Boulder Amateur Television Club

TV Repeater's REPEATER

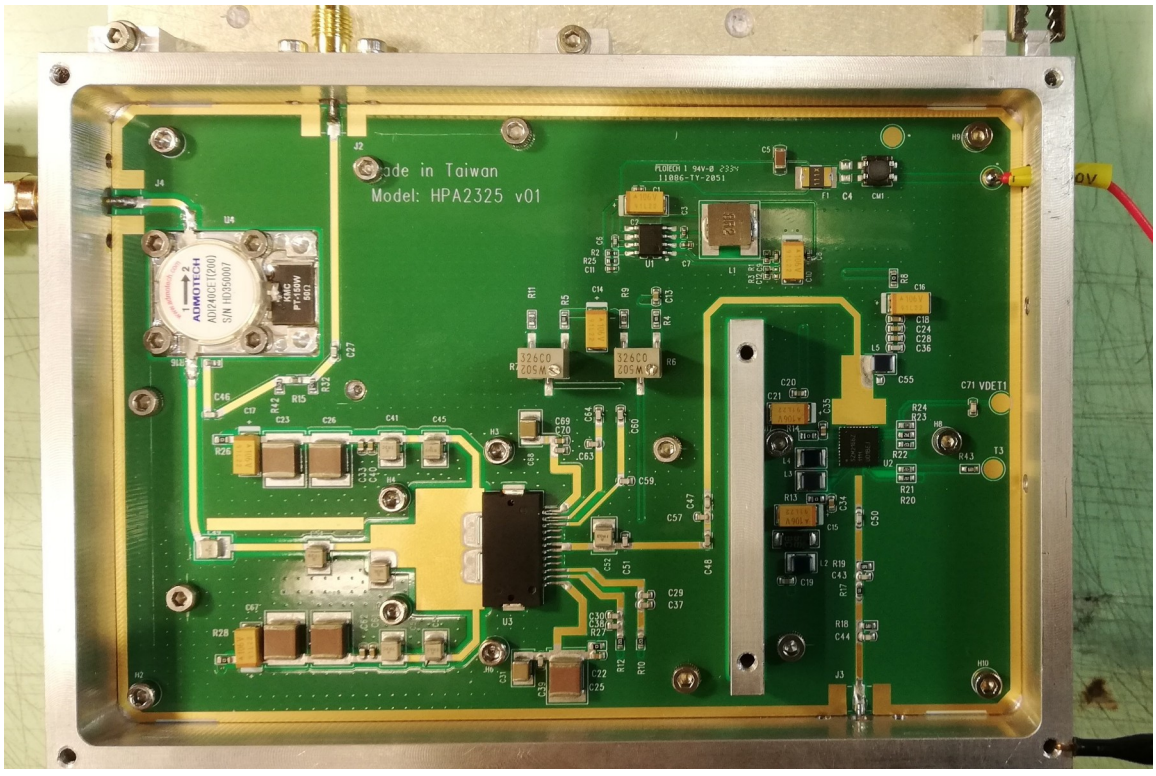
November, 2023
3ed edition, issue #147

BATVC web site: www.kh6htv.com

ATN web site: www.atn-tv.com

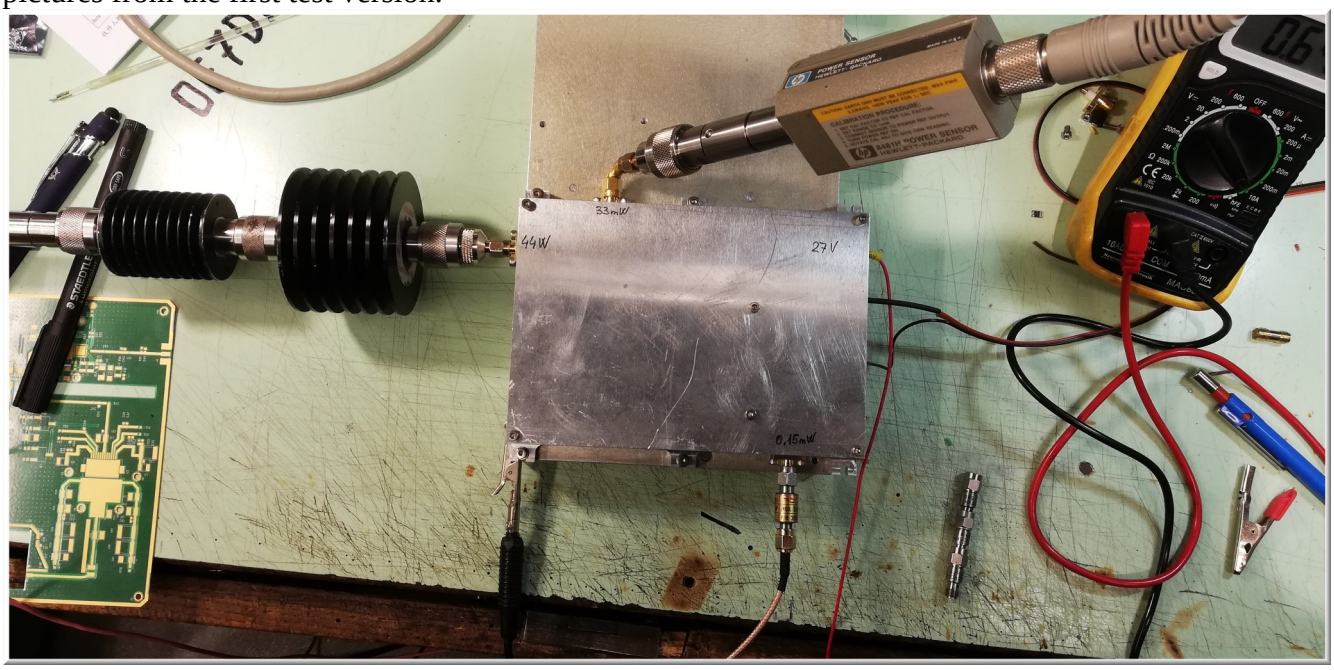
ATN
The Amateur Television Network

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



NEW, Hi-Des 13cm DTV
LINEAR RF POWER AMPLIFIER

We have just received this communciation from Darko, OE7DBH
"We (HiDes and OE7DBH) are currently developing a new 2-stage power amplifier for the 13cm (2.4 GHz) amateur radio band, also good for DVB-T operating mode. Expected DVB-T performance is around 5 Watts output in hardware configuration with HV320. Gain around 45 dB. Here are a few pictures from the first test version."



Editor's Note: *Looking carefully at these photos we can gain some additional info about this new amplifier being developed. The interior photo shows two gain blocks, U2 & U3 in cascade. U2 is the driver MMIC. U3 is the final power amplifier block with heat sinking. J3 (lower right) is the SMA input. J4 (upper left) is the SMA output. J3 (top upper left) is an rf output signal sample port SMA. U4 (upper left) is a circulator with a 50 Ω termination on it's 3ed port. It is used for VSWR isolation to protect the final amp. Reading the hand written labeling on the prototype amplifier we see that the DC power supply is 27 Vdc. The test rf input power was 0.15mW (-8dBm). The rf power output was 44 Watts (+46dBm). Thus implying a gain of 54dB. The J4 test port is labeled as 33mW (+15dBm)*

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Free Space Laser Communications Q ?

