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BATVC web site: www.kh6htv.com

ATN web site: www.atn-tv.com

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

NB-ATV on HF -- Legal or Not ?

In our July issue #166, we published an article entitled "***10m ATV/DATV New Update***" from Grant, **VE3XTV**. Since then Grant has posted several more updates on his development work for a narrow band, digital ATV system which he hopes to use on the HF bands, especially 10 meters. His postings are on the ***https://groups.io/g/DigitalATV/*** web site. I have been reluctant to publish more of his material because I felt that it was illegal to be used on our HF bands here in the USA.

I recently sent this letter to the ARRL asking for their advice.

I am the editor of an Amateur Television newsletter. There is a ham who is working on developing a new modulation technique to send live (not slow-scan) digital TV pictures in a narrow bandwidth over the HF bands, starting with the 10 meter band. Right now he is trying to do it in a 100 kHz bandwidth. I have tried reading the FCC rules part 97 and no where do I find any table or other material expressly stating what the max. bandwidth is allowed.

What would be the legal maximum bandwidth here in the USA for ATV (i.e. live video, either analog or digital) on 10 meters ?

Here is the ARRL's reply

Hi Jim --- We've had a conversation and looked at the applicable rules and we agree that, assuming he takes the appropriate steps to make sure this transmission is publicly identifiable and decodable, ATV of the proposed bandwidth would not be permissible on the 10m band because it exceeds the

allowable transmission bandwidth for amateur image signals which is 8 kHz (eCFR :: 47 CFR Part 97 Subpart D -- Technical Standards Section 7 Subsection f Paragraph 2). A3E Emissions are AM communications bandwidths which are limited to 8 kHz. NFM is allowed on 10m, not WFM. If he is interested in experimenting with a video link that wide he will have to do it on the 70cm band or higher. Hope this helps, feel free to call or email if you have any questions.

Best Regards, John McAuliffe, W1DRF, Digital RF Engineer
ARRL, The National Association for Amateur Radio
jmcauliffe@arrl.org

Editor's Note: Here is the relevant material directly from the FCC regulations, John is referring to.

97.307 Emission Standards

(f) The following standards and limitations apply to transmissions on the frequencies specified in § 97.305(c).

(2) No non-phone emission shall exceed the bandwidth of a communications quality phone emission of the same modulation type. The total bandwidth of an independent sideband emission (having B as the first symbol), or a multiplexed image and phone emission, shall not exceed that of a communications quality A3E emission.

More FEEDBACK on 3 cm DATV Frequencies:

What does the ARRL have to say on the issue? Here it is directly copied from their published band plan. Bottom line, per ARRL it is OK to use any frequency between 10.375 to 10.450 GHz for ATV.

ARRL BAND PLAN for 3 cm Band: (***https://www.arrl.org/band-plan***)

10367.000-10368.300 6 kHz or less SSB, CW, Digital Weak-Signal & NBFM (Note 1 **10368.100** is the National Weak-Signal Calling Frequency)

10368.300-10368.400 6 kHz or less Beacons

10368.400-10370.000 6 kHz or less SSB, CW, Digital Weak-Signal & NBFM

10370.000-10375.000 <=50 kHz Analog & Digital; paired with 10120-10125

10375.000-10450.000 >=1 MHz Analog & Digital; paired with 10125-10200 (Note 2)

Note 2: Broadband segment may be used for any combination of high-speed data (eg: 802.11 protocols), Amateur Television and other high-bandwidth activities. Division into channels and/or separation of uses within this segment may be done regionally based on needs and usage.

N0JK comments: Jim – Thanks for the newsletter. **Re. 10 GHz** – There are two high power, well equipped 10 GHz stations in Kansas – N0OY EM18 and WQ0P EM19. While it is unlikely 10 GHz DTV from the Boulder, Colorado would QRM them unless their antennas are aimed at

Colorado, there may be ops in Colorado that would like to contact the Kansas 10G stations on tropo. WQ0P has worked Ohio and Georgia on 10 GHz tropo.

73 de Jon Jones, **N0JK**, Lawrence, Kansas

Bill, **K0RZ**'s reply -- I am aware of the 10368 weak signal activity in Colorado which has diminished to almost no activity. There used to be a fair number, but most are now SKs. I can count 5 stations including N0YE and myself K0RZ that are still capable of operating on 10368.1 SSB.

