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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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3.4 GHz Band is Worth a Lot of $$$$

The October issue of Microwave Journal reports --- "AT&T has agreed to purchase certain wireless spectrum licenses from EchoStar for a total of approximately **$ 23 BILLION** in an all cash transaction. . . . . AT&T will acquire approximately 30 MHz of the nationwide 3.45 GHz mid-band spectrum."
(*editor's note: This is the portion of the 9cm ham band we recently lost. See how valuable it is ! Use it or lose it.*)
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Low Cost 10 GHz Amplifiers

On the weekly Boulder, CO ATV net recently, Steve, WA0TQG, showed us a new, relatively low cost amplifier he had found for 10 GHz. He found it on E-Bay.

The amplifier Steve showed us was called an RF Power Amplifier for the C, X & Ku bands (5-18 GHz). It's model number was QM-PA051815D. Key specs. are: 15dB gain, +19dBm (P1dB), +5V @ 120mA.

Steve said he paid $80 including free shipping from China. However, now with the high Trump tariffs on imports for China, the current price is higher, typically with added shipping charges.

Also now listed on E-Bay is a similar LNA in the same package. It has an even broader frequency coverage from 2 - 18GHz, including the S band. As an LNA, they claim 1.8dB noise figure. Gain of 18dB and max. power out of +14dBm at 10 GHz. 5 Vdc @ 80ma. Price is $116.

These items look worthwhile for putting together a QRP - 3cm rig.

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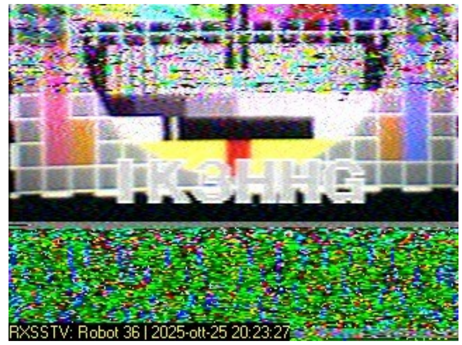

SSTV and Aircraft Reflection: A Successful Experiment Between IZ5TEP and IK3HHG

A successful **SSTV** transmission using the reflection off the fuselage of a passing aircraft is a true gem — and a tribute to technical creativity and operational precision. The UHF-SSB, link between Filippo, IZ5TEP, in Viareggio, Italia and Francesco, IK3HHG, in Treviso - with Francesco on reception, shows how collaboration and passion can push beyond the limits of conventional propagation. Try it to believe it. They used 437 & 1297 MHz.

Aircraft Fuselage Reflection in Motion This fascinating phenomenon turns an aircraft into a temporary reflector for radio waves, enabling transmissions that would otherwise be impossible. In SSTV, each received frame is a small victory against atmospheric randomness — a fleeting moment captured through a perfect blend of timing and technique.

Observations: (1) Aircraft reflections offer unique opportunities for UHF/SHF experimentation.
(2) SSTV's analog nature makes the success of each image transmission visually rewarding.
(3) Collaboration between skilled operators is key to seizing these rare propagation windows. This experiment is proof that shared passion leads to remarkable results.

The SSTV test with the PD120 system via air bounces is really fascinating, especially considering the distance and geography between IZ5TEP and IK3HHG. Here's a quick technical summary and some ideas for improving or documenting the experiment: 📷 PD120 SSTV test via airborne bounces Technical setup: Distance: ~300 km, separated by a mountain range Radios: IK3HHG: ICOM IC-705 IZ5TEP: ICOM IC-905 Antennas: 2 x 180 cm dishes for 1296 MHz 22-element Yagi for 430 MHz

Modulation: SSB SSTV RX software: compatible with PD120 Aircraft tracking: AirScout Results: Images received were not perfect, but still legible and impressive Good synchronization thanks to automatic aircraft tracking.

73 de Filippo, IZ5TEP & Francesco, IK3HHG

Application Note AN-72

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Filtering Requirements Design for a 70 cm DVB-T Repeater

Jim Andrews, KH6HTV

Does your local ATV group need a TV repeater? Are you debating should it be an in-band 70cm repeater, or instead perhaps a cross-band repeater? Tight budget? Technically complex with lots of "bells & whistles" or KISS (Keep It Simple Stupid) ?

Rptr. App. Notes: KH6HTV application note, AN-23 "DVB-T Television Repeater" [1] discusses the various types of ATV repeaters and the basic design principles. KH6HTV Video also has several other app. notes [2-6] describing specific ATV repeaters. They all describe various "basic" DVB-T repeaters. The Boulder, Colorado ATV, W0BTV repeater is a very "complex" repeater with three DVB-T receivers (70cm, 23cm & 3cm) plus two transmitters. One for digital DVB-T on 70cm band and the other analog FM-TV on the 5cm band. It is described in detail in AN-51 & AN-53 [7-8].

