Boulder Amateur Television Club
TV Repeater's REPEATER

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BATVC web site: www.kh6htv.com

ATN web site: www.atn-tv.com

The Amateur Television Network

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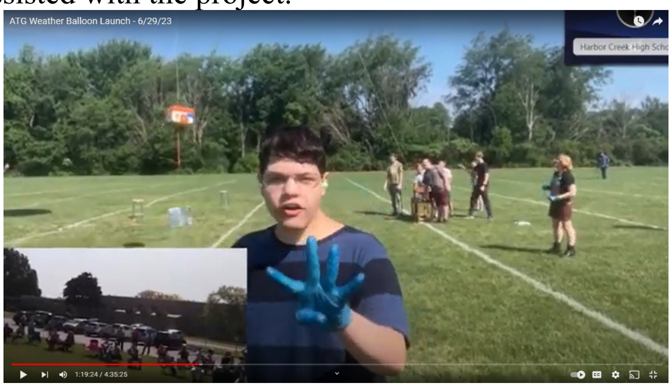
Kids Have Successful BALLOON Flight with DATV Video

Breaking NEWS Bulletin -- We just received this exciting email from Drew, AC3DS, in Fairview, PA, in north-west Pennsylvania near Lake Erie. -------- *"Jim, We successfully launched our High Altitude Balloon and had live video for the entire duration except the last 2 minutes before*

touchdown. It reached a little over 90,000 feet. If you would like to see the video, here is a link to our livestream of the event: https://www.youtube.com/watch?v=8chs4MXjdnc 73 de Drew, AC3DS"

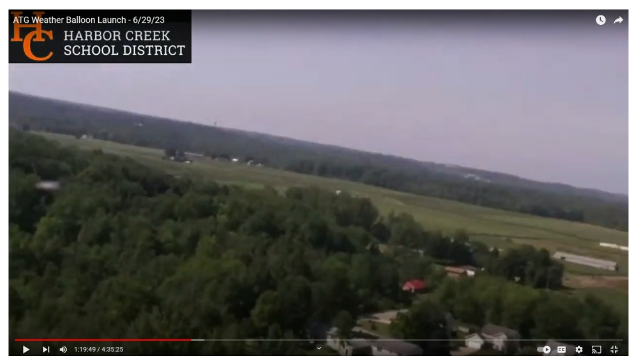
This was a STEM project of the Harbor Creek School District. The 4 1/2 hour You Tube video documents their June 29th balloon flight from start to recovery. It definitely shows the enthusium exhibited by all the kids involved. The actual flight lasted a little over 2 hours.

Drew, AC3DS, designed the DVB-T system. Rick, WA3MKT, designed the balloon's ATV antenna. The ATV transmitter consisted of a Raspberry Pi camera with HDMI output, a Hi-Des model HV-320 modulator and a KH6HTV Video model 70-7B rf linear power amplifier. The amplifier's output power was throttled back below it's normal 3 Watts to conserve battery power. Eight other hams also assisted with the project.



Count Down 5, 4, 3, 2, 1 - Launch !

