U3. I also added time delays to turn on these regulators, to allow time for the SMA coax relay to switch. The LM2941 has a logic on/off pin #2. Normally pin 2 is simply grounded. By adding the 100uF cap, C2, and 2.2K resistor R3, I delay the grounding of pin 2, thus providing a 600ms turn on delay.

The K0RZ surplus SMA coax relay happened to be a 12V relay with a single coil. Testing it I found it pulled quite a bit of current at 300mA at 13.8V. This seemed to be a waste of good battery current to keep this relay energized. So, taking Chris', K0CJG's idea of using a voltage doubler to drive his 24 V relay, I used the same concept to switch my relay, but then drop the current after it switched. So on the schematic you will find C8 and R9. C8 is charged to 13.8V and has enough oomph to pull in the relay on transmit. R9 then provides still enough current to hold the relay in, but drops the overall current to 125mA.

I packaged everything into a basic 10"x8"x3" aluminum chassis with a cover plate. For the critical 10GHz rf paths, I used short 6" pieces of low loss, 0.141" semi-rigid coax with SMAs. For the other rf connections, I used flexible, RG-316/U, SMA cables. The Hi-Des receiver and modulator sit on the top cover along with the brick LO. They are all connected to the interior components via SMA connections on the rear panel.

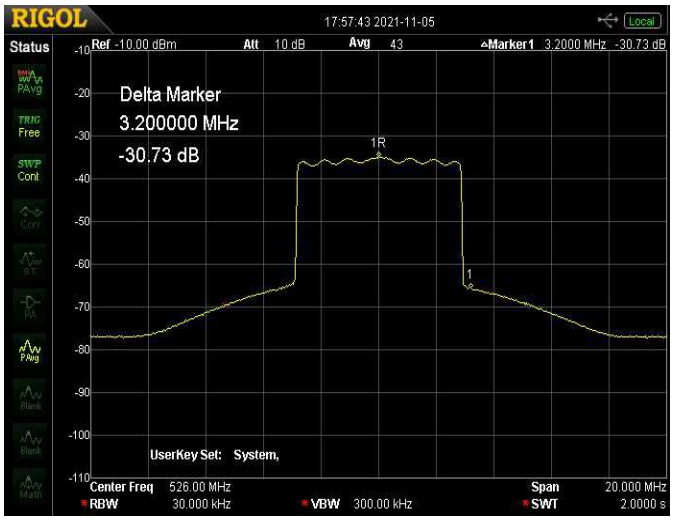



OK -- now that the box is built, how well did it perform ? Pretty much as designed fortunately. I tested it using the test setups shown above. I used another Frequency West brick LO and an X-band mixer. When testing the transmitter, the mixer's IF output went to my Rigol spectrum analyzer. When testing the receiver, I drove a DVB-T signal into the IF port of the mixer. When testing the transmitter, a 30dB SMA attenuator was placed in front of the mixer to avoid over loading it.

Testing the transmitter portion of the transverter, I had predicted that the RF output would be +14dBm of RF power when transmitting DVB-T and that is exactly what I measured. This was with the rf spectrum skirt's break-points set to -30dB as shown in the plot on the next page. At this point I detected no degradation in the transmitted S/N. For QPSK, 16-QAM & 64-QAM, I measured the ideal values of 23dB, 26dB, and 32dB, identical to what came out of the Hi-Des modulator. I measured the rf power with my HP-432 power meter and 8478B thermistor power head, plus a 10dB SMA attenuator. The transmitter gain from IF input to RF output was measured to be 24dB.

