Application Note
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Evaluation of Hi-Des HV-310E
DVB-T Modulator & Comparison with HV-100EH & HV-320E

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Fig. 1 --- Hi-Des, DVB-T, Modulators. Front View.
Bottom is HV-100EH. Top Left is HV-310E. Top Right is HV-320E

About six years ago, Hi-Des, in Taiwan (*www.hides.com.tw*) introduced their model HV-310E, DVB-T transmitter. Note: Hi-Des calls them "transmitters", but I prefer to call them "modulators" because of the relatively low, milli-watt output powers from them. So in 2015, Jack, K0HEH, purchased one of the HV-310Es. Jack let me evaluate it. I ran a few tests on it and was un-impressed. My reaction at the time was "Do Not Buy !". However, I did not fully evaluate it, nor publish my results. More recently, Chris, K0CJG, purchased an HV-310E and he has kindly loaned it to me to again evaluate and this time publish the results of my tests. Again after this most recent evaluation, my conclusion remains the same, i.e. "Do Not Buy" for ATV service.

This evaluation focuses on the HV-310E, but also compares it against two other Hi-Des, DVB-T modulators. They are the original model HV-100EH and a later one which came after the 310, the model HV-320E. The 100 & 320 were evaluated in 2016 & 2017 and documented in AN-28a and AN-42 [1, 2] which are also recommend reading. The table on page 3 summarizes the results of the current tests for these three models.

Fig. 2 --- Hi-Des, DVB-T, Modulators. Rear View.
Bottom is HV-100EH. Top Right is HV-310E. Top Left is HV-320E

Hi-Des sells the model HV-310 in several different versions. The difference being the final rf amplifier installed. All versions cover from 0.1 to 1.35GHz. Different amplifiers are optimized for different frequency ranges. For amateur TV (ATV), the bands of most interest are the 70cm (420-450MHz) and 23cm band (1240-1300MHz). The one tested for this app. note was the model HV-310E which is optimized for the 70cm band with +15dBm of rf power. The other versions available are: the HV-310EH with power peaked for 23cm band (+5dBm) and the HV-310EH-PA1200 with extra power peaked for 23cm and +20dBm max. output. The 310 also includes a rear panel switch to allow the final amplifier to be switched in and out of the circuit. In the HV-310E, this amplifier had a gain of 21dB at 70cm.

CAUTION: Hi-Des has in it's HV-310 instruction manual this warning.
Never operate the transmitter without a 50 Ohm antenna or dummy load connected to the antenna port. Never operate the Hi/Low gain switch when the power is on. Doing either will burn out the final amplifier.

Comparison Table - Hi-Des models HV-100EH, HV-310E, & HV-320E

Parameter	HV-100EH	HV-310E	HV-320E
Price	$560	$279	$369
Frequency Coverage	50-950MHz & 1.2-1.35GHz	90-950MHz & 1.09-1.35GHz	100MHz - 2.5GHz
Bandwidth	1, 1.5, 2, 2.5, 3, 4 5, 6, 7 & 8 MHz	1, 1.5, 2, 2.5, 3, 4 5, 6, 7 & 8 MHz	1, 1.5, 2, 2.5, 3, 4 5, 6, 7 & 8 MHz
Pout (430MHz)	3.2, 5.0 & 3.3dBm	14.7, 16.4 & 13.6dBm	7.4, 9.1 & 6.4dBm
Pout (915MHz)	0.9, 2.8 & 0.0dBm	14.2, 16.0 & 13.6dBm	5.4, 7.1 & 4.3dBm
Pout (1.27GHz)	-5.0, -3.0 & -5.7dBm	0.2, 2.0 & -0.7dBm	5.2, 7.0 & 4.3dBm
Pout (2.4GHz)	NA	NA	0.2, 1.9 & -0.8dBm
Internal switchable Amplifier	No	Yes, 21dB gain (70cm) 18dB gain (23cm)	No
Attenuator Range	+6 to -40dB	+6 to -40dB	0 to -47dB
Attenuator useful range	+6dB to -10dB	+6dB to -6dB	0 to -47dB
QPSK, 16 & 64 QAM	Yes	Yes	Yes
Carrier Leakage	Yes, -32dBm	Yes, -35dBm	No
Out of Channel Spectrum Suppression > 40dB	Yes, except for gain of +5 or 6dB	**NO !** even in best setting, humps of -35dB noted	Yes
QPSK,16QAM & 64QAM - Signal/Noise	22, 26, & 29dB	20, 24 & 28dB	23, 26 & 32dB
HDMI Input to 1080P	Yes	Yes	Yes
Composite Video + Line Audio In	Yes	Yes	Yes
MPEG-2 & H.264	MPEG-2 & H.264	H.264 only	H.264 only
Adj. Resolution	480i to 1080P	480i to 1080P	480i to 1080P
Boot-Up Time	35 seconds	12 seconds	15 seconds
HDMI loop-thru	Yes	No	No
Front Panel Channel Select Buttons	Yes	NO, must use remote control	Yes
PC control port	USB	RS-232	UART
Ethernet	Yes	No	No
Ventilating Fan	No	No	Yes
Current @13.8Vdc	420 mA	400 mA	450 mA
Conclusion	2ed choice to buy	**NO - do not buy**	**1st choice to buy**