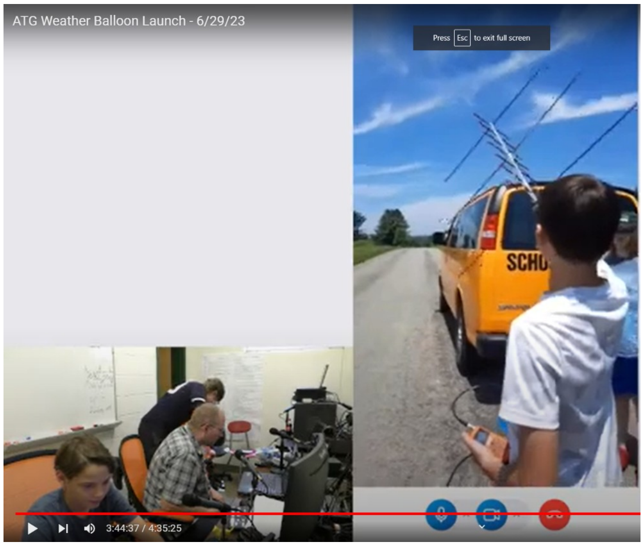
Mission Control Center



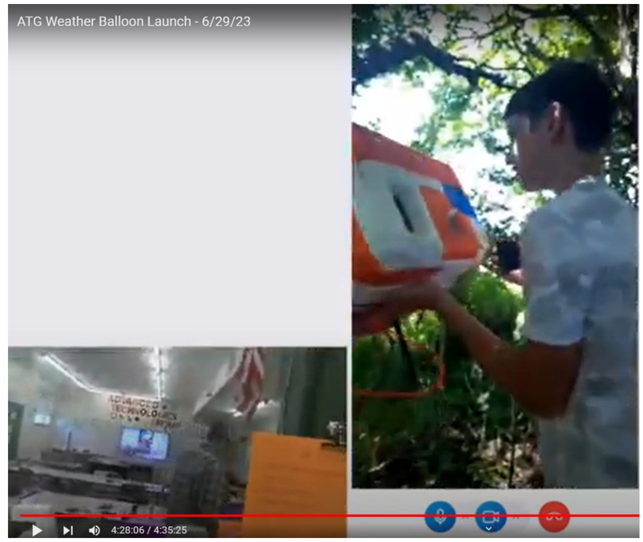
First Video Views from the balloon

View from Space !

Descent -- On our way down !



Now to find the downed balloon



We found it !

BALTIMORE, Maryland DATV Repeater Progress

We have recently had some correspondence with John, K0ZAK, about his efforts to get the Baltimore, Maryland, ATV repeater up and running with digital TV. I am including here some of his recent e-mail letters.

6/25 --- Hi Jim. I've been tasked with rebuilding the second Baltimore ATV repeater. The BRATS club was in the process of upgrading it to Digital before Covid hit and the hospital it is located in got locked down. The upgrade has been stalled for various reasons since then.

I just went there and retrieved the equipment to finish the upgrade. The transmitter is a HiDes HV-100 driving one of your 10 watt, model 70-9B amplifiers.

The club never got around to putting a digital receiver on line. There is still an analog receiver at the location. I was planning on replacing it with a HiDes HV-110 but am now a bit concerned after reading your problems with the HDMI cables and HDCP encoding in one of your recent newsletters. I'm hoping that I don't run into that issue.

I have built a BATC, ATV controller based on a RPI4 for the repeater site, which will be driving a HDMI seamless switcher. I have been reading about using certain HDMI splitters to get around the HDCP issues, but I believe you mentioned that didn't work for you. I have noted that the AVsender program allows you to turn off HDCP on the HV100& HV320 transmitters, but see no equivalent way to do that on the HV110 receivers. That make sense however as you have the choice or usingit or not on transmitting your own video, but not receiving someone elses. I may just have to locate an older HV110 like you did.

John Kozak, K0ZAK

6-26 -- Due to the lack of info available for the current controller and hardware, and changes in the TMARC frequency coordination for the repeater, we thought it best to start with a clean sheet on the repeater re-design, using what parts that may be available.

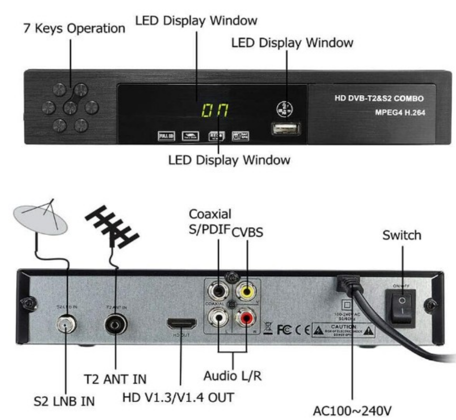
Plans are to have the transmitter on 427.25 using the HV-100 & your 70-9B amplifier running DVB-T at 2 MHz bandwidth. The Controller will be the BATC repeater controller built on a Raspberry Pi 4 driving an HDMI seamless switcher. Receiver for now is planned to be a HiDes HV-110 set to 439.25 Mhz DVB-T @ 2 MHz bandwidth. Analog receivers and alternate bands will be considered in future upgrades. All equipment will be supported with PC's connected via a network to allow remote reprogramming and resetting as needed. Dead Man resetting will be built into the system in case of unexpected lockouts. The BATC controller will also allow DTMF control over FM radios.