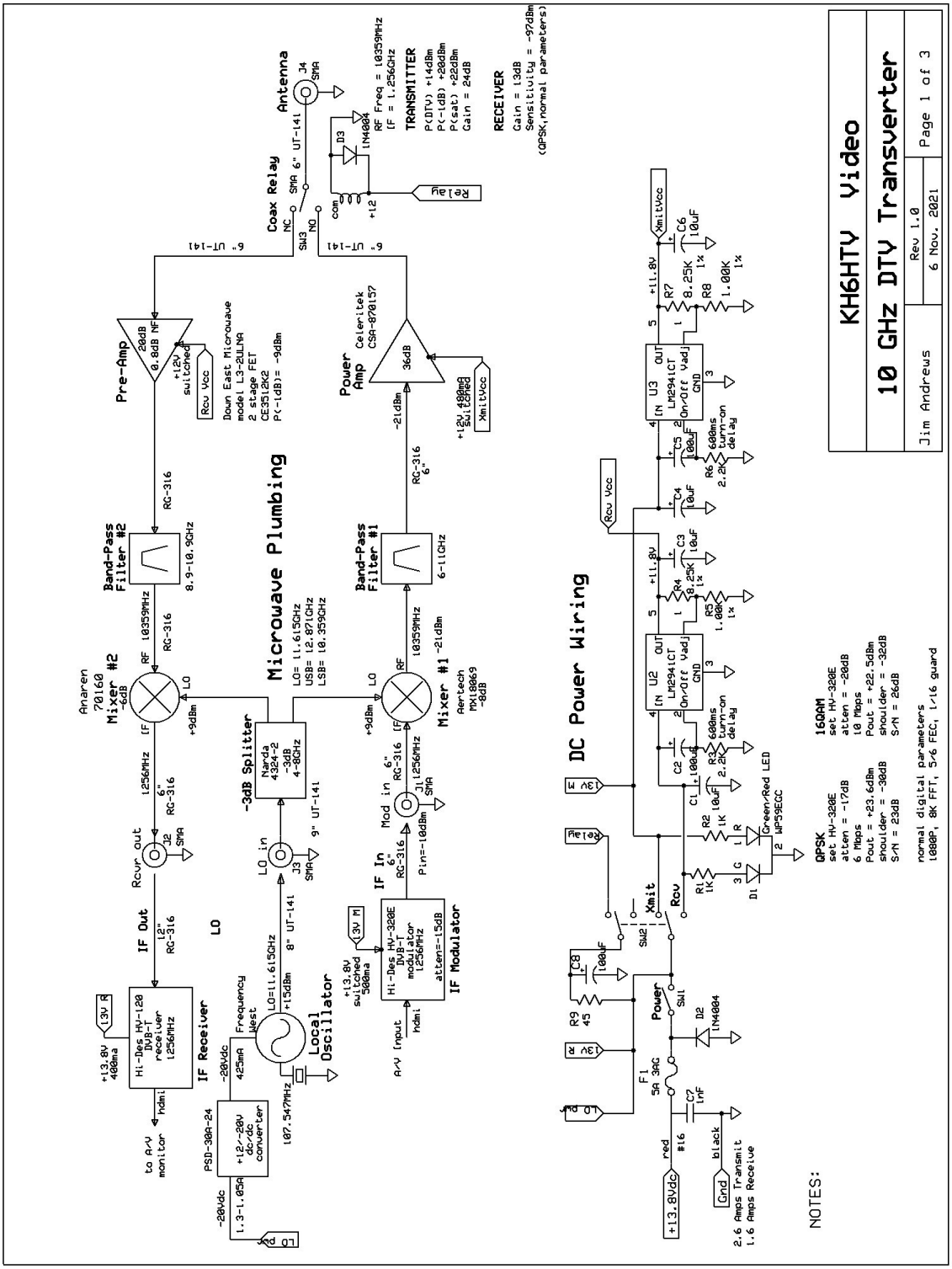



DVB-T spectrum of RF output from the 10GHz transverter.
10dB/div & 2MHz/div. Pout = +14dBm

For testing the receiver's sensitivity, a live video & audio program from a DVD was input to the HV-320 modulator. The modulator's output was the IF input to the mixer. It was set to -13dBm. The mixer added -6dB conversion loss. The cabling for the step attenuator on the rf output added more attenuation so that the test signal level was -21dBm. A fixed 30dB SMA attenuator was used along with a Weinschel, step attenuator to then set known levels of weak signals to test the receiver. The step attenuator had 1dB and 10dB steps for an overall range from 0 to -69dB.

