Amateur Television Journal

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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

Coming Soon !
12th Annual International ATV QSO Party

Mark your calendars. The Big date is scheduled for UTC, August 31, 00:00 (or in USA, Friday, 30 Aug, 5 pm PDT). More details to follow.

your host - Peter, VK3BFG

Press Release
Contact Information:
Amateur Television Network
Roland Hoffman – KC6JPG - Digital Systems Director
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For Immediate Release August 10, 2024

Preparing the Stage for the Annual DATV QSO Party 2024!

Rancho Cucamonga, CA USA – The Melbourne Amateur Television Group along with the Boulder Amateur Television Club, Amateur Television in Central Ohio, and the Amateur Television Network is preparing our worldwide "stage" for the upcoming DATV QSO Party 2024! The DATV QSO Party is an annual event utilizing the mode of amateur television within the amateur radio spectrum. This grand event on video begins on Saturday, August 31, 2024, beginning at 00:00 UTC (***Friday, August 30, 2024 beginning at 5:00pm Pacific Daylight Time / 8:00pm Eastern Daylight time in the USA***). The DATV QSO Party links up with participating ATV repeater systems and chapter stations throughout the world during the approximately 11 hour event, but could go longer depending on the number of check-ins received. This event is the ultimate amateur television "Net." Hams and the general public will be able to watch our live-stream on YouTube, Facebook, BATC, and through the AREDN system.

This annual event will be hosted by our Master of Ceremonies, Peter Cossins – VK3BFG as he will kick-off the DATV QSO Party from the VK3RTV repeater system in Melbourne, Australia. Peter will open with a warm welcome to our participating ATV operators throughout the world. After our official intro, we will open up the "party" to include check-ins from ATV stations throughout the world!

About the DATV QSO Party

"We will be celebrating our 12th DATV QSO Party in 2024," says Peter Cossins – VK3BFG. The 'party' first started between Art - WA8RMC with the Columbus Repeater, Don - KE6BXT and the Californian Network, along with myself and with our great ATV team with the Melbourne ATV Group. Art and Don anchored their Repeaters in the USA, and I anchored the Australian end. We had stations checking-in from Sydney and Hobart, as well as Port Pirie in South Australia accessing the Melbourne DATV Repeater VK3RTV.

1st QSO party with Peter & Don (insert)

The early days of linking distant stations, we linked via IP using Skype, then moved on to Zoom. Currently, we utilize our new SRT (Secure Reliable Transport) protocol at the VK3RTV repeater so ATV stations from around the world are able to access the VK3RTV Melbourne directly, which is the key Repeater at the Australian end. We are so excited to have Bill AB0MY in Boulder, Colorado, and Roland - KC6JPG in Los Angeles to utilized their extensive broadcast and network capabilities to the DATV QSO Party. It is going to be a great event." -- 73 de Peter, VK3BFG

"This year's DATV QSO Party is going to be better than ever." says Roland Hoffman, the Digital Systems Director and Net Control Operations for the Amateur Television Network. "Not only we will be featuring our ATV operators from their local repeater and our chapter stations utilizing our IP linking system, but we will experience for the first time to include video check-ins with our European amateur television operators that will be up-linking into the QO-100 satellite. The down-link will be

KC6JPG ATN Video Production Studio

linked into our "party-line" as we will witness the video transmission from the QO-100 satellite. It will be an experience like no other in amateur television." concludes Roland.

All licensed ham radio operators with an amateur television station setup are invited to participate with the largest amateur television party in the world. If the local ATV repeater is participating in the "party," the ATV'ers can operate directly with the participating local repeater system, and the RF from the repeater will be IP-linked into the VK3RTV repeater in Melbourne, Australia. Participating repeater systems and uplink system for this year's "party" so far includes but not limited to:

VK3RTV – Melbourne, Australia
WR8ATV – Columbus, Ohio, USA
W0BTV – Boulder, Colorado, USA
W6CX – Northern California, USA
W6ATN – Southern California, USA (6 ATV repeater systems linked)
W7ATN – Arizona, USA
WB9KMO – Mesa, AZ USA
QO-100 OSCAR Satellite

If your local repeater system is not listed, have your repeater trustee contact us and we can coordinate an IP video streaming link from your repeater system into the VK3RTV Melbourne repeater so you can participate with us. Contact Roland – KC6JPG at kc6jpg@gmail.com and we can make this happen.