Alternate receive plans are to install my BATC Knucker and Minituner receivers into the system so as to allow realtime comparisons of DVB-T & DVB-S inputs using different bandwidths. These receivers however are not really repeater friendly. They will require manual resetting every time the power drops. They will really just be used for testing alternate transmission modes.

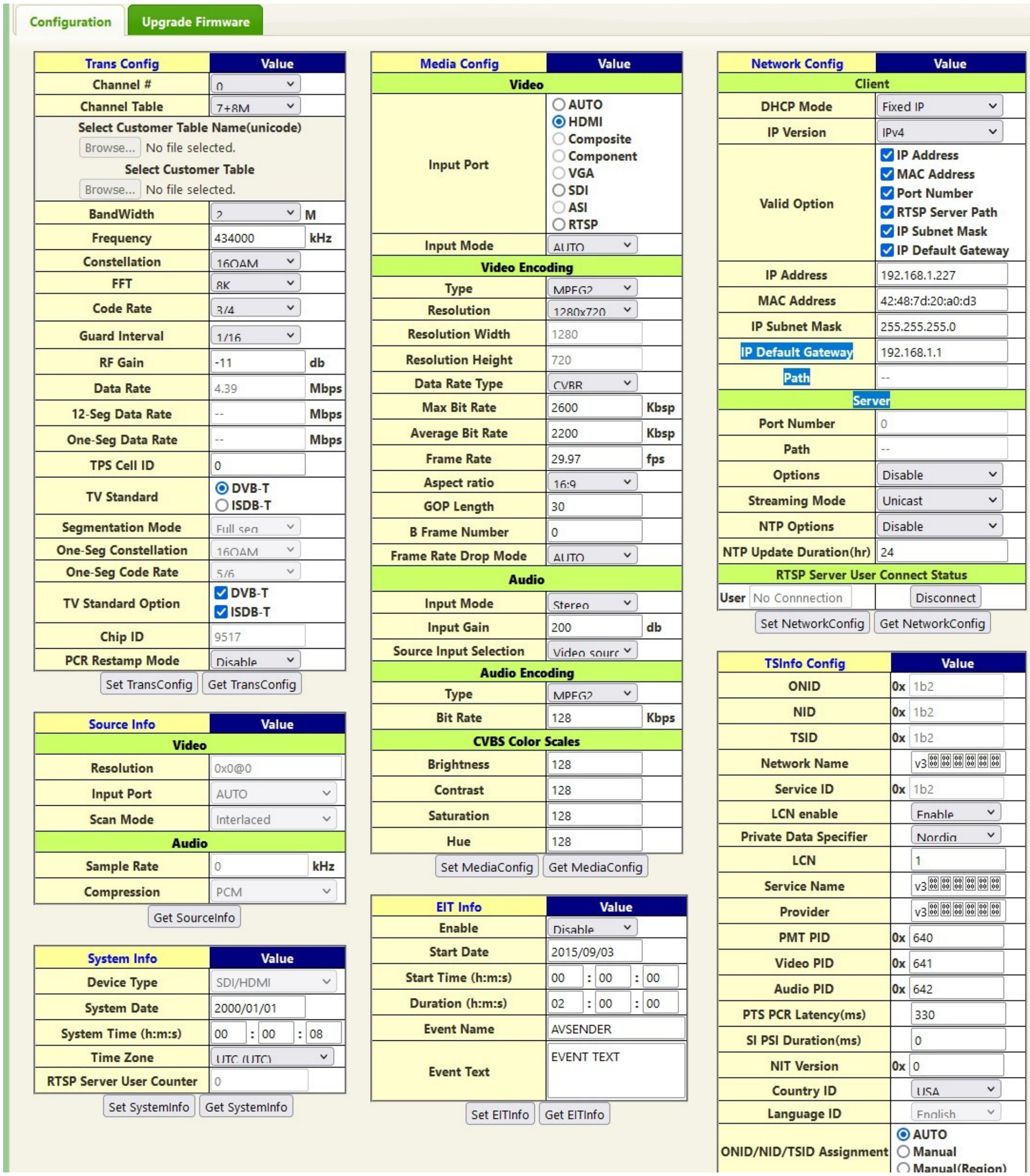
I have been waiting for Art Townslee's latest Versatuner receiver hoping it would be better suited for this task, but from what he said in his recent Dayton hamfest talk, the DVB-T & DVB-S frequency ranges don't overlap. Therefore I won't be able to do direct mode comparisons on 439.25 MHz
Thanks for all your comments and support for this ATV stuff,

