Boulder Amateur Television Club
TV Repeater's REPEATER

February, 2024
issue #154

BATVC web site: www.kh6htv.com

ATN web site: www.atn-tv.com

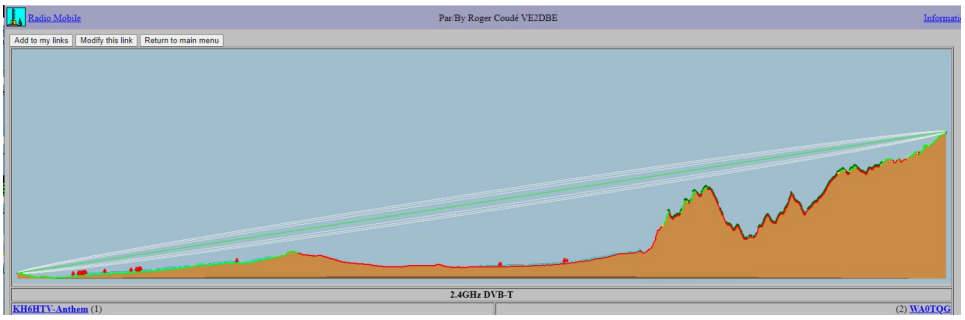
Jim Andrews, KH6HTV, editor - kh6htv@arrl.net www.kh6htv.com

2.4GHz, WA0TQG as received by KH6HTV

2.4GHz, KH6HTV as received by WA0TQG

Boulder ATV Hams Back on Microwave Bands

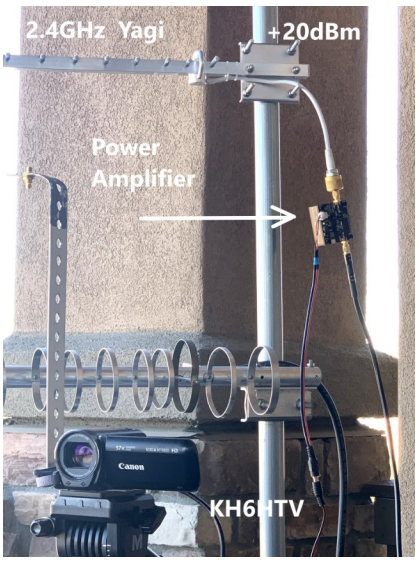
After a long absence the Boulder, Colorado ATV hams are once again getting back on the microwave bands with DVB-T, ATV video. Steve, WA0TQG, was the "spark-plug" driving it this time. Last fall, he announced on the weekly ATV net that he was going to design a new all-mode Transverter for the 2.4 GHz band to complement what he had already designed and was using for the lower bands. His objective was to be able to put out a 5 Watt, DTV signal on the 13 cm band. Most recently, he announced that he had finished building his new transverter and was ready to test it out live on the air. This motivated Don, N0YE, and Jim, KH6HTV, to dig into their closets and dust off their old gear for 13 cms.



RF path between KH6HTV and WA0TQG

View looking east from WA0TQG's tower mounted camera

On January 23ed, Steve and Jim made their first 2.4 GHz, DVB-T contacts between their home QTHs. Steve lives up on Sugar Loaf mountain in the western part of Boulder County. Jim presently is living out east on the prairie, just across the county line, east of Lafayette. The distance between the two is 30 km (18.6 miles). The above photo shows Steve's view to the east on the day of the test. Both were using 17dBi yagi antennas, horizontally polarized. The 2.4 GHz yagi is the one seen in the lower right corner of the above photo. Steve's transmitter was putting out 5 Watts (+37dBm). Jim was running QRP with only 100mW (+20dBm) (DVB-T average power). They had a successful, two way contact. Jim reported receiving a -90dBm signal with 8 dB s/n. After correcting for the 50 ft. of LMR-400 coax, it was more of the order of -86dBm. Steve did not have any means of measuring the received power, nor s/n.