If you are a licensed ham radio operator and don't have an ATV station , you can still join in on the fun and festivities of the DATV QSO Party. You can participate with us on our ATN IP video insertion channel on our Whereby system at: https://whereby.com/atn-tv and you can check-in and participate with our chapter stations and be included into the "party."

Mark your calendar and come join us for the biggest amateur television party on the planet for the 12th Annual DATV QSO Party on Saturday, August 31, 2024 beginning at 00:00 UTC. It will be the ATV video party of the year!

How to Watch: You can watch the "party" through our streaming channels:
YouTube: ***https://www.youtube.com/AmateurTelevisionNetwork***
https://www.youtube.com/@IanVK3QL
Facebook ***www.facebook.com/AmateurTelevisionNetwork***
BATC: ***https://batc.org.uk/live/w6atn***

About the Melbourne Amateur Television Group --- The Melbourne Amateur Television Group are ham operators that support the VK3RTV digital amateur television repeater in Melbourne Australia. The VK3RTV system is one of the first digital amateur television repeater system utilizing the DVB-T2 format with full bandwidth and full HD resolution. For more information about the Melbourne Amateur Television Group, contact Peter – VK3BFG at ***pcossins@bigpond.com***.

About the Amateur Television Network --- The Amateur Television Network (ATN) is a series of amateur television repeaters throughout the Southern California, Nevada, and Arizona areas of the United States, making it possible for the amateur television operator to make contacts with other amateur television stations within the network coverage area. The ATN also provides an IP link for our chapter stations operating amateur television to check-in and communicate with other ATV'ers from around the world. For more information about the Amateur Television Network, contact Roland Hoffman – KC6JPG at: kc6jpg@gmail.com -- or -- check out their web site at: ***www.atn-tv.com***

Amateur 33cm (900 MHz) Band is Threatened !

Tom O'Hara, W6ORG, has just called our attention to a new threat to the Amateur 33 cm (900 MHz) band. On August 6th, the FCC just released a Public Notice seeking comments on a recent petition filed by NEXTNAV to make major changes in the band. To see the notice go to:

https://docs.fcc.gov/public/attachments/DA-24-776A1.pdf

Tom writes -- "This petition to take the 33cm band, will affect areas that are running ATV. This petition specifically asks for comment from the amateur service in the form of "justify your use." The proposed changes are not compatible with known large part 15 uses in the band. It could push us out of the band entirely as the easiest way to eliminate a problem. It asks for justification why we could not be accommodated in other spectrum. The radiolocation folks want to clear out the middle 15 MHZ for their effectively exclusive use and want to be absolved of the non interference to part 15 clauses in the existing rules (this is badly paraphrased, but the elements are in there)."

ATV Repeater Coordination Considerations for the Amateur 23 cm Band

Jim Andrews, KH6HTV

(note: I recently received a request from some hams in New England asking for support in their application to their frequency co-ordinator for a new ATV repeater. I wrote the following document for them. I think it is relevant information to share with our fellow ATV readers.)

With 60 MHz of spectrum available for our 23 cm band, it could potentially support up to ten, 6 MHz ATV channels. However ten channels are not really available because we share the band with other communication modes, SSB, CW, FM, etc. The current Band Plan for the 23 cm band from the ARRL (***https://www.arrl.org/band-plan***) provides for three, 6 MHz wide, channels for Amateur Television (ATV). They are: Ch 1 = 1240-1246, Ch 2 = 1252-1258, Ch 3 = 1276-1282. It also provides two more slots intended for simplex ATV operation. They are from 1260 to 1270 and also 1288-1294 MHz. They also provide one 20 MHz, wide-band channel for FM-TV from 1240-1260 MHz. The ARRL band plan does not further distinguish which ATV channels should be used as repeater inputs and outputs. That is left up to local frequency coordinating committees. ATV should in particular stay away from the designated CW/SSB weak signal & EME frequencies around 1296 MHz. (1295.8 - 1296.2 MHz).