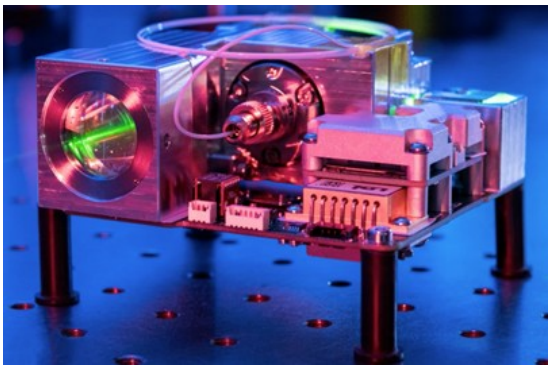
Mario, KD6ILO

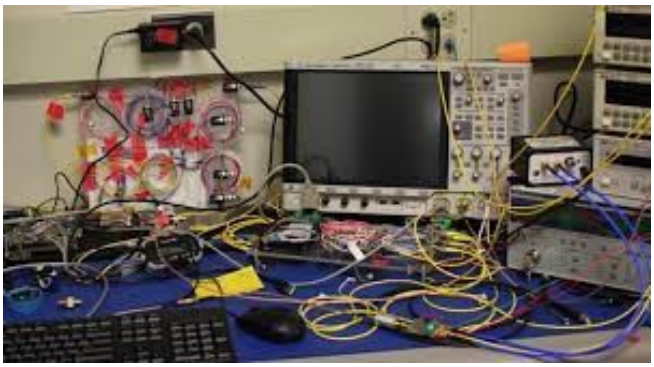
The San Diego ATV Society and myself are experimenting and using Free Space Optics [Laser] Communications for our 2024 project. WE have one(1) working system at our Carlsbad lab sending a beam 13 miles line-of-sight to our Ramona site {voice, video and data at Gigabit speeds.

Q? 1: I was asked why use lasers for Amateur TV and cost?
You can assemble a simple test system using form factor computer(s) such as the Raspberry pi 5 for example and other models of similar cost. Using low cost effective laser transmitter/receiver assemblies on the market. Knowing how to write basic code helps.

Q? 2: Yes AREDN MESH can benefit from this too, especially when data from sources which send heavy message traffic, video streaming technology from multiple venues, there's endless possibilities.

--Advantages of using laser communications over radio waves, increased bandwidth, enabling the transfer of more data in less time and quicker, sharper, video images. The improved technology of today is much smarter, smaller, lighter, and takes up lass space to assemble as I've found out first hand. That's why our team will bring it into our amateur radio lab in Carlsbad, CA with the help of grant funding and will acquire products from the Mitsubishi products lab in Japan. Optical-Data modems help as a gateway {light to binary data} and vice versa speeds 1- 7.2 Gbit/s flawless and to achieve 100% throughput at all times. No bandwidth or RF challenges, just free space communications.


Laser


KD6ILO laser comms work bench

Q? 3; How are aiming the laser over a long distance to the receiver unit?

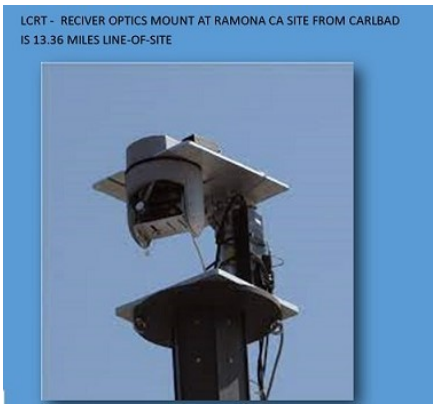
Answer: As for alignment, for me I don't bother with a gimbal to point the laser beam. Instead, I used a custom error-signaling system that adjusts the entire LCT itself to point precisely towards the receiver optical lens. Like I said earlier, knowing coding helps. This allows the optical components to be miniaturized.

My home built system uses surplus parts and buying some new components such as for my receiver makes for a less costly mistake on my part budget wise. It works, I'm just getting my laser modem setup with a special router, a LinkStar H68K. then put everything in a nice package unit.

Q? 4: Can you give us a project that your STEM students use for Laser communication?
Answer: Sure! here is the link information;
https://electroniqueamateur.blogspot.com/Optical receiver prototype for laser communication terminal (LCT)

In conclusion we must also keep up with technology as it takes hold over us and time this is not new but improvements over time. Amateur Radio must keep pace so we can educate our younger hams in our community {STEM} as we have in our classes on a weekly basis. We have moved forward from analog, digital DVB-T,S, ATSC and now newer laser upgraded technologies. 2024 will be a big step forward. I will see NASA's new space Internet DSN grow with improvements. I know what's coming...do you?