RF POWER: The major selling point for Hi-Des for the HV-310 is it's rf output power compared to the HV-100EH or HV-320E. The secondary selling point is cost as it is their lowest cost modulator at $279. RF power is mainly a selling point for people wanting to install it as a stand-alone, digital TV transmitter in an R/C aircraft, or drone. For ATV operators, we are usually wanting and needing much higher powers in the watt region, not milli-watts. Thus, we are using these Hi-Des units as modulators driving, high gain, high power amplifiers. The higher power of the 310 is not an issue. In the above table, the max. RF output power was measured for the three different modulation modes of QPSK, 16QAM and 64QAM. The rf power measured is the RMS value. I used an HP-432A power meter with HP-8478B thermistor power head.

RF SPECTRUM: This is the one area with major differences between the three models. It is also the area I found the most objectionable on the HV-310E and my reason for my "Do Not Buy" recommendation. Fig. 4 on the following page compares the spectrums of the HV-100EH, HV-310E & HV-320E. The three colored traces are for the maximum rf output and with the internal attenuator set to lower the output by -6dB & -12dB. These were measured at 441 MHz in the amateur 70cm band. Most of the evaluations were performed at this frequency. Operation was also verified in the 23cm band.

The spectrums were measured using the spectrum analyzer settings specified by the ITU [3] for DVB-T. They are: Center Frequency = channel center frequency, Span = 20 MHz, Detector = RMS, Resolution Bandwidth = 30kHz, Video Bandwidth = 300kHz, Sweep scan = 2 seconds. In addition, I use 10 signal averages. The ITU specifies that the out of channel spectrum shoulder be measured at 200kHz beyond the channel edges. Thus for a 6 MHz channel, it should be measured at ± 3.2 MHz from the center frequency.

The Hi-Des advertised specifications for the Spectrum Shoulder (adjacent channel) is -45dB (HV-100EH), 40dB (HV-310E) and >48dB (HV-320E) Their spec. for Carrier Suppression is: >42dB for all three models.

HV-100EH: This is the top photo in Fig. 3. At the max. rf output, the spectrum shoulder breakpoint is -35dB. It only meets shoulder spec. when the output is dropped with the internal attenuator by -3dB or more. The major spectrum defect of the HV-100EH is carrier frequency leakage. It is just noticeable as a small spike on the cyan trace. Increasing the internal attenuator setting more does not lower this leakage spike. It remains at -32dBm, far worse than spec. by 10dB. Because of carrier leakage, I do not recommend the internal attenuator be set any lower than -10dB. This carrier leakage also compromises the ultimate signal to noise ratio, especially for 64QAM.

HV-310E: This is the middle photo in Fig. 3. It does not meet the >40dB spec. At the max. rf output, the spectrum shoulder break-point is -38dB, but the far worse situation is the broad hump in the spectrum occurring ± 6MHz from the center frequency. At max. rf output, it is -35dB down. But when lowering the rf output using the internal attenuator, it remains unchanged and thus becomes even worse relative to the in-channel spectrum. I also was able to measure carrier frequency leakage of -35dBm which was the same regardless of attenuator setting. I got essentially identical results when using the low power switch setting and also on the 23cm band. Because of the humpy spectrum, I do not recommend the internal attenuator be set any lower than -6dB. The signal to noise (S/N) of the rf output is also compromised by both the poor spectrum and carrier leakage.

