Boulder Amateur Television Club
TV Repeater's REPEATER

August, 2020
2ed edition

BATVC web site: www.kh6htv.com

ATN web site: www.amateurtelevisionnetwork.org

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

W0BTV Details:

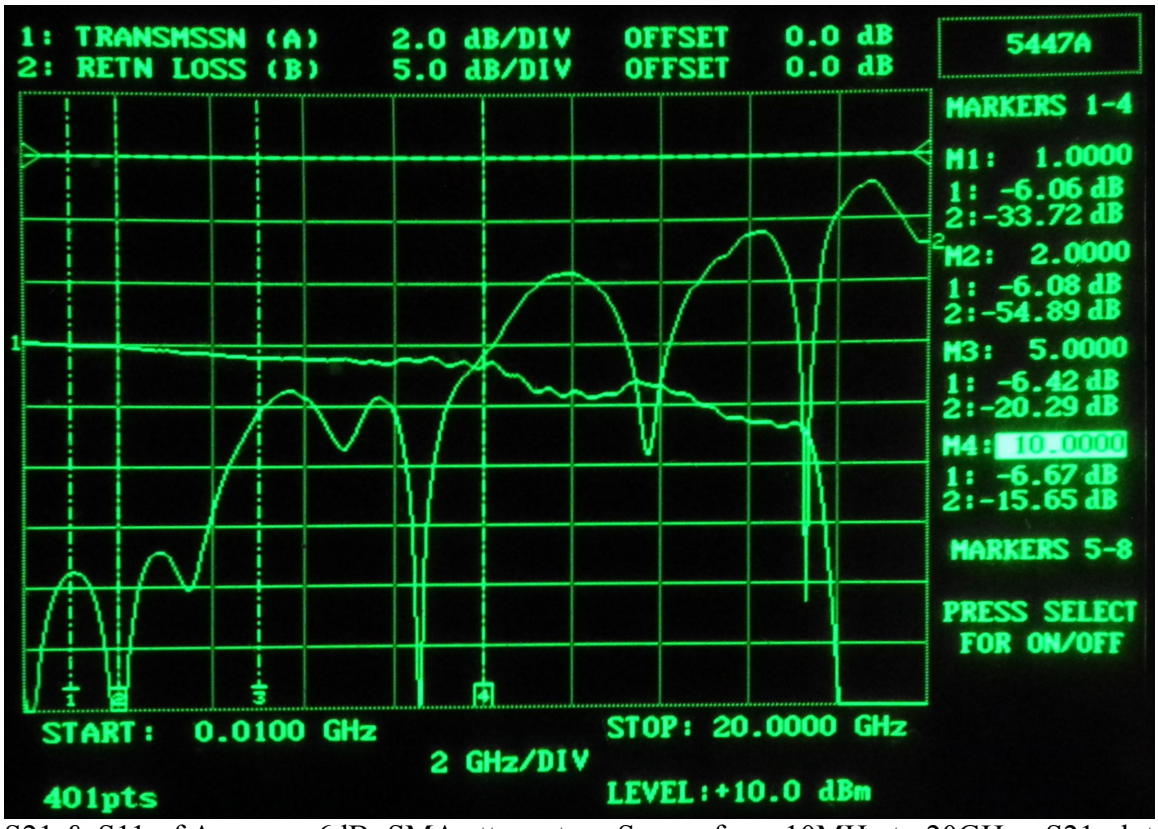
Inputs: 439.25MHz, analog NTSC; 441MHz/6MHz BW, DVB-T & 1243MHZ/6MHz BW, DVB-T Output: 423MHz/6MHz BW, DVB-T Operational details in AN-51a Technical details in AN-53a. Available at: https://kh6htv.com/application-notes/ We hold an ATV net on Thursday afternoon at 3 pm MDT. ATV nets are streamed live using the British Amateur TV Club's server, via: https://batc.org.uk/live/kh6htvtvr or n0ye.

New App. Notes:

This issue of the ATV newsletter contains two new KH6HTV application notes. AN-50a deals with the sideband sensitivity of DVB-T with a total reversal of the findings previously published in AN-50 a year ago. AN-57 reviews the differences in three Hi-Des, DVB-T, receivers, namely the HV-110, HV-120A and the newest HV-122.

Are AMAZON SMA Attenuators OK ?