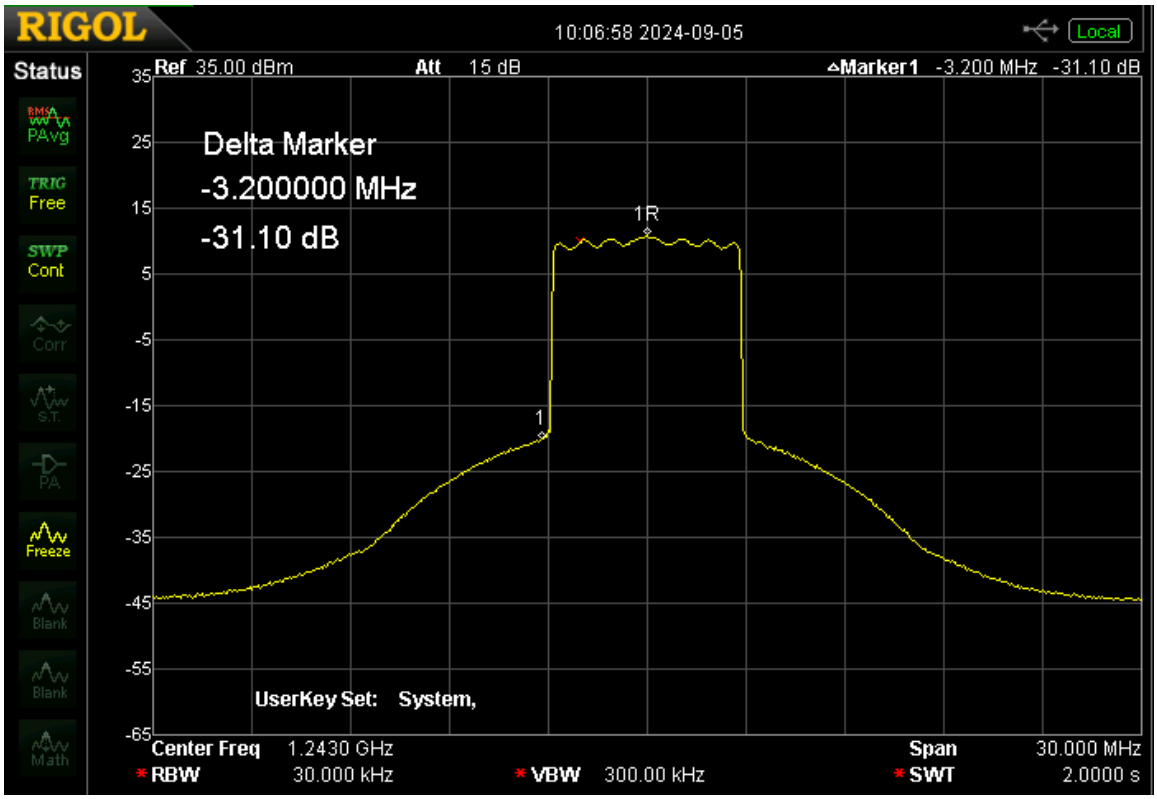
73, Bill, **K0RZ**, Boulder, Colorado

WA6SVT comments: Immediately after receiving the previous issue #170, your editor received a telephone call from Mike Collis, **WA6SVT**, of ATN-California. Mike's basic message was that he supported Boulder's choice of 10.380 GHz for our DVB-T input to our W0BTV - ATV repeater. He said that it was far enough removed from the SSB frequency of 10.368 GHz to not cause any QRM to the SSBers. He quoted the long time experience that hams out in southern California have had using ultra-wideband (36 MHz) FM-TV on 10.400 GHz. He said the spectrum of the multiple FM side-bands of those WBFM-TV signals extended much further than our cleaner DVB-T signals. He said that a lot of the serious California microwave SSBers were also as a matter of fact active in microwave ATV. He never heard complaints from any of the of the 10.4 GHz FM-TV causing QRM to their SSB activities.

G0MJW comments: Thanks Jim --- Interesting to see the comments on 10380 MHz for DVB-T and interference to narrow band (which seems a non-problem but might not be for a TV repeater if the SSB operators are on the same hill.

