Boulder Amateur Television Club
TV Repeater's REPEATER

July, 2022
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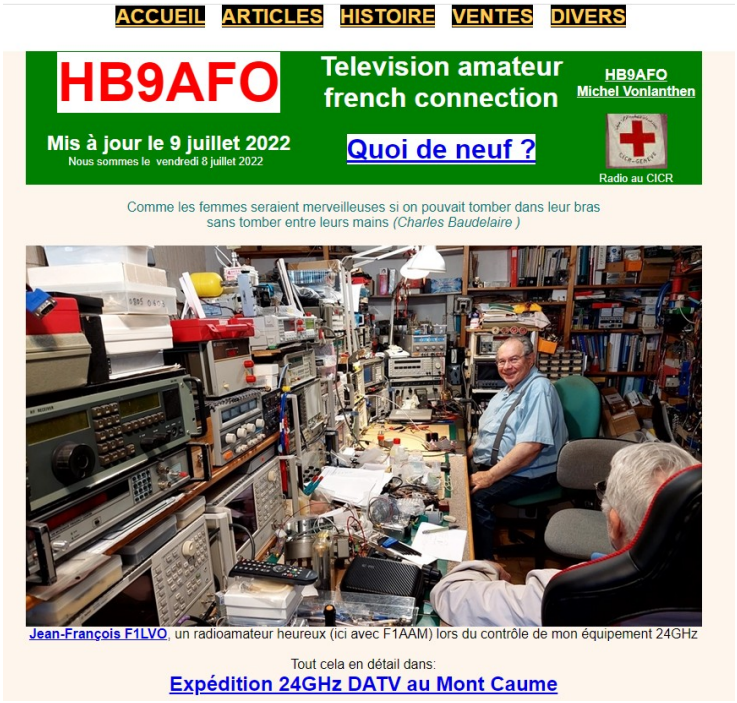
BATVC web site: www.kh6htv.com

ATN web site: www.atn-tv.com

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



Check out www.hb9afo.ch
for more ATV news from Europe

Thanks Jim --- I think European OMs will appreciate your magazine. I will write on the French lists each time you send me your magazine. You will see it here: www.hb9afo.ch

73 Michel, HB9AFO, Bussigny, Switzerland

Great Noise Figure, but still can't hear?

Paul Wade W1GHZ ©2022
w1ghz@arrl.net

Most of us have taken preamps to a conference to measure noise figure. Sometimes we are disappointed, but most recent devices provide very good measured noise figures. Then when we get home, they don't improve things as much as we had hoped.

Early GaAsFET preamps provided good noise figure with a terrible input match, very critical tuning, and sometimes marginal stability. Connecting a real antenna could produce different results and even oscillations. Modern designs tend toward unconditional stability and better matching, so that real world performance is good.

At VHF and UHF frequencies, MMICs are available with excellent noise figure with no tuning, making broadband preamps possible with minimal effort. Except for EME, there seems to be little need for anything fancier.

What's the problem?

I designed a new 432 MHz transverter in 2018, and was pleased with the performance. The front end was an untuned MMIC, followed by two printed combline filters separated by a second-stage amplifier to provide good band-pass characteristics. It worked very well for a couple of years.

Activity in this area is sporadic, so I leave the rigs monitoring beacons – for 222 and 432 MHz, VE2FUT/b at 195km distant is weak but solid, a good performance monitor. Sometime last year, the 432 beacon became hard to find; perhaps I should have been concerned. Then in the 2022 January VHF contest, I found that the background noise was very high to the east, so that I was unable to make any contacts in that direction. I suspected that a neighbor had gotten a new gadget and I would have to chase it down when the weather got warmer.

During the 2022 Spring Sprints, N1JEZ complained of overload from me on 222 MHz. Afterward, we ran some tests; his mast-mounted preamp plus new transverter had too much gain – easily fixed. Then we ran a quick test on 432, and I couldn't hear him. Something was seriously wrong.

