Boulder Amateur Television Club
TV Repeater's REPEATER

November, 2022
3ed edition, issue #116

BATVC web site: www.kh6htv.com

ATN web site: www.atn-tv.com

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

Our 10 GHz Band is now in
DANGER !

The ARRL has just become aware of a recent petition filed with the FCC to open up the 3 cm amateur band (10-10.5 GHz) to other users. To read the actual petition, go to:
https://www.fcc.gov/ecfs/search/search-filings/filing/1004923311843

We shouldn't be surprised at this happening. We already got whacked on the 3.5 GHz band. We should not sit idly by and let this happen again at 10 GHz.

Tom, WA1MBA, writes -- "Dave Siddall, K3ZJ (***k3zj@arrrl.org***) at the league would like to hear from amateurs about our use of the 10 GHz band. I believe that short comments (no emotional reactions please) would be helpful. At some point the FCC will probably release a proposal for public comment. Hopefully, the league will have info from us and others to formulate a strong response, and of course individuals can also respond directly to the FCC when there is an invitation for public input.

10 meter Trans-Atlantic Tests of NB-DATV

Just to gauge what maybe needed I'm running a test signal on 29.250 on and off for the next two hours 15:30 - 17:30 UTC (*sent on Sunday, 6 Nov*).
Running 100 Watts of 66Ks DVB-S2 to 3 element Yagi beaming North America. I know that's unlikely to work with the fading I'm seeing, but would be interested if anyone with a reasonable antenna gets enough s/n to catch a glimpse occasionally...
I'm seeing myself right now on this kiwisdr: http://kiwisdr.k3fef.com:8073/ located in Milford, PA, USA.

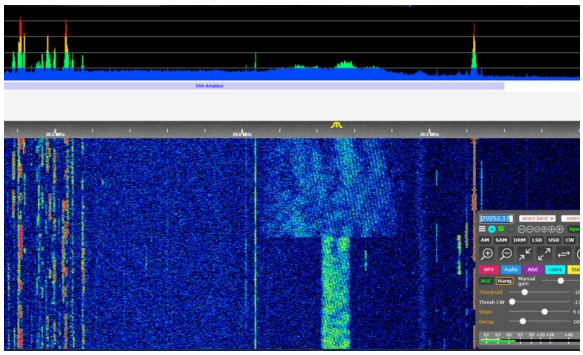
Rob, M0DTS, Yarm, England

Rob -- Definitely seeing the signal on that *kiwisdr* site in Milford, Pa. It was very strong for a while then faded down. I was not able to see a signal on my wire antenna north of Baltimore, Maryland though. I hope to have my 4 element, 10 m, yagi installed in the next few days, but don't have a narrow band DVB-S decoder here. I do have a Knucker rx for DVB-T however.

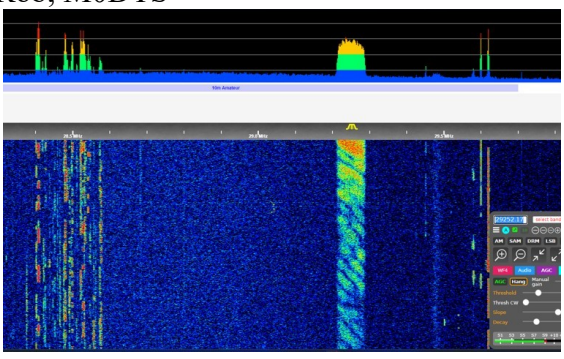
John Kozak : K0ZAK

Thanks for looking John. Let me know when you're ready to try some tests and I'll put some more signals out. I'm available all this week after 15:00 UTC, if anyone else wants to look for signals. I can do DVB-T or DVB-S/S2.
Below is a comparison in strength of 66Ks DVB-S2 vs 333Ks of DVB-T on the K3FEF *kiwisdr*, and one image of the stronger peaks I saw.