KH6HTV transmitter & Yagi

The contacts were made on 2.393 GHz. Hams have an exclusive 10 MHz of 2.39-2.4GHz just below the Wi-Fi band. Spectrum monitoring prior to the contact showed this part of the spectrum to be

quiet, while just above 2.4 GHz, it was full of Wi-Fi RFI signals. They used the standard 6 MHz wide ATV channel. To maximize their chances of success, they also used the most aggressive digital parameters of: QPSK and 1/2 Forward Error Correction (FEC), i.e. 1/2 Code Rate, plus 8K FFT, 1/16 Guard, H.264 encoding, 720P and 3.2 Mbps. Audio was MPEG2 at 96kbps.

We hope to have many more details in the future to share with our readers from Steve telling us about his new 2.4 GHz Transverter design. Plus details from Don about his home-brew rig.

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70 cm & 23 cm Mobile Antenna Gain Results

Jim Andrews, KH6HTV & Don Nelson, N0YE

In previous issues starting with the Dec. 2023 issue #150, we have been reporting on an ongoing Boulder project to measure the gain of 70cm and 23cm antennas for use as ATV antennas. In our last issue #153, we said the mobile antenna measurement results were disappointing and we had found an issue with our test equipment, so the gain values previously reported were thus suspect. We have since acquired some more mobile antennas to test and on Jan. 28th, Don, N0YE, and Jim, KH6HTV, repeated the tests on mobile antennas. The test site used was again Jim's vacant lot in Spanish Hills. We will soon be publishing a new application note, **AN-66 "Comparison Tests of Various 70 & 23 cm, Antennas for ATV"**. It will contain the full details of all the tests. We will announce in a future newsletter when it will be available on our web site: www.kh6htv.com In the meantime, here are the summary results from our most recent gain measurements on mobile antennas.

Note: For the mfgr's gain specs., not every manufacturer uses dBi, we find a bewildering array of gain definitions used. Some meaningless. So our list contains, dB, dBd, dBR, etc.

70cm Antenna Gains (in dBi) vs. DATV 6 MHz Channels' Center Frequency

ANTENNA	**Mfgr's** Gain Spec.	**423 MHz**	**429 MHz**	**435 MHz**	**441 MHz**	**447 MHz**
Diamond NR2000NA (2m/70cm/23cm, N, 41" tall)	+6.3dBi	+4.9	+6.6	+5.3	+3.6	+4.4
Diamond MR77 (2m/70cm, PL-259, 20" tall)	+3.4dBi	***-0.3***	+1.2	***-0.4***	***-2.2***	***-4.2***
Vmuksan 770R (2m/70cm, PL-259, 39" tall)	5.5dB	+4.9	+6.1	+3.6	+2.1	+2.5
Browning BR-1713-B-S (70cm, NMO, 34" tall)	5.5dBd	+2.7	+3.5	+2.5	+1.5	+2.5
Generic NMO 1/4 wave	none	***-2.5***	***-3.6***	***-2.7***	***-2.4***	***-1.6***
Diamond SRH999 (6m/2m/70cm/23cm, 19.5" tall) (HT whip on mag. mt.)	4dBR	+0.3	+0.6	+0.6	+0.4	+0.7
Bingfu BFN00606 (2m/70cm, 15" tall) (HT whip on mag. mt.)	+3dBi	+1.1	+1.3	***-0.8***	***-3.4***	***-5.3***

23cm Antenna Gains (in dBi) vs. DATV 6 MHz Channels' Center Frequency

ANTENNA	Mfgr's Gain Spec.	1243 MHz	1255 MHz	1267 MHz	1279 MHz	1291 MHz
Diamond NR2000NA (2m/70cm/23cm, N, 41" tall)	9.7dBi	+9.2	+9.4	+7.9	+7.2	+6.9
Diamond NR124 (23cm, N, 29" tall)	8.4dBi	+9.9	+9.0	+6.9	+4.8	+4.1
Diamond SRH999 (HT whip on mag. mt.)	4dBR	0.0	+0.9	+1.0	+1.8	+2.6