After tests confirmed that the problem was the transverter, I opened it up and started tracing signals using a TinySA [2] spectrum analyzer, probing with a 470 ohm resistor with short leads on an SMA connector, in Figure 1. The resistor minimizes loading on the circuit and only reduces signal level by perhaps 10 dB – not a problem for a sensitive spectrum analyzer. I quickly found that the front-end MMIC was not amplifying. I also

noticed the fairly strong digital TV signals in Figure 1 being picked up by the short probe, roughly -80 dBm around 470 and 509 MHz.

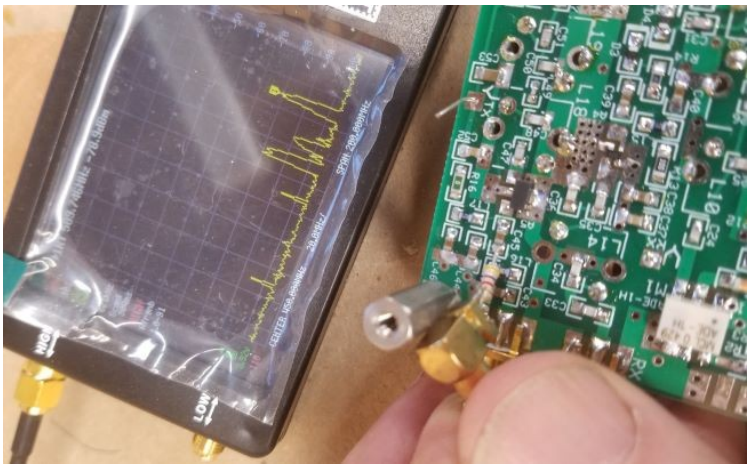


Fig. 1 Probing RF circuit with Spectrum Analyzer thru isolating resistor probe.

The failed front-end MMIC was a Minicircuits PSA4-5043. I replaced it with a PGA-103, which is slightly larger and draws more current, but still has a low noise figure; I thought it might be more robust than the one that failed.

After things were back together, I connected the antenna and still couldn't hear the beacon. The noise floor seemed high and rose much higher with the antenna to the east. Maybe that TV signal was adding noise.

I dug out a combline filter [3] that I built several years ago to see if it would help. It has about 2 dB loss, but 470 MHz is 52 dB down. Putting it in front of the transverter reduced the noise floor by 20 dB and eliminated the additional noise to the east. And the beacon popped right up in the panadapter.

What is going on?

Obviously, the problem is caused by out-of-band signals that the filter attenuates enough. My QTH is line-of-sight to all the TV broadcast transmitters – I can see the towers, 42km away, out the shack window. I connected the TinySA spectrum analyzer to a WA5VJB[4] log-periodic antenna for 400 to 1000 MHz, took it outside, and pointed it at the towers (283 degrees). The 470-476 MHz TV channel peaked at -32 dBm, with additional channels at 482-488 MHz and 506-512 MHz nearly as strong. The TinySA display in Figure 2 shows the DTV signals filling the 6 MHz channels.

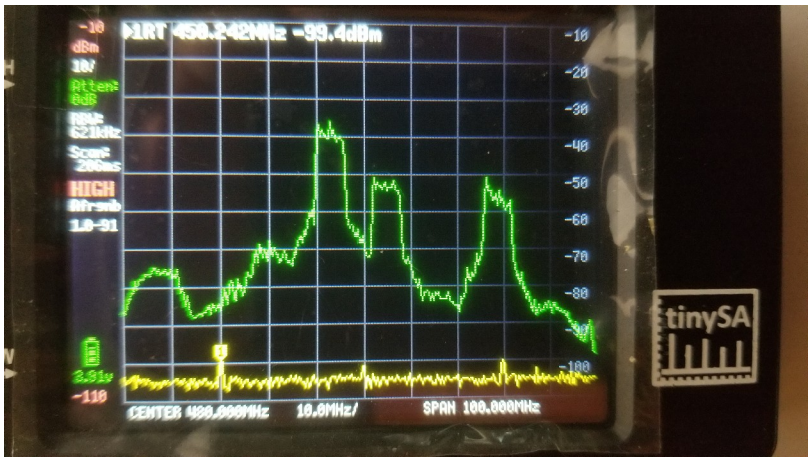


Fig. 2 DTV signals received on log-periodic antenna

How much of this power gets into the 432 MHz yagi?