Rob, M0DTS



66 Ks vs 333 Ks

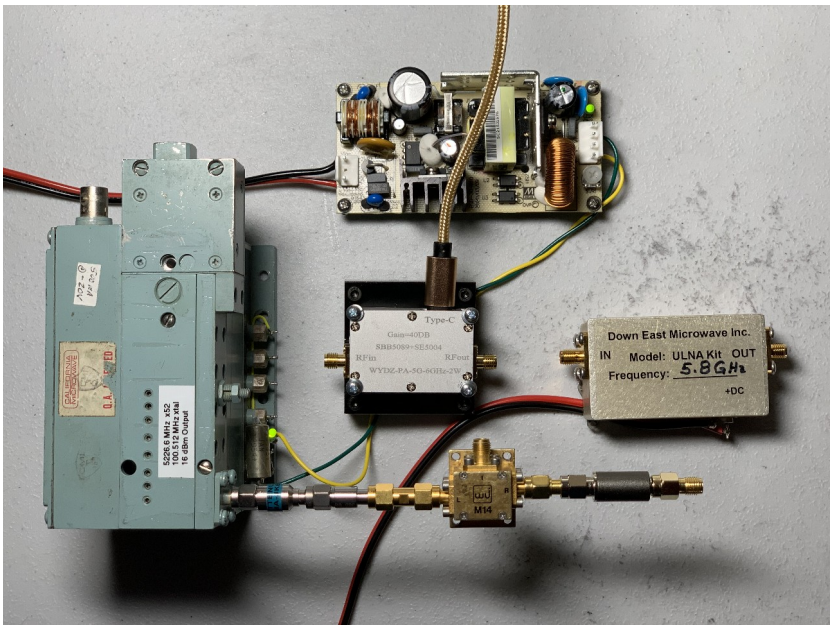


strongest peak

Editor's Note: *For any North American ATV hams with appropriate receiving gear, if you note band openings on 10 meters to Europe, I suggest you contact Rob directly and ask him to again put his DVB-S2 or DVB-T signal on the air. His email is: rob@m0dts.co.uk*

5 cm Digital ATV

Most ATV activity occurs on the 70cm (420-450 MHz) and 23cm (1240-1300 MHz) ham bands. At least on these bands, we can be somewhat "appliance operators" using for the most part, off the shelf, commercial gear. For some of us hams however, we feel challenged to push the envelope and try working at even higher frequencies in our microwave bands. The next bands for us are: 13cm (2.4 GHz), 5cm (5.8 GHz) and 3cm (10 GHz). The 9cm, 3 GHz band is "sun-setting" and going away to be used by the telecomm folks. For this newsletter issue, I am focusing on the 5 cm band. The amateur 5 cm band extends from 5.65 to 5.925 GHz. It straddles, the 5.8 GHz, ISM, Wi-Fi band.



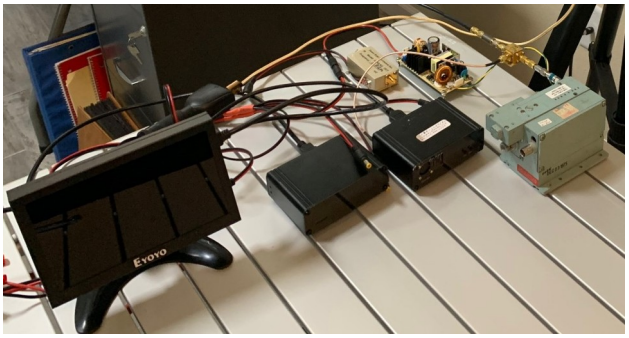
Equipment Required: So what equipment is required to get onto the higher microwave bands with digital ATV ? Well, we already have two key pieces of the equation, if we are already on 70cm DVB-T. Namely a modulator and receiver. Examples would be the Hi-Des models HV-320E modulator and HV-110 receiver. Plus a TV camera and a video monitor. At a bare minimum, the only other items needed would be a local oscillator (LO), and a mixer, plus an antenna. The above photo shows the minimal number of extra components required for me to put a DVB-T signal on the 5 cm band.