70cm In-Band Repeater: A 70cm in-band ATV repeater is usually the most desirable. Propagation at UHF-TV frequencies seems to be optimum in the 400-500 MHz range. Plus from a user standpoint, his/her $$ investment in equipment, antenna, etc. is minimized compared to a cross-band repeater. From the repeater designer's point of view an in-band 70cm repeater is considerably harder to design and build than a cross-band repeater. It not only will be more complex to make work right, but also more costly. Why? You need really great, ATV channel, band-pass filters (BPF) for both the receiver and transmitter to make it function properly without serious de-sense.

BPFs: These BPF filters are not easy to come by, nor in-expensive. If you are lucky, you might find some commercial, broadcast quality, UHF-TV channel filters which can be tuned down to our 70 cm band. Otherwise, it means - build or buy. KH6HTV app. note AN-22b [9] discusses such filters and how you might build your own. Most builders of ATV repeaters in the past have been using ATV channel filters from DCI in Canada (***www.dcifilters.com***). Note: DCI has been purchased recently by the Kavveri Telecom Products in Bangalore, India and communications with them now need to be addressed to mktg@kavveritelecoms.com For 70 cm, ATV, DCI offers a 6 MHz filter in either 8 or 10 pole configuration. The price tag is not inexpensive. They are currently quoting $850 for the 8 pole filter and $1,050 for the 10 pole. Plus, the DCI filters are 19" rack mount size and BIG !, but they do work quite well.

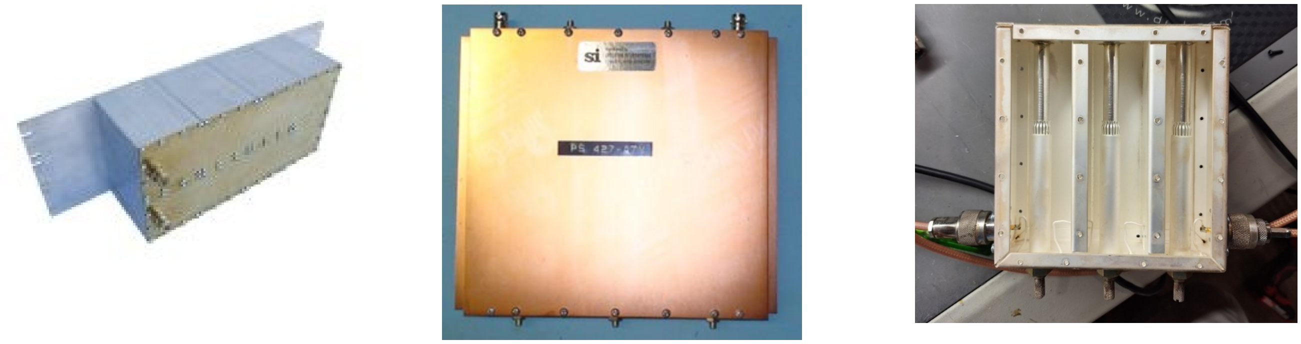

Fig. 1 Typical Band-Pass Filters used for 70 cm ATV repeaters. Left is 19" rack mount DCI filter. Middle is Spectrum International filter Right is commercial UHF-TV broadcast filter (shown with cover removed)