For a lot of home-brew projects, especially for microwaves, we often need to use a coaxial attenuator. In the past, these have been quite expensive. Perhaps the least expensive of the major, USA, microwave suppliers has been Mini-Circuits (www.minicircuits.com) From Mini-Circuits an SMA attenuator with a DC-18GHz, 2 Watt rating sells for $32 each. Now with Amazon.com importing lots of stuff from China, we are starting to see SMA attenuators for much lower prices. Most all of the SMAs offered on Amazon are listed as 2 Watts, DC to 6GHz, but with no other specs. Some are selling for as low as $7 each. The ?? is -- are they any good? Pete, WB2DVS, recently purchased some from Amazon and asked me to test them on my Wiltron 20GHz network analyzer. Pete loaned me a 3dB & 6dB pad for testing. Here is the result for the 6dB attenuator.



S21 & S11 of Amazon, 6dB, SMA attenuator. Sweep from 10MHz to 20GHz. S21 plot at 2dB/div. is top curve #1 starting from the left side. S11 plot at 5dB/div. is the bottom curve #2 starting from the left side. Markers show measured values at 1, 2, 5 & 10 GHz. Measured on Wiltron model 5447A Network Analyzer.

The attenuator tested very well out to 10 GHz. It should not be used beyond 10GHz. It shows a dramatic cut-off above 17 GHz. The impedance match, S11, was extremely good up to 4GHz. The 3dB attenuator's result was similar. Thus, the 6 GHz rating is believable.

Jim, KH6HTV

El-Cheapo RP-SMA Adapter:

Don, N0YE, has come up with a zero cost adapter for some reverse polarity SMAs. If you want to adapt an RP-SMA plug which has a female center pin to a conventional SMA jack which also has a female center pin -- Don suggests simply using a short wire. For a standard polarity SMA, the center pin has a 0.9mm diameter. This is exactly the same diameter as the center conductor for 0.141" semi-rigid coax cable (RG-402). Thus if you happen to have any scrap pieces of 0.141 laying around, simply snip off a short piece of the center conductor and Bingo ! you have yourself an RP adapter.

Application Note
AN-50a

Sept, 2019
Rev. July, 2020

web = www.kh6htv.com email = kh6htv@arrl.net

Is DVB-T Sideband Sensitive ?

Jim Andrews, KH6HTV

Application Note, AN-36, in 2017, has previously discussed the basics of what is required to operate at microwave frequencies with DVB-T. We can purchase from Hi-Des in Taiwan, both modulators and receivers that will work up to the 13cm (2.4 GHz) band. Above there in frequency, we need to then start using mixers and local oscillators to up/down convert. So, one question arises right away -- *"What happens when sidebands are inverted ?"*

When using a mixer and LO, the resultant output contains two mixing product signals,

$$f_{usb} = f_{lo} + f_{if} \quad \& \quad f_{lsb} = f_{lo} - f_{if}$$

The polarity of the RF sidebands remains the same as the IF for the plus (+) mixer product. But the polarity of the sidebands is reversed for the minus (-) mixer product. When running single sideband voice, this makes a big difference. Inverting the sidebands results in un-intelligible speech. *What does it do to a DVB-T, digital TV signal ? ? ?*

The Quick Answer is ---- YES ! DVB-T is sensitive to inverted sideband. *

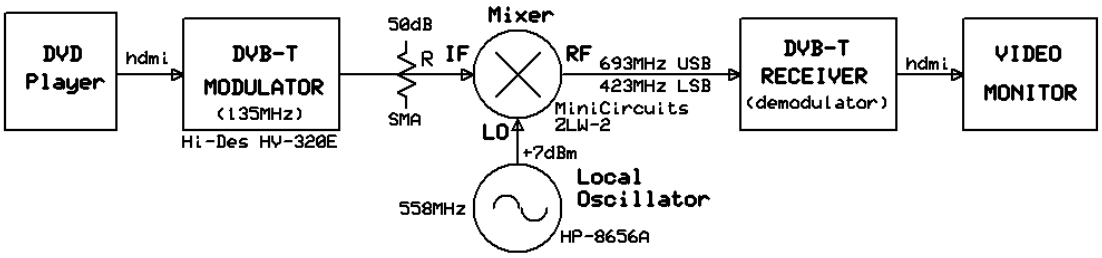


Fig. 1 Test set for mixer/LO tests of DVB-T

To experimentally determine this, I set up a controlled experiment. See above Fig. 1. I started with a DVB-T receiver which had already been trained to receive normally 423

** note - This conclusion is contrary to what I originally published in the first version of this AN-50 in Sept. 2019.*

MHz on the 70 cm band. I also then trained the receiver to receive normally on 693 MHz. I then programmed the HV-320E modulator to put out a normal DVB-T signal on 135 MHz. With a local oscillator set to 558 MHz, the USB product was 693 MHz, while the LSB product (with inverted DVB-T signal) was on 423 MHz. I then tried three different Hi-Des DVB-T receivers. They were the models HV-110, HV-120A & HV-122.