Antenna Return Loss (in dB)

note: -14dB RL => 1.5:1 vswr, -10dB RL => 2.0:1 vswr

ANTENNA	fo	RL(fo)	> 14dB	> 10dB
70 cm Mobile Antennas:				
Diamond NR2000NA (2m/70cm/23cm, N, 41" tall)	441 MHz	-32dB	443-450	439-452
Diamond MR77 (2m/70cm, PL-259, 20" tall)	426 MHz	-20dB	420-437	410-443
Vmuksan 770R (2m/70cm, PL-259, 39" tall)	434 MHz	-19dB	420-438	416-441
Browning BR-1713-B-S (70cm, NMO, 34" tall)	443 MHz	-47dB	>20dB 425-451	NA
Generic NMO 1/4 wave	422 MHz	-32dB	<410-455	NA
23 cm Mobile Antennas:				
Diamond NR2000NA	1295 MHz	-30dB	1290-1298	1253-1300
Diamond NR124	1267 MHz	-31dB	1260-1272	1255-1274

#1 -- These tests confirmed once again the hands down winner for all around good ATV performance is the **Diamond NR2000NA**. It works on all three bands, 2 meters, 70 cms, and 23 cms. It has been our recommendation to ATV hams since 2011 and will continue to be our 1st choice. It sells for $85. It does require a separate N connector base mount. We recommend the Diamond DPK-4NM-N which sells for $55.

#2 -- We did find on Amazon a good deal on a useful dual-band, 2 meter / 70 cm mobile antenna. It is the Chinese **Vmuksan model 770R**. It is sold as a package deal including a PL-259 magnetic mount base for only $39. It was one of the few 2m/70cm antennas we found which was actually specified to work lower in the 70cm band. Most all are specified for the upper 5 MHz FM portion of the band.

Our gain and return loss measurements on the 770R do show that it favors the lower portion of the band.

Another antenna we tested was one advertised to have extremely broad-band coverage from 406 to 490 MHz with 5.5 dBd gain. It was the **Browning BR-1713-B-S**. It sells for $42. It is an NMO antenna and does require a separate NMO base to be purchased with it. We did find it had an excellent Z match across the specified wide range. The gain did turn out to be approximately 5.5 dB, but it was +5.5 dB higher than the gain we measured for an NMO 1/4 wave vertical antenna. It was gain thus referenced to that antenna and not dBi.

We also measured the two best performing HT whip antennas for possible use as emergency mobile antennas. They performed similarly, but not exactly to how they performed when they were previously measured on the camcorder / antenna bracket. They were the Diamond SRH999 and the Bingfu BFN00606.

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ANTENNA FEED-BACK: **Mario, KD6ILO** writes --- "I agree with Mike, great newsletters Jim on the review of antennas for ATV operation from this one to the last. **Directive System Loop Yagi** is in my inventory and operational in our network and is also a favorite among the team especially during field operations. The **Diamond SRH999**, I have a handful of as well as many of the members. We use them with our small unit packages for on site video transmissions and yes mobile on all-terrain vehicles for SAR OPs."

Allen, K0ARK, BCARES chairman & EC

Pete, WB2DVS, BCARES equipment officer

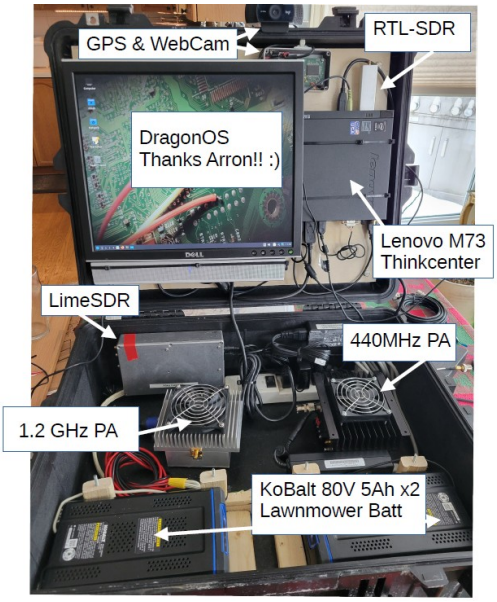
BCARES Holds Annual Meeting

Boulder County ARES (BCARES) held their annual meeting of the membership on Monday, Jan. 29th, at the Boulder County Sheriff's headquarters building. Some of our active ATVers hold key positions in BCARES. They include Allen, K0ARK, and Pete, WB2DVS, Allen is currently the chairman and emergency coordinator (EC). Pete has held the position of equipment officer for an extremely long time now. At least 30 years ! THANK YOU Pete for your many years of dedicated service keeping all of the multitude of BCARES gear in tip-top condition.