As you know we in Europe use more SVB-S2 than DVB-T which allows us to use much narrower bandwidths, e.g. 333ks fits in 500kHz, 1Ms fits into 1.3MHz. Not only does this allow us to re-use narrowband gear as-is but DVB-S2 can get more power from the PA before the spreading becomes too much. You also gain SNR by the ratio of the bandwidths, so 333kS gives you over 13dB gain in link budget and 125kS at high FEC which is only useful for contest exchanges, gains more like 20dB. The multipath tolerance of DVB-T is less important at 10GHz because of the ratio of the signal bandwidth to the carrier. IT does make a difference on 70cm but even so we have found reduced bandwidth DVB-S2 goes further, largely because of the link budget gains. If we had decent reduced bandwidth DVB-T receivers, things might be different.

73 de Mike Willis, G0MJW, Harwell, U.K.



*RF Spectrum of a Typical Amateur TV Transmitter running DVB-T modulation in a 6 MHz TV channel. Span shown is 30 MHz (3 MHz/div.) Vertical scale is 10dB/div. Resolution Band-width was 30 kHz. The actual waveform appears as approximately random white noise and sounds like white noise in a SSB rece*iver.

Technical Discussion of QRM Potential of DVB-T Signals on the 3 cm Band

Jim, KH6HTV

There has been considerable controversy recently in this ATV newsletter about the choice of frequencies to be used for digital ATV on the 3 cm (10 GHz) band. Some weak signal SSB operators have expressed fears of DTV signals causing QRM on their 10.368 GHz, SSB frequencies. The ARRL band plan accounted for this by moving the region for wide-band (> 1 MHz bandwidth) rf transmissions up to 10.375 GHz and above. To allow compatibility and dual use of existing SSB equipment to also be used for DTV, the Boulder, Colorado ATV group has selected a center frequency of 10.380 GHz as the third input to their W0BTV-ATV repeater. Running standard 6 MHz TV channel widths, this means the lower band edge would be at 10.377 GHz, 2 MHz above the lower limit recommended by the ARRL.

I would like to present here some calculations showing that the potential for QRM to SSB users at 10.368 GHz is quite minimal.

Let's first make some assumptions about the 10 GHz amateur microwave station. Let's assume it is a high power station using a 10 Watt (CW/FM) (+40dBm) traveling wave tube amplifier (TWTA). The antenna is a high gain dish with +33 dBi gain and 4 deg. -3dB beamwidth. The dish is fed with very low loss waveguide and mounted up high on a tower with an antenna rotator.

Max. ERP possible = +40dBm + 33dBi = +73dBm ==> 20 KiloWatts

In reality, most microwave hams would love to have such a station, but few are able to actually have one. The reality is more likely to be running a transmitter with at most 1/10th the power into a smaller, portable dish antenna.

Let's now consider the particulars of our digital TV transmitter. For this discussion, I will limit it to using DVB-T modulation with a standard 6 MHz TV channel. For our QRM to SSB discussion, we need to focus on what the resultant spectrum will be.

I will be referring for the technical authority on DVB-T a classic reference book written by Rhode & Schwartz company in Germany.
Reference: ***"Digital Video and Audio Broadcasting Technology"*** by W. Fischer, 3ed edition, 2010, Springer-Verlag, Berlin --- in particular see chapters 20 & 21 relating to DVB-T.

Proper input drive adjustments for a DVB-T amplifier to maximize the possible DTV rf output power are to run the rf input drive level up while simultaneously monitoring the transmitter's output spectrum. Stop when the out of channel spectrum shoulder breakpoint reaches -30dB. The breakpoint is measured at 200 kHz outside the TV channel band edge. See the above photo for an example of a typical amateur DVB-T transmitter's spectrum.

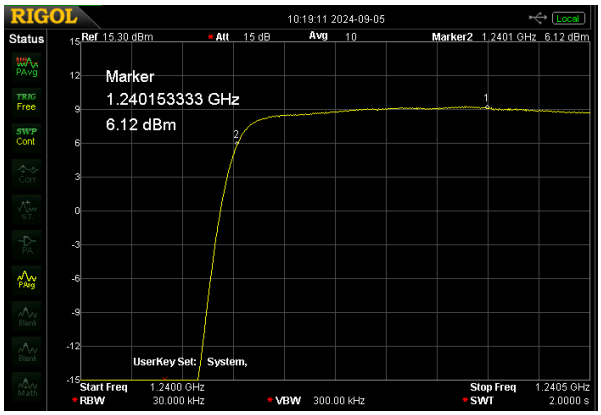
At this -30 dB break-point the rf power head-room is typically about 8 dB. This means the average rf power output is typically -8 dB below the max. saturated rf output power capability of the amplifier. At this level most of the peaks in the random noise-like DVB-T signal are still amplified properly without clipping. If clipping occurs it impairs the resultant transmitted S/N. If the amplifier is driven much harder, then severe clipping occurs with poor S/N and horrible, out of channel spectrum skirts.

