# Boulder Amateur Television Club
# TV Repeater's REPEATER

**March, 2020**
**2ed edition**

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

**ATN web site: www.amateurtelevisionnetwork.org**



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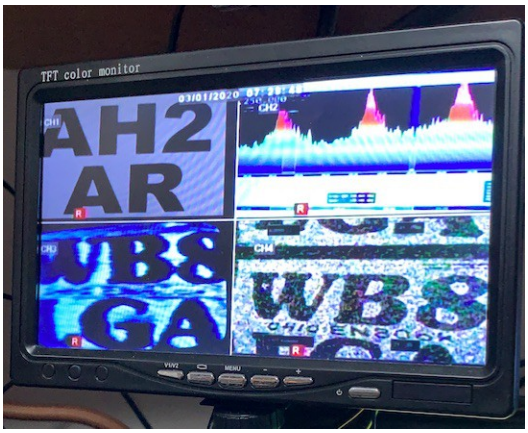
**Future Newsletters:** If you have contributions for future newsletters, please send them to me. We also encourage you to forward this newsletter on to other ham friends in your clubs.

**5.8 GHz - FCC:** The 5.9 GHz comments by ATN (national) ATN-AZ & ATN-CA have been filed with the FCC. Looking on the FCC website, I noted over 90 percent of the comments submitted were against reallocating the lower part of 5.9 GHz band to Wi-Fi. Most of the comments were by state departments of transportation. The next biggest group was ham radio. Only a small handful wanted to reallocate the band to Wi-Fi. Out of the transportation group, many did not want the CV2X mode but wanted to stay with the existing system stating the new system was a hybrid for safety but also had a commercial side that they did not want. Other transportation groups were OK with CV2X.

I want to thank all of the various ATN chapters for your input into the filings and to Jim, KH6HTV, for providing support information, a great team effort! The next agenda item is reply comments to the 3 GHz band filings. Reply comments allow us to comment on the filed comment responses of other parties. One good comment was from Lockeed Martin who manufactures Radars and needs to keep most of the band for testing and final alignment of systems it makes for US, NATO and other friendly counties. If you find you have some time to read through the comments and make some notes about any comments that stick out to you as useful to our preparing ATN's reply comments, that would be great. 73, Mike WA6SVT, ATN

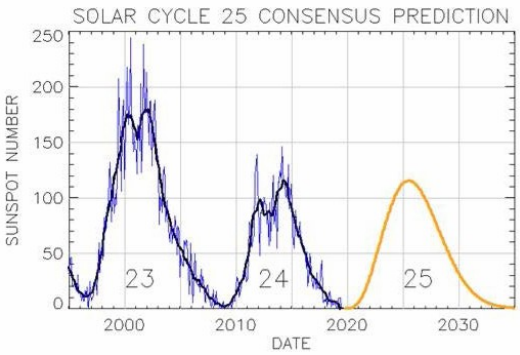
**ATV Repeater Directory:** I recently discovered another amateur repeater directory which unlike the ARRL's is on-line and free. It is: www.repeaterbook.com It included a listing of ATV repeaters for USA & Canada. It listed a total of 39 ATV repeaters. I cross checked against the list of active repeaters, Art, WA8RMZ, and I found

a year ago when we put together our ATV repeater directory (see AN-47). I found 20 which were not on our list. I then tried to contact via e-mail all of these to determine their current status. I got no replies from most of them. Three said they were now off the air and two are active repeaters. Conclusion: the RepeaterBook ATV directory is woofully out of date and unusable. Since Art and I created this directory a year ago, I have since added four more ATV repeaters. We now in the USA have 41 known, active ATV repeaters. I have now posted a revised, up-dated ATV repeater directory, AN-47, to my web site www.kh6htv.com https://kh6htv.files.wordpress.com/2020/03/an-47-atv-rptrs-rev-mar2020.pdf