The major topic of the meeting hosted by Allen this time was in fact ATV. Both he and Pete had several displays setup. Pete demoed the microwave VOIP equipment which BCARES hopes to eventually install in several key public safety locations around the county. Plus using the Rocky Mtn. ham microwave network as the back-bone, then connect to other EOCs up and down the Colorado Front Range. Allen demoed the four newly repackaged BCARES, 70cm, DVB-T, video pac-sets. He also demoed his drone video system which he uses on Boulder Sheriff's SWAT and BES call-outs.

Allen discussed the need for funds for BCARES. Most all of the various BCARES and MERN FM voice repeaters are really old and in dire need of replacing. Some are even still of the vacuum tube era. Also Allen discussed plans to add a second ATV repeater to enhance the coverage of the county. All of this will require $$$. Recently the voters in Boulder County approved a new sales tax dedicated to emergency services. Allen said he has the support of both the EOC manager and also the Sheriff for BCARES to get some of this new tax money. He said he submitted an application for 2023, but it was turned down. Not because it was deemed un-worthy. But because the county committee reviewing the applications made the decision for 2023 to only fund projects for the various county fire departments. We were encouraged to re-submit an application for 2024 funds, which Allen intends to do.

Mike, VA3TEC, Ottawa, Canada writes --- "How do you like my new **DATV, GO BOX !**"



ATV Activity in Ottawa ? --- I find around here not much people know or understand the mode, plus not any desire to. On top of that, try to acquire the equipment for the mode.

The ICOM 905 is a great start. But they currently cannot do Digital DATV mode. I just hope that they can do a firmware update to include it. I am just not sure if the FPGA in the 905 is supported yet.

ATV Contests ? --- Another point that I wanted to bring up with you, Contests.

So for a little while now, I have noticed that for ham radio to get more people involved in ham radio they use contests as a means to generate interest. It does work, but for the most part the video modes are not part of the scoring. Are you able to bring this up with the ARRL or the contests bodies to include the video modes? Like for example you get 20 extra points or something like that. If that happened, I know a few around here would be ALL over that. 73 de Mike, VA2TEC