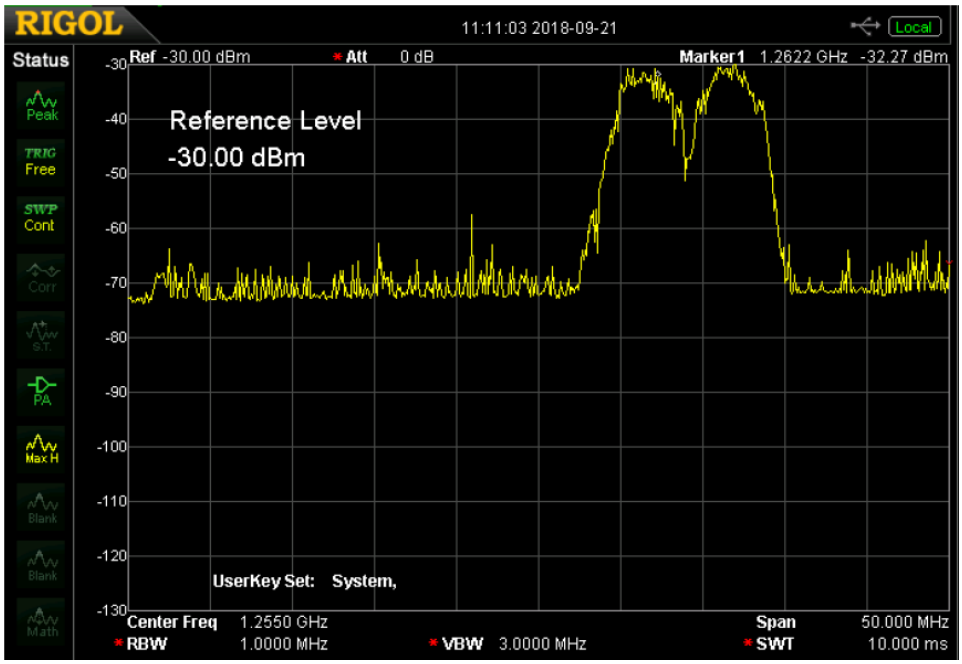


Fig. 1 23cm RADAR RFI 1255 MHz center freq. 10dB/div & 5MHz/div

RADAR RFI: There are two big, major issues when deciding upon ATV 23 cm repeater frequencies. One is spectrum splatter out of band or out of channel. The other issue which rears it's ugly head is the need to avoid in-band RFI with government RADARs. We amateurs are designated

as secondary users of the 23 cm band. The primary designated user is the government for aeronautical Radio Navigation (i.e. radar) and several other govt. services. A dozen years ago, the FAA started deploying a new generation of radars in the 23 cm band. In April, 2012, the ARRL sent out a notice alerting amateurs to this. (***https://www.arrl.org/news/amateurs-must-protect-new-radars-in-23-cm-band***) The implications for ATV are several. First we are not allowed to interfere with these new FAA radar receivers. So don't transmit directly on their frequencies. Second, we must accept any RFI from their radar transmitters. We here in Boulder, Colorado can speak from hard learned experience that this is no simple matter. These FAA radars are very powerful, then combined with their high gain rotating dish antennas, they can de-sense our ATV receivers very easily even when we use large frequency separations. We reported in detail about our 23 cm radar RFI situation in our Boulder ATV newsletter back in 2018 (see issue #4). See the above spectrum analyzer measurement of what we had to deal with. To solve it for our repeater we had to move our input frequency to the extreme bottom 6 MHz ATV channel (1243 MHz), plus have a very high quality, custom designed band-pass / band-reject filter designed and fabricated for our receiver.

SPECTRUM ISSUES: It is important we not interfere with other amateur band users on nearby frequencies. Especially important to avoid difficulties with the FCC is for us to limit our emissions either below 1240 or above 1300 MHz.

AM-TV: Commercial broadcast TV in the USA uses 6 MHz wide TV channels. This dates back to 1941 when the FCC solidified the standards for TV. Then it was purely analog. Digital had not even been dreamed of them. It was based upon using the conventional modulation method of that era, i.e. amplitude modulation (AM). The video bandwidth allowed at the time for B&W TV was limited to 4.2 MHz. An AM modulated TV transmitter produced double side-bands and thus if very clean still required a minimum of at least 2 x 4.2 = 8.4 MHz. In addition, a second transmitter was used for the audio content. This was transmitted using FM modulation on a second frequency spaced 4.5 MHz above the AM video carrier frequency. Early TV engineers discovered they could conserve some band-width if they transmitted the video carrier and the full upper sideband, and only about 3/4 MHz of the lower sideband. By doing this, they were thus able to pack both the video and audio signals into a 6 MHz wide TV channel and leave a small amount of guard band to boot. This technique was called Vestigal Upper Sideband (VUSB-TV). To achieve VUSB-TV, commercial transmitters started off with an AM-TV signal and they used very good, sharp cut-off, 6 MHz wide, band-pass, channel filters to slice off the lower sideband. These were very exotic and very expensive filters.