HEADING	308°	270°	90°	103°(back of Yagi)	
470-476	-52	-54	-48	-44 dBm	WCAX ch3
482-488	-64	-62	-52	-51	WFFF ch44
506-512	-50	-53	-42	-40	WPTZ ch5
578-584	-64				WETK ch33
174-180	-66	-72			WVNY

The highest power into the Yagi is off the back. This is not surprising – at frequencies above the operating frequency, the directors on the Yagi act as multiple reflectors, while to the rear there is only one reflector.

A year or so ago, the FCC reshuffled the DTV channels, moving several of them closer to 432 MHz. I had to rescan the TV set, but hadn't noticed any immediate effect on 432 – I wasn't paying close enough attention.

Intermod

A DTV signal is spread out over the entire 6 MHz channel, as seen in Figure 2. To a narrow band receiver, it is 6 MHz noise source. If we just consider the fundamental signals, the sum and difference frequencies cover the range of 6 to 42 MHz; if the DTV signals get into the mixer, any common IF frequency would suffer.

If the third-order inter-modulation products[4], 2F1 – F2 and 2F2 – F1, are considered, the result is even worse. The combination of the strongest channel 506-512 MHz with either 470-476 MHz or 578-584 MHz results in IM products from 428 to 446 MHz, effectively wiping out the entire 70cm band. The untuned front end of my transverter adds another 20 dB or so to the signal levels in the table above, enough to cause intermod in almost

any semiconductor device. For a device with a high IP3 (third order intercept point), the calculated intermod level might be 100dB down, but that is still above the noise floor.

Solution

Clearly, the solution is to keep the DTV signals out of the front end. The comb-line filter [2] has about 2 dB loss, increasing system noise figure by 2 dB, but it is 52 dB down at 470 MHz, with rejection increasing at higher frequencies. With the filter, the noise floor dropped by roughly 20dB, and is low in all directions. The beacon popped right up at the expected level, so the filter has cured the problem without significantly affecting sensitivity. Better to lose a small amount than not to hear anything.

I had previously noticed the need for a filter on 222 MHz, after a DTV station was moved to Channel 13 (210-216 MHz). The filter here reduced the noise floor by at least 6 dB. I haven't checked recently, but the table above shows nothing on Channel 13. The station that had been there is now on 482-488 MHz. The new station on 174-180 MHz has a signal level of -51 dBm on the 222 MHz antenna.

Having a filter before the front end should be adequate for anything but EME. Some EME stations use cavity preamps – a good one should keep the DTV noise down and have excellent noise figure.

Summary

All sorts of new electronics devices are generating increased RF noise. Broadcast signals were pretty stable for 50+ years, so they could be dealt with once, but today things are shifting around. Whatever the source, it pays to keep track of your noise floor. Monitoring the noise floor and the signal level of beacons on a panadapter makes accurate comparisons possible. Don't trust your ears – noise increases are often small and insidious.

The morning after I finished the first draft of this paper, I noticed that the noise floor on 222 MHz had increased by 5 or 6 dB, not noticeable by ear. Since the beacon level can vary by 30dB from day to day, that is a poor indicator. Swinging the antenna around found that the increase was mainly in the direction of the TV towers; something had changed. It appears to have gone back down after a day or two.

But that evening, the noise floor on 432 jumped about 15 dB, with dirty signals wandering through the passband. Rotating the antenna made no difference, so I suspect it is some new gadget in the house. This one went away after a bit, so I'll have to chase it down.

So keep an eye on your noise floor. If you wait for a contest or opening, like I did, you might get an unpleasant surprise and miss some QSOs.