Both the HV-110 and the HV-120A worked perfectly with either sideband.

But the HV-122 refused to decode the inverted sideband at 423 MHz.

Thus the conclusion is: Yes, DVB-T is Sideband Sensitive.

Pete, WB2DVS, had recently purchased the HV-122, which I tested, for use with a 10 GHz transverter which in fact used an LO which inverted the polarity of the received DVB-T signal and he found that he was unable to receive any of the other Boulder ATV ham's 10 GHz, DVB-T signals. Pete contacted customer support at Hi-Des and they confirmed for him that "Yes, in fact, the HV-122 will not decode inverted sideband signals."

Further research on the subject by Bill, AB0MY, and Don, N0YE, looked into using USB TV Tuner dongles as potential receivers for microwave, DVB-T, experiments. They also found the dongles would not decode inverted sideband signals. They were using the free computer program, VLC, to run their dongles. They did find in the Advanced Options menu of VLC a line labeled "Spectrum Inversion" which should handle this situation. However changing this setting, it still refused to work with their dongles.

DVB-T SENSITIVITY to Frequency Error and Phase Noise:

Frequency Offset: With this same LO/mixer test set, it was then a simple matter to determine the sensitivity of a DVB-T receiver to having a signal with the center frequency offset from the correct frequency. Adjusting the LO frequency of the HP signal generator, I found that I could move the LO up or down about ± 550 kHz and the receiver would retain lock. Thus, a DVB-T signal with Doppler shift up to this amount should still work.

Phase Noise: The next test was also simple to perform. What happens with phase noise? I was able to simulate this by turning on the FM modulation of the HP signal generator. What I found was the DVB-T receiver was very sensitive to small amounts of FM deviation of the center frequency. With a 1 kHz test tone, the receiver worked only up to about 600 Hz deviation. With a lower 400 Hz test tone, it was worse. 200 Hz deviation caused pixelization and anything higher, the receiver failed. The following table shows the degradation of a DVB-T signal's signal to noise ratio (S/N) with increasing FM deviation with a 1 kHz test tone. (the test DVB-T signal was QPSK,

1080P, 6Mbps, 1/2 FEC, 1/16 guard). Bottom Line -- DVB-T can not tolerate much FM or phase noise.

Deviation	S/N
none	23 dB
100 Hz	23 dB
200 Hz	20 dB
300 Hz	14 dB
400 Hz	11 dB
500 Hz	9 dB
600 Hz	8 dB
700 Hz	0 dB (i.e. no picture)

==========

Application Note
AN-57

August, 2020

web = www.kh6htv.com email = kh6htv@arrl.net

Comparison of Hi-Des DVB-T Receivers

Jim Andrews, KH6HTV

HV-110 Receiver (170 - 950 MHz)

HV-120A Receiver (100 - 950 MHz & 1.15 - 2.65 GHz)

HV-122, Diversity Receiver (170 - 862 MHz)

The major supplier of DVB-T equipment for USA, ATV hams is Hi-Des in Taiwan (www.hides.com.tw). They supply both modulators and receivers. App. note, AN-42 reviewed the most popular modulator, the model HV-320E, and compared it to the older HV-100EH [1]. App. note, AN-27a, reviewed the HV-120 receiver and compared it to the original HV-110 [2]. Since then Hi-Des has added a newer receiver, their model HV-122. This application note reviews the Hi-Des models HV-110, HV-120A & HV-122. It also discusses in more detail the HV-122.

