Boulder Amateur Television Club
TV Repeater's REPEATER

November, 2019
Special - 5th issue

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Future Newsletters: If you have contributions for future newsletters, please send them to me. We love to also include news from other ATV groups.

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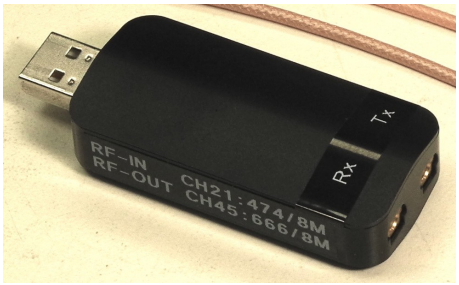
More on the Hi-Des BR-101 REPEATER



In the previous issue, Dave, AH2AR, called our attention to another Hi-Des product, the BR-101, USB dongle DVB-T repeater. Dave contacted me and asked me to do a complete evaluation of the Hi-Des BR-101EH Repeater. Dave is working with Art, WA8RMC, of the Amateur Television in Central Ohio (ATCO - WR8ATV) to establish an ATV link-up of the Dayton and Columbus, Ohio, ATV repeaters. They were considering using the BR-101EH as the key element in their WR8ATV / W8BI link translator. Dave provided me with a new unit to evaluate. I have now completed my evaluation. Dave and I have documented our findings in a joint authored, new KH6HTV Video application note, AN-54. This special issue of our ATV newsletter consists of only AN-54. It is now also posted to the web site: www.kh6htv.com

Application Note
AN-54

November, 2019

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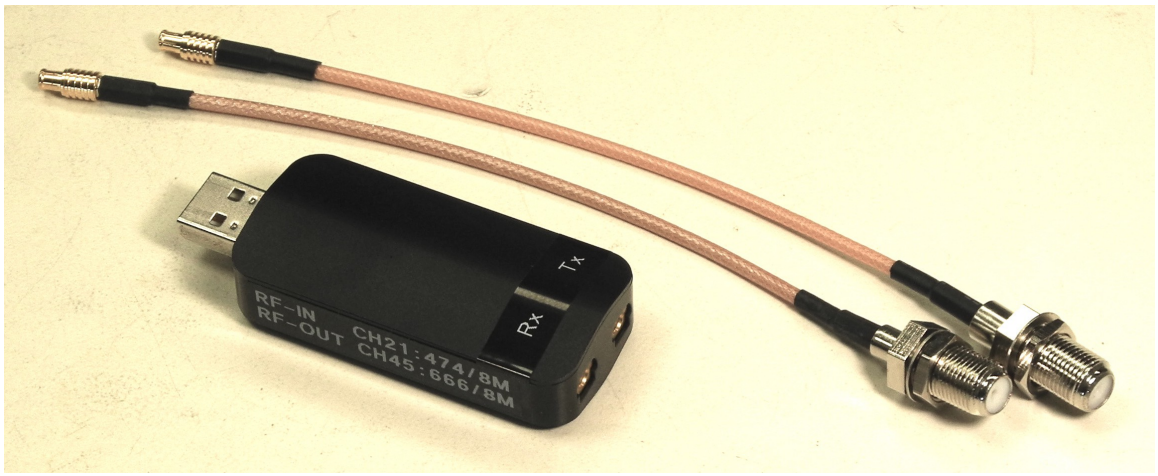
Evaluation of Hi-Des, Model BR-101EH, DVB-T Repeater