Notes

1. Paul Wade, W1GHZ, "432 MHz Transverter for an SDR."
   http://www.w1ghz.org/xvtr/432MHz_Transverter_for_an_SDR.pdf
2. www.tinysa.org
3. Paul Wade, W1GHZ, "Combline Filters for VHF and UHF."
   http://www.w1ghz.org/filter/Combline_Filters_for_VHF_and_UHF.pdf
4. www.wa5vjb.com
5. https://www.everythingrf.com/community/what-is-intermodulation-distortion

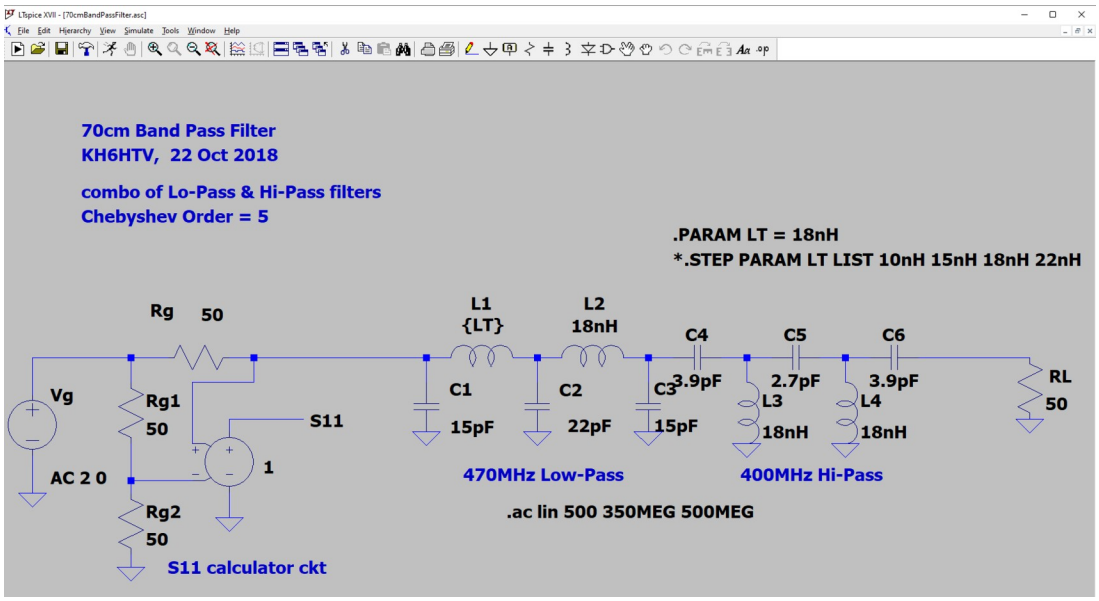
73 de Paul, W1GHZ, Cabot, Vermont

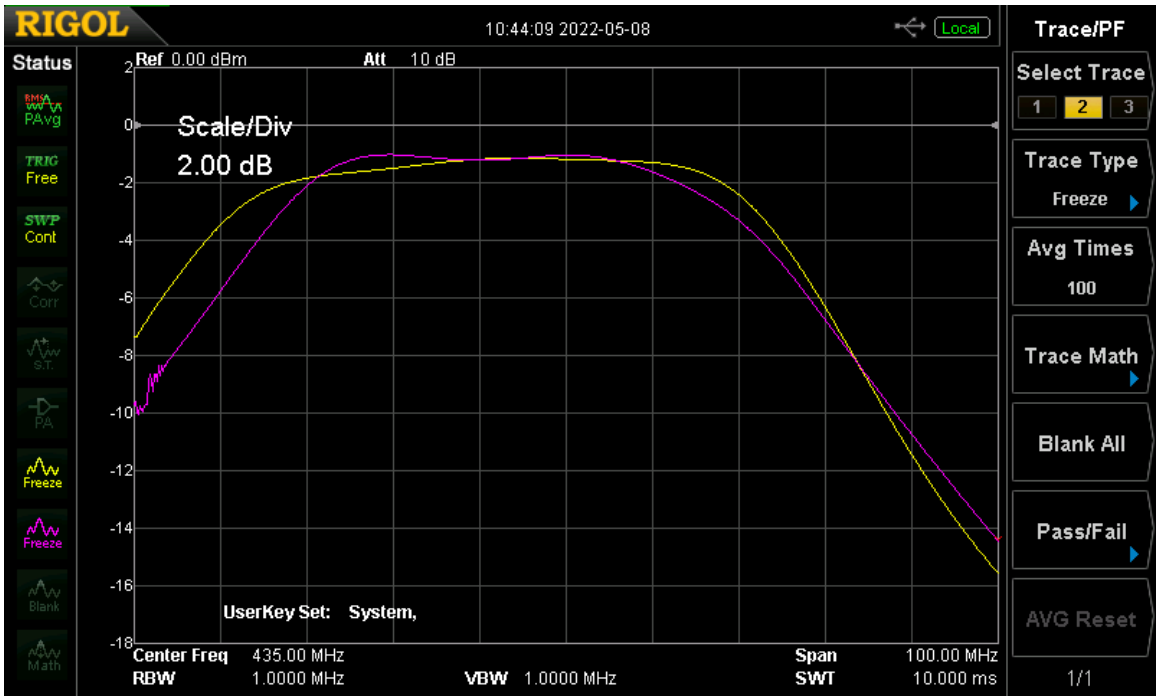
Editor's Note: *Thanks to Paul for this en-lightening article. Reprinted with permission. If a microwave Big Gun like Paul has these issues and recognizes them, we should all take heart when we find ourselves in similar predicaments. Paul has a wealth of microwave related material on his web site at: www.w1ghz.org Paul is also the editor of the "Microwavelengths" column in ARRL's QST magazine.*

70cm Band-Pass Filter

This issue of our newsletter is devoted to solving the problem of receiver front-end overload. Extremely severe cases of RFI might require the use of narrow-band (6 MHz or less) band-pass filters with extremely steep skirts. Such as the comb-line filter used by Paul, W1GHZ. Or inter-digital filters such as used to be sold by Spectrum International, etc. Also see KH6HTV Video application note, AN-22b, "Inter-Digital Band-Pass Filters" If you have access to some good machine shop tools, you can roll your own.