LO: The most critical item is the local oscillator. The previous issue (#115) of this newsletter discussed LOs in detail. For DVB-T, a low phase noise LO is critical for achieving the ultimate sensitivity. The light green module on the left in the photo is the LO. It was made by California Microwave in the mid 70s. This particular one was a gift from Don, N0YE. It consists of an ovenized, 100 MHz crystal oscillator, a phase-

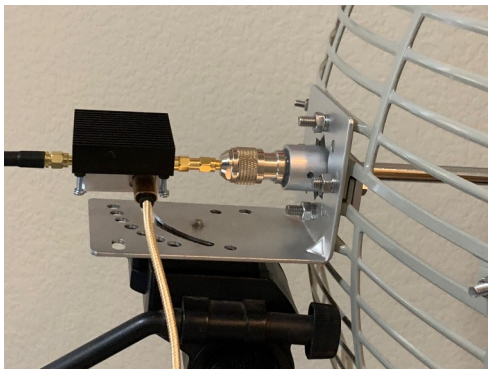
locked L band oscillator and SRD frequency multiplier. This particular LO from Don was on 5226.6 MHz and put out +20dBm of rf power. It requires -22Vdc at 1/2 Amp. The open frame power supply in the top of the photo converts +12Vdc to -22Vdc. It is a Meanwell model PSD-30A-24 from Jameco for $15. With this LO frequency of 5226.6 MHz and our local Boulder DATV, RF frequency of 5678 MHz, the resultant IF frequency is 451.4 MHz. Very close to our 70cm band and well within the working limits of our Hi-Des modulator and receiver.

Mixer: The gold module in the bottom of the photo is the mixer. It was made by Watkins-Johnson and was their model M-14. Key specs. are: RF & LO 4-8 GHz, IF DC - 2 GHz, +7dBm LO drive, 5-6 dB conversion loss. I found it on E-Bay for $35. A great source for surplus microwave components, such as this mixer, is Phil Schnabel's, Western Test Systems in Wyoming (http://westerntestsystems.com/) I used SMA attenuators to lower the LO power to +7dBm required by the mixer. They are readily available from Amazon for about $10 each.

Band-Pass Filter: A BPF is not mandatory, but is good engineering practice to use one. I found a good one from Digi-Key for $25. It is made by Taoglas and is their model BPF.58.01. Passband from 5.4-6.2 GHz with about -1dB insertion loss. The only drawback is the reverse polarity SMA connectors. Thus RP-SMA adapters were required. The BPF is the dark, cylindrical module in the lower right of the photo attached to the RF port of the mixer.



LO, mixer, BPF & IF modulator & receiver, plus 7" video monitor on table


Power amplifier mounted on antenna

PRE-AMPLIFIER: The other items in the photo were the amplifiers. A pre-amp and a power amp. The pre-amp is from Down-East Microwave, model L5ULNA, $85 as a kit. (www.downeastmicrowave.com). It has 13dB gain and advertised noise figure of 0.7dB.

POWER AMPLIFIER: The power amplifier was a real lucky find recently. $20 from E-Bay. It is from China and is labeled WYDZ-PA-5G-6GHz-2W. Also labeled as ".SBB5089+SE5004" as these are the MMICs used in the amplifier. This amplifier was reviewed in the previous issue (#114) of this newsletter. I added the heat sink to the amp

as it ran very hot without one. Both the pre-amp and the power-amp were quite small, so I was able to mount them directly on the antenna. Thus 0dB feed-line loss. I used a 3 ft., low loss, LMR-240, SMA cable to connect the amplifiers to the BPF and mixer/LO on a nearby table. Another Amazon purchase for $10.

ANTENNA: The antenna I use is from L-Com. (www.l-com.com) It is a BBQ grill style, dish antenna. Model #HG4958-22EG. 22dBi gain, 10-12° beamwidth, 12"x16" grid, $98

SYSTEM PERFORMANCE: So, how well does the above 5 GHz transverter work ? Actually quite well. In transmit configuration, I adjusted the IF drive level from the HV-320E modulator to set the RF output spectrum shoulder break points to -30dBc. At this setting the DVB-T, RF average output power was +23dBm (200mW). With the +22dBi antenna gain, the ERP was thus +45dBm. The up-conversion gain was 40 dB.