Radio Amateurs have been experimenting with TV since the earliest days of TV. As to be expected, hams have always looked for the simplest, and cheapest way to communicate. So as a result, the vast majority of ATV hams in years past ignored VUSB-TV and instead used very simple AM-TV transmitters. These typically simply used a power video modulator for collector voltage modulation on the final transistor in a class C amplifier. For many years, the prime supplier of ATV equipment was Tom O'Hara, W6ORG, of P.C. Electronics (***www.hamtv.com***). Tom's main products were 70 cm AM-TV transmitters. He also sold similar transmitters for the 33 and 23 cm bands. Fig. 2 on the right shows the very broad spectrum coming from one of these transmitters.

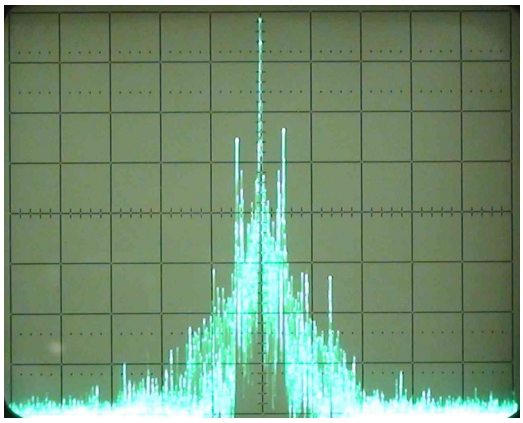


Fig. 2 Spectrum of typical ham AM-TV transmitter 10dB/div & 10MHz/div

I was always an advocate of conserving spectrum and never using these low cost AM-TV transmitters. I published an article in Feb. 2013, QST advocating the use of VUSB-TV instead. My very first application note, AN-1, in 2011 discussed this issue. The technique I pushed for was to use a commercial, cable TV (CATV), head-end modulator to generate a low level (order of 0 dBm or less) very pure VUSB-TV signal and then amplify it with a linear rf power amplifier. Fig. 2 shows the results. A very dramatic improvement in occupied bandwidth over the typical AM-TV transmitter.

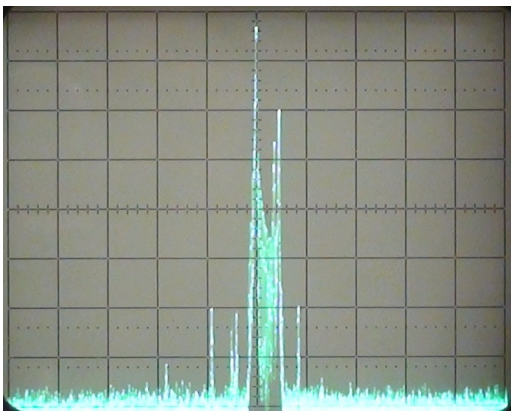


Fig. 3 Spectrum of typical ham VUSB-TV Transmitter 10dB/div & 10MHz/div

The other technique most often used by hams to generate VUSB-TV is to start with the low cost AM-TV transmitter and then follow it with an inter-digital band-pass filter. However, these filters do not come cheap, so as a result most hams didn't ever try VUSB-TV. The only ones actually doing VUSB-TV were the builder's of ATV repeaters for their transmitters. They typically only used the BPFs.

Fabricating a suitable 6 MHz BW channel filter for the 70cm band is not easy, but it can be done with simple machine tools. However, it gets considerably more difficult to build a suitable filter with low insertion loss and the required very sharp cut-off skirts for the 23 cm band. Using a UHF CATV modulator and an up-converter to the 23cm band followed by a linear amplifier is a much easier technique to obtain a VUSB-TV signal on 23 cms.

For these reasons, essentially the only hams who would even consider putting a VUSB-TV signal on the air on the 23 cm band will be the owners / builders of 23 cm ATV repeaters. I wager that all other ATV hams, if they plan to do analog ATV on the 23 cm band, will ignore VUSB-TV and simply use the low cost approach of AM-TV. Thus be prepared to see the very wide spectrums, as shown in Fig. 2.

Because of the wide spectrum coming from AM-TV transmitters, most frequency coordinators will chose to put an analog TV repeater's output frequency at the bottom end of the band and also require that it use VUSB-TV modulation with suitable band-pass filters to keep it's spectrum all within a 6 MHz wide TV channel and limit the amount of radiation below the band edge.