**Dayton ATV News:** A marginal East-West, 70cm band enhancement occurred on Sunday (3/1). Pictured below is the received signal coming from WB8LGA in Morrow County, Ohio, received by AH2AR in Vandalia Ohio (an approximate 90 mile separation path). To better explain the QUAD screen display, The upper left portion of the screen is an AH2AR ID video screen in standby, the upper right-hand portion of the screen is the 439.250 Mhz Analog received signal from WB8LGA being directly received on an AirSpy SDR receiver in Vandalia , the lower right hand portion of the QUAD screen is WB8LGA's analog signal being re-transmitted by the Huber Heights DARA ATV repeater though its digital output to Vandalia, and the lower left hand screen is WB8LGA's direct-received analog video, being received in Vandalia. Note that analog video continues to be alive and well in this region. We tried to complete the link on 70cm DVB-T during this enhancement but the band was not fully cooperating... probably due to QSB. --- 73 de Dave, AH2AR

## NOAA's Prediction for the next Sun Spot Cycle



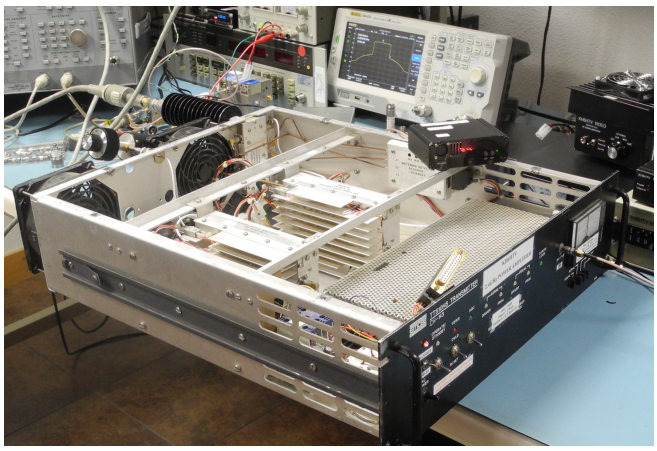

NOAA scientist, Doug Biesecker, gave a talk at the February Boulder Amateur Radio Club meeting. This is NOAA's prediction. Solar Minimun 24/25 will occur in April, 2020 ± 6 months. Solar Maximum 25 will occur in July, 2025 ± 8 months with a maximum, smoothed sunspot number of 115 ± 10.

tnx to BARC's BARK, Feb. 2020 issue

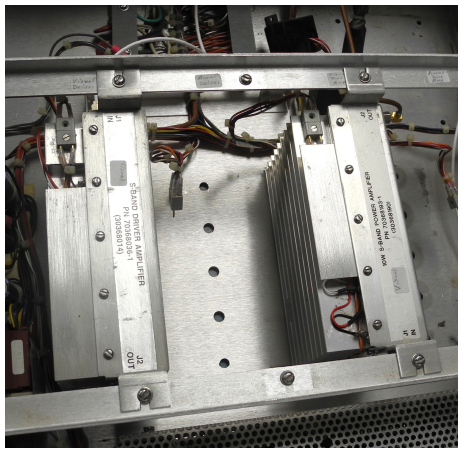

# 2 Watt, 2.4 GHz, DVB-T Transmitter

**Jim, KH6HTV**

Several years ago, Bill, K0RZ, gave me a surplus ShowTime MDDS, analog TV transmitter. It was used on the commercial MDDS, 2.5-2.7 GHz band. It was built by EMCEE and was their model TTS10HS and labeled to work on channel H3. It was found to contain two identical transmitters, one Visual and the other Aural. Each transmitter was rated for 10 watts. It was a BIG Beast with two very noisy cooling fans. I didn't know what to do with it for a long time, so it sat gathering dust on a shelf in my garage for an extended period of time. When I eventually became interested in trying out the 2.4 GHz ham band for DVB-T, I decided to see what I could do with this transmitter. Opening the box, I found a whole of of stuff. Most of it was unusable for my purposes. So, I proceeded to gut out most of it. Included was pulling out the second, Aural transmitter, which I then gave to Don, N0YE. All that was left was the one driver amplifier, the final 10 watt amplifier, the metering circuits, and the necessary, big, heavy, linear dc power supplies and one very noisy cooling fan. It was still big, bulky and heavy. So would it work ? Read on.