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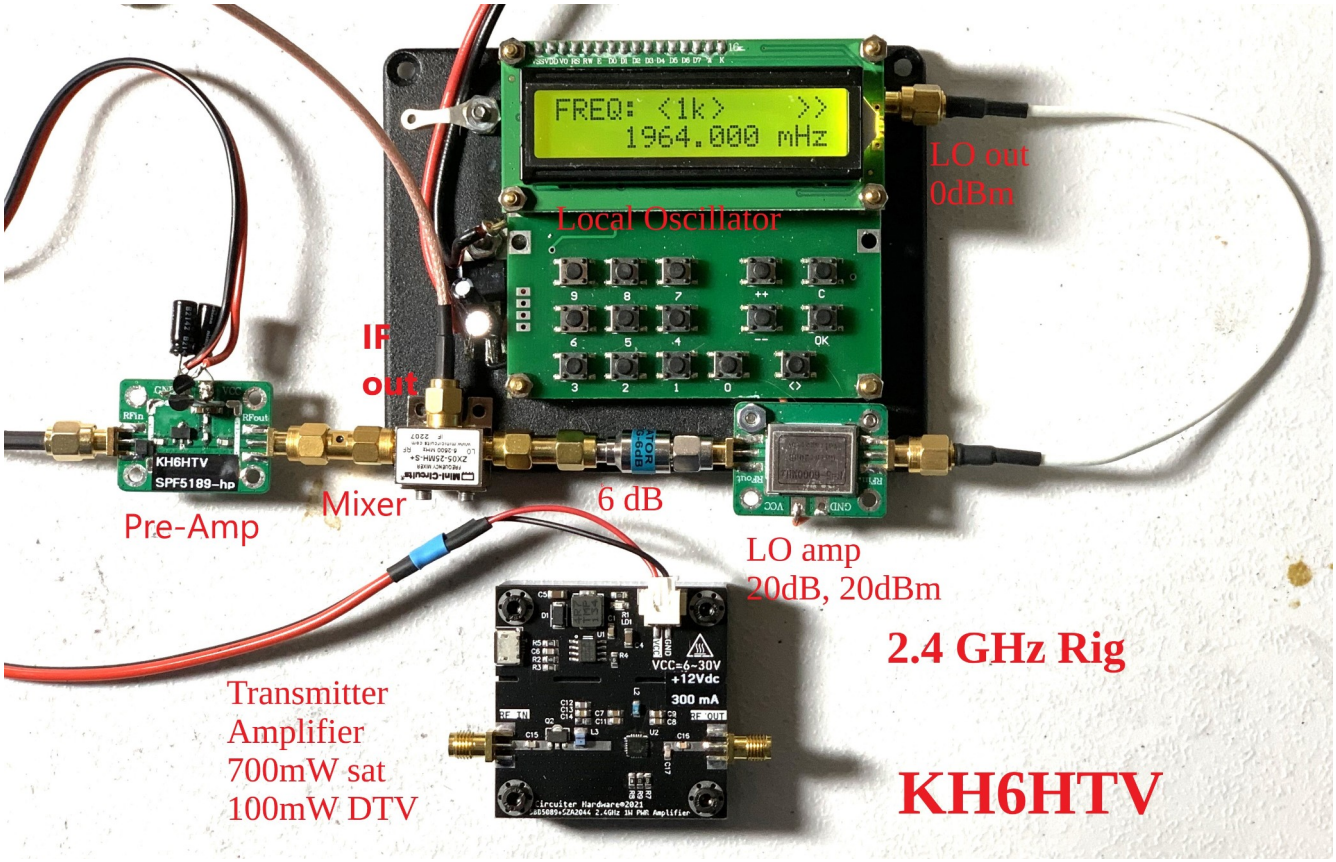
An Inexpensive Amazon 2.4GHz, DVB-T Rig

Jim, KH6HTV

The above article told about our getting back on microwaves with DTV signals. I thought I would share with our readers my low cost approach to getting on the 13 cm (2.4 GHz) band. Perhaps this might help motivate others to also give it a try. The major cost item for DVB-T is the modulator. If we are already doing DVB-T on 70cm, we already own that. Most of us are using the Hi-Des model HV-320. It is extremely broad-band with coverage extending from 100 MHz to 2.5 GHz. Thus covering our first ATV bands of 70cm, 33cm, 23cm and 13cm all in one box. But it costs a stiff $400.



This photo shows my entire 2.4 GHz rig for DVB-T. All built from low cost parts available from Amazon.

Transmitter: Because the HV-320 works up to 2.5 GHz directly, our transmitter situation is very simple. We only need to add an rf power amplifier as the "After-Burner" behind the HV-320. Here some googling the internet pays off. I found the power amplifier shown in the below photo on Amazon for a low $30. It uses two MMIC chips. The driver amp is an SBB5089 while the final power amp is an SZA2044. The gain is about 40dB. Driven hard to saturation, I got 700mW out of it. Driving it with the HV-320's DVB-T signal and carefully adjusting the drive level I got 100 mW (average) (+20dBm) out with very respectable -33dB shoulder break-points. The amp pulls 260 mA at +12Vdc. The amp is also small enough, it can be mounted directly onto the 2.4 GHz antenna, thus eliminating any feed-line loss.