73 de Mario, KD6ILO



LCRT Optics - Ramona, CA

KD6ILO Test Station LCT Platform
Carlsbad, CA

Mobile, Portable LC Transceiver Station

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Editor Reminisances about Laser Comms: Mario's recent notes above about his new interest in optical communications, caused me to reflect upon my early career. While working for the National Bureau of Standards (NBS, now NIST) in Boulder, Colorado -- they sent me and my family on a one year assignment in 1971-72 to work in the French national telecom labs (CNET) in Lannion, Brittany, France. CNET was the French equivalent of our Bell Labs. There I was assigned to work with some other engineers on the birth of fiber optics for telecom. In particular, I was measuring

laser pulse dispersion in the picosecond region in glass fibers. During that year, we and others made a couple of major break-throughs which were land marks in proving fiber optics could eventually replace conventional wired telecom. First was a dramatic improvement in optical fiber attenuation. In 1971, we were working with fibers which had 1,000dB/km loss ! Right -- I said 1000 dB ! That year, glass chemists were able to get the loss down dramatically to 20dB/km. That showed it was suddenly feasible to send comms over long distances. Today, optical fiber losses are even much lower. The second major break through was the development of a laser diode which would work continuously (CW) at room temperature. Previously the only laser diodes which would work CW had to be cooled to cryogenic temperatures.

After returning back to Boulder and NBS a couple of years later, I designed and built a couple of complete, working fiber optic telecom demonstration set-ups to send full band-width (4.2 MHz), baseband, NTSC, color TV signals over a fiber optic cable. The first one was analog. I AM modulated an IR LED with the TV signal. At the receive end I had an avalanche photo diode detector followed by a wide-band video amplifier with AGC.

The second, much more complicated one was a 100 Mbps digital system. I designed and built all of the various component pieces with one exception. The only commercial piece of gear I used was a then state-of-the-art 8 bit, A/D converter running at 10 MHz clock rate. The A/D was in a full 3" high, 19" rack mount cabinet ! A real dinosaur by today's standards ! My fiber optic telecom system ran at an overall data rate of 100 Mbps. We didn't do any data compression in those days. Simply sent the raw, un-compressed video signal as an RZ serial data train. My 100 Mbps data package consisted of the first bit always being a "1" as sync, followed by the 8 bits of video from the A/D, plus 1 additonal data bit for another lower speed data channel. 100 MHz ==> 10 ns long data with each data bit occupying 1 ns. The digital transmitter included a 100 MHz xtal clock, the 8 bit, BCD, A/D converter, parallel BCD data to serial converter, etc. All done in ECL.

I then pulse modulated on & off a semiconductor laser diode with the 100 Mbps data steam. The laser's light beam was launched into a muli-mode fiber optic cable. At the other end of the fiber cable was an avalanche photo diode detector followed by a broad-band amplifier. This then went to my digital receiver which included a clock recovery circuit, data detector, serial to parallel converter, then an 8 bit D/A converter, and video amplifier. The digital receiver was again done in ECL plus discrete components for my D/A design. Surprise ! It all worked !

When I gave a live demo of the system to the NBS staff, it blew them away at the time. They hadn't seen such digital tech before. What was especially an eye-opener to them was digital quantization. My live demo included disabling one or more of the 8 data bits and seeing what it did to the resultant TV image on the video monitor.

What Mario is proposing is really nothing new. It is just that technology has improved a whole lot since my early attempts in the 70s (50 years ago !). Here in Boulder by the late 70s, some E.E. professors at the University of Colorado were experimenting with exactly what Mario wants to do. i.e. send video data though the atmosphere using lasers and optics. Yes, they worked, but not without issues. And Yes, it will work for Mario, but some of the same issues now as then. A couple of Biggies that everyone will encounter are:

1. Antenna Pointing -- If you think it is difficult to align your 30dBi dish antenna for 10 GHz at a target 10 miles away, try doing that with an infinitely narrower beam-width from a laser ! Not impossible, but damm hard to do. Now try to stabilize it and keep it on target.

2. Atmospheric Effects --- We all know what happens to visibility on a foggy day. Light propagation drops to very short distances. Plus even on a clear day, have you noticed wavy lines on the horizon due to thermal effects ? i.e. all sorts of propagation issues to attenuate, scatter, distort and bend our laser beams. For NASA and space laser comms -- not an issue, but here on Mother Earth a big issue.

73 your editor, Jim, KH6HTV, Boulder, Colorado

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DVB-T Digital Parameters -- How do they impact system performance ?