Comparison Table for the 3 Hi-Des Receivers

Parameter	HV-110	HV-120A	HV-122
List Price	$169 (sometimes on sale for $125)	$209	$269
Frequency Coverage	170-950MHz	100-950MHz & 1.15-2.65GHz note: 2 separate SMA antenna inputs	170-862 MHz
ATV Amateur Bands covered	70cm & 33cm	70cm, 33cm, 23cm & 13cm	70cm only
Measured Sensitivity, ** see note	-95dBm, 70cm -93dBm, 33cm	-95dBm, 70cm -96dBm, 33cm -91dBm, 23cm -92dBm, 13cm	-95dBm, 70cm
Measured Sensitivity -- with low noise preamp	-98dBm, 70cm	-98dBm, 70cm -97dBm, 23cm	-98dBm, 70cm
Bandwidths supported	2, 3, 4, 5, 6, 7 & 8 MHz	2, 2.5, 3, 4, 5, 6, 7 & 8 MHz	1, 1.5, 2, 2.5, 3, 4, 5, 6, 7, & 8 MHz diversity, 2.5 MHz or higher
Inverted Spectrum supported	Yes, Automatic	Yes, Automatic	NO
Diversity Reception	NO	NO	YES, 2 antenna inputs
Video Coding Formats supported	MPEG-2, MPEG-4 H.264	MPEG-2, MPEG-4 H.264	MPEG-2, MPEG-4 H.264
A/V Outputs	HDMI & composite video + stereo line level audio	HDMI & composite video + stereo line level audio	HDMI & composite video + stereo line level audio
Control	IR remote control only	IR remote control & Up/Down channel push buttons	IR remote control & Up/Down channel push buttons
Front Panel Display	2 digit Channel #	2 digit Channel #	2 digit Channel #
On Screen Display S meter in dBm	Yes	Yes	No
On Screen Display Signal/Noise dB	Yes	Yes	Yes
Cooling Fan	No	Yes	Yes
DC Voltage	+5 V	+12 V	+12 V
DC Current	600 mA	390 mA	450 mA

** Note: The sensitivity was measured using "Normal" ATV digital parameters. They are: QPSK modulation, 1080P resolution, 5/6 code rate (i.e. FEC), 1/16 guard, 6 Mbps.

For detailed comments on the earlier models HV-110 & HV-120A, see AN-27a, reference [2]. The following comments are for the newest model, HV-122.

Frequency Coverage: The HV-122 worked at the low spec. limit of 170MHz, but would not work at the high spec. limit of 862 MHz. It did function properly at 850 MHz. The HV-122 only covers the amateur 70cm band for ATV. The HV-110 & HV-120A cover more amateur bands.

Low Bandwidths: The HV-122 did work all the way down to 1 MHz bandwidth. I used the HV-320A to generate low bandwidth, DVB-T test signals. At 1 MHz, I was only able to use 360x480 resolution video at 400 kbps. 2 MHz bandwidth worked with 720x480 video at 2 Mbps. 4 MHz bandwidth worked with 1280x720 video at 4 Mbps.

Spectrum Inversion: There is no Hi-Des specification given on the ability to work with inverted sideband DVB-T signals. The HV-122 was tested and found that it would not work with an inverted sideband. Both the HV-110 and HV-120A work fine with inverted sideband spectrum and they do it automatically. For details on the measurement to test spectrum inversion, see AN-50a, [3]

Sensitivity: The HV-122 was found to have the same identical sensitivity on the 70 cm band as the HV-110 & HV-120A. For details on the measurement procedure to test sensitivity, see reference [4].

dBm S Meter: The HV-122 does not have an On-Screen-Display (OSD) capability for displaying the RF input power level in dBm. Both the HV-110 and HV-120A do have this capability. What the HV-122 does have is a relative signal strength bar graph which can be activated, via the remote control, along with a lot of other digital parameters. This appears as a semi-transparent, gray over-lay on the video image. A calibration curve was run on the HV-122 bar graph. The bar graph has values ranging from 0 to 100%. With no input signal, the background, residual noise level indicated 9%. When performing the sensitivity measurements, the P5 picture digital threshold indicated 15% (at -95dBm, 70cm). From that point on upward, I found that for each 10dB increase in input power level, the bar graph increased 10%. It maxed out at 100% with -4dBm input. Thus, with this calibration curve, one could calculate the actual rf input power in dBm.

Diversity Reception: I set up an experiment to verify if the diversity feature really worked on the HV-122. Using the same setup as I used to measure sensitivity, I split the DVB-T test signal into two paths using a 6dB resistive power divider. I put a 20dB, SMA attenuator in one path and connected that to one of the two antenna inputs. In the other path, I put a rotary step attenuator (0-69dB in 1 dB & 10dB steps) and connected it to the other antenna input. I intentionally used different cable lengths to alter the incoming phase between the two antenna inputs. I set the overall test signal level so that the max. input signal to the receiver was about 10dB above the digital threshold. I then rapidly switched the step attenuator through it's range. At 0dB setting, it's signal was the

strongest input. When it was 20dB, both antenna signals were equal. When the step attenuator was set > 20dB, it's signal was weaker. As I changed the attenuator settings, the HV-122 receiver never lost lock on a signal. However, I noted that the switching back and forth from one antenna receiver to the other was not seamless. There was always a jerkiness in the displayed video when switching between antenna inputs.