John Kozak, K0ZAK

Editor's Comments: *I am sorry to say that I can no longer endorse the Hi-Des DVB-T receivers. I have had way too much grief in the past year with their new production receivers. They are too finicky about their HDMI connections. My current HV-110 for example will only work with my 24" Visio TV receiver/monitor. It refuses to display anything on two other video monitors, I have here in the shack. Both are capable of 1080P resolution with screen sizes of 7" and 11" and operate from 12 Vdc power. They were purchased for out in the field, portable or mobile ATV operations.*



However, for narrow bandwidths of less than 6 MHz, our choices for a DVB-T receiver are extremely limited. Currently, for hams wanting to do DVB-T, ATV on the 70cm band, using 6 MHz band-width, I recommend using the "Combo" DVB-S / DVB-T receiver shown here. Most all of the Boulder ATV hams are using them and are quite happy with their performance and lack of issues. For more details, see my app. note, AN-65 ---- Jim, KH6HTV



ATN - Southern California

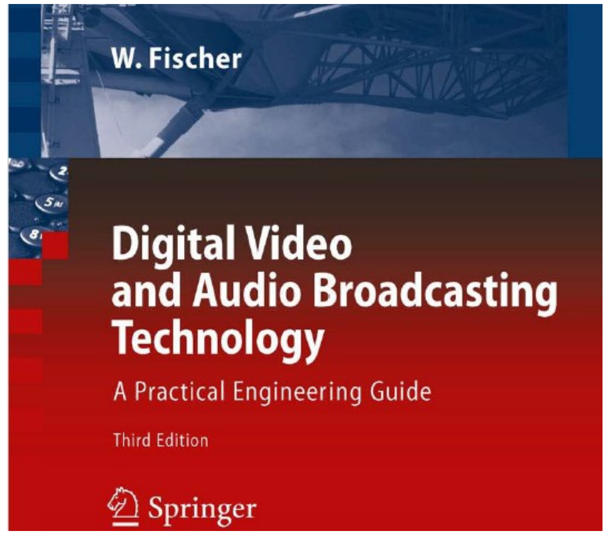
2 MHz BW, DVB-T Modulator Settings

Roland, KC6JPG, has provided us with a screen grab shot showing us his recommended settings for DVB-T modulation with 2 MHz band-width. In quick summary, the major settings are: Media Config

= HDMI, MPEG2 video encoding, 720P resolution, 2.6 Mbps max. bit rate. MPEG2 audio encoding at 128 Kbps.   Trans Config = 16QAM, 8K FFT, 3/4 Code Rate and 1/16 Guard Interval.   For PID, they use: PMT = 640, Video = 641 & Audio = 642

Measuring DVB-T Signals

Jim Andrews, KH6HTV



I consider this book to be the "Bible" for most all questions relating to digital TV.

The author, Walter Fischer, Dipl. Ing. was a Television engineer working in the Broadcast division for Rohde & Schwarz, in Munchen, Germany.

The book is over 800 pages in length.   It starts out with analog TV.   Then moves on to MPEG, both audio and video. It discusses the various TV systems of DVB-C, DVB-S, DVB-T, ISDB-T & ATSC plus IPTV.   Also included are digital audio of DRM and DAB.