Jim, KH6HTV

This is a report on some experiments performed to determine the impact of chosing various DVB-T digital parameters upon the sensitivity of a DVB-T receiver. The tests were performed in a perfect lab environment with a coaxial cable connection between the transmitter and receiver. They obviously did not cover all of the nasty issues encountered out in the real world with radiated signals. Issues such as multi-path, mobile flutter, RFI, etc. rear their ugly heads out there. Some of the digital parameters are intended to deal with those but don't necessarily impact receiver sensitivity. To test them, would require additional field testing.

The digital parameters considered are those which can be selected on the Hi-Des HV-320 modulator using the windows PC program called AV-Sender. They include:

Media Configuration:

Video Encoding Type: MPEG2 or H.264
Video Encoding Resolution: 15 choices from Auto, 360x480 up to 1920x1080
Max Bit Rate: any arbitrary value may be entered up to the calculated theoretical upper limit
Video Encoding GOP (Group of Pictures) Length: any integer value. typical is 30 or 60
Video Encoding Frame Rate: we use 30 fps for the USA
Audio Encoding Type: MPEG2, AAC, or AC3, most common is MPEG2
Audio Encoding Rate: 96, 128, 192, or 384 Kbps

Transmission Configuration:

Center Frequency: 100 MHz to 2.6 GHz, in 1 kHz increments
Band-Width: 1.5, 2, 2.5, 3, 4, 5, 6, 7 or 8 MHz
Modultation Method (Constellation): QPSK, 16QAM, or 64QAM
Number of Sub-Carriers (FFT): 2K, 4K, or 8K
FEC - Forward Error Correction (Code Rate): 7/8, 5/6, 3/4, 2/3, or 1/2

Sync (Guard Interval): 1/32, 1/16, 1/8, or 1/4
Modulation Data Rate: *Based upon the choices made in the above Trans. Config. parameters, the computer then calculates a theoretical max. possible data rate. This is then taken into consideration when selecting the video encoding data rate in the Media Config. Hi-Des reccommends that it be set no higher than 80% of the theoretical max. This is to allow for the audio data plus other overhead data to also be transmitted. For very low band-widths, an even lower % should be used.*

"Standard" Parameters: These are the values typically used by the Boulder ATV hams, plus they are used in the Boulder, W0BTV repeater transmitter.
Media Configuration: HDMI, H.264, 1920x1080, 5.5 Mbps, 60 GOP, Audio = MPEG2, 96 Kbps
Trans Configutation: 6 MHz BW, QPSK, 8K sub-carriers, 5/6 FEC, 1/16 sync

Receiver Parameter Requirements: Fortunately, the DVB-T receivers are "smart". They work automatically with any combination of the above parameters, except for band-width. They will even switch seamlessly if the transmission parameters are changed abruptly mid-steam. The transmitter sends out a meta-data header informing the receivers what it will be using.

Receiver Sensitivity Test Proceedure: The transmitter was a Hi-Des model HV-320E modulator. A live HDMI video source was a DVD player playing a live action video with constant motion and audio. The receiver was a Hi-Des model HV-110. Some tests also placed a low noise, pre-amplifer in front of the receiver. The pre-amp was a KH6HTV model 70-LNA. The transmitter and receiver were connected via a long coaxial cable permitting adequate seperation between the two units to minimize any residual rf leakage coupling. The internal attenuator in the HV-320 was adjusted to provide exactly 0 dBm rf average power at the far end of the coax cable. Additional attenuation was inserted in front of the receiver with fixed 20dB & 30dB SMA attenuators plus a rotary step attenuator (0 - 69dB in 1 & 10 dB steps). The step attenuator was adjusted to determine the weakest possible signal which still gave perfect P5 / Q5 video and audio. The signal level and resultant signal / noise ratio were then recorded. An additional 1 dB of attenuation caused either freeze framing or complete loss of signal. This state was also indicated by the Signal LED on the front panel of the HV-110. It flickered red/green. The LED was solid green when receiving a P5 picture. The LED was solid red when no signal was present at all.