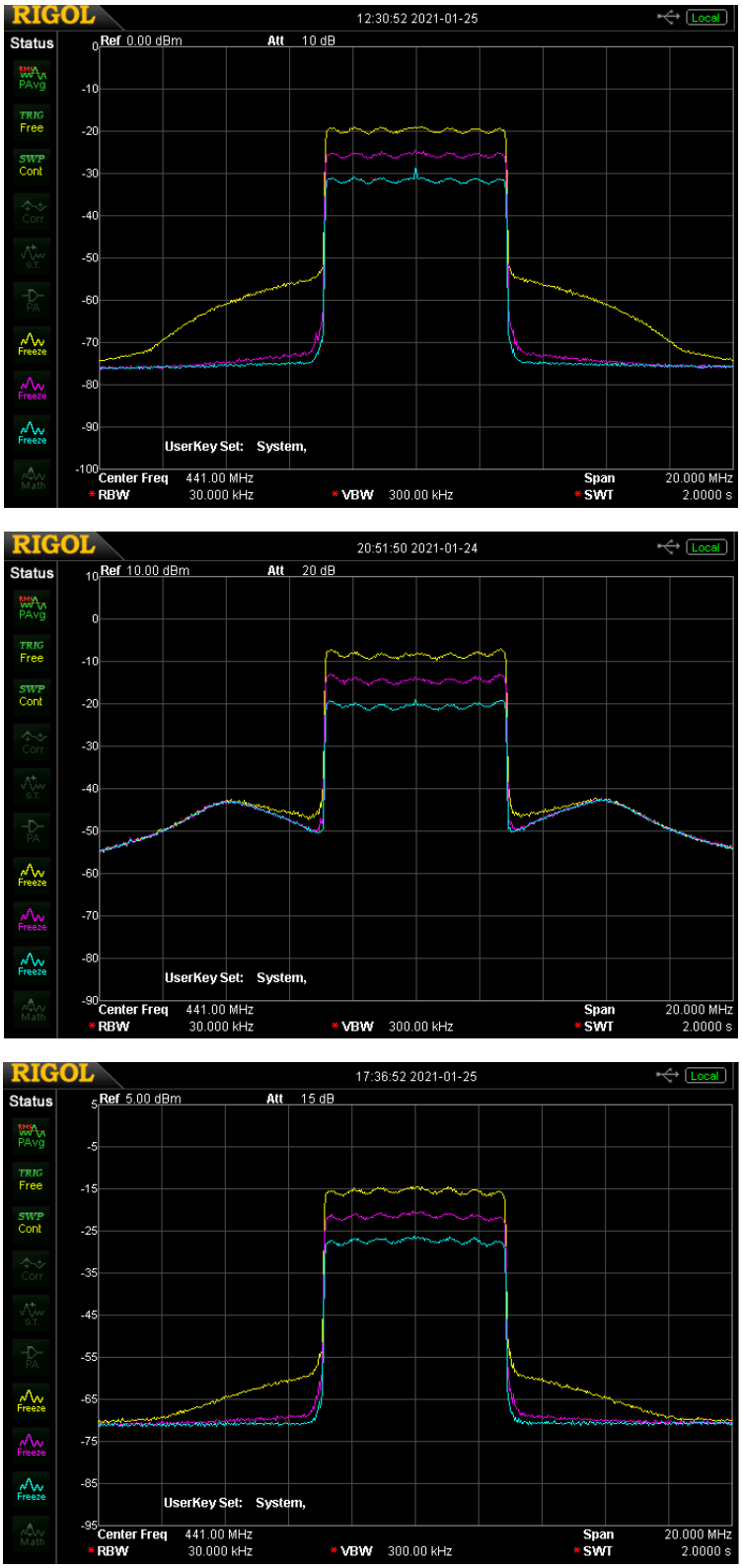

Fig. 3 --- Comparison of modulator spectrums for a 70cm DVB-T signal with 6 MHz bandwidth. Top = HV-100EH, Middle = HV-310E & Bottom = HV-320E. Spectrum analyzer settings per ITU specs. Center frequency = 441 MHz, 10dB/div & 2 MHz/div. Yellow = Max. RF output Magenta = -6dB & Cyan = -12dB