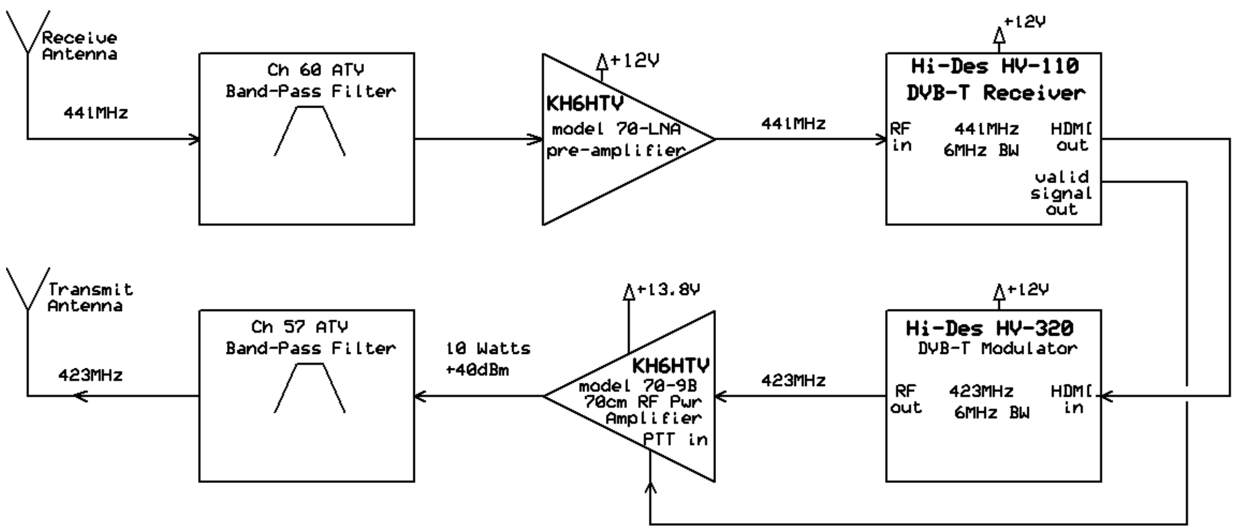

Fig. 2 Basic 70 cm DVB-T Repeater Block Diagram

Typical 70 cm ATV Repeater Design: Fig. 2 shows the main components for a typical 70cm repeater. The most commonly used frequencies, and those advocated by the ARRL 70 cm band plan, [10] are an input on Ch 60, 441 MHz and an output on Ch 57, 423 MHz with 6 MHz wide TV channels. Note: the band plan actually specifies 439.25 and 421.25 MHz, but those are hold-overs from the old analog, NTSC, TV days. Today, for digital TV, we designate the center frequency of a TV channel rather than the old NTSC video carrier frequency which was located 1.25 MHz up from the lower band edge. Note, two separate antennas are typically used for a TV repeater, unlike FM voice repeaters which use one antenna and a duplexer.

For this app. note, we will also assume the following pieces of equipment are used.

DVB-T Receiver is Hi-Des, model HV-110
DVB-T Modulator is Hi-Des, model HV-320
Receiver Low-Noise Pre-Amp is KH6HTV model 70-LNA (18dB, 0.8dB NF)
RF Linear Power Amplifier is KH6HTV model 70-9B (10 Watts avg. output)

Filter Requirements: The purpose of this app. note is to work the reader through the process of determining the requirements of the filters to be used in an ATV repeater.

Step 1 Determine receiver sensitivity and de-sense characteristics
Step 2 Determine the out of channel spectrum splatter from the transmitter
Step 3 Determine the isolation between the transmitter and receiver antennas
Step 4 Compute from above results the required skirt selectivity of both the transmitter and receiver BPFs.
Step 5 Obtain necessary BPFs and test
Step 6 Assemble Basic Repeater and test

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Step 1 - Receiver Tests: The first step is to determine the receiver characteristics relative to "de-sensing" from undesired signals. In our case, the undesired signal will be coming from our own transmitter. Our receiver could be de-sensed either by leakage of the transmitter signal on an adjacent channel - or - by the low level, out of channel transmitter spectrum skirts landing in our receive channel. The tests were performed with DVB-T modulators creating "normal" ham DVB-T signals with 1080P, H.264, 5.5Mbps and modulation of QPSK, 5/6 code (FEC) and 1/16 guard (sync). With these settings, a receiver required a minimum signal to noise ratio of 8dB. Modulators were running live video from pre-recorded home videos.

Receiver Sensitivity: Using a single HV-320 modulator and step attenuator, the digital threshold sensitivity of the pre-amp / receiver combo was found to be **-97 dBm**. digital threshold is defined as the weakest signal which gives perfect P5 video and Q5 audio. On the HV-110 the front panel red/green LED also will glow a solid green with no flickering. Note: If really "aggressive" Forward Error Correction (FEC) is used of 1/2 (with 720P, 3.5Mbps), then the sensitivity will be improved by another 3dB to -100dBm with a resultant minimum S/N of 5dB.

Receiver De-Sense Measurements: The test configuration to measure de-sense was to use two HV-320 modulators with step attenuators on their outputs. Their outputs were then combined in a Mini-Circuits 3dB splitter/combiner. The composite signal was then put into the 70-LNA preamp followed by the HV-110 receiver. One modulator was set to Ch 60 (441 MHz). The other modulator was used to create the RFI signal on either the same channel or adjacent channels, down to Ch 57.

RFI tests were then run with the desired Ch 60 signal being either +3dB, +10dB or +20dB above the digital threshold. (i.e. -94dBm, -87dBm or -77dBm).

Co-Channel RFI: The first test was for co-channel RFI, i.e. the RFI source was also on Ch 60. The RFI signal source was first set way too low in level. It was gradually increased in 1dB steps until visible interference was noted. Interference manifested as freeze-framing of the picture.

At +3dB, F/F occurred when the RFI was equal in strength to the desired signal.
i.e. the RFI = -94dBm
At +10dB & +20dB, F/F occurred when RFI was about -5dB below
the desired signal.

When the DVB-T RFI was stronger than the desired signal, total blocking occurred with no picture being decoded and only a black screen visible. When the DVB-T RFI was 8 to 10dB stronger than the desired signal, then the RFI signal captured the receiver and it's picture was then decoded P5/Q5.

Adjacent Channel RFI: The next test was to then move the RFI source to lower adjacent channels of 59 (435), 58 (429) and 57 (423 MHz) and to again determine the signal level required to create freeze framing. The results for the desired Ch 60 signal being weak at +3dB (-94dBm) above digital threshold (-97dBm) were:

Ch 59 = -48dBm Ch 58 = -38dBm Ch 57 = -30dBm

Conclusions for Receiver RFI: Assuming the ultimate case with 1/2 FEC (min. s/n of 5dB), the RFI coming from the repeater's transmitter must be kept below the following levels to avoid compromising the repeater's sensitivity with de-sense.