TEST RESULTS -- RECEIVER SENSITIVITY for VARIOUS DIGITAL PARAMETERS

QPSK vs. 16QAM vs. 64QAM: All were measured with "standard" parameters. Only items changed were modulation method and video data rate. The "max" values are the calculated theoretical max. possible encoding data rates. Hi-Des recommends we never exceed 80% of the max. The measured receive sensitivities and resultant signal to noise ratios were:

QPSK (5.5 Mbps 7.32 max) = -94dBm / 8dB s/n (max s/n = 23dB)
16QAM (11.5 Mbps, 14.64 max) = -88dBm / 14dB s/n (max s/n = 26dB)
64QAM (16 Mbps, 21.96 max) = -80dBm / 22dB s/n (max s/n = 32dB)

conclusion: 16QAM is 6 dB worse and 64QAM is 14 dB worse compared to QPSK

QPSK - vary the Code Rate (i.e. FEC): measured with standard parameters. Only items changed were FEC and video data rate. The measured receiver sensitivities were:
7/8 (6.0 Mbps, 7.68 max) = -93dBm / 9dB s/n 5/6 (5.5 Mbps, 7.32 max) = -94dBm / 8dB s/n
3/4 (5.0 Mbps, 6.59 max) = -95dBm / 7dB s/n 2/3 (4.5 Mbps, 5.85 max) = -96dBm / 6dB s/n
1/2 (3.5 Mbps, 4.39 max) = -98dBm / 5dB s/n
conclusion: Each step increase in FEC adds about 1dB improvement in sensitivity and required s/n. But at the expense of considerable reduction in encoding data rate.

QPSK - 6 MHz BW vs. 2 MHz BW: measured with standard parameters. Only items changed were band-width and video data rate. The measured receiver sensitivities were:
6 MHz BW (5.5 Mbps, 7.32 max) = -94dB / 8dB s/n
2 MHz BW (1.5 Mbps, 2.39 max) = --98dB / 8dB s/n
conclusion: Going from 6 to 2 MHz band-width buys 4 dB improvement in sensitivity, but at a considerably lower data rate.

MPEG-2 vs. H.264 Video Encoding: No change was noted.

 # Sub-Carriers - 8K vs. 2K: No change was noted

Guard Interval (i.e. Sync): Only items changed were guard interval and video data rate. No change was noted.

Video Encoding Resolution: No change was noted.

Parameters for Best Sensitivity:
6 MHz BW = -98dBm Trans. Config = QPSK, 8K FFT, 1/2 Code (FEC), 1/16 Guard
Media Config = H.264, 1080P, 2.5 Mbps
2 MHz BW = -102dBm Trans. Config = QPSK, 8K FFT, 2/3 Code (FEC), 1/16 Guard
Media Config = H.264, 640x480, 1.2 Mbps

Add a Low-Noise PreAmp: measured with standard parameters.
6 MHz BW: HV-110 = -94dBm 70-LNA + HV-110 = -98dBm
2 MHz BW: HV-110 = -99dBm 70-LNA + HV-110 = -102dBm

Ultimate Performace: Best Sensitivitity Parameters + plus low noise preamp
6 MHz BW = -102 dBm / 5 dB s/n
2 MHz BW = -105 dBm / 6 dB s/n

LNA Conclusion: adding a low noise (NF < 1 dB) pre-amplifier improves HV-110 receiver sensitivity by about 3-4 dB.

ATN-California, Recommended 2 MHz Parameters with 16QAM:
see the July, 2023, ATV newsletter, issue #135, page 5

Trans. Config = 2 MHz BW, 16QAM, 8K FFT, 3/4 Code (FEC) & 1/16 Guard
Media Config = MPEG2, 1280x720, 2.6 Mbps, & 30 GOP
HV-110 = -93dBm / 14 dB s/n 70-LNA --> HV-110 = -97dBm / 13 dB s/n

ADDITIONAL READING: If you want to find out a lot more about the various digital parameters, or anything else about DVB-T (or DVB-S, DVB-C, etc.), I suggest the book I consider the "Bible" for DTV. ------ ***"Digital Video and Audio Broadcasting Technology --- A Practical Engineering Guide"*** by Walter Fischer (TV engineer at Rhode & Schwartz, Munich, Germany). Springer, 3ed edition, 2010