Receiver: For DVB-T receivers on VHF/UHF up to the 33cm band, many of us are using some very low cost (< $50) receivers found on Amazon, E-Bay, etc. (note: only for 6, 7 or 8 MHz BW). Above 1 GHz, our selection for DVB-T is quite limited. At present, the best choice is probably the Hi-Des model HV-122A at $330. It is a dual-diversity receiver covering 170 to 2700 MHz. Hi-Des also offers a lower cost receiver, their UT-130 which covers 100 - 2600 MHz and costs $200. But it is strictly a USB receiver and requires an external PC computer. Hi-Des previously offered the HV-120A with broad frequency coverage up to the 2.4 GHz band, but they no longer offer it for sale.

Personally, for DVB-T receivers, I only have the Hi-Des HV-110 and GT-Media V7 Pro. Both only work up to the 33cm band. So for microwave work above 1 GHz on 1.2 GHz, 2.4 GHz, and higher, I need receiving down-converters.

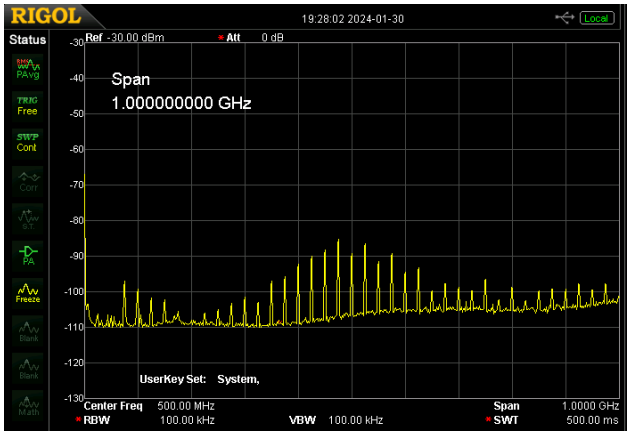
Mixer: The basic receiving down-converter consists of just a mixer driven by a local oscillator with the IF being in the range of my basic DVB-T receivers. The photo above shows my complete, low cost, 2.4 GHz down-converter. The mixer is a Mini-Circuits 25MH. It is a double balanced schotky diode mixer with specs. of: RF/LO 5-2500 MHz, IF 5-1500 MHz, +13dBm LO drive, -7dB conversion loss. It costs about $55 from Mini-Circuits. I used it because I already owned it. The same mixer on Amazon is available in a pc board version with SMA connectors as a model ADE-25 for about $15-$20. I have tested it with the Amazon mixer and got identical performance.

LO: The Local Oscillator (LO) is a frequency synthesizer using an Analog Devices IC, the model ADF-4351. It tunes from 35 MHz to 4.4 GHz. It is available from Amazon, E-Bay, etc. in several different pc board and completed boxed configurations. The one shown above is the least expensive at about $30. It has a pc mounted keyboard for data entry and LCD display. The only draw-back is the lack of a back-up memory. The desired LO frequency must be entered every time it is powered up. The rf output from the LO is about 1 mW (0dBm). This is not sufficient to drive the mixer which requires +13dBm (20mW).

To boost the LO drive power, I added a low cost, broad-band MMIC amplifier. It is shown in the photo labeled "LO Amp". It uses the SBB5089 MMIC. 20dB gain and +20dBm max. output power. +5V at 90mA. Also available as a low cost pc board with SMA connectors from Amazon for about $10. The rf output from this amp. is actually too high for the mixer at +20dBm, so an SMA, 6 dB attenuator is placed on it's output to drop the LO drive power back down to the recommended 13-14dBm. Good quality, SMA attenuators are also available from Amazon for about $6 each.

A mixer and LO are the minimum required components for a down-converter. Weak signal performance can be enhanced by adding a low noise pre-amp in front of the mixer. The one shown in the photo is still another Amazon item, available as a pc board with SMA connectors. Also about $10. This one uses an SPF5189 MMIC, The gain is not flat but rolls off dramatically at high frequencies. At low frequencies it is about 30dB. At 2.4 GHz, it is about 10dB, but still sufficient to help the sensitivity. I modified my pre-amp to add a high pass filter to help reduce overload from much lower frequency rf signals. If desired, this pre-amp is also so small and light weight, that it too could be mounted directly at the antenna to eliminate coax feed-line loss.