It has a whole chapter devoded to "Measuring DVB-T Signals".   Chapter 21, pages 421-450.   A key parameter many of us use when setting up the drive level for our RF power amplifiers is the measurement of the RF output power and also the out-of-channel, spurious spectrum, shoulder attenuation.   I would like to address these here in this newsletter.   They all use a spectrum analyzer for the measurements.   Reproduced here directly from section 21.2, pages 425-426 is as follows:

21.2 Measuring DVB-T Signals Using a Spectrum Analyzer

"A spectrum analyzer is very useful for measuring the power of the DVB-T channel, at least at the DVB-T transmitter output.   Naturally, one could simply use a thermal power meter for this purpose but, in principle, it is also possible to use a spectrum analyzer which will provide a good estimate of the carrier/noise ratio. Firstly, however, the power of the DVB-T signal will now be determined. A COFDM signal looks like noise and has a crest factor which is rather high. Due to its similarity with white Gaussian noise, its power is measured in a comparable way.

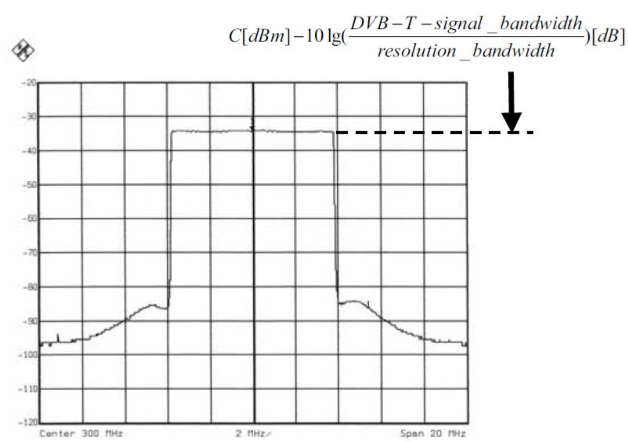


Fig. 21.5. Spectrum of a DVB-T signal

To determine the carrier power, the spectrum analyzer is set as follows: On the analyzer, a resolution bandwidth of 30 kHz and a video bandwidth of 3 to 10 times the resolution bandwidth, i.e. 300 kHz, is selected. To achieve a certain amount of averaging, a slow sweep time of 2000 ms is set. These parameters are needed because we are using the RMS detector of the spectrum analyzer. The following settings are then used:

• Center frequency: center of the DVB-T channel
• Span: 20 MHz
• Resolution bandwidth: 30 kHz
• Video bandwidth: 300 kHz (due to RMS detector and logarithmic scale)
• Detector: RMS
• Sweep: slow (2000 ms)
• Noise marker: channel center (resultant C' value in dBm/Hz)

(*editor's note: I also recommend using the signal averager with at least 10 averages*)

To measure the power, the noise marker is used because of the noise-like signal. The noise marker is set to band center for this but the prerequisite is a flat channel which can always be assumed to exist at the transmitter. If the channel is not flat, other suitable measuring functions must be used for measuring channel power but these depend on the spectrum analyzer.

The level indicated in the useful band of the DVB-T spectrum (Fig. 21.5.) depends on the choice of resolution bandwidth (RBW) of the spectrum analyzer (e.g. 1, 4, 10, 20, 30 kHz, etc.) with respect to the bandwidth of the DVB-T signal. The signal bandwidth of the DVB-T signal is

• 7.61 MHz in the 8 MHz channel,
• 6.66 MHz in the 7 MHz channel,
• 5.71 MHz in the 6 MHz channel."

(*editor's note: This is due to the presence of a very sharp roll-off of the DVB signal just inside the band edges to provide guard bands. Thus a 6 MHz signal does not really fully occupy a full 6 MHz TV channel.*)

Editor's Comments: A spectrum analyzer's markers can thus be used to measure the actual rf power in a DVB-T signal, but a dB correction factor must always be used to account for the difference between the resolution bandwidth and the signal bandwidth. For example on my Rigol DSA-815 spectrum analyzer I have found that I need to use a dB correction factor.