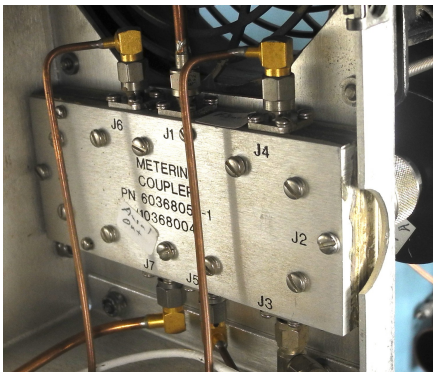
Transmitter - after "Gutting"



Driver & 10 W Final Amplifier

I have just completed some evaluation tests on the "Beast". I used a Hi-Des, model HV-320E, DVB-T modulator as my DTV signal source. I used 2393 MHz as the test

frequency. To measure the output power, I used a Narda, 30dB, 50 W attenuator and my HP-432 power meter with an rms responding, HP thermistor head. To look at the output spectrum, I lashed together a down-converter consisting of a Vari-L, 3 GHz mixer, a frequency synthsized Local Oscillator set to 2.0GHz, +7dBm and the IF went to my Rigol DSA-815 spectrum analyzer (0.1-1500MHz). Setting the Rigol to 393 MHz allowed me to thus look at the 2393 MHz spectrum.



Output Directional Coupler

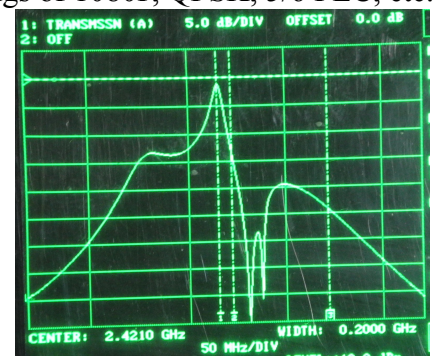
Front Panel Metering

All tests were at the desired 13cm operating frequency of 2393 MHz. I first ran a CW test of the power curve of the amplifer and found the small signal gain to be 57.5dB. The -1dB gain compression, Pout(-1dB) occured at +38.5dBm = 7.1 Watts. The max. saturated power output was +39.7dBm = 9.3 Watts. I then ran tests for digital TV. I used the HV-320E modulator. It was set for "Normal", amateur digital parameters with 6 MHz BW, 1080P resolution, QPSK, 5/6 FEC, etc. I used a step attenuator on the output of the HV-320E to carefully set the input rf drive level. I monitored the resultant spectrum on the Rigol. I increased the rf drive upwards until the spectrum shoulder breakpoints (measured at ± 200 kHz beyond the band edges) hit -30dB. I then used the HP power meter to measured the ouput power. I found it to be +33 dBm = 2 Watts (rms). At this level, the front panel power meter indicated 50%. This amplifier will work well as a 2.4 GHz After-Burner and can be driven directly by the Hi-Des HV-320E modulator.

**N0YE's 2.4GHz Tranmitter:** As mentioned in the previous newsletter, N0YE & KH6HTV, had less than outstanding luck trying to send DVB-T pictures on 2.4 GHz across town recently. At the time, Don measured his output power to be a puny +13dBm when his DVB-T spectrum showed -30dB shoulders. Don's home-brew transverter uses Hi-Des gear as his 430 MHz IF. He uses a Frequency West brick as his LO driving a mixer. For transmit, the mixer output goes through a Mini-Circuits amplifier and his final amplifier is in fact the same identical 10 watt amplifer from the ShowTime transmitter as described above. So after Jim's recent tests on the ShowTime amplifer (see above article) showed that this amplifier really was capable of up to 2 Watts (+33dBm) of DTV power -- Don went back to the drawing board. He reworked his power / gain distribution of his transmitter chain and "Voila" -- he was able to dramaticlly improve it's performance. At -30dB DTV shoulders, he now is getting +29dBm (800mW). Thus he was able to improve his output power by a whopping 16dB. Congratulations Don ! Now to head out into the field again for real propagation tests. Those will wait until nice, warm spring weather arrives for good.