FM-TV: In years past, it was common to find ATV hams using FM-TV modulation on the 23 cm band. A typical amateur FM-TV transmitter used 4 MHz deviation. Fig. 4 shows the resultant typical spectrums from such a transmitter. The photo on the right is with two sound sub-carriers, while the one on the left is simply with video modulation.

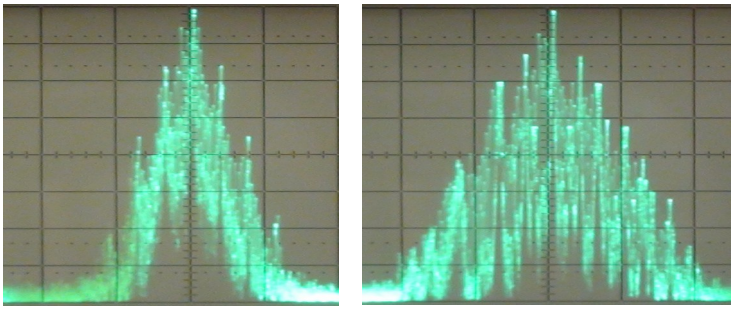


Fig. 4 Spectrums of typical ham FM-TV transmitter, 10dB/div & 10MHz/div

The popularity of the older analog TV is diminishing today. This is partially due to the increasing difficulty in finding either AM-TV, VUSB-TV, or FM-TV equipment available on the commercial market. The major ATV supplier in years past was P.C. Electronics. Tom, W6ORG, has since retired and his gear is no longer available except at ham radio swap-fests and on E-Bay. Low cost FM-TV gear is still available, but is mostly only available for the 5 cm (5.8 GHz) band.

DIGITAL ATV: Today, many ATV hams are making the transition from analog to digital TV. It is more expensive than the older analog gear used to be, but it is available new on the commercial market. In Europe, the favorite system is DVB-S. Here in the U.S.A. most digital ATV hams are using DVB-T.

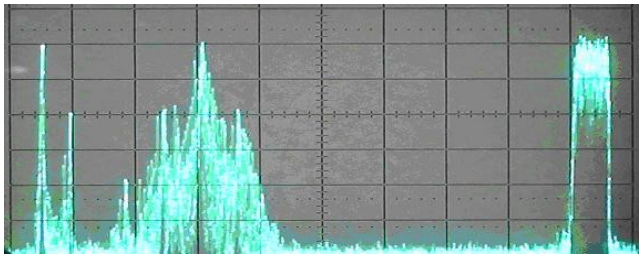
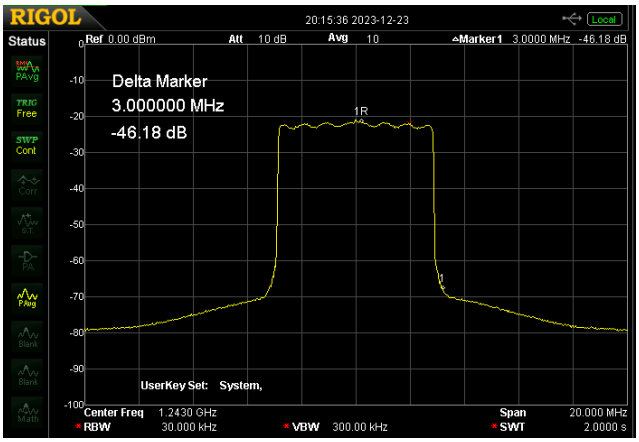


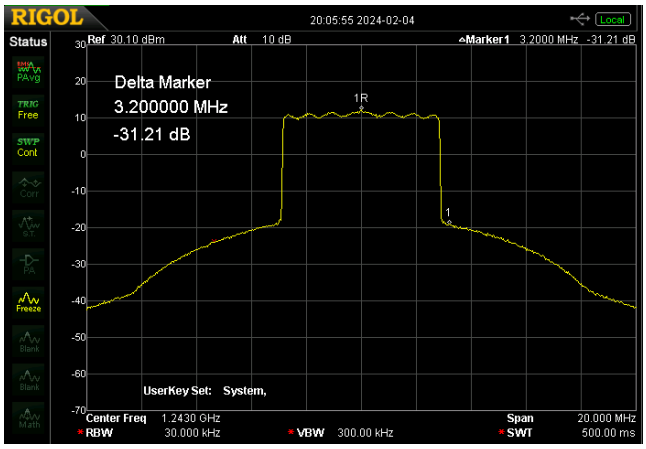
Fig. 5 Comparison of VUSB-TV, FM-TV & DTV

The spectrums and their issues are considerably different from those encountered with the older analog TV. For an AM-TV or VUSB-TV signal, it's spectrum consists of a lot of spikes found every 15 kHz at the horizontal line scan rate with the bulk of the energy clustered within ±1 MHz of the video carrier, plus energy around the 3.58 MHz color sub-carrier and the 4.5 MHz sound sub-carrier.