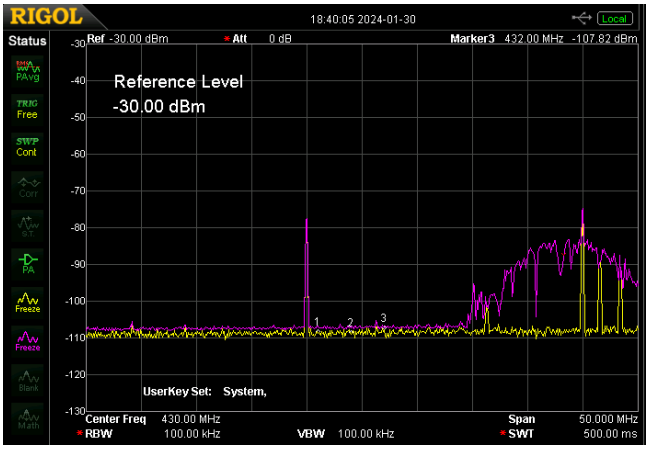
IF: For my 2.4 GHz down-converter the RF input frequency is 2.393 MHz. I set the LO to 1.964 GHz which then gave an IF output on the 70 cm band at 429 MHz. I do need to mention that the RF output from the ADF-4351 is not perfectly clean. There is some low level "crud" which comes out in the few 100 MHz region which will disturb the ultimate sensitivity of the down-converter receiver.



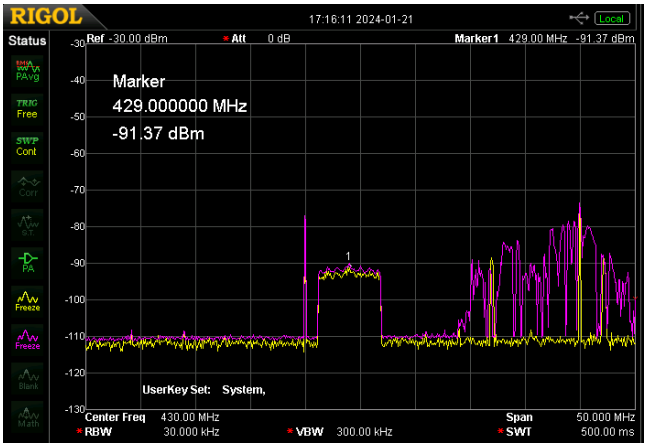
LO spurious noise - sweep 0 to 1GHz

This spectrum analyzer plot shows what came out of the mixer IF port as feed-thru from the LO. The top reference line is at -30 dBm, (10dB/div & 100MHz/div). The SA's noise level setting the bottom of the trace is at about -110 dBm. Obviously some "birdies" to be avoided !

So it was necessary to carefully study on a spectrum analyzer the IF output to select an appropriate LO and IF frequency to avoid these "crudies". For my particular ADF-4351 and particular RF, I thus chose an LO of 1964 and IF of 429 MHz.



IF Out - No input RF signal



IF Out - 2.393GHz DVB-T signal, +20dB

These photos show the IF output on the 70cm band (center freq. = 430 MHz, span = 50 MHz). The yellow trace is a "live" sweep. The magenta trace is with the analyzer in the "peak hold" mode. What I noticed was the spikes on the yellow trace walked around quite a bit. So putting the analyzer in peak hold I was able to capture where all they walked to and their strength. The photo on the left shows the

70 cm IF with no input 2.4 GHz signal. With this study, I was thus able to find the "sweet spot" quiet region to use as my actual IF frequency. In this case I found channel 58 (426-432, 429 MHz center) to be quiet. Markers 1, 2 & 3 show Ch 58. The photo on the right now shows the IF output with a strong DVB-T signal on 2.393 GHz. In this case, it was set to be +20dB above digital threshold.

So, how well did this down-converter perform ? I set up my HV-320 as my test source with the most aggressive digital parameters possible (6 MHz BW, QPSK, 1/2 FEC, 1/16 guard, H.264, 720p, 3.2Mbps). A good receiver will work with these parameters down to a digital threshold signal to noise ratio of a low 5 dB. Using my HV-110 as my calibrated receiver, I found the digital threshold to be -85dBm using the mixer alone. Adding the 10dB pre-amp, the sensitivity dropped to -94dBm.