Ch 60 = -100dBm Ch 59 = -54dBm Ch 58 = -44dBm Ch 57= -36dBm

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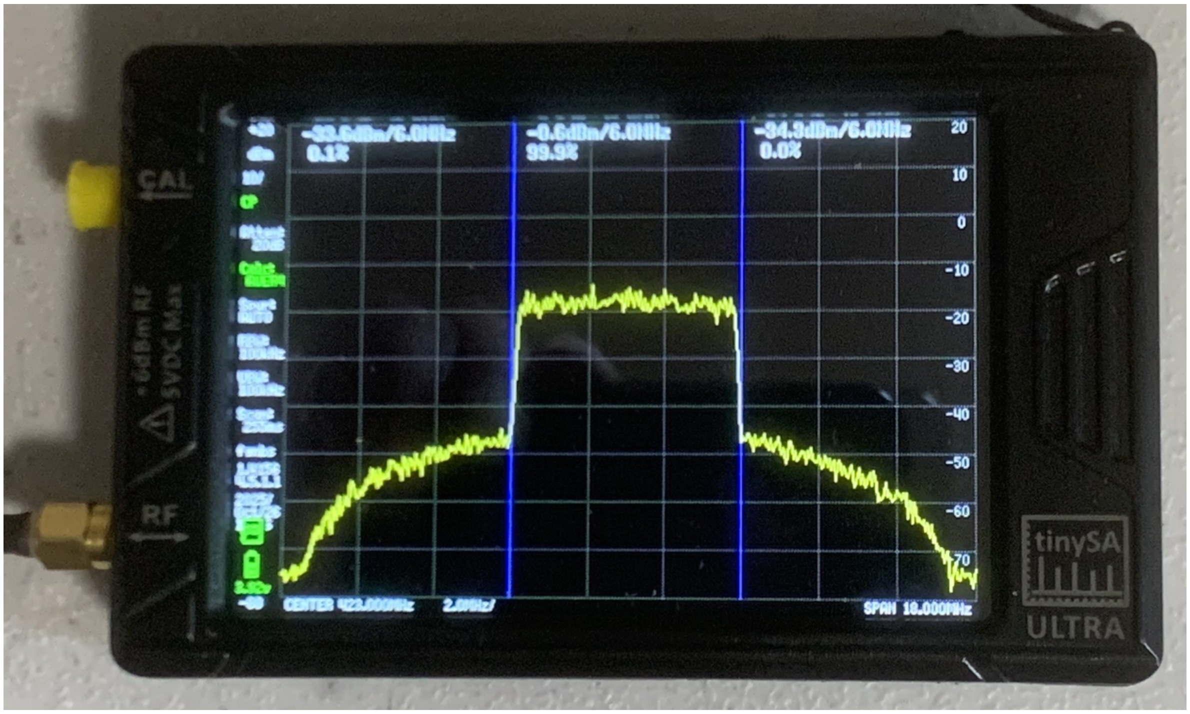

Fig. 3 TinySA Spectrum Analyzer, Channel Power measurement. Test transmitter was HV-320 modulator and KH6HTV model 70-9B amplifier. 423MHz center frequency, 18MHz span (3 TV channels), 10dB/div & 2MHz/div.

Step 2 - Transmitter Tests: The next step is to characterize the transmitter's out of channel spectrum skirts. Perhaps the most convenient, and least expensive, test instrument for this purpose is a TinySA, spectrum analyzer. One of it's several measurement modes is "Channel Power". It is ideal for characterizing broad-band signals, such as a DTV signal. In the Ch Pwr mode you specify the TV channel's center frequency and band-width. The TinySA then sets the span to three TV channels. It then integrates the total power in each channel and displays on screen the results. See Fig. 3. This shows the average RF power in both the upper sideband and lower sideband, immediately adjacent TV channels is only about -35dB down from the power in the desired TV channel. The results for the 70-9B amplifier are:

Ch 57 = +40dBm Ch 58 = +8dBm Ch 59 = -21dBm Ch 60 = -29dBm

Note 1: For DATV use, we normally bring up the rf drive level to our rf power amplifiers, until the spectrum shoulder break-point is -30dB below the in channel spectrum. It is measured at ± 3.2 MHz from the center frequency.

Caution: the max. input power allowed for the TinySA is +6dBm. Always use sufficient external attenuators to avoid overdriving and damaging the TinySA. For the test shown in Fig. 3, the 10 Watt (40dBm) output from the 70-9 amplifier was attenuated by 40dB using a 50 Watt, 30dB attenuator and a 2 Watt, 10dB attenuator.