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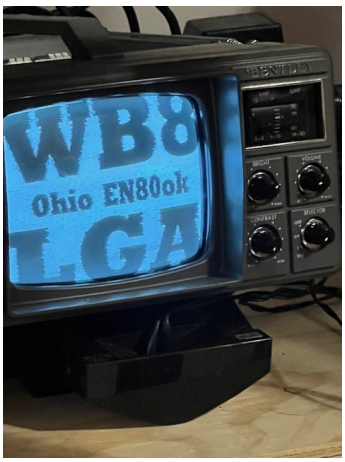
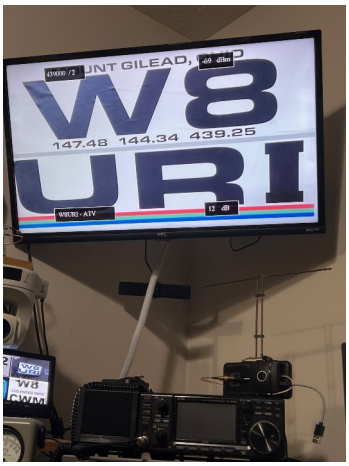
Another Mid-West ATV Band Opening !

Photos are WB8LGA's analog ATV signal from 90 miles to AH2AR's hamshack, along with W8URI's distant 85+ mile DVB-T signal also being received at AH2AR's shack in Vandalia on Sunday, Nov.18th. ATV DX continues to be alive and well within the Midwest region. W8URI has built a 1 KW 70cm pallet amplifier, and was transmitting about 130 watts on DVB-T. Two way DVB-T and analog, A5 contacts were accomplished with both stations. 73 de Dave, AH2AR



analog ATV



digital ATV

FEEDBACK:

ATV Trivia: Alan, AD6E writes --- "Yes, it's an amazing job of deep research by someone at ARRL to find that photo. It makes me wonder what else they could dredge up. ;-) I'm sure it's the only one in existence of me standing next to an ARRL banner. Here's another, but of Jim this time.

Kent, KH6CJJ writes --- "Nice picture of you and Alan, Jim. Gee that seems so long ago! I am reading this in Japan nearing the end of a 24 day visit. Unfortunately, no ham radio contacts here although a near miss. I need to wear a hat with my call on it on future trips. Aloha, Kent"

Feedback on Remote Receivers: Mike, WA6SVT, writes --- "Great newsletter Jim! BTW, you can set up the remote receiver for a 5 MHz bandwidth or the main receiver that way with the remote at 6 MHz. Having a different bandwidth will allow the selection to take place and the users would set up each bandwidth on a different channel but same center frequency. Simular way as using a different PL tone for NBFM voice receivers." 73, Mike

W0BTV Repeater Status Update:

For details: www.qrz.com & www.kh6htv.com

Recently Don, N0YE, made yet another trip up the hill to service our repeater. This time he made a trip to the roof top to tighten up the bolts on our receive antenna. He also replaced the Video ID media player with a new unit and new USB memory. Once back home, he tested the media player and decided that the problem with the tearing of the video images was due to a defective USB memory stick, thumb drive and not the media player itself.

We also still are having "flaky" issues with the repeater controller. Toning up the Quad Display mode leads to unpredictable behaviour. Sometimes it works properly, other times not. Most recently it has been dropping out of quad mode after a few minutes and then hanging up the repeater transmitter. The only way out is to then tone in the control code for a System Master Reset-Boot. Never a dull moment when you have a repeater ! ! !

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Disturbing RFI Products found on AliExpress !

On a recent Boulder ATV net, Colin, WA2YUN, showed us a new, Chinese, low cost, 23cm amplifier he had found on Ali-Express. Looking at the link to it Colin sent me I also noticed some other items advertised. I was really troubled by their presence. But considering the current world situation with wars being fought in the Ukraine and Israel/Gaza with a proliferation of war drone aircraft, I guess I shouldn't be surprised. So just what did I find ? Under the banner "Frequency Shield" were some low cost frequency jamming equipment marketed as "Frequency Control". Here is directly from the AliExpress ad ---- "Module overview -- Used to generate a sweep frequency suppression signal in a certain frequency band to shield and interfere with the equipment in the corresponding frequency band. It is widely used in WiFi signal shielding, 433M signal, GPS positioning, UAV countermeasures and other application scenarios. --- available for 315MHz, 300-400MHz, 433MHz, 840-960MHz, 1200-1400MHz, GPS 1575MHz, 2400-2500MHz, 5160-5320MHz & 5725-5850MHz"

If we here in Boulder thought our 70cm RFI issue was bad for our W0BTV repeater, just imagine what it will be like if enough bad guys start using this *^%%#*$ stuff from China which is so cheap and readily purchased over the internet !