So let's start making some math calculations to determine how much QRM will actually fall within an SSB receiver's 2.4 kHz band-width.

For a 10 Watt TWTA the max. DVB-T output will be +40dBm - 8dB = +32dBm ==> 1.59 watts

While the designated TV channel width is 6 MHz, the actual DVB-T signal does not occupy the full 6 MHz. In reality, provision was made to have guard bands of about 150 kHz at each band edge. See the photo on the right.

See the reference, section 20.4 DVB-T system parameters. p. 383, table 20.7 Signal Bandwidths for a a 6 MHz TV channel, the signal bandwidth is actually 5.706 MHz wide.



DVB-T Guard Band -- start freq. is lower band edge. shown at 3dB/div & 100 kHz/div

The resultant in-band RF power density = +32 dBm / 5.706 MHz ==> 0.278 µW/Hz

For a 2.4 kHz BW, SSB receiver, then the resultant rf input power would be a max. of 0.667 mW, i.e. only about -2 dBm. Darn weak signal, and this is still what is occurring within the actual TV channel.

Now let's go outside of the TV channel. See the above first photo for a typical ham transmitter spectrum. The shoulder break-point is about -31dB down at 200 kHz below band edge. This is equivalent now to a 2.4 kc wide signal of only -33dBm. OK, now the Boulder hams want to work at 10.380 GHz. This means that their center frequency is 12 MHz away from the SSB frequency of 10.368, or their lower band edge is 9 MHz away. Consulting the above photo and measuring the skirt we find that it is now a whopping -54 dB down from the in channel rf power spectrum.

So now, the max. transmitted power our high powered DTV transmitter is going to be putting out on 10.368 into the 2.4 kHz BW, SSB receiver is an extremely weak -56 dBm.

OK, now worst case, let's assume the DTV ham is using his high gain +33dBi gain dish pointing right at the SSB guy. What is his max, boresight ERP in a 2.4 kc BW? ==> -56 dBm + 33 dBi = -23 dBm. NOT +73 dBm if he were running SSB or CW ! This is a 96 dB difference ! OK, now add in the rf path propagation losses, etc. Not much getting over to the SSB fella.

Now let's also throw in some probabilities of this happening -- What is the likely hood the DTV ham is pointing his dish at you? He has a possible 360 degrees where he might point it. If his antenna has 3.6 deg BW, then P(ant pointing) = 3.6º / 360º = 0.01 = 1%

Now how about operating time probability ? We are not 24/7 broadcast stations. For the typical ATV ham, he probably at most is on the air 1 hour / week.

P(op. time) = 1 hr / (24 hrs/day x 7 days/wk) = 1 hr. / 168 hrs = 0.006 = 0.6%

BOTTOM LINE: I don't see a problem here with QRM of DTV to SSB on the 3 cm band.