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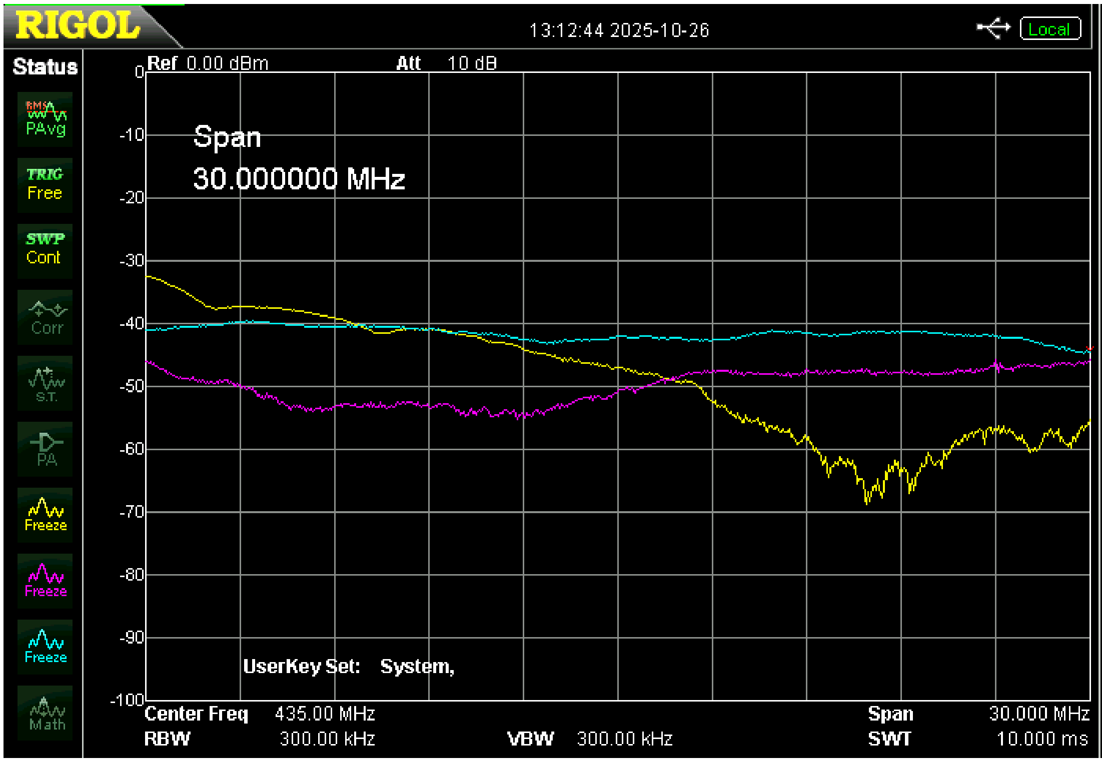

Fig. 4 Example of Antenna Isolation measurement. 70 cm band sweep from 420 to 450MHz, 10dB/div & 3MHz/div

Step 3 - Antenna Isolation: If one already has the necessary antennas installed, then it is a simple test to use CW signals to measure the isolation between the receive and the transmit antenna. Fig. 4 above shows a swept frequency measurement using a spectrum analyzer and tracking generator. The antennas tested were KH6HTV's home installation using three 70 cm antennas. They were an old KLM, 6 element yagi. A Diamond NR-2000 2m/70cm/23cm mobile mounted on the top of the mast holding the yagi. The third was a Diamond X-50 2m/70cm base station. It was mounted on a separate mast located 10 ft. from the other antennas. The yagi and NR-2000 were separated vertically by about 3 ft. The X-50 was located on the back side of the yagi. All antennas were vertically polarized. In Fig. 4 the yellow trace is the isolation between the yagi and the NR-2000. The magenta trace is the yagi and the X-50. The cyan trace is the NR-2000 and the X-50.