The receiver's gain from RF input to IF output was measured to be +13dB. For DVB-T reception, I used QPSK modulation with "normal" digital parameters (1080P, 8K FFT, 5/6 FEC & 1/16 guard). I measured the threshold sensitivity of the transverter to be -97dBm at a S/N of 8dB.

Jim, KH6HTV, Boulder, Colorado


KH6HTV Video
10 GHz DTV Transverter
Jim Andrews
Rev 1.0
6 Nov. 2021
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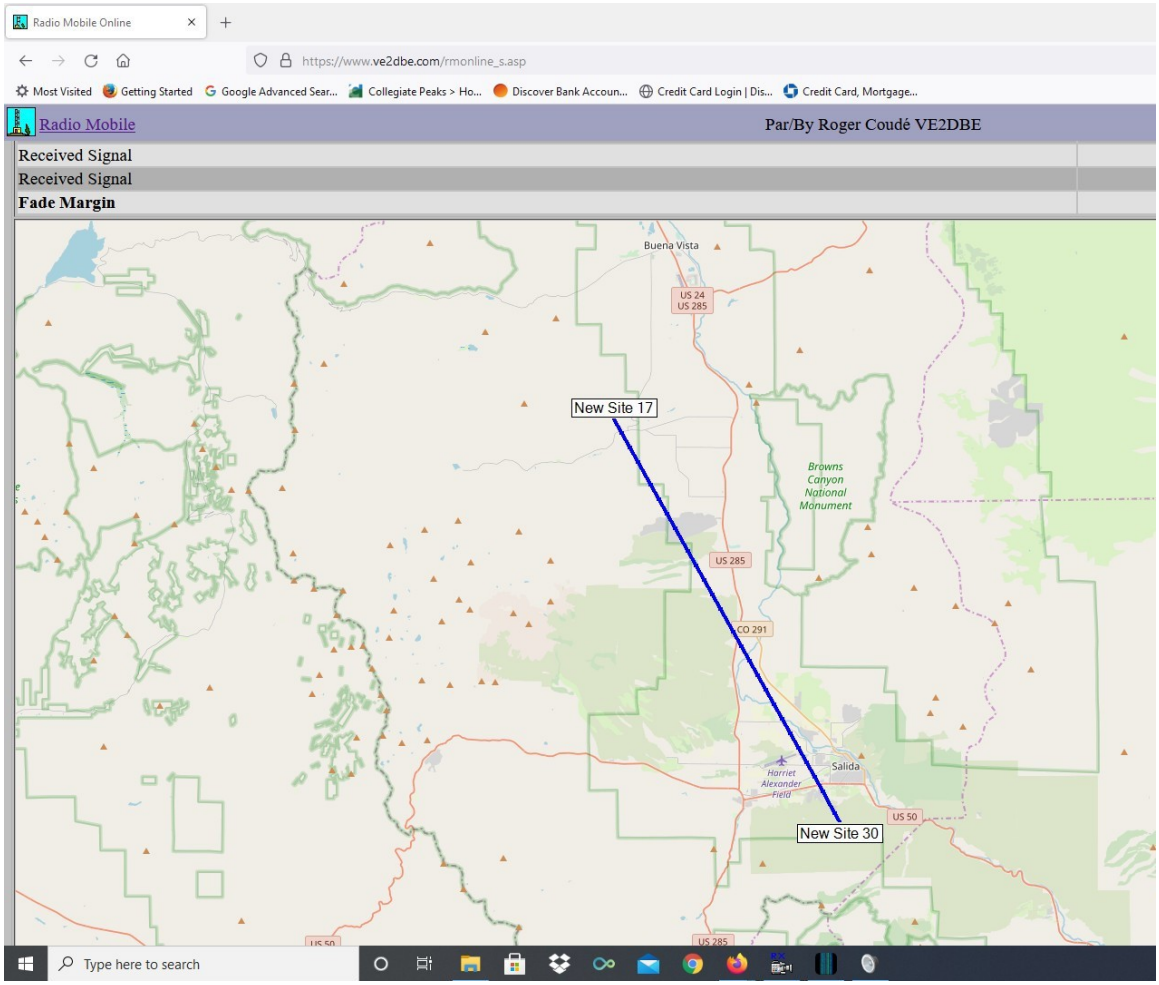
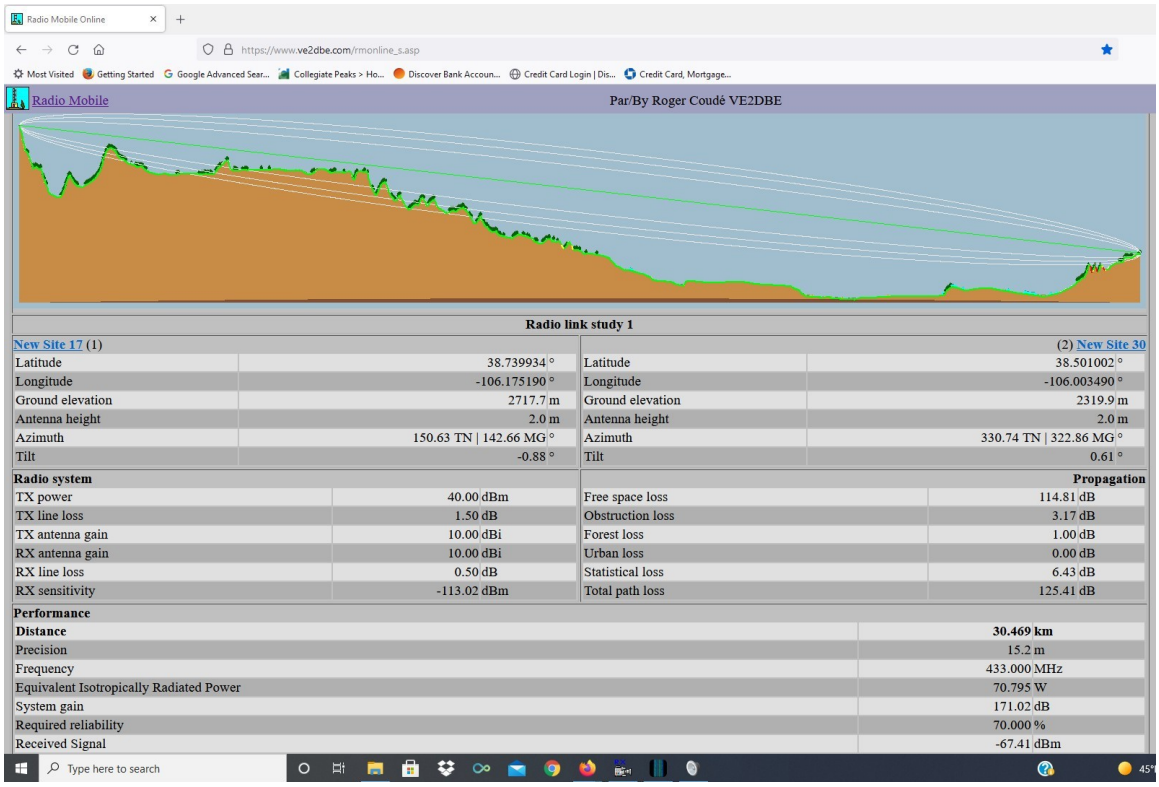
Microwave Plumbing
DC Power Wiring
Antenna
Coax Relay
Pre-Amp
Power Amp
Band-Pass Filter #2
Band-Pass Filter #1
Mixer #2
Mixer #1
-3dB Splitter
IF Out
IF Receiver
LO
Local Oscillator
IF In
IF Modulator
TRANSMITTER
RECEIVER
NOTES:

# A UHF Propagation Question

**The Question:** Can an inversion layer, located at an elevation midway between stations at higher and lower elevations, significantly block UHF signals between them?




**Background:** Leon Golden, NØVWX, and Rick Peterson, WA6NUT planned an ATV DXpedition for the morning of November 10, 2021. The operation would be between two mountains in the Colorado Rockies. Leon set up his portable 70 cm. ATV equipment above Salida part way up Methodist Mountain. Rick's equipment was set up at a location on Mount Princeton. Leon was located about 400 ft. above Salida, at 7609 ft elevation, at the Rainbow Trail parking lot. Rick was located at 8914 ft. elevation, at Frontier Ranch, a youth camp. The weather was cold and blustery, with Leon reporting occasional snow squalls at his location. Leon's ATV transmitter was a Videolynx VM-70X, with about 3W output on 439.25 MHz (cable channel 60). Rick was also transmitting with a VM-70X, but also with a home brew amplifier with about 10W output. Both were using 8-element Quagi antennas.




**Radio link study 1**

| New Site 17 (1) | | (2) New Site 30 | |
|---|---|---|---|
| Latitude | 38.739934 ° | Latitude | 38.501002 ° |
| Longitude | -106.175190 ° | Longitude | -106.003490 ° |
| Ground elevation | 2717.7 m | Ground elevation | 2319.9 m |
| Antenna height | 2.0 m | Antenna height | 2.0 m |
| Azimuth | 150.63 TN \| 142.66 MG ° | Azimuth | 330.74 TN \| 322.86 MG ° |
| Tilt | -0.88 ° | Tilt | 0.61 ° |

| Radio system | | Propagation | |
|---|---|---|---|
| TX power | 40.00 dBm | Free space loss | 114.81 dB |
| TX line loss | 1.50 dB | Obstruction loss | 3.17 dB |
| TX antenna gain | 10.00 dBi | Forest loss | 1.00 dB |
| RX antenna gain | 10.00 dBi | Urban loss | 0.00 dB |
| RX line loss | 0.50 dB | Statistical loss | 6.43 dB |
| RX sensitivity | -113.02 dBm | Total path loss | 125.41 dB |

| Performance | |
|---|---|
| **Distance** | **30.469 km** |
| Precision | 15.2 m |
| Frequency | 433.000 MHz |
| Equivalent Isotropically Radiated Power | 70.795 W |
| System gain | 171.02 dB |
| Required reliability | 70.000 % |
| Received Signal | -67.41 dBm |

Figure 1 above is a map showing the 18.92 mile path between Frontier Ranch (transmitting) and Rainbow Trail (receiving). Figure 2 above is the RF path profile and calculations using Radio Mobile Online software. The software estimates received signal levels and path losses. The path profile shows a clear path. Note that the -67.41 dBm received signal level calculated by the software should give P3-P4 images at the Rainbow Trail location.

But no images were detected at either end. WA6NUT received only faint sync bars at the Mount Princeton location. Despite checks of the equipment and changing antenna headings, there were simply no TV images. Note that the 2 meter FM voice link was solid throughout their experiment, with only 1.5W transmitted from an HT at the Mount Princeton end. With similar setups, Leon and Rick had previously sent P4-P5 video over 5-mile and 10-mile paths.

After packing up and returning home, they tried to analyze the problem. Perhaps the Radio Mobile Online software was too optimistic in its estimation of received signal level. Perhaps the "Obstruction Loss" calculated by the software was too optimistic, failing to account for the grazing of the signal over the top of a ridge near the transmitting end. But the software has been used with great success by other amateurs, so they looked for another explanation.

**Another Explanation?** What if an inversion layer had been located at about 8300 ft. elevation (1100 ft. above Salida), at an elevation roughly midway between the elevation

at Mount Princeton (8914 ft.) and Rainbow Trail (7609 ft.)? Would Rick's signal from Mount Princeton bounce off the top of the layer and would Leon's signal from Rainbow Trail bounce off the bottom of the layer, so that neither Rick nor Leon would receive the other's signal? Or could the signals get trapped in a duct formed by the inversion layer? They'd like to pose these questions to readers of the WØBTV Repeater newsletter. Would anyone like to help them solve the mystery? Any comments would be greatly appreciated!