For a DTV signal, it instead appears as a uniform spread of white noise across the entire 6 MHz TV channel. If you were to tune it in on a SSB receiver it is indistinguishable from the normal background noise, until you look at the S meter. A DTV signal is less likely to cause RFI issues with a narrow-band FM or SSB receiver than an analog TV signal. This is because the full rf power is distributed evenly across a very wide band of frequencies. Thus the power density in Watts/Hz is quite low. For example a 10 Watt, 6 MHz wide DVB-T signal is equivalent to only a 25 mW, not 10 Watt, signal appearing on the input frequency for a 15 kHz band-width FM voice receiver.



DVB-T Modulator Spectrum 10dB/div & 2MHz/div



DVB-T Transmitter Spectrum 10dB/div & 2MHz/div

Fig. 6 Typical spectrums for a DVB-T Modulator (left) and the transmitter output (right) after amplification with a linear rf power amplifier. The rise in the spectrum skirts is due to amplifier non-linearites.

The typical spectrum of a DVB-T signal consists of a band of white noise raised on a rectangular pedestal with very sharp cut-off shoulders at the band edges. There are then some residual, low level, out of channel tails in the immediate adjacent channels. They are characterized by the shoulder break-points which are measured at ±200 kHz beyond the band edges. This measurement is shown above in Fig. 6. For the modulator the shoulder break point was -46 dB. The transmitter output from the linear amplifier shows higher level shoulders. This is a result of amplifier inter-mod products creating out of channel spectrum products. At lower drive levels, hence lower output power, these IMD products are much smaller. The standard compromise in maximizing the RF output without destroying the integrity of the digital signal (i.e. higher Bit Error Rate) is to typically increase the rf drive level until the spectrum shoulder break points reach about -30 dB. At this point, the rms average output power is typically about -8 or -10 dB below the max. saturated output power of the amplifier.

With the spectrum shoulders on a typical DVB-T transmitter being suppressed at least by 30 dB, we feel comfortable operating such a transmitter on a TV channel immediately adjacent to our ham band upper or lower band edges. Thus on the 23 cm band, using the bottom channel at 1243 MHz (1240-1246) should be considered perfectly acceptable as either a simplex or repeater input frequency.

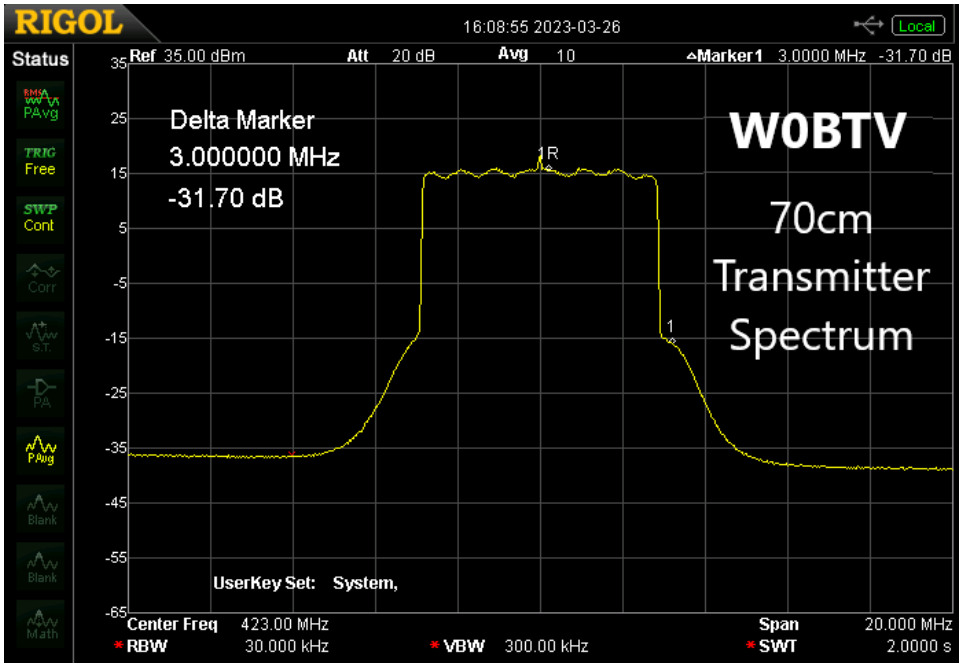
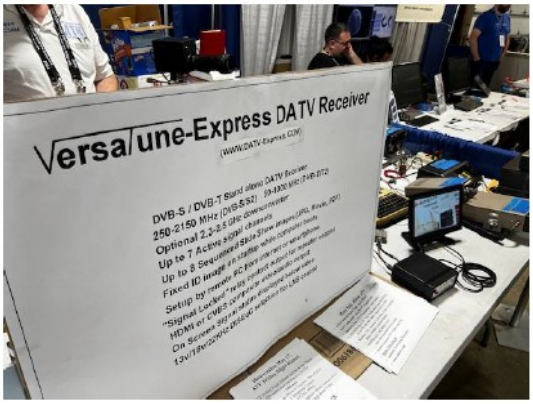