**CONFUSING 2.4GHz RECEIVER TESTS:** In addtion to Don & I reworking our 2.4 GHz, DVB-T transmitters, we also were looking again at our receivers. In my (KH6TV) case, I am using the Hi-Des HV-120 receiver which tunes up to and including the 2.4GHz band. I rechecked the receiver sensitivity. My sensitivity test set consists of an HV-320E modulator and a DVD player running a continuous, "live" movie with moving video & audio, plus calibrated attenuators. To avoid any possible "rf leakage paths" on the test bench, I placed the modulator & DVD player in another room and ran a long, lossy, RG-58 coax cable into the ham shack. I calibrated the dB loss in the cable. I used a Weinschel rotary step attenuator with 1 & 10dB steps to set the level into the receiver under test precisely. I define the receiver sensitivity as the lowest input rf level which gives perfect video and audio with no freeze framing. For the tests reported below, I used "Normal" amateur DTV settings of 1080P, QPSK, 5/6 FEC, etc.


2393 MHz Band-Pass Filter




S21 swept response 5dB/div, 200MHz span

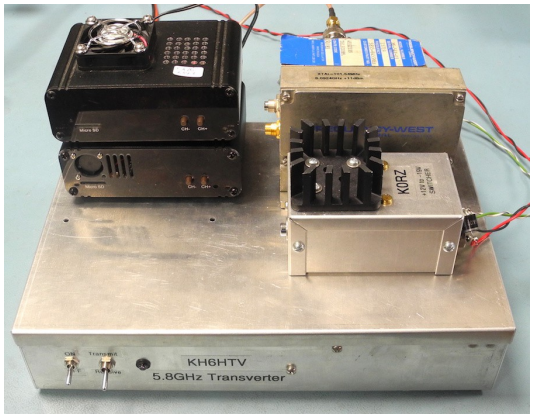
I tested various combinations of the Hi-Des receiver, a low-noise preamplifier and a band-pass filter. Don, N0YE, has a very well equipted collection of misc. microwave components which he has accumulated over the years from ham swapfests, etc. He loaned me several 2.4 GHz BPFs to play with. I selected one which gave me the narrowest pass-band. It was a 3 pole resonator filter with 2 additional reject, notch filters at the ends. See the above photo. I tuned this filter to pass 2393 MHz and reject as much as possible of the Wi-Fi band. The above S21 plot shows it's response. The first marker is at 2393, the second at 2400 and the third at 2450 MHz. The insertion loss of the BPF was -1.3dB at 2393 MHz. The resultant -3dB bandwidth was a bit narrow at 5 MHz for our 6 MHz wide DVB-T signal. The preamp used was the SPF-5189 (WB-LNA-3) discussed in the previous Feb. newsletter, #35, pp. 5-6. This preamp had exceptionally low noise on 2m thru 23cm bands of 0.6, 0.5, 0.7dB NF. On the 13cm (2.4G) band it had 1.5dB NF & 9.4dB gain.

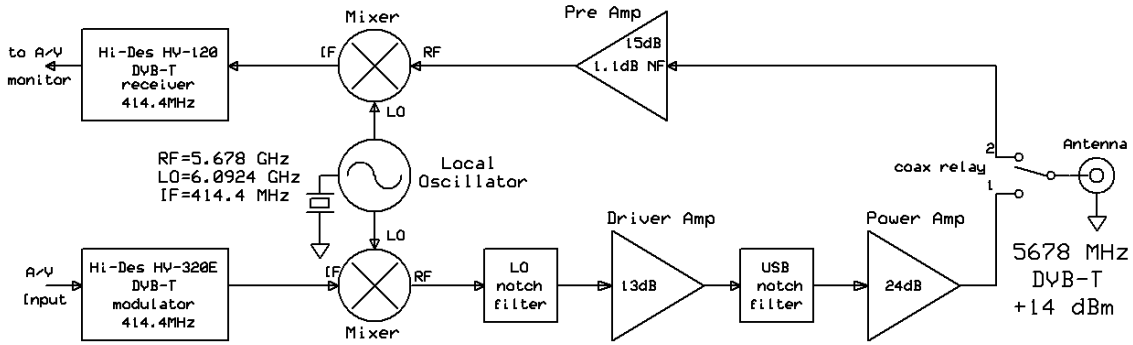
The receiver sensitivity results for the various combinations tested were:

| # | **Combination** | **Sensitivity** |
|---|---|---|
| 1. | HV-120 Receiver alone | -92 dBm |
| 2. | Pre-Amp => HV-120 | -91 dBm |
| 3. | BPF => HV-120 | -86 dBm |
| 4. | BPF => PreAmp => HV-120 | -88 dBm |
| 5. | PreAmp => BPF => HV-120 | -91 dBm |

# 5.8 GHz TRANSVERTER

**Jim, KH6HTV**



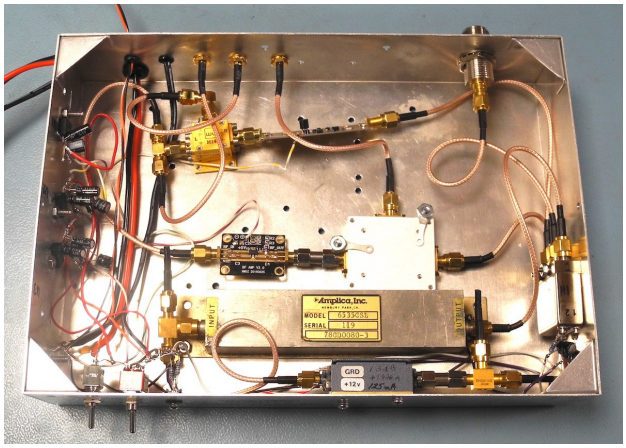




Back in August, shortly after my ATV Repeater article appeared in QST, I got an e-mail from Fumio, KA0RUZ, in Japan. He described their microwave DX-peditions where they achieved a distance of 287 km on 5 GHz using the Japanese equivalent of DVB-T (ISDB-T). Fumio also included a link to You Tube to see them in action on 5 GHz. This immediately triggered an interest here in Boulder among several ATVers to get busy pushing DVB-T to the higher microwave bands, beyond 23 cm. See the Sept. newsletters, issue # 19 & 20, Oct. #22. Don, N0YE, had previously built over the years, several home-brew, 10 GHz, SSB rigs. He loaned these out for some inital 10 GHz, DVB-T, outings this past fall.

I got intertersted in what I might be able to throw together for a microwave DTV rig. My junk box is pretty sparce for 10 GHz stuff, but I did have an assortment of misc. C band (4-8 GHz) components. So, I decided to try to build a 5.8 GHz transverter for DTV. My inital plan was was to use my Hi-Des HV-320E modulator and HV-120 receiver as the IF. transceiver. and to use the new Analog Devices microwave frequency synthesizers as my LO for up/down converting. I discussed these AD synthesizers in the October newsletter, # 21. I took the old 2.4 GHz transverter I had built a couple of years ago and gutted it for parts and rebuilt it for 5.8 GHz service. This past fall, then Don, N0YE, and I took to the field to test it out. Don set up his rig on Flagstaff Mtn. and I set

up mine in my back yard where I had a direct line-of-sight path to Flagstaff. Don immediately reported seeing my DVB-T signal. Then he proceeded to transmit to me. NOTHING ! We were both running similar rf power levels and similar antennas, but I was not able to see anything. Bummer ! -- Back to the lab.

The project then ended up on the back burner for awhile as I worked on other projects. I intermittantly went back to it trying different combinations of IF frequencies, different local oscillators, mixers, etc. I concentrated on the 5.8 GHz receiver sensitivity. What I discovered was very "eye-opening". After many false starts, I realized that a major issue was poor phase noise in the Analog Devices frequency synthesizers. While they worked fine for receiving high level DVB-T signals, when one really got down to the -80 -90dBm range, NO Picture ! The poor phase noise destroyed the signal to noise ratio. Another eye opener was the discovery that some diode mixers also were crummy performers for really weak signals.