**Reference:** Tropospheric Propagation website by VK3FS (includes an excellent YouTube presentation) https://3fs.net.au/tropospheric-propagation/

73 de Rick, WA6NUT, Buena Vista, Colorado



**ATCO NEWS:** ATCO's leader, Art, WA8RMC, exchanges their newsletters with us. ATCO is one of the oldest ATV groups in the US. They started in 1980 The ATCO ATV repeater is impressive. It is located in downtown Columbus, Ohio on the top of the Ohio State Office Tower. Their antennas are 630 ft. above street level ! Their ATV equipment is in the communications room at the top of the building. They have six ATV transmitters. 423MHz (10W, DVB-T, 2MHz BW), 427.25MHz (100W pep, VUSB-TV), 1258MHz (40W, FM-TV), 1268MHz (20W, DVB-S), 2397MHz (0.6W Mesh) and 10.350GHz (1W, FM-TV). Likewise, they have multiple receivers on 70cm, 23cm, 13cm and 3cm bands for analog TV, DVB-T and DVB-S.

Art reports that ATCO has 57 members. About 40 of them live within a 50 mile radius of their repeater. They hold a weekly ATV net on Tuesday nights. It is held on ZOOM and starts at 8pm (local). Nets usually run for about an hour. They welcome all ATVers to join their net. Contact Art for the zoom meeting ID and password. towslee1@ee.net

Art writes about recent ATV repeater repairs. ---- "I've now been given access to our location in the State Office Tower communication room. The repair activity is still going on and the roof area is still a mess but it's passable. The Mesh transceiver on the roof has been inoperable for over a year but now I can get there so I wanted to make it operable before it gets too cold. I removed the entire unit, antenna, filters and all. An inspection at home revealed that a break in the cable insulation feeding the power to it allowed water intrusion to both ends and ruined the Ethernet connector in the Mesh transmitter and the connector on the interconnect box which houses the 10GHz equipment. Luckily only the male cable connector on the interconnect box was damaged, not the receptacle. At home, I replaced the Mesh Bullet unit and cable, then returned it to its position beside the SOT tower beacon light. Stan, AA8XA, checked it for operation. A-OK now."

"While I was at the repeater, I noticed the fan in the DATV transmitter unit was frozen. (We have two fans). It was a simple chore to replace so all is well now. Other things were checked and found to be OK. I did string a new Ethernet cable from the Mesh Bullet unit down the girders and coiled it up close to the roof entry point outside. No actual connections were made because roof work to replace the cable entry feeds are scheduled but not until next Spring so the cable will be ready when they do that."