I used a Hi-Des HV-320E modulator as my signal source on the 70cm band. I first measured the true average power of a 6 MHz BW, DVB-T signal using an HP thermistor power sensor with my HP-432 power meter. I set the rf power to approximately 0 dBm. I then measured the same signal on the Rigol. The spectrum from the HV-320 is not perfectly flat, but has about a 1dB ripple across the pass band. Thus there is some uncertainty in where to exactly set the SA's marker. Thus expect a similar amount of uncertainty in the absolute accuracy of your power measurement.

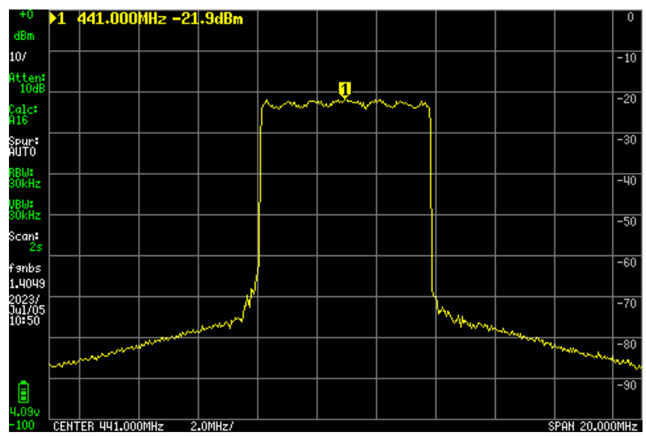
You can use either the marker readout in Power (dBm) or the Noise marker readout in dBm/Hz. Using 30 kHz resolution bandwidth and 300 kHz video bandwidth, with the power marker, I got about -22 to -23 dBm. Thus a correction of +22/23dB needs to be added to the readings to determine the actual rf power of a 6 MHz BW, DVB-T signal. If I used the Noise Power marker, then the value was about -

67 dBm/Hz. The correction factor to account for the total bandwidth of a 6 MHz channel (actually 5.71 MHz) correcting 5,710,000 Hz relative to 1 Hz is to add 10*log(5,710,000) = +67.7 dB to the Noise Power marker readings.

If I changed the resolution bandwidth on the Rigol SA to it's various settings of 1 MHz, 300 kHz, 100 kHz, 30 kHz, 10 kHz, 3 kHz, etc. -- I found there was essentially a 5 dB change in the Power marker readings between each band-width. Thus going from 30 kHz to 100 kHz, the reading increased from -23 dBm to -18 dBm. No change occured in the Noise Power marker readings as they were always expressed as dBm per Hz.

When setting up your spectrum analyzer to make measurements on a DTV signal, keep in mind that the waveform is definitely not a sine wave, but looks more like totally random noise with lots of peaks and valleys. For accurate measurments, the peaks must not exceed the linear upper limit on your analyzer or severe compression will occur. Always best to start with too much attenuation and then remove some to optimize the results. For example the crest factor for DVB-T is theoretically 40 dB higher than the average power. For typical transmitters it is usually limited to about 13 dB or a bit less.

Tiny-SA - Ultra Spectrum Analyzer:



So, can I also use the low cost, Tiny SA ? The answer is a definite **YES !** I found that it works quite well for making measurements on DVB-T signals. I got essentially the same results as I did with my more expensive Rigol. Using the same identical settings as recommended by Fischer and used on the Rigol, I got the same spectrum plot shown on the right as on my Rigol. The power marker values agreed quite close. The TinySA noise marker values were a bit off. The plot shows a marker readout at the center frequency of about -22 dBm, consistant with the Rigol's measurement. I also noted that using bandwidths other than the recommended 30 kHz, the correction factor change of 5 dB did not track as the shape factor of the TinySA's other band-widths were probably not the same as the Rigol's.