Yagi Antenna: Again, Amazon to the rescue. While I have a really BIG, BBQ grill dish antenna for 2.4 GHz, it is big, bulky and unwieldy to maneuver and aim. A smaller, light weight yagi would be nice to have also. What I found on Amazon works perfectly. Plus, it only cost $35. It is a very rugged Yagi made by the Chinese company Tupavco. It is the model TY-24-117-20. It is specified to work over 2.4 - 2.483 GHz with < 1.5:1 vswr. Gain = +17dBi. 18dB F/B, 25° beam width, 100 watts max., 35" boom, rear mount, with type N connector pigtail.

BONUS -- 23cm, 1.2 GHz Rig ! Surprise ! You can also use this same rig on the 23cm band with no modifications except to change the LO frequency. Essentially identical performance.

Transmitter: The rf power amplifier also works well on the 70cm and 23cm bands, in addition to the 13cm band. On 1.2 GHz, it had a bit higher gain. The max. saturated output power was 500mW. In DVB-T service, I got +19dBm (average). At 430 MHz, the max. saturated output power was 400mW and for DVB-T, I got +16dBm. -- Such a bonus for only $30 !

Receiver: For my desired rf frequency of 1243 MHz, the IF "sweet spot" I found free of "crudies" was TV channel 9 (189 MHz). Thus the LO frequency chosen was 1054 MHz. For this I found the receiver sensitivity was -86dBm for the mixer alone, or -96dBm with the pre-amp / mixer combo. Note, the SPF5189 pre-amp has more gain (15dB) at 1.2 GHz.

Well, I hope I have encouraged some of you ATV hams out there to thus venture a bit higher in frequency than just the 70 cm band. With Amazon's help, you can move up to the microwave region with just a few bucks investment.

73 & Great ATV microwave DX de Jim, KH6HTV, Boulder, Colorado

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E-MAIL DELIVERY ISSUES: Some readers may no longer be able to receive this newsletter. A lot of them bounced on the previous issue #153 (Jan. 23ed). Apparently the i-cloud server no longer likes me. To avoid having the email servers dump newsletters, it has been my policy to send them out in groups of 15 or less. This means a lot of emails being sent out as we now have 500-600 subscribers to this ATV newsletter. If you no longer are getting the newsletter via e-mail, then I suggest you instead check periodically our web site for the latest issue and down-load it from there. ***https://kh6htv.com/newsletter/***

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 is a free newsletter distributed electronically via e-mail to ATV hams. The distribution list has now grown to over 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.*

ANTENNA CLEARANCE SALE

all items are **NEW** -- only used for antenna tests

Diamond X6000A, 2m/70cm/23cm base station vertical antenna. mfgr's specs. Gain 6.5/9/10 dB, 100 watts, 10.5 ft tall, N connector -- New HRO price is $190 -- selling it for $140

Diamond NR124N, 23cm mobile antenna. mfgr's specs. Gain 8.4dBi, 50 watts, 25" tall, N connector note: requires a separate N mounting base. -- New HRO price is $55 -- selling it for $40

Browning BR-1713-B-S, 70cm mobile antenna. mfgr's specs. very broad-band 406-490 MHz (vswr < 1.85:1), 5.5dBd gain, 160 watts, 34" tall, stainless steel whip & spring, NMO connector. note: requires a separate NMO mounting base. -- New Amazon price is $42 -- selling it for $25, 2 available

NMO antenna, magnetic mounting base & 70cm 1/4 wave, NMO antenna no band name - 3 1/2" magnet base, 16ft RG-58 coax with PL-259 connector -- New Amazon price is $30 -- selling it for $15

N connector, magnetic mounting base no brand name - 3 1/2" magnet base, 16ft RG-58 coax with SMA connector New Amazon price is $20 -- selling it for $10

Jim Andrews, KH6HTV, e-mail kh6htv@arrl.net, 303-594-2547 local sales only - will not ship