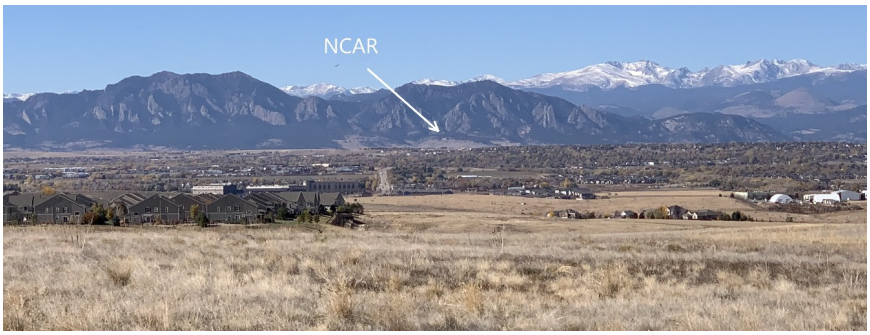
In the receive configuration, I measured the digital receive sensitivity to be -92dBm if I used only the BPF and mixer/LO. Using the low noise, pre-amp, the sensitivity improved to -99dBm. These measurements were made with a DVB-T signal of 6 MHz BW, QPSK, 8K FFT, 5/6 FEC, 1/16 guard, 1080P, & 5.5 Mbps. Digital threshold occurred when the received S/N dropped to 8dB. The down-conversion gain was 5 dB.

Jim Andrews, KH6HTV, Boulder, Colorado

FIELD TESTING NEW 5 GHz DVB-T Transverter

On Wed, Nov. 2ed, our newest ATV ham, Larry, N8GGG, joined me out in the field to test out our new 5 GHz gear. The fella in the above photo is Larry standing next to his pickup truck with his new 5 GHz, FM-TV gear. I set up my new 5 GHz, DVB-T gear on the table and dish antenna on the left. We were setup at 152ed St. and Lowell Blvd.,

just over the east Boulder county line. It is the highest point in the south-east part of the county and also close to Larry's and my houses.



Don, N0YE, set up his 5 GHz, DVB-T transverter and dish antenna in the parking lot of NCAR. This is also where our W0BTV-ATV repeater is located. It is on a mesa, 800 ft. above the City of Boulder. From our site on Lowell Blvd. we looked out over a large open space field with a direct view to the west towards Don and NCAR. We could visually see NCAR. We had a very clear line-of-sight rf path to NCAR. The distance was 12.7 miles (20.4km).

Don was the first to transmit. We were on 5.678 GHz with 6 MHz band-width, QPSK, DVB-T. Don said he was transmitting +10dBm into an L-Com, 22dBi, BBQ grill dish antenna. I was using an identical L-Com dish antenna. We immediately reported to Don, via 2 meters FM, we were receiving a perfect P5/Q5 signal from him. My Hi-Des HV-110's rf power S meter and S/N meter reported -77dBm and 17dB (23dB is perfect). Correcting for the transverter's receive gain of 5 dB, gave the received signal strength at -82dBm.

Don on the 7" video monitor

Don's video captured with the HV-110 DVR

While we were receiving video from Don, we then tried out Larry's new **BIG** BBQ grill dish antenna. You can see it side by side with my smaller L-Com dish. Larry found it on Amazon for $67. It is a Hana Wireless model HW-DCGD58-30NF. Advertised gain of 30dBi. 4° beamwidth, 35"x24" dish. It's construction looked to be identical to our L-Com dishes, including the unique feed. Thus we suspect they were all made by the same manufacturer. With the narrow beamwidth of Larry's BIG dish, it was extremely

difficult to point accurately. We optimized the pointing using the HV-110's S meter. Once bore-sighted onto Don's signal, Larry's antenna did prove to have 8 dB more gain than the L-Com. Thus confirming the difference in specs. of +22dBi vs. +30dBi gain.