Fig. 7 Typical Spectrum for an Amateur Band, Digital TV Repeater's Transmitter

For DATV repeaters, it is however considered "Good Practice" to go the extra mile and add further suppression to the out of channel spectrum. The rf drive level is increased to the point at which the amplifier's spectrum shoulder break points are at -30 dB. Then the spectrum shoulders are further suppressed by passing the output signal through a 6 MHz wide, band-pass, channel filter. See Fig. 7 above for an example.

73 de Jim Andrews, KH6HTV, Boulder, Colorado

VersaTune Receiver Progress Report:



Art, WA8RMC, had his new VersaTune, DATV receiver on display at the Dayton Hamvention. He had an actual working prototype receiver there. Art said "Software refinements are in progress and if no further issues are found, we should have units to sell by the first of 2025." In the July issue of the ATCO Newsletter, Art further reported "My VersaTune stand alone DVB-S / DVB-T receiver project is still in process. Bob found another software routine that produced marginal results causing him to completely re-write parts of it. That change took some time but now, the receiver performance is rock solid. Some timing issues remain but I now believe the “light at the end of the tunnel” is NOT a train this time!

ATCO ATV REPEATER TECHNICAL DATA SUMMARY:

Repeater Call Sign:	WR8ATV
Web Site:	www.ATCO.TV
Location:	Downtown Columbus, Ohio
Elevation:	630 ft. above the average street level.
TV Transmitters:	423 MHz, 2 MHz BW, DVB-T, 10 Watts
	427.25 MHz, analog NTSC, VSB AM, 100 Watts (pep)
	1258 MHz, analog NTSC, FM-TV, 40 Watts
	1268 MHz, DVB-S, 20 Watts
	2397 MHz, Mesh Net, 600 mW
	10.350 GHz, analog NTSC, FM-TV, 1 Watt
TV Receivers:	439 MHz, 2 MHz BW, DVB-T
	439.25 MHz, analog NTSC, A5, VUSB-TV
	1288 MHz, analog NTSC, FM-TV
	1288 MHz, DVB-S
	10.450 GHz, analog NTSC, FM-TV

For more details about ATCO and their ATV repeaters, contact Art, WA8RMC.

Forest Fire Video Feed-Back:

Hello Jim -- Great that your DVB-T system could be of help for the Fire department and can see where the fire is. Best Regards, Fran, PA0FEX

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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 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

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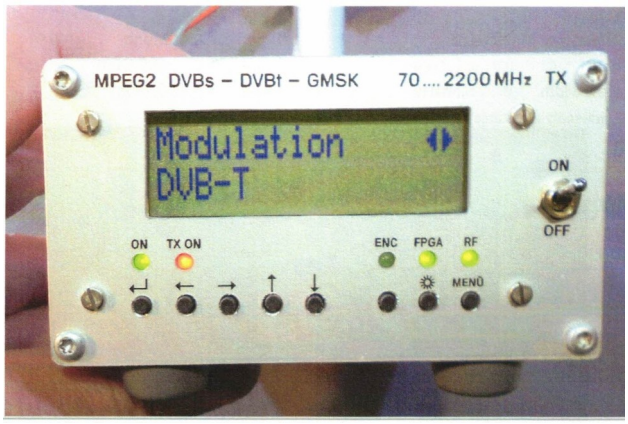