Disgusted ! -- de Jim, KH6HTV

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W0BTV Details: **Inputs:** 23 cm Primary (CCARC co-ordinated) + 70 cm secondary all digital using European Broadcast TV standard, DVB-T 23cm, 1243 MHz/6 MHz BW (primary), plus 70cm (secondary) on 441 MHz with 2 receivers of 6 & 2 MHz BW
Outputs: 70 cm Primary (CCARC co-ordinated), Channel 57 -- 423 MHz/6 MHz BW, DVB-T
Also, secondary analog, NTSC, FM-TV output on 5.905 GHz (24/7 microwave beacon).
Operational details in AN-51c Technical details in AN-53c. 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/*** Select ***ab0my or n0ye***. We use the Boulder ARES (BCARES) 2 meter FM voice repeater for intercom. 146.760 MHz *(-600 kHz, 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 over 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.*

DVB-T Receiver for Sale: I have a brand new Hi-Des model HV-110 that I don't plan to use. It comes with everything shown - HV-110 receiver, software CD, power supply, video cable, and remote control. I purchased it a few weeks ago after seeing a talk at Pacificon but decided I'm not ready to get into this part of the hobby yet. I plugged it in to confirm it works (it does). Price is US$90 shipped. Contact me at ***chancekp@yahoo.com*** if you are interested. Kevin, KN6WKM

(*editor's comment -- the new price from Hi-Des is $119, so you can save $29 buying it from Kevin*)
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HV-320 DVB-T Modulator 70-7B Amplifier 70-9B or 23-11A Amplifier

Your NEW DVB-T 70cm or 23cm Transmitter

What is required to put a digital ATV signal on the air ? 1. Video source, such as a cam-corder camera 2. A DVB-T modulator 3. A Linear RF Power Amplifier & 4. An Antenna. **KH6HTV Video** can supply you with a "Turn-Key" DVB-T Transmitter. No building DIY, nor programming required, just "plug-n-play". The transmitter would consist of a Hi-Des model HV-320B Modulator and one of the above Amplifiers. The modulator would come pre-programmed to work on the amateur ATV channels. I am offering to purchase the modulator for you, program it, and resell it to you at cost. The catch is you also need to purchase an amplifier from me.

For base station, or repeater use, I offer the larger amplifier package shown on the right in the above photo. For the 70cm band, it is my model 70-9B. It is a 70 Watt amplifier (FM/CW service) which puts out 10 Watts average power in digital TV service. It operates from a +12Vdc supply and pulls 8 Amps. For the 23cm band, it is my model 23-11A. It is a 30 Watt amplifier (FM/CW service) which puts out 4.5 Watts average power in digital TV service. It operates from a +12Vdc supply and pulls 6.5 Amps.

For out in the field, portable ATV operations, we run on batteries. There conserving battery capacity is very important. So we need to use equipment with much lower current requirements. The 70cm, model 70-7B amplifier was designed specifically for these applications. It is the ideal choice if your local ARES group is considering adding ATV capability to the services they offer to the public safety agencies. For example, the Boulder, Colorado ARES group (BCARES) has 4 complete DVB-T portable pack sets, all using the 70-7B amplifier. The 70-7B is a 25 Watt amplifier (FM/CW service) which puts out 3 Watts average power in digital TV service. Operating from a 12Vdc battery it pulls 2.6 Amps at full power. The RF power can also be lowered with a front panel rotary switch by -5dB & -10dB. The respective current draws are thus: high power = 3 W @ 2.6 A, medium power = 1W @ 1.2A and low power = 300 mW @ 700 mA. ***www.kh6htv.com***

If you are interested, contact KH6HTV for a detailed quote at 303-594-2547 or ***kh6htv@yahoo.com***