video received by N0YE from KH6HTV

Larry, N8GGG smiling for the camera

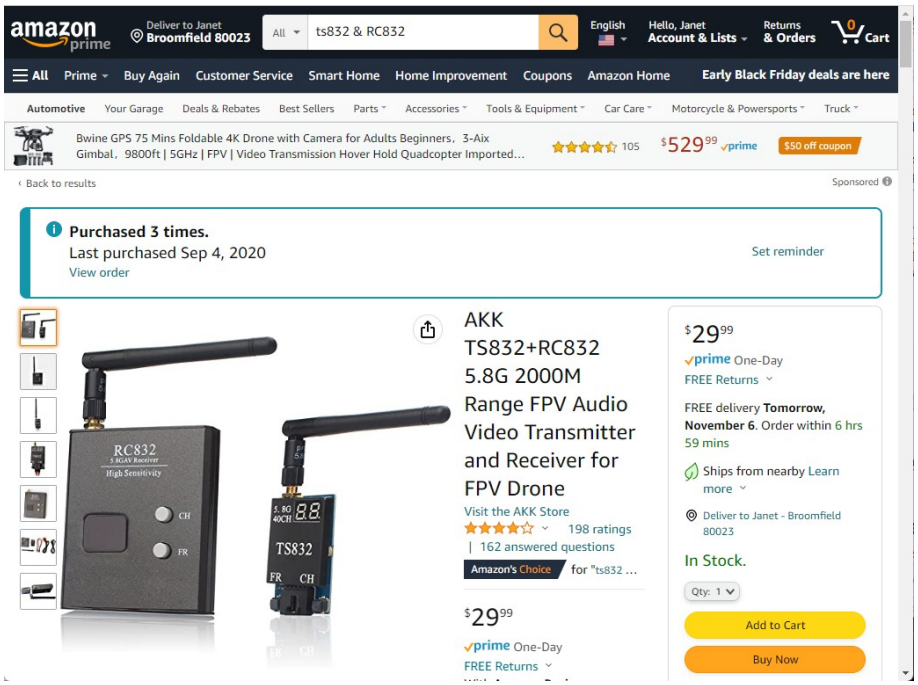
We then re-configured my transverter for transmit operation. The LNA and power amp were swapped out with the power amp mounted directly on my L-Com dish. The DVB-T, rf power to the antenna was +23dBm (200mW). Don immediately reported receiving a P5/Q5 picture with audio from us. He reported -59dBm and 23dB S/N.

We finished off the morning's activities by then switching over to 5.8 GHz FM-TV. Larry had very recently purchased the new, $30 combo package from Amazon of the TS-830, 600mW transmitter and RC-832 receiver. Aside from looking at his own signal in his ham shack, he really hadn't yet given it an acid test. Our W0BTV-ATV repeater has a secondary FM-TV transmitter running as a 24/7 Beacon on 5.905 GHz. It is radiated as a +33dBm (2 W) signal from a horizontally polarized, 10dBi, omni antenna on the top of NCAR. It has a very large coverage area over the eastern prairie. Using my L-Com antenna and Larry's new RC-832, he immediately got a perfect P5 picture from the W0BTV beacon.

Larry's first love is videography. He says he got his first camcorder way back in 1980. He loves to shoot and edit video. He put together a short, 3 minute, YouTube video of our 5 GHz outing. You can watch it at:

https://www.youtube.com/watch?v=rrK5hb_7DCg

73 de Jim, KH6HTV, Boulder, Colorado



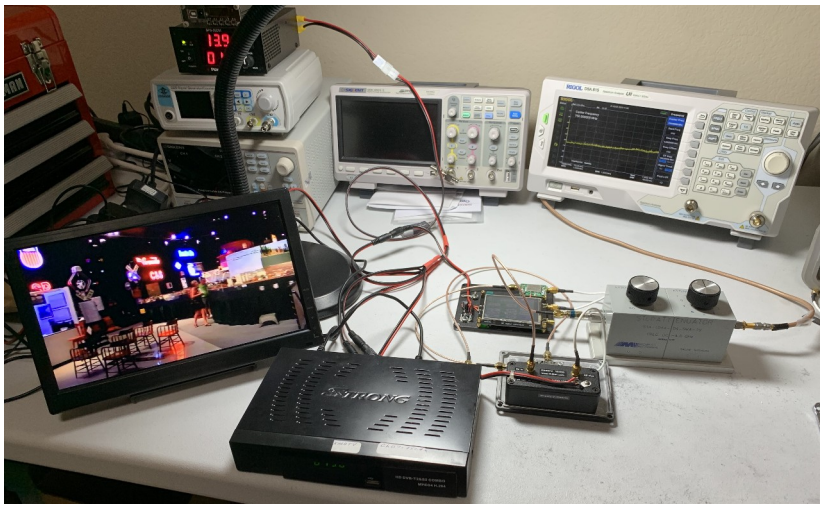
ANALOG TV on 5.8 GHz BAND

We have written about this before here in our ATV newsletter. However, it is still worth while honking our horn about this one. ATV hams have bemoaned about (1) the cost of entry and (2) complexity of digital vs. analog. Well for only $30 investment, these issues are blown away. See the above advertisement from Amazon. This is an unbelievable offer. For only $30 you get a complete analog TV transmitter and companion receiver, plus two rubber duck antennas. And it really does work ! Simply add an analog, composite video source, such as a camera to the transmitter. Connect the A/V outputs from the receiver to the analog, composite input of a video monitor. Power it all with +12Vdc --- BINGO ! You are on the air with analog ATV.

All right, you say you still don't want to spend $$ for a camera and video monitor. Well Amazon again to the rescue. For only $14, they offer a pin-hole, analog camera complete with built-in microphone. Small flat-screen, color video monitors which work on 12Vdc can

also be found on Amazon for prices as low as $35. However, shop around for the features you want. Longmont, local ATVer, Lou, K0ANS, put together just such a pin-hole, ATV rig and has recorded some really long distance ATV-DX with it.
The TS-832 does take a minor bit of wiring to be useful. I cut off the supplied connector and added RCA jacks to the wiring. Also the TS-832 has a useless microphone on the pc board. Bill, AB0MY, has figured out how to disable it for use with an external audio source. For details, see our ATV newsletters from 2019, issue #27 & 29. Also see our more recent July issue, #106.

73 de Jim, KH6HTV, Boulder, Colorado



DIY 23 cm & 13cm DOWN-CONVERTERs

With the new frequency synthesizer from Maxim discussed in the previous issue (#115), it was time to revisit what it takes to make a Do It Yourself (DIY), ATV receiving down-converter for our 23cm band (1240 - 1300 MHz) and also our 13cm band (2.3-2.31 GHz & 2.39-2.45 GHz). Back in March, 2021, I had written an application note entitled "Low Cost, DIY, Microwave Up & Down Converters". It is AN-61 and still available on my web site: *www.kh6htv.com* It is recommended reading to go along with this present article. Having lost all of the misc. components I had back in 2021 to the fire, I decided to start over again. But this time using the new, low noise Maxim MAX-2870 as my LO.

23cm Down-Converter

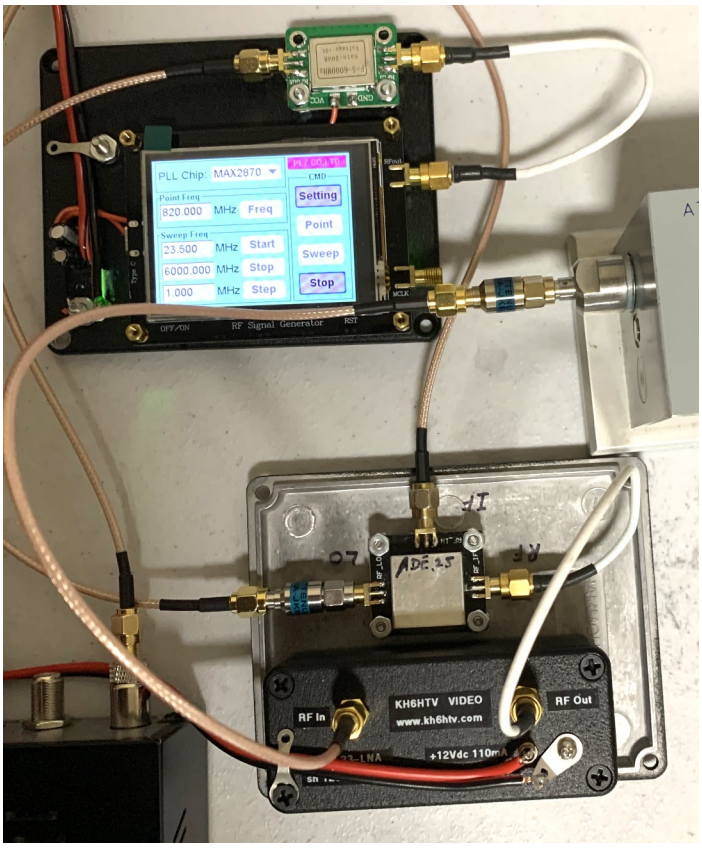
MIXER: For my mixer, I purchased two of them. The first was again a low cost ($10) Chinese knock-off labeled as an ADE-25. It had the same specs. as a Mini-Circuit model ZX05-25MH. So, I also purchased one of them for comparison. It cost $46 Their key specs. were: RF/LO 5 MHz - 2.5 GHz, IF 5 MHz - 1.5 GHz, +13dBm LO drive, -7dB conversion loss. Measurements showed both mixers performed identical. Both had -7dB conversion loss for 23cm band. However, as noted in the previous newsletter, I found a curious thing happened when I measured sensitivity. If I interchanged the RF and IF ports, I got much better sensitivity, 10 dB better !