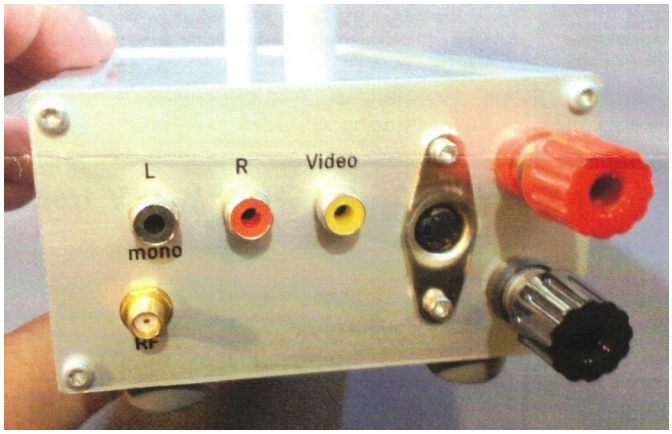

For Sale: SR Systems Combo DVB-S & DVB-T Transmitter
Price is 450 Euros

Frequency Range = 380-565 MHz & 760-1130 MHz. Output Power = 0.05 to 3mW, adjustable
DVB-T Bandwidth = 1 to 8 MHz DVB-S Symbol Rate = 1 kSym to 49 kSym
Modulation = QPSK, QAM16 or QAM64
Video Input = analog composite video plus stereo audio (***note: not digital***)
Contact = Darko Banko at *9a6rzn@gmail.com*

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Western Test Systems

Web Site = *www.westerntestsystems.com* E-Mail = ***pschnabel@mindspring.com***

Telephone # = 307-325-6081 - or - 800-538-1493

Attention - all Ham Micro-Wavers. Here is the ultimate supplier for surplus, quality, microwave components for your home-brew, micro-wave projects. Phil Schnabel has been the supplier of choice for Denver area microwave hams for the past 30 years. Phil started Western Test Systems in 1993 as a supplier of refurbished microwave test components and electronic test equipment. He says their mission is to provide equipment which is verified to meet manufacturers' original specifications. He started out in the 90s in Broomfield, Colorado (a suburb of Denver). He then relocated to Cheyenne, Wyoming. Now more recently he and Laurie moved out into the wide open spaces of central Wyoming to the tiny town of Hanna. His warehouse is bulging with a huge inventory of surplus microwave components, both coaxial and waveguide.

Check out Phil's web site and his very detailed listings of his inventory. He has it all very carefully tablulated with Mfgr. Name, model #, summary of tech. specs., price and quantity he has in stock.

The list of manufacturers at Western Test Systems reads like a "Whos Who" from the 1960s to 2000+. It includes such well known microwave names as: Adams Russell, Aertech, Agilent, Alan, Alford, Alpha, Amphenol, Anaren, Andrew, Anritsu, Anzac, Avantek, ARRA, AstroLab, Bird, Cobham, CTI, Dynatech, Emco, EMF Systems, Fairview, Florida RF, Frequency Sources, Frequency West, FXR/Microlab, General Microwave, General Radio, Gigatronics, Gore, Hewlett-Packard, Huber+Suhner, INMET, JFW, KAY, KDI/Triangle, Keysight, Krytar, Loral, M/A-COM, Mac Tech, Marki Microwave, Maury Microwave, MECA, Merrimac, Micronetics, Micro-Coax, Micro Lambda, Midisco, Midwest Microwave, Mini-Circuits, Miteq, Narda, Norsal, Omni-Spectra, Pasternack, Picosecond Pulse Labs, RLC, Rohde& Schwarz, Rosenberger, Sage Labs, Sanders Assoc, Scientific Atlanta, Sector Microwave, Storm, Systron Donner, Tektronix, Teledyne, Telonic, Times Microwave, Trak, Triangle Microwave, Transco, Trilithic, TRM, TRW, Vari-L, Varian, Vectron, Watkins-Johnson, Wavetek, Weinschel, Western Microwave, Werlatone, Wiltron, Zeta Labs -- etc. etc. etc ! ! ! Whew - what a long list ! Don't believe me -- check out Phil's web site.

73 de Jim, KH6HTV, Boulder, Colorado