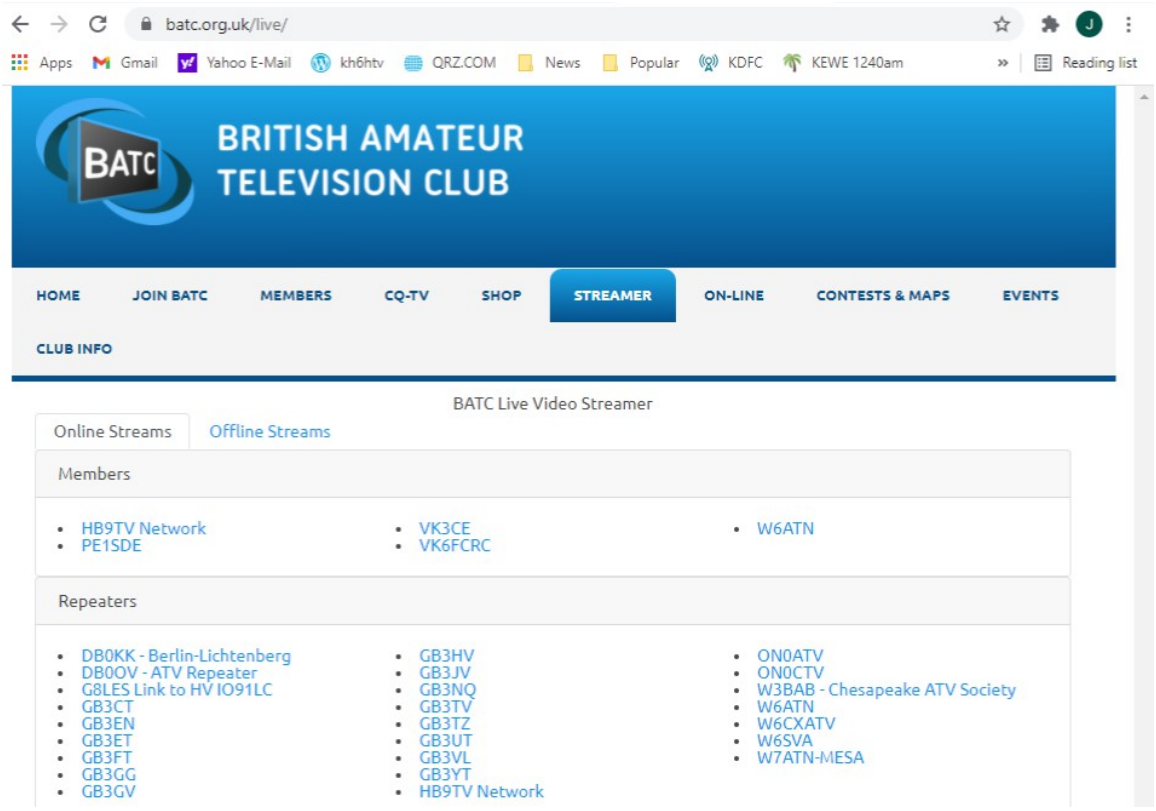

# CQ-DATV Feedback:

**Rudi, S58RU**, in Slovenia has sent us an email notifying us that our ATV newsletter is now being listed on the Slovenian S50LEA Amateur Radio Forum web site ( http://forum.hamradio.si/ ) and the Associazione RadioAmatori Italiani amateur radio forum web site ( http://www.arifidenza.it/ )

**Mark, WB9QZB**, has also informed us that the Amateur Radio Newsline Report on Friday, the 12th reported the demise of CQ-DATV.

Jim --- I wanted to drop you a line after reading about CQ-DATV and mention that it did occur to me that what you're doing with your own DATV notes that you periodically publish might be more important than ever now. Just wanted to share a little appreciation and support for your efforts!

73, Grant, KB7WSD, Everett, Washington




## WATCH ATV FROM AROUND THE WORLD:

Check out the BATC web site. https://batc.org.uk/live/ There you can watch live streams from 62 ATV repeaters, plus several hundred ATV hams from around the world. There are some repeaters that are streaming 24/7, but it may not be a "live" program, but simply a test pattern. But you can still catch some interesting live programs in progress. Our own Boulder ATV group streams our Thursday afternoon nets live via the BATC. Click on either KH6HTV-TVR under repeaters, or N0YE under members.

## BARC FOX HUNT:

The Boulder, CO ham club (BARC) is organizing a 2 meter Fox Hunt. It will be held on Saturday, Dec. 4th. For details, contact Mike WF0M, at Mike@HoweWasserburger.com

## W0BTV Details:

**Inputs:** 439.25MHz, analog NTSC, VUSB-TV; 441MHz/6MHz BW, DVB-T & 1243MHz/6MHz BW, DVB-T

**Outputs:** Channel 57 --- 423MHz/6MHz BW, DVB-T, or optional 421.25MHz, analog VUSB-TV. Also, secondary transmitter, FM-TV output on 5.905 GHz (24/7).

Operational details in AN-51a Technical details in AN-53a. Available at: *https://kh6htv.com/application-notes/*

**W0BTV ATV Net:** We hold a social ATV net on Thursday afternoon at 3 pm local Mountain time (22:00 UTC). The net typically runs for 1 to 1 1/2 hours. A DVD ham travelogue is usually played for about one hour before and 1/2 hour after the formal net. ATV nets are streamed live using the British Amateur TV Club's server, via: *https://batc.org.uk/live/kh6htvtvr* or *n0ye*. We use the Boulder ARES (BCARES) 2 meter FM voice repeater for intercom. 146.760 MHz ( -600kHz, 100 Hz PL tone required to access).

**Newsletter Details:** This is a free newsletter distributed electronically via e-mail to ATV hams. The distribution list has now grown to about 500. News and articles from other ATV groups are welcomed. Permission is granted to re-distribute it and also to re-print articles, as long as you acknowledge the source. All past issues are archived at: *https://kh6htv.com/newsletter/*

# ATV HAM ADS

**Free advertising space is offered here to ATV hams, ham clubs or ARES groups. List here amateur radio & TV gear For Sale - or - Want to Buy.**