To address this specific problem, back in 2018, I designed a low cost 70cm BPF for receiver protection. I started out using LTspice as my design tool. I wanted a BPF with a flat response across the entire 70cm band (420-450MHz), low insertion loss, and then as steep cut-off skirts as possible. Using conventional filter design tables for BPFs, I was unable to come up with any workable design which didn't require totally unreasonable values. Extremely tiny << pF caps or << nH inductors. So I hit upon the idea of instead using a cascade of a low pass filter (LPF) and a high-pass filter (HPF). That worked. I am sharing with our readers my design. Each filter was a Chebyshev of order 5. The LPF was designed with a cut-off of 470MHz. The HPF was designed with a cut-off of 400MHz. All of the capacitor and inductor values were reasonable values.





Measured insertion loss performance of an actual 70-BPF. S21 (yellow) & S12 (magenta) center freq = 435MHz, 100MHz span, 2dB/div & 10MHz/div.

Readers can build your own 70cm BPF from the above design. Or if you want to "buy off the shelf", I offer them for sale as my model 70-BPF for $60 each, tuned up, and supplied with a test report. I build them on a pc board with surface mount components

and SMA connectors. The inductors are hand-wound, air-core. The 18 nH inductors are used as the tuning elements. All is mounted in a die-cast metal box.

It should be noted that because this is a non-symmetrical filter design, slightly different responses are obtained depending upon which port is used as the input. i.e. S21 and S12 are quite similar, but not identical. Likewise S11 and S22 are slightly different.