Low Latency Mode: Both the HV-120A and HV-122 are capable of working in a low latency mode. This feature is important IF one if using the equipment to actually fly an R/C aircraft, such as a drone, using the on board camera to actually pilot the aircraft. Otherwise, the typical DTV long latency is a major safety issue. Thus Hi-Des has included this option. One needs to go into the setup menu to activate this feature in the receiver firmware. However, it only works when used with a matching Hi-Des modulator (Hi-Des calls them transmitters) in which the same low latency mode in the firmware has been activated. For general ATV activity with multiple transmitters being used by various ATV hams, one should stay with standard DVB-T coding and not use the low latency mode.

Encryption: The Hi-Des modulators and receivers are capable of having their DVB-T transmissions encrypted. This feature should never be activated as it is illegal for USA radio amateurs to use encrypted transmissions.

CONCLUSION: *I do not recommend the HV-122 receiver as a 1st choice for amateur radio/TV (ATV) usage.* It is more suitable for use with remote control (R/C) aircraft, such as drones. In that environment, the diversity reception is an important feature to be able to track a moving aircraft with constant doppler shift and fading rf signals. Other reasons for my conclusion include: Cost -- it is the most expensive of the 3 receivers. Frequency Coverage -- it only covers the 70cm amateur band. Spectrum Inversion -- For ATV use at microwave frequencies, it restricts the options on available local oscillators. S Meter -- the other receivers have a direct reading dBm S meter.

AVAILABILITY: Unfortunately, at the present time (Aug., 2020), Hi-Des seems to be trying to push the HV-122 in preference to the older HV-110 and HV-120A. They are obviously trying to market it to the drone market (the buzz word is FPV for First Person View). Plus they sell it for a higher price. Oftentimes, when checking the Hi-Des, E-Bay web site, they do not list for sale the HV-110 or HV-120A. They only offer the HV-122. If you really want to purchase the HV-110 or HV-120A, I thus recommend that you contact Hi-Des customer service directly via e-mail. (sales@hides.com.tw) The customer support from Hi-Des is excellent. If you ever encounter any issues with your Hi-Des equipment, do not hesitate to contact them. They respond to e-mail inquiries within 24 hours or less.

Other Hi-Des Receivers: Hi-Des sells several other options for the receivers reviewed here along with several other receiver products.

HV-110: There are no other options. The 110 was Hi-Des' original, stand alone, DVB-T receiver.

HV-120: Besides the "A" version reviewed here, Hi-Des also offers two other options (-1.2G & 2.4G) which include a SAW band-pass filter on the front end of the High Band SMA input. With the SAW filter, the high band, frequency coverage range is thus limited to only the 23cm or 13cm band.

HV-122: The standard HV-122 version is reviewed here. The -2.4G version includes a SAW filter and only works on the 13cm band (2.1 - 2.55GHz). The "A" version covers a very wide band from170MHz to 2.7GHz. But Hi-Des warns in a small footnote on their web site, it has very poor sensitivity, down -20dB, from 170 to 700MHz. Thus it is only really useful from 0.7 to 2.7GHz. Thus I feel it is not worth considering.

USB TV Tuner Dongles: Hi-Des also sell several USB dongles with model numbers of UT-100, UT-120, UT-130 & UT-160. The USB dongles all require a supporting PC computer. Thus, I feel they are only useful for ATV service in the ham shack. They are not as generally useful as the stand alone units. Plus they are quite expensive, compared to the garden variety of TV tuner dongles, which can be purchased for $25 or less.

REFERENCES:

1. "Second, Re-Evaluation of Hi-Des, Model HV-320E, DVB-T, Modulator", Jim Andrews, KH6HTV Video Application Note, AN-42, Dec. 2017, 7 pages

2. "Evaluation of New Hi-Des, Model HV-120A, DVB-T, Receiver", Jim Andrews, KH6HTV Video Application Note, AN-27a, March 2016, 5 pages

3. "Is DVB-T Sideband Sensitive ?", Jim Andrews, KH6HTV Video Application Note, AN-50a, July, 2020, 3 pages

4. "Measuring ATV Receiver Sensitivity & Received Signal Strength", Jim Andrews, KH6HTV, -- Boulder Amateur TV Club -- TV Repeater's REPEATER, club newsletter, issue #46, June, 2020, pp. 6-9. available at: https://kh6htv.com/newsletter/

==========

Newsletter Details: This is a free newsletter distributed electronically via e-mail to ATV hams. The distribution has now grown to almost 350. 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. 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.**