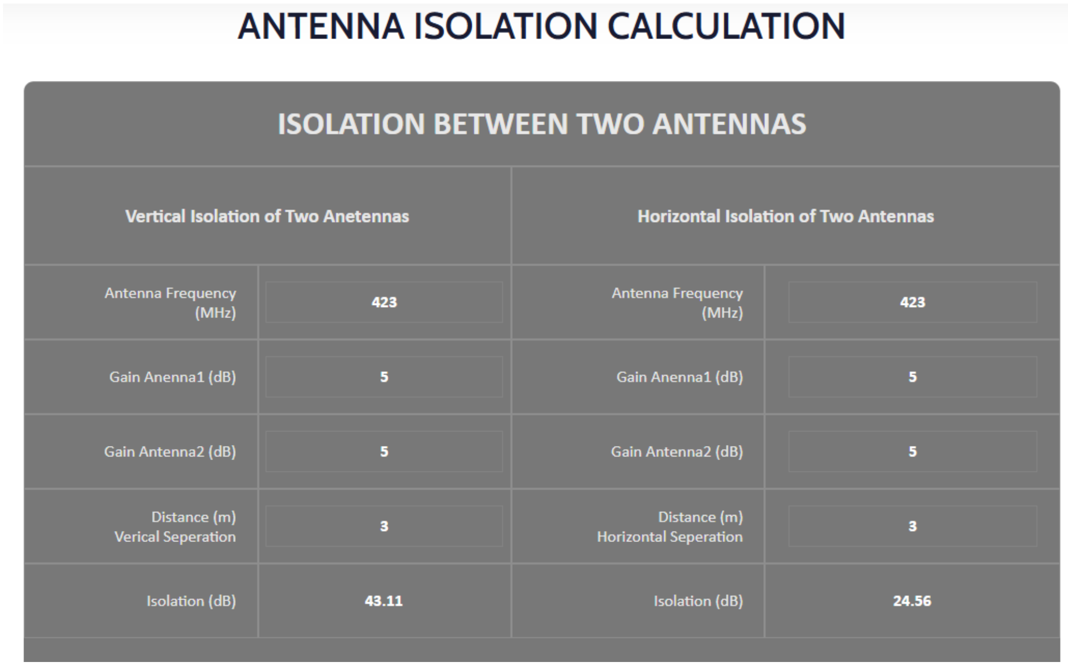

Fig. 5 Example of an on-line, antenna isolation calculator. www.assendive.com

If you do not have an existing antenna situation and are still in the design phase, then an on-line Antenna Isolation calculator is a handy tool. Reference [11] gives several found on-line. Fig. 5 shows an example using two X-50 antennas with 7dBi (5dBd) gain when mounted with either 3 meter vertical or horizontal separation. The respective isolations are then predicted to be either 43dB or 25dB.

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Step 4 - Compute Required Filter Skirts: For this example, we will assume using a 10 Watt (+40dBm) transmitter on 423MHz. 441 MHz receiver with -100dBm sensitivity. Two identical antennas with -40dB isolation.

Transmitter BPF: The Ch 60 receiver can not tolerate any more than -100dBm of broadband RFI noise on it's input channel (438-444MHz). Thus the broadband, out of channel spectrum shoulders from the Ch 57 transmitter must be severely attenuated. The isolation required is: -100dBm - (-29dBm) (Ch 60 noise from Ch 57 transmitter) = -71dB. If our antenna isolation is -40dB, then the transmitter BPF must supply at least **-31dB** more attenuation at the Ch 60 band edge of 438 MHz.

Receiver BPF: The Ch 60 receiver BPF needs to block the main Ch 57 signal from the transmitter. Thus Isolation required is +40dBm (Ch 57 transmitter) - (-36dBm) = -76dB. If our antenna isolation is -40dB, then the receive BPF must supply at least **-36dB** more attenuation at the Ch 57 band edge of 426 MHz.

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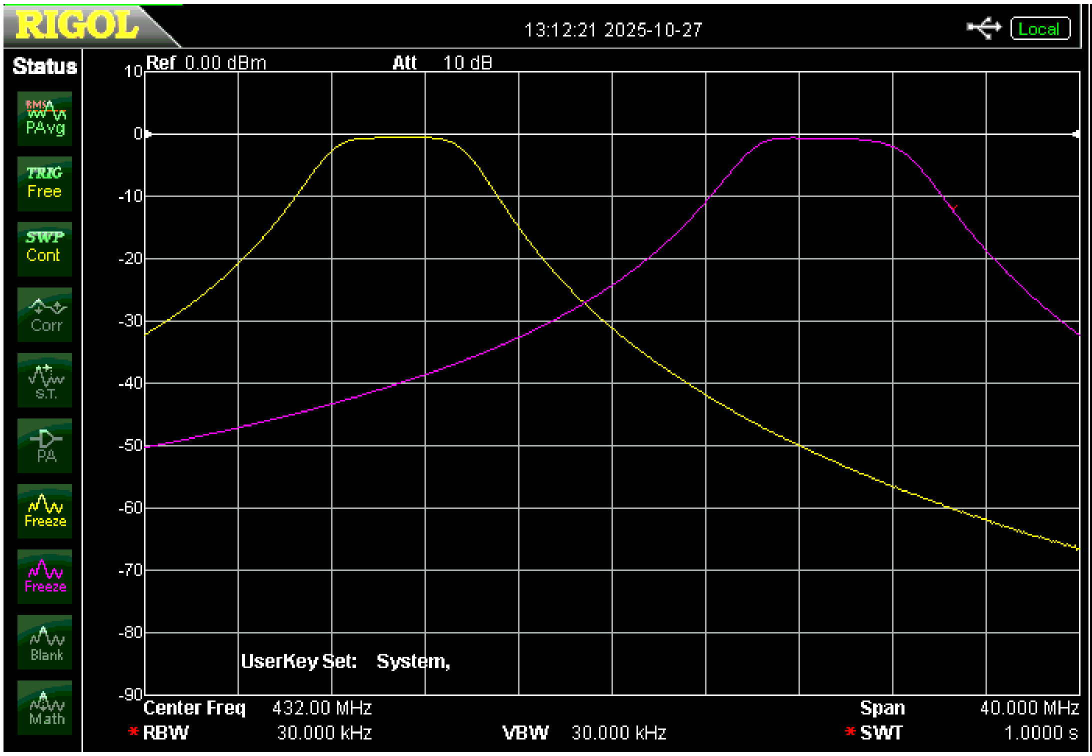

Fig. 6 S21 swept frequency response of 3 pole, UHF-TV BPFs tuned to Ch 57 (yellow) and Ch 60 (magenta). 432MHz center frequency 40MHz span 10dB/div & 4MHz/div

Step 5 -- Test Real BPFs: The next step is to evaluate possible candidate BPFs for the proposed DATV repeater. Fig. 6 shows the stop-band frequency responses of a pair of commercial broadcast, 3 pole, TV channel filters. (see the right photo in Fig. 1).