73 de Jim, KH6HTV, Boulder, Colorado

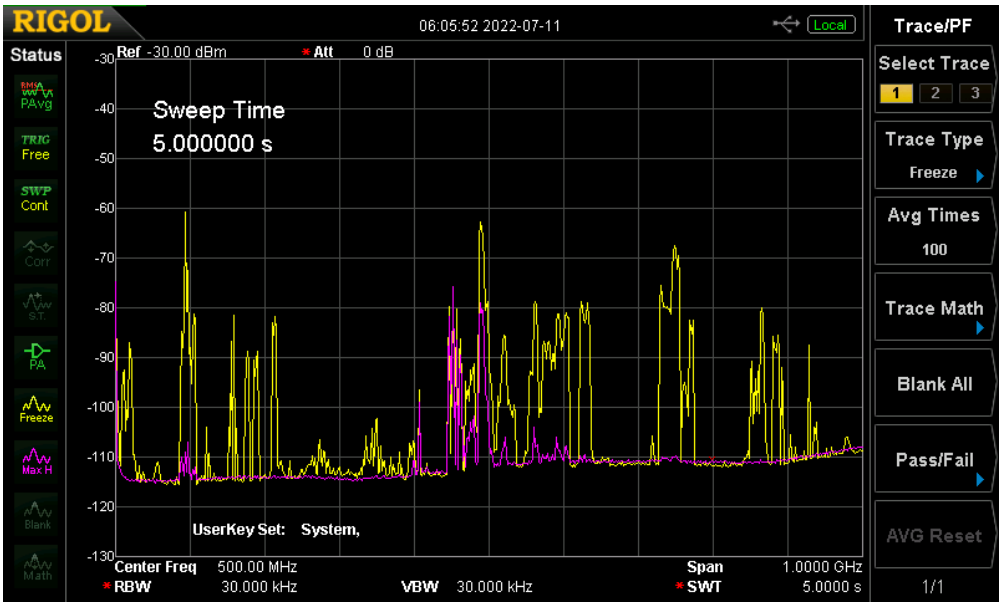
My Own Testimonial on using a BPF to solve RFI Receive Issues

Like Paul, I too was suddenly whacked with some new source of RFI on the 70cm band. After the fire, I relocated to a new QTH east of Lafayette. I am about 12 miles now from our Boulder ATV repeater, W0BTV. But I truly lucked out and have a true line of sight rf path from my back deck to the repeater. So I set up my 23cm uplink and 70cm downlink yagi antennas on a tripod mast on the back deck. Got a nice strong signal both into and out of the ATV repeater. That is until a couple of weeks ago. I started having major issues receiving the repeater. Lots of freeze frames. Plus some RFI hits even disabled the HDMI output ! My video monitor would occasionally tell me "lost HDMI input". Being on a high spot out on the eastern prairie of Colorado, I also have a line of sight path to Lookout Mountain in Golden where most of the Denver high power TV transmitters are located, plus cell towers, etc.

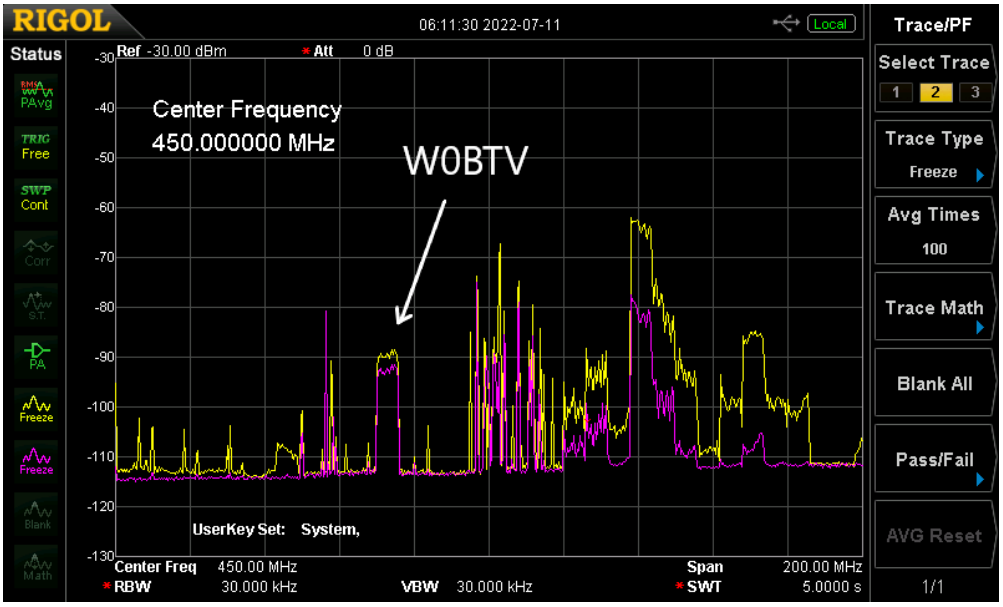
I was receiving a quite strong rf signal from the W0BTV repeater at about -65dBm, so I didn't need any more gain from a pre-amp. But it sure seemed like the situation called for a 70cm band-pass filter. So I installed one of my model 70-BPFs ahead of the DVB-T receiver (see above article describing this filter). Bingo ! --- the RFI problem went away.