HV-320E: This is the bottom photo in Fig. 3. This modulator has a very clean spectrum. The out-of-channel spectrum shoulders were virtually non-existent. Even at max. rf output with the internal attenuator set to 0dB, the shoulder break-point was -44dB. The internal attenuator has a range of 0 to -47dB and can be used with no issues over it's entire range. No carrier leakage was detected.

Spectrum Pollution: I have always been an advocate for spectrum conservation and cleanliness. This is especially important for ATV where we use very wide bandwidths for our signals. To be a good neighbor with our fellow hams, we should not use any more bandwidth than absolutely necessary. Thus in the old, NTSC, analog TV days, I was a strong advocate for using Vestigial Side-Band (VUSB-TV), following commercial broadcast standards. I refused to use AM-TV. I even published an article in QST [4] advocating VUSB-TV over AM-TV. All analog ATV in Boulder, Colorado has been VUSB-TV since the early 90s as a result. Now, in the current, digital TV era, we can have very clean DTV signals and keep our spectrums within the designated 6 MHz (or less) TV channel. With clean spectrums, it is now even possible to operate DVB-T on adjacent TV channels. This has been shown in lab bench experiments in my app. note, AN-19 [5]. We have also with our Boulder ARES group successfully operated simultaneously DVB-T on all four, 70cm, 6 MHz, TV channels (423, 429, 435 & 441 MHz on actual field operations without interference.

So, now with the HV-310E, this would not be possible. If one lowers it's rf output to properly drive an RF linear power amplifier, the ± 6 MHz "Hump" as seen in Fig. 4 (middle photo) will start to dominate and also be amplified. These humps will directly impact and prohibit operation of any other TV transmitter, or other RF service, in both the lower and upper, adjacent TV channels. They pollute the spectrum. For this reason, I say again -- "Do Not Buy".

Out of Date Specs: The spec. sheets on the Hi-Des web site for these various models are all somewhat out of date. With more recent versions of firmware installed, I have found that all three modulators have enhanced capabilities. In particular, the bandwidths of all can now be adjusted down to 1 MHz and include 1.5 MHz, 2 and 2.5 MHz, in addition to 3, 4, 5, 6, 7 & 8 MHz. Now the output resolution is also adjustable, independent of the input resolution.

Recommendations: My personal recommendation for a DVB-T modulator is the Hi-Des model HV-320E for use on both the 70cm and 23cm band for ATV service. For a DVB-T receiver, see my app. note, AN-57a, [6] for a review of the various Hi-Des receivers. My recommendation for a 70cm receiver is the model HV-110. It is also a good buy at $99. For a 23cm receiver, I recommend the model HV-120, but with the addition of a KH6HTV Video model 23-4LNA pre-amplifier (0.9dB NF). If the HV-120 is unavailable, then instead use the HV-110 receiver with a KH6HTV Video model 23-7 Down-Converter.

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-320E DVB-T Modulator" Jim Andrews, KH6HTV Video Application Note, AN-28a, April, 2016, 14 pages.

3. "Digital Video and Audio Broadcasting Technology", W. Fischer,3ed edition, 2010. Springer Heidelberg Dordrecht, London & New York, ISBN 978-3-642-11611-7. See Chapter 21 "Measuring DVB-T Signals"

4. "Modern ATV System Design", Jim Andrews, QST, Feb. 2013, pp. 46-47.

5. "Analog & Digital TV Co-Channel & Adjacent Channel RFI Measurements", Jim Andrews, KH6HTV Video Application Note, AN-19, Sept. 2014, 8 pages.

6. "Comparison of Hi-Des DVB-T Receivers", Jim Andrews, KH6HTV Video Application Note, AN-57a, Sept. 2020, 6 pages