73 de Jim Andrews, KH6HTV, Boulder, Colorado

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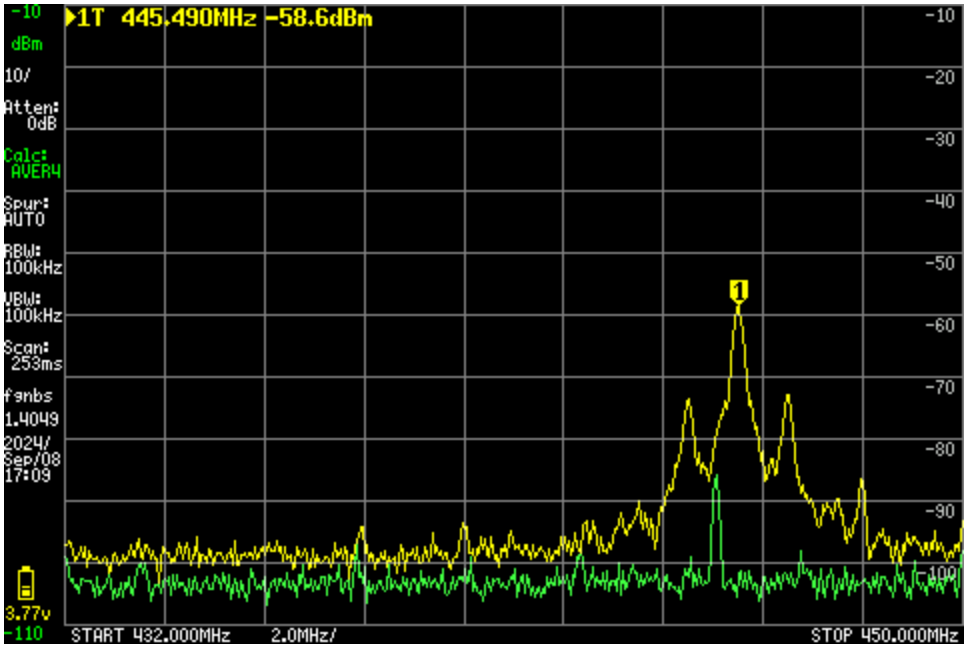
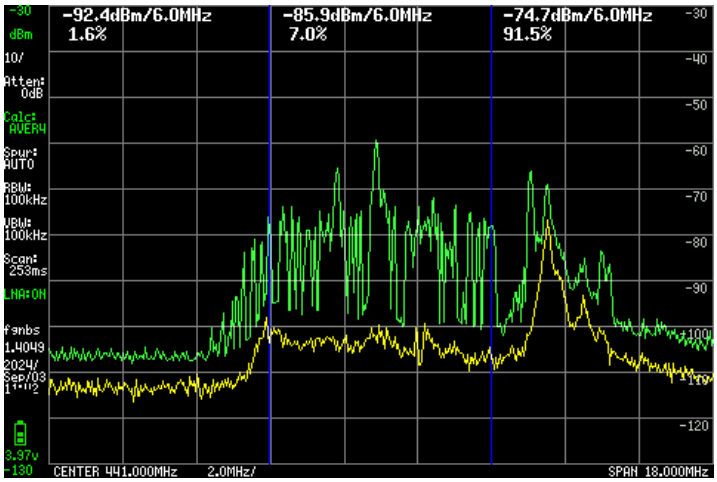


HDMI RFI

a 70 cm RFI Source IDed

While trouble-shooting our W0BTV-ATV repeater, Don, N0YE, and I were perplexed by an unusual spectrum we kept seeing on our 70 cm receiver's input. While we were focused on the intermittant RFI noise spikes which randomly appeared within our Ch 60 (438-444 MHz) band-pass filter's pass band, we were also troubled by seeing a permanent pattern of a single tall spike at 445.5 MHz. What could be causing that ?



70cm RFI measured at NCAR repeater site

This spectrum analyzer photo was taken at the NCAR repeater site. The TinySA-Ultra spectrum analyzer was connected directly to the output of the 70cm receiver's pre-amp. Ahead of the preamp was a Ch 60 (438-444) band-pass filter, antenna triplexer and the X50 receive antenna. The analyzer was setup for 441 MHz center frequency with 18 MHz span. 10dB/div vertical and 2 MHz/div horizontal. The yellow trace shows the baseline noise seen at the output of the preamp with the receive antenna removed and a 50 ohm termination attached to the antenna input port of the repeater. For the green trace, the roof top, X50 antenna was attached. The analyzer was put in the peak hold

mode. As we watched the trace, noise spikes appeared and disappeared in the Ch 60 BPF's pass-band. Their composite was thus captured with the peak hold mode. A few ham FM voice signals also intermittantly appeared in the pass-band, but we were able to ID what they were.

The repeater was removed from the repeater mesa top site and taken to Jim's QTH for repair and modification. The defective DTMF decoder / relay board was replaced and the 441/2 MHz receiver was re-purposed to become the 322 MHz IF receiver for the new 3 cm, microwave receiver.

While on the bench, Jim and Don took the opportunity to do some more detective work to try to figure out what was causing the signal we saw at 445.5. The intermittant RFI noise spikes we saw in the Ch 60 passband when we were at the repeater site were NOT present when using an outdoor antenna at KH6HTV's QTH. But the 445.5 spike was still there.

We used again the TinySA but this time with a small whip antenna on it as a signal sniffer to probe all around our repeater. We tried disabling / enabling various components and combinations of components. After much trial & error and head-scratching, we think we have finally IDed the source. What is it ? It seems to be an artifact related to the **HDMI** signaling protocall.