Here are a couple of spectrum plots taken from my Rigol spectrum analyzer. They show what my 70cm yagi is picking up. It is an M-Squared, model 440-6SS, six element Yagi with 11dBi gain. I use 50 ft. of LMR-400 coaxial cable for the run from the back deck into the ham shack.

73 de Jim, KH6HTV, Boulder, Colorado



Broad-band signals picked up on KH6HTV's, 70cm yagi antenna. Sweep from 0 to 1GHz. 10dB/div & 100 MHz/div. BW set to 30kHz. Yellow trace is the rf signals picked by the antenna. Magenta trace is after inserting 70-BPF, 70cm band-pass filter.



70 cm signals picked up on KH6HTV's, 70cm yagi antenna. Center Frequency = 450 MHz, 10dB/div & 200 MHz/div. BW set to 30kHz. Yellow trace is the rf signals picked by the antenna. Magenta trace is after inserting 70-BPF, 70cm band-pass filter.

5.8 GHz BBQ Grill Antenna

For several years now, the 5.8 GHz antenna of choice among Boulder ATV hams has been the L-Com model HG-5822EG. L-Com has now discontinued this model. Fortunately, they have replaced it with their model HG-4958-22EG.

The new model # seems to be identical to the old one, with the sole exception of the gain spec. It is now +22dBi vs. +23dBi.

It now is selling for $94 + shipping & tax for a total of $107. It can be ordered on-line directly from L-Com at: www.l-com.com

ANALOG TV is Still Alive !

While recent issues of this newsletter have moaned about the demise of analog ATV gear, all is not lost yet.

We have written previously about the availability of really great FM-TV gear for the amateur 5.8 GHz band. It is still available, and dirt cheap !

Go to Amazon.com and search for "RC832 & TS832" This is a matched set of a 600 mW transmitter and receiver. The amazing low price is only $30 and Prime shipping has it on your door-step the next day. Both units feature built-in frequency synthesizers for 40 channels. Many of which fall into our 5.8 GHz band.

The TS832 transmitter comes with a built-in tiny microphone mounted on the pc board. Bill, AB0MY, has discovered how to disable it, and instead insert line level audio from your camcorder, DVD player, etc. For details, see our previous ATV newsletters, issues #27 & 29.

The Boulder, Colorado, ATV repeater, W0BTV, includes an FM-TV transmitter on 5.905 GHz. It is using the TS832 transmitter, plus a 2 watt power amplifier driving a 10dBi, omni-directional, horizontally polarized antenna. For details, see past issue #58 of this

newsletter. In field tests, we have confirmed reception of this FM-TV beacon signal out to at least 70 miles.

In other field tests using the TS830 & RS830 combo along with the L-Com BBQ grill antenna, Bill, AB0MY, and Gary, WB5PJB, exchanged live P3 color pictures with audio over a 53 mile path.