Adjusting Drive Level to Transmitter Power Amplifiers:

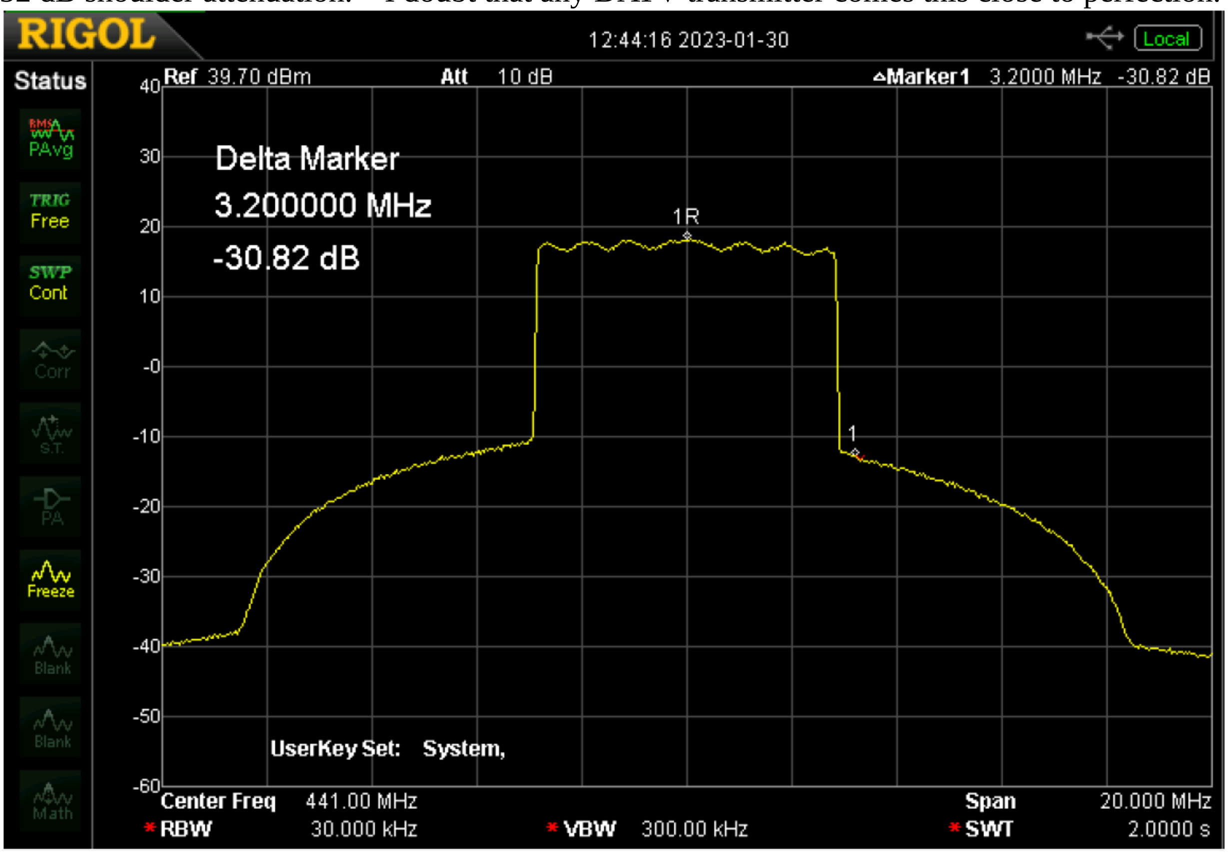
Again I refer directly to Fischer's book, section 21.7, pages 446-449.

21.7 Measuring the Shoulder Attenuation

"The system does not utilize the full channel bandwidth, i.e. some of the 2K or 8K subcarriers are set to zero so that no interference to adjacent channels will be caused. Due to nonlinearities, however, there are still outband components and the effect on the spectrum and its shape has given rise to the term ‘shoulder attenuation’. In the Standard, the permissible shoulder attenuation is defined as a tolerance mask. Fig. 21.30. the spectrum of a DVB-T signal at the power amplifier output, i.e. before the mask filter. To determine the shoulder attenuation, different methods are defined and especially a relatively elaborate method in the Measurement Guidelines [ETR290]. In practice,the DVB-T spectrum is in

most cases simply measured by using three markers, setting one marker to band center and the others to +/- (DVB-T channel bandwidth/2 + 0.2 MHz). With an 6 MHz channel, this results in test points at +/- 3.2 MHz relative to band center. ..... The DVB-T standard [ETS 300 744] defines various tolerance masks for various adjacent channel allocations.
In practice, the following shoulder attenuations are achieved:
• Power amplifier, undistorted: approx. 28 dB
• Power amplifier, equalized: approx. 38 dB
• After the output BPF: approx. 52 dB (critical mask)"