What finally was the clincher in IDing HDMI as the culprit was a simple experiment of only testing a DVB-T receiver by itself on the test bench along with a video monitor. We set the TinySA with it's whip antenna next to the receiver. The above top photo shows the results. The TinySA was setup identical to when we did the test at the repeater site. The green trace shows the background noise picked up by the antenna when the receiver was turned off (no DC power). The only signal seen was a ham FM TV signal at 445. The yellow trace was what happened when we powered up the DVB-T receiver. It only appeared after boot up and when valid HDMI data was being transmitted and displayed on the video monitor. If we turned off the video monitor, or unplugged the HDMI cable this 445.5 spike disappeared.

OK was this unique to just the receiver tested ? NO ! We then tested four more totally different DVB-T receivers and got the same results. We tested Hi-Des HV-110, Hi-Des HV-120, GT Media-V7 Pro, Pantesat HD-99 and an older model combo DVB-S/T receiver of unknown brand. Next the test was repeated using a Sony Blu-Ray DVD player driving a video monitor. We again saw the same 445.5 spike signal, but suppressed by 20dB relative to what we saw from the DVB-T receivers. Obviously a result of Sony doing a much more effective job of shielding their equipment to contain any RFI within their boxes. The older combo receiver's spike signal was suppressed by 10 dB relative to the other receivers. It was built in an all metal enclosure whereas the others were not.

So were we able to isolate the 455.5 RFI and keep it out of the input to our 441 receiver ? Unfortunately, after trying many different ideas, the answer is NO ! Guess we have to live with it. Plus we will still have to live with the in-band, external RFI source. Bummer.

73 de Jim Andrews, KH6HTV, Boulder, Colorado

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Advice to First Time DATV Repeater Builders

K I S S

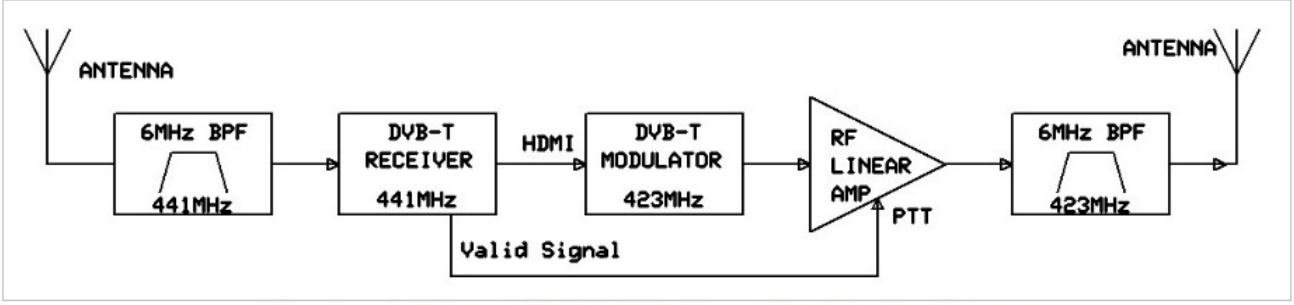

Fig. 1 A 70 cm, Digital TV Repeater, block diagram.

I have recently been chatting with a ham who is wanting to convert their ATV group's analog cross-band (70cm in / 23cm out) ATV repeater to digital. Their group is just now getting their feet wet experimenting with DVB-T. He has been concerned about all of the complexity of dealing with the conversion. My bottom line advice to him and others in similar situations is KISS, i.e. "Keep It Simple Stupid"

The most basic configuration for a digital ATV repeater is shown above in Fig. 1. For the first time operators, don't try to make it any more complicated. No Bells & Whistles the first time around. Learn to Walk before trying to Run. This configuration is actually simpler to implement than a comparable analog ATV repeater. As a matter of fact, for a cross-band repeater, it is even simpler and can be assembled within less than 10 minutes time, even out in the field in a portable or mobile situation. For the cross-band (70cm to 23cm - or - 23cm to 70cm), simply delete the 6 MHz channel band-pass filters. I definitely endorse doing cross-band rather than an in-band 70cm repeater. Much simpler. It has the added advantage that users can monitor their own signal going thru the repeater.

The absolutely bare-bones repeater configuration thus boils down to only three basic modules, plus two antennas. First we have the DVB-T receiver with an HDMI A/V output. Simply run an HDMI cable from the receiver directly over to the HDMI input of a DVB-T modulator. The output of the modulator (typically of the order of a milli-watt or less) is then amplified up to the Watts level using an RF Linear Power Amplifier. Add suitable antennas and we have a DATV repeater.