The Ch 57 filter (yellow trace) would be used on the transmitter. At 438 MHz, it's insertion loss is -46dB, while we require it to be at least -31dB.

The Ch 60 filter (magenta trace) would be used on the receiver. At 426 MHz, it's insertion loss is -36dB, which is the absolute minimum our calculations show to be required.

If a user's particular situation required even steeper stop-band skirts, then a cascaded pair of the 3 pole filters could be used. Fig. 7 shows the result.

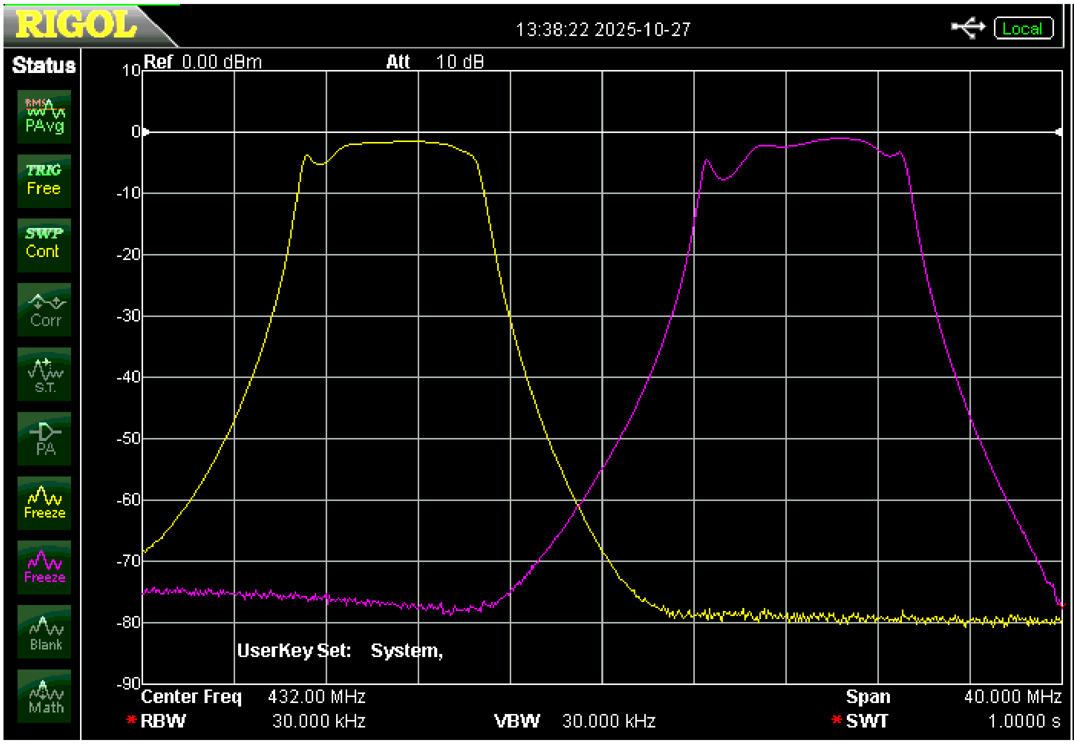

Fig. 6 S21 swept frequency response of 6 pole, UHF-TV BPFs tuned to Ch 57 (yellow) and Ch 60 (magenta). 432MHz center frequency 40MHz span 10dB/div & 4MHz/div

Step 6 -- Assemble a Real, Basic DATV Repeater

The final step is to assemble on the test bench a lash-up of a real, basic DATV repeater following the block diagram shown in Fig. 2.

Fig. 7 Bench Test of DATV repeater

To test the resultant repeater's sensitivity, a 30dB directional coupler was connected directly to the receiver's input band-pass filter. A known level DVB-T test signal on Ch 60 was injected via the directional coupler. A step attenuator (1dB & 10dB steps) was used to adjust the test signal level.

The bench test confirmed that only one, 3 pole, UHF-TV channel filter was required for the Ch 57, 10 Watt transmitter. Fig. 8 shows the improvement in the transmitter's out of channel spectrum shoulders. However, as suspected, the test showed that a single 3 pole filter was not sufficient for the receiver. So, two 3 pole filters in cascade were used for the receiver. They are seen in the foreground of the photo, Fig. 7.

For the actual operational testing, all three of KH6HTV's 70 cm antennas were used. See the previous Step 3 and Fig. 4 for a discussion of these antennas.