So after many hours ( really days & weeks ) of trying various combinations, I finally hit upon a workable solution. It is shown in the above block diagram and also the detailed schematic on a following page. I scrapped out the idea of using the Analog Devices synthesizers. I am now using a low noise, Frequency West brick oscillator as my LO (see Oct. newsletter #23). Because it was a gift from Don, N0YE, there was no choice of the LO frequency. I had to take what I was given. The LO crystaled to work on 6.0924 GHz. Thus to operate on 5.678 GHz, my IF frequency had to be 414.4 MHz.

For my receiver, I found an old Watkins-Johnson mixer from my junk box worked well. I used a Down-East Microwave, model L5ULNA, as my preamplifier. Testing it on an HP noise figure meter, I found the DEM-LNA had 15dB of gain and a 1.1dB noise figure. With this receiver, if I only used the W-J mixer, the DVB-T sensitivity was -92dBm. Adding the LNA, the sensitivity was improved to -96dBm.

For the transmitter chain, I used the new HMC219N mixer from China. It was a very poor performer for a receiving mixer, so I used it instead in the transmitter chain. The amplifiers used in the transmitter chain were from my microwave junk box. The driver was an Avantec AMT-8052. The final amp was an Amplica 6535CSL. Using a mixer one gets as the output, the desired sideband, in this case the lower sideband, plus the undesired upper sideband and also some leakage of the LO frequency. I thus needed to filter out the LO and USB. I accomplished this using a pair of simple tee notch filters.

They were SMA tees with a short piece of open-circuited, RG-174 coax cable on the third arm. I used my Wiltron network analyzer to fine tune these filters. I made the coax initially too long and then using wire cutters to carefully trim the coax length to put the notches on the desired frequencies. The notchs were about -26 to -28dB in depth and I had less than 1dB loss at the transmitter frequency of 5678 MHz.

An SMA coax relay (again from the junk box) was used as the antenna switch. I controlled the timing of the turn on / turn off of the various amplifiers to avoid transmitting back into the receiver. I used LM2941 low drop-out voltage regulators. I added an R-C circuit to the enable pin on these regulators to slow their turn-on. In operation, I leave the Hi-Des receiver powered up all the time. I only power up the Hi-Des modulator when I want to transmit. There is sufficent rf leakage to the receiver when transmitting that I am able to use the receiver to monitor the transmitted video.

So, how well does it work? The transmitter is definitely NOT high power. It is a milli-QRP rig. For DVB-T, with the modulator's rf drive power adjusted so the spectrum skirts break-points are set to -30dB, the output power is a whopping +14 dBm ! The max. saturated output from the Amplica amplifier is +25dBm. The receiver is quite good (finally ! ) with a sensitivity of -96dBm when tested with "Normal" digital parameters (1080P, 5/6 FEC, etc.). The final acid test was to go out in the field and exchanging pictures with Don, N0YE. The below photos are proof that it really works !


I set up my rig at the Boulder 911/EOC near the Boulder airport looking south toward's N0YE's QTH. Don lives on a high ridge line on the south side of town. We have a good line-of-sight path between the two locations. The path distance was 7.4 km. We both used +23dBi dish antennas. Don was transmitting +10dBm with -4dB coax cable loss. I was transmitting +14dBm with 0.3dB cable loss. I was able to receive Don's picture, as shown in the above photo. The received power was measured to be -83dBm with a s/n of 14dB. Radio Mobile computer program predicted that I would get -79dBm from Don. Don was not so lucky. He did not receive my signal. Don said he was having issues with his HV-110 receiver locking up. His receiver stopped receiving even his own transmitted signal a few minutes before I started transmitting to him. Re-booting several times didn't solve the problem until much later back in the ham shack on the work bench.

Whew ! -- you know this microwave DVB-T stuff was a lot more work and required an awfull lot more parts than doing this with the el-cheapo 5.8 GHz, FM-TV gear ! ! !