As it stands, the repeater then can be turned on and off with an on-site control operator simply turning on/off the rf power amplifier. Now if we want the repeater to be automatically keyed up by an incoming DVB-T signal and not require the presence of an on-site control operator, we simply need to

add one more circuit. Note in Fig. 1 the control line labeled "Valid Signal" which is driving a PTT (Push To Transmit) input on the rf power amplifier.

So where do you get the Valid Signal ? It is a simple one transistor modification added to the DVB-T receiver if you are using a Hi-Des receiver. The Hi-Des receivers have a front panel red/green LED indicator lamp. It glows red until a valid incoming DTV signal is detected and then the LED glows green. I have documented this circuit modification in my old application note from 2015, AN-23e, "DVB-T Television Repeater. (available from my web site: ***www.kh6htv.com***) Also there is AN-48 which documents a simple 70cm repeater which I built in 2019 for the Pueblo, Colorado ham club.

Now you say, "Wait a minute, what about FCC IDing?" Couldn't be simpler. The DVB-T protocol already does it automatically for you. When setting up the DVB-T modulator for the first time, you program it with your repeater's call sign. From then on it is transmitted automatically as part of the meta-data header.

OK, now you say "But what about FCC requirement to disable the repeater in the event of malfunction?" OK, then add an additional relay in the Valid Signal - PTT logic line to interrupt the PTT control. Control this relay as in the past over a telephone line, remote radio link, etc.

So where to get the parts ? The DVB-T receiver and modulator can be purchased from Hi-Des in Taiwan (***www.hides.com.tw***). I build and sell suitable rf linear amplifiers for both the 70cm and 23cm band. My amplifiers come with a built-in PTT circuit. They have a typical On/Off ratio in excess of 90dB. For 70cm the model 70-9B amplifier will give you 10 Watts average DTV power. For 23cm the model 23-11A amplifier will give you 4.5 Watts average DTV power. (***www.kh6htv.com***)

73 de Jim Andrews, KH6HTV, Boulder, Colorado

W0BTV Details:

Inputs: 23 cm Primary (CCARC co-ordinated) + 70 cm & 3 cm secondary all digital using European Broadcast TV standard, DVB-T with standard 6 MHz wide TV channels. Frequencies listed are the center frequency of the TV channel.
23cm = 1243 MHz (primary), 70cm = 441 MHz & 3cm = 10.380 GHz
Outputs: 70 cm Primary (CCARC co-ordinated), Channel 57 -- 423 MHz with 6 MHz BW, DVB-T
Also, secondary analog, NTSC, FM-TV output on 5.905 GHz (24/7 microwave beacon).
Operational details in AN-51d Technical details in AN-53d. 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 newsletter was started in 2018 and originally published under the title "*Boulder Amateur Television Club - TV Repeater's REPEATER*" Starting with issue #166, July, 2024, we have changed the title to "*Amateur Television Journal.*" This reflects the fact that it has grown from being simply a local club's newsletter to become the "de-facto" ATV newsletter for the USA and overseas hams. This is a free ATV newsletter distributed electronically via e-mail to ATV hams. The distribution list has now grown to over 800+, both in the USA and overseas. 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

Ubiquiti Air Bridge

FOR SALE: Hi Jim --- I have a couple items that might be able to be repurposed to ATV and might interest your newsletter readers. I have a set of 24GHz, part 15 bridges and a high quality TV studio / ENG camera.

First up is the Ubiquiti Air fiber 24 bridge set. They are full duplex 24 GHz on 2 channels and have a conservative range of 8 miles for 500 to 600 MB throughput. There are manuals, quick start guide and spec sheets at the Ubiquiti website. I'm asking $600 for the pair.

Next I have a JVC ProHD GY-HM750U 1080p camera with extras. I'm asking $1300.00 for this setup. See pic. The JVC website has manuals and spec sheets. This is a very versatile studio camera.

Both items are local pickup and cash (will accept PayPal Friends and Family as well with local pickup) only in Scottsbluff, NE. We are about 3 hrs drive from Denver. The airfibers are too bulky and large to ship and the camera I hate to see what UPS or FedEx would do to such a fine piece of equipment during shipping.

ENG Video Camera with accesories

Thanks, Robert Chrysafis, KC8GPD, WRCM325, Scottsbluff, Nebraska
telephone = 308-672-4360 email = kc8gpd@gmail.com