LO: For the local oscillator, I tried two different frequency synthesizers. See the previous Nov. 2022 ATV newsletter, issue #115 for a discussion of synthesizers from both Analog Devices and Maxim. For this experiment, I used the older Analog Devices ADF-4351 and the newer Maxim MAX-2870. The ADF-4351 was the version on an open pc board with a key pad for data entry. Cost was $35. The MAX-2870 was also an open pc board with a touch screen for data entry. Cost was $76. I wanted to down convert the 23cm band down to the 70cm band. So RF = 1243 MHz and the desired IF = 423 MHz. Thus the LO frequency was 820 MHz. The synthesizers had been modified with added large capacitors on their +3.3Vdc voltage regulators to improve their phase noise. Both synthesizers put out rf of the order of 1 mW (0 dBm). So I used a $10 SBB5089 Chinese amplifier to boost their output. The result was about 100mW (+20dBm). I then used a 6dB, SMA pad to drop the LO drive power to +14dBm.

Pre-Amp: I used two dramatically different pre-amps for comparison. The first was a $10, Chinese, broad-band, LNA of generic description. Bare pc board with SMA connectors and it required +5Vdc power. The second was a KH6HTV Video model 23-LNA with 14dB gain, 0.7dB noise figure. It included a 23cm band-pass filter to exclude out of band signals. It required +12Vdc at 100mA. Price is $90.

Band-Pass Filter: I also tried using a 70cm band-pass filter on the IF line between the mixer and the IF receiver. I used a KH6HTV Video model 70-BPF. -3dB pass-band 400-470 MHz, -1dB, $60

IF Receiver: I used a consumer grade, combo DVB-T & DVB-S receiver for these experiments. Cost is $60.



Experimental DIY 23cm / 70cm Down-Converter

Test Signal Source: I used a Hi-Des model HV-320E DVB-T modulator to generate the test signal for measuring sensitivity. I set it up for standard, normal ham operation conditions of: 6 MHz band-width, QPSK, 8K FFT, 5/6 code rate (FEC), 1/16 guard, HDMI 1080P, 5.5 Mbps. I set the frequency to 1243 MHz. The rf output was +6dBm. I used a DVD player with a pre-recorded home video to provide "live" video and audio. The DVD player and modulator were on one test bench in the ham shack. A long 18ft, run of coax cable took the test signal to another test bench where the receiver under test was located. This was necessary to provide spatial rf isolation between the strong test source and the receiver under test. Fixed SMA attenuators plus a 0-69dB step attenuator were then used to provide a weak signal to the receiver under test.

TEST RESULTS: I measured the digital threshold sensitivity for several different combinations. Sensitivity is defined as the weakest rf input signal which gives perfect P5/Q5 video and audio. Losing one more dB causes either freeze framing or total loss of signal.

Two key observations: (1) Both the MAX-2870 and the ADF-4351 LO gave the same performance. (2) Both of the mixers also gave the same performance. Plus I needed to interchange the RF and IF ports for best sensitivity.