So, analog TV is not dead yet -- plus you can do it quite inexpensively. Give it a try !

70cm AM-TV Exciter & Demodulator

As long as we are on the subject of the issue of analog TV and the difficulty in obtaining gear these days, let's not forgot some items from China which ATV hams have discovered.

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Back in 2020, Burt, N7CS, discovered the HLLY brand, model TVX-50, NTSC TV transmitter. We reviewed it in our ATV newsletter issue #45. It was useable on the ham 70cm band, producing AM-TV, not VUSB-TV. The only issue we found with it at the time was deceptive advertising. It was advertised to be a 0.5 Watt transmitter and we found that it was really a 30 mW transmitter. But it certainly could be used as an exciter driving a higher power, linear amplifier.

We have just googled it and find that it is still being advertised for sale on E-Bay from China for about $110. The only difference now being the model number is changed slightly to TVX-50M and they advertised the output power to be 50 mW.

Also a quick Amazon search for "NTSC Demodulators" came up with this one. It tunes CATV channels 2 thru 139, thus including channels 57-61 in the ham 70cm band. Amazon prime price is $85. We have not personally tested this item, so can not vouch for it. But looks promising.

So, you die-hard, NTSC, analog ATVers out there, get out and buy some of this stuff coming from China. Check it out. Then write up reviews of what you find, and we will publish them for the benefit of our readers.

73 de Jim, KH6HTV, editor

World-Wide ATV-DX Records

Compiled by Michel, HB9AFO, available on his web site at:
https://www.hb9afo.ch/records/default.htm

This is a brief summary. 50MHz - 60km 144MHz - 407km 430MHz - 902km (also 4041km, analog in 1994, Hawaii to California) 1200MHz -- 440km (650km, analog) 2.3GHz - 902km (720km analog) 5.7GHz -- 464km (710km analog) 10GHz -- 902km (1564km analog) plus even higher bands up to visible laser light at 118km

Correction: In the last issue, my typo listed Dave's call sign as AH8AR. It should read AH2AR.

W0BTV Details:

Inputs: 439.25 MHz, analog NTSC, VUSB-TV; 441MHz/6MHz BW, DVB-T & 1243 MHz/6MHz BW, DVB-T
Outputs: Channel 57 --- 423 MHz/6MHz BW, DVB-T, or optional 421.25 MHz, analog VUSB-TV. Also, secondary transmitter, FM-TV output on 5.905 GHz (24/7).
Operational details in AN-51a Technical details in AN-53a. 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/kh6htvtvr* or *n0ye or ab0my*. We use the Boulder ARES (BCARES) 2 meter FM voice repeater for intercom. 146.760 MHz (-600 kHz, 100 Hz PL tone required to access).

Newsletter Details:

This is a free newsletter distributed electronically via e-mail to ATV hams. The distribution list has now grown to about 500. News and articles from other ATV groups are welcomed. Permission is granted to re-distribute it and also to re-print articles, as long as you acknowledge the source. All past issues are archived at: https://kh6htv.com/newsletter/

ATV HAM ADS

Free advertising space is offered here to ATV hams, ham clubs or ARES groups. List here amateur radio & TV gear For Sale - or - Want to Buy.

Pre-Amps with Front-End Filtering

The KH6HTV Video model 70-LNA, pre-amp is offered in two versions. The most popular version is the lowest noise at 0.7dB with the 70cm band-pass filter on the output of the active device. Ordering it as - option 2, the band-pass filter is on the input circuit for use in more severe RFI environments, like encountered by Paul, W1GHZ. The insertion loss of the BPF adds 1dB to the noise figure. Both versions sell for $90 each. A test report including noise figure measurement is included. ----- Jim, KH6HTV, www.kh6htv.com

Sunday August 28, 2022- Adams County Fairgrounds

DENVER RADIO CLUB HAMFEST

NOTE: NEW PLACE AND DATE!!!

Adams County Fairgrounds

9755 Henderson Road in Brighton

Sunday August 28, 2022

9:00 am – 1:00 pm