Editor's Comments: Fisher is describing a typical high power, broadcast TV transmitter. The rf drive level is first brought up until the shoulder break point hits -28 dB. What he then means by "equalized" is then turning on an electronic feed-back, digital pre-distortion equalizer in the driver which results in lowering the shoulder break points by 10 dB to about -38 dB. What he calls the "Mask Filter" is what we ATV hams refer to as our Band-Pass, Channel Filter. The commercial folks use really great filters with very close in, steep roll-off skirts to achieve the desired commercial result of -52 dB shoulder attenuation. I doubt that any DATV transmitter comes this close to perfection.



Typical Amateur, 70cm, 10 Watt (+40dBm), DVB-T Transmitter's RF Output Spectrum

DATV Amplifiers: I am unaware of any amateur TV operation which uses electronic, digital pre-distortion on their transmitter amplifiers to reduce out of channel spurious shoulders. For our ATV repeaters, we do however, try to always use ATV channel filters on the outputs of our transmitters. There is always a fine line to draw between wanting to drive our amplifiers to get the maximum possible RF output power and yet radiate a clean, distortion free signal. So what should we shoot for ? In general, the commonly accepted practice for DATV amplifiers is a shoulder break-point of about -30 dB relative to the in-channel power level.

The above plot shows a typical DATV transmitter running QPSK modulation. The RF output power was measured to be 10 Watts average. If this same amplifier were driven hard into saturation for FM service, it would put out about 70 Watts. Thus for DATV service we are getting about 8.5 dB less power. This is our Crest Factor.

I have run comparisons for the three different DVB-T modulations (constellations) of QPSK, 16QAM and 64QAM. Using a Hi-Des HV-110 receiver's built-in diagnostic capability for decoded Signal / Noise ratio (S/N), I was able to reliably determine at what level of drive, the amplifier started to degrade the quality of the transmitted signal. Under ideal conditions, the S/N max. is 23 dB, 26 dB and 32 dB respecively for QPSK, 16 QAM and 64QAM. I found that I got the same results for either QPSK or 16QAM of no degradation of S/N for shoulder break-point of the order of -30 to -32 dB. For the more complex waveform and constellation of 64QAM, I needed to back off the drive power level by 1 dB with an attendant shoulder break-point of the order of -32 to -34 dB. Thus the RF output power was also 1 dB less, implying the need for a higher crest factor, also by 1 dB of at least 9.5 dB.

73 de Jim, KH6HTV, Boulder, Colorado

FEEDBACK:

W0BTV's RFI: Jim --- You can solve your RFI 70 cm ATV problem if you switch to Horizontal polarization. ---- Cheers, Dave P. AH2AR

BATVC's Reply: --- Yes, Dave is correct. The dominant signals seen on the 70 cm band, which are causing our RFI grief to our repeater are predominantly vertically polarized. Going to horizontal polarization would buy us an additional 20 dB of isolation. However, we need to go back in our history. The major compelling reason we ever started ATV in Boulder in the first place back in 1990 was for ARES purposes to support our local Sheriff's department. In return, the Sheriff provided funding, plus a location and tower access for our ATV repeater. The ARES field ATV units would be carrying their gear in back packs and using vertical whip antennas, or operating mobile units, again with vertical whip antennas. Hence the repeater needed to support vertical polarization. Support for ARES and the OEM and Sheriff are still today, the major reason for us having ATV (now DATV) in Boulder. Without our providing emergency comms capability to public safety agencies, we would probably not be able to continue to occupy our excellant repeater site.

W0BTV Details: **Inputs:** 23 cm Primary (CCARC co-ordinated) + 70 cm secondary all digital using European Broadcast TV standard, DVB-T 1243 MHz/6 MHz BW (primary), plus 439 MHz/6 MHz BW and 439 MHz/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*).

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