This table summarizes the results. RF in = 1243 MHz. IF out = 423 MHz. LO = 820 MHz. A dramatic improvement is made using an LNA over just the mixer. The 70cm BPF helped by 1dB.

23cm Down-Converter Configuration	**DVB-T Sensitivity**
Mixer Alone	- 83 dBm
Mixer + China LNA	- 91 dBm
Mixer + KH6HTV model 23-LNA	- 93 dBm
Mixer + KH6HTV model 23-LNA + 70cm BPF	- 94 dBm
Hi-Des model HV-120-1.2G Receiver	- 90 dBm
Hi-Des model HV-120-1.2G Receiver + KH6HTV model 23-LNA	- 97 dBm
KH6HTV Video model 23-7 Down-Converter (*)	- 99 dBm

For purposes of comparison, I have also included measurements made on a Hi-Des model HV-120-1.2G DVB-T receiver. It is broad-band with frequency coverage from 100 to 950 MHz plus 1200 to 1300 MHz. Current price is $259. Hi-Des also has made in the past the HV-120A version which also covers 1150 to 2650 MHz. The -1.2G version includes a 23cm SAW filter. The "A" version does not.

(*) (data from AN-61) The last item listed was the KH6HTV Video model 23-7 Down Converter. It had the best sensitivity of all coming in at -99 dBm. It was built much along the same line as the down converter discussed here. It included the same model 23-LNA and the same mixer. It's performance was due to a much quieter frequency synthesizer LO. However, it is no longer available for sale. I was previously offering it for sale at $350. At this price level, I had almost no sales. I developed it in 2013 and had only sold 10 of them over the years. I had some extremely expensive, obsolete components in it which drove the price up dramatically. I lost all of my inventory of those obsolete parts in the fire.

13cm Down-Converter

In the paragraphs above we discussed how to roll you own 23cm down-converter. As it turns out most all of the same components can be re-used for a 13cm (2.4 GHz) down-converter. It mainly consists of simply re-programming the LO frequency. This assumes the $10 broad-band LNA is used instead of the 23cm only, KH6HTV model 23-LNA.

The best location in the 13cm band for ATV is in the 10 MHz immediately below 2.4 GHz. The 2.3 GHz, 10 MHz band segment is primarily for the weak-signal SSB/CW/EME folks. This 2.4 GHz, 10 MHz slot is exclusively allocated for amateur radio use. Above 2.4 GHz, we have to share with thousands (millions !) of un-licensed ISM, part 15, Wi-Fi users. So going as far as possible away from Wi-Fi, would dictate we place our 6 MHz DATV at a center frequency of 2393 MHz. We can pick most any IF frequency in the VHF/UHF band as our DVB-T receivers typically tune up to at least

850 MHz. I picked an IF of 803 MHz. Thus, the LO required was 1590 MHz. However, you can use most any arbitrary LO & IF.

TEST RESULTS: The ADE-25 and the Mini-Circuits mixer are specified to work up to 2.5 GHz. I measured the conversion loss of both to be about -9 dB. I also measured the sensitivity of the down converter for receiving DVB-T signals. I used the same test setup as described above for the 23cm band. This table summarizes the results. RF in = 2393 MHz. IF out = 803 MHz. LO = 1590 MHz. For this band, using the Maxim MAX-2870 demonstrated lower phase noise and gave a significant 3dB improvement in sensitivity.

13cm Down-Converter Configuration	**DVB-T Sensitivity**
Mixer Alone + ADF-4351 LO	- 82 dBm
Mixer + China LNA + ADF-4351 LO	- 87 dBm
Mixer Alone + MAX-2870 LO	- 85 dBm
Mixer + China LNA + MAX-2870 LO	-90 dBm

SUMMARY: Are you looking for some way to be able to receive DVB-T signals on the 23cm and 13cm bands ? Well, if you are willing to do something similar to what I am showing here, you can do it for about $75 minimum. This breaks down to LO $35, LO amp $10, SMA pad $10, mixer $10 and LNA $10 as a bare minimum. Good Luck !

73 de Jim, KH6HTV, Boulder, Colorado

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).

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