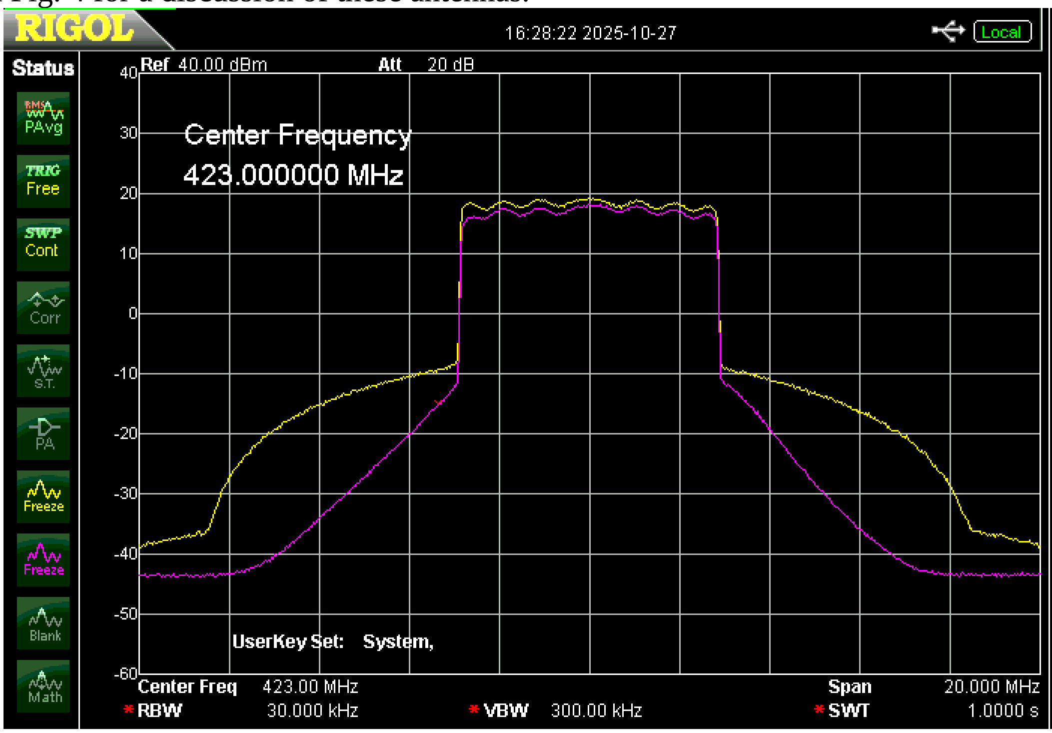

Fig. 8 Ch 57 DVB-T Transmitter's Spectrum. Yellow trace is without BPF. Magenta trace is with 3 pole, UHF-TV BPF. center freq. = 423MHz, 20MHz span, 10dB/div & 2 MHz/div.

The final test results of the basic repeater were:

(1) The receiver's digital threshold sensitivity using two cascaded BPFs was **-98dBm**. -2dB was lost in the insertion loss of the cascaded 3 pole BPFs. This was tested with a dummy load for the receive antenna. The ultimate "aggressive" digital parameters were used of 720P, H.264, 3.5Mbps -- QPSK, 1/2 Code (FEC) and 1/16 Guard (sync).

(2) Removing the dummy load and using the outside Diamond X-50 antenna, the sensitivity was degraded -2dB by external noise to -96dBm. Transmitter was turned off.

(3) Using either the Diamond NR-2000 or the KLM Yagi antenna for the transmitter, and turning on the 10 Watt transmitter on Ch 57 --- no desense was noted. The receiver sensitivity remained at **-96dBm**.

References:

1. "DVB-T Television Repeaters", Jim Andrews, KH6HTV Video application note, AN-23h, (original June, 2015), updated March, 2025, 12 pages

2. "Building a Basic, 70cm, DVB-T, Television Repeater", Jim Andrews, KH6HTV Video application note, AN-48, July 2019, 7 pages

3. "70cm, DVB-T, Television Repeater with a Duplexer", Jim Andrews, KH6HTV Video application note, AN-49a, Oct. 2021, 7 pages

4. "70cm to 23cm Cross-Band DVB-T Repeater", Jim Andrews, KH6HTV Video application note, AN-69a, June 2025, 8 pages

5. "23cm to 70cm Cross-Band DVB-T Repeater", Jim Andrews, KH6HTV Video application note, AN-70, June 2025, 8 pages

6. "70cm In-Band DVB-T Repeater", Jim Andrews, KH6HTV Video application note AN-71, June 2025, 8 pages

7. "W0BTV, Boulder, Colorado - Digital Amateur Television Repeater", Jim Andrews, KH6HTV Video application note AN-51e, original Feb. 2020, revised Dec. 2024, 19 pages - gives operational details of repeater

8. "W0BTV, Boulder, Colorado Digital ATV Repeater Current Technical Details and Tech History", Jim Andrews, KH6HTV Video application note AN-53, original Oct. 2019, revised Dec. 2024, 30 pages

9. "Inter-Digital Band-Pass Filters", Jim Andrews, KH6HTV Video application note AN-22b, July 2015, 8 pages

10. "ARRL Band Plans", available on the web at: http://www.arrl.org/band-plan

11. Antenna Isolation Calculators available on-line
Andrew -- https://www.andrew.com/resources/calculators/
Assendive --- https://www.assendive.com/antenna-isolation-calculation/
WA6ILQ --- https://www.repeater-builder.com/antenna/separation.html

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.
23 cm = 1243 MHz (primary), 70 cm = 441 MHz & 3 cm = 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. 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/

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