Jim Andrews, KH6HTV & Dave Pelaez, AH2AR



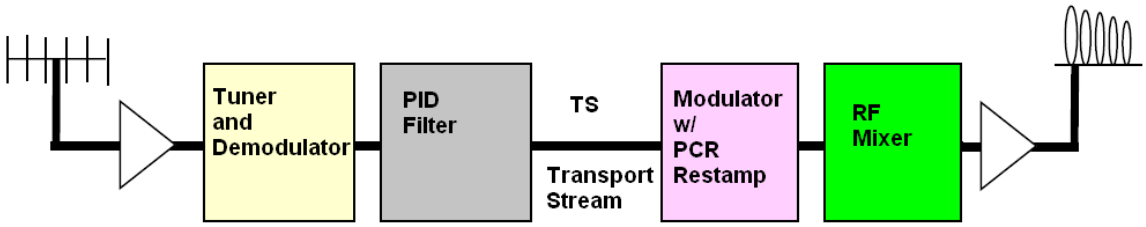


Fig. 1 Hi-Des BR-101EH & block diagram

The Hi-Des model BR-101EH is a complete, self-contained, DVB-T repeater. As seen in Fig. 1, it is extremely small. It is essentially a USB dongle TV receiver and TV transmitter combo (admittedly of very low power) with coax connectors. It is a stand-alone unit, in that it does not need a support PC computer when in operation, just a 5Vdc power supply. A PC is necessary however to initially set-up the unit's operating parameters, such as frequency, bandwidth, etc.

The block diagram in Fig. 1 shows that the incoming TV rf signal is demodulated down only to a Transport Stream (TS) level and is then modulated onto a new, different TV rf carrier frequency. Because it only goes down to a TS stream and not all the way down to an HDMI signal, and then from HDMI back again through extra decoding & coding processes, there is essentially no digital signal degradation. Hi-Des claims no MER loss or noise addition.

The input and output channels are totally independent. The new transmit channel's frequency, bandwidth, code rate, guard interval, FFT, constellation can be totally different from the original received signal's. If the input channel data rate is less than the output, auto null-packet insertion will be done in the modulator.

KEY SPECS: for the BR-101EH from the Hi-Des web site are: Receiver frequency range = 50-950MHz; Transmitter frequency range = 50-950 & 1200-1350MHz; Bandwidths 2 to 8MHz; RF power out = -4dBm, & -18dBm (1.2GHz band), MCX rf connectors, runs on USB power of 5Vdc at 390mA. Size is a large USB dongle. Price is $239 (shipping included)

http://www.hides.com.tw/product_BR101eh_eng.html

Hi-Des CUSTOMER SUPPORT: Before proceeding we want to comment on the excellent customer support from the Hi-Des company. We encountered two problems with both of the two new BR-101s we tested. The first, most serious was they did not work on the 33cm band. They quit above 880MHz. The second issue was the video call sign feature on the turn-off trailer did not work. The trailer and timer worked but no call sign video appeared. We contacted Calvin Yang at Hi-Des about these issues. Hi-Des immediately went to work and within a week got us a new firmware update which resolved both issues. So, if you ever have issues with any Hi-Des gear, do not hesitate to shoot an e-mail to Calvin at calvin@hides.com.tw

ACCESSORIES: Hi-Des supplies along with the BR-101EH, a 5Vdc, 2 Amp - AC wall wart power supply, a 7" USB extender cable, two coax cables with MCX & F connectors, and a CD. The CD contains in .pdf the spec. sheet, instruction manual, and the necessary program(s) files to set-up the unit.

SOFTWARE: The software supplied on the CD was labeled: BR-101EV03 DTV Bridge-DVBT2DVBT_V1.1_20150827. This was dated from 27 August 2015 and was their latest version as of Nov. 2019. Thus the design of the BR-101 dates from 2015. The first step in evaluating the BR-101EH was to install on a Windows PC the programming software called "DTV Bridge Controller". The Hi-Des manual is clear on how to install and use this program, except for the Call Sign. More on that later.

After encountering the above mentioned issues, Hi-Des supplied us with new firmware identified as: IT9517_1_19_1_0_DVBT_EagleDongleV3.bin If the reader should purchase in the future a BR-101, do not use the old 2015 firmware, but be sure the newer firmware is installed. If not, contact Hi-Des to get a copy of the latest firmware.

Set DTV bridge board in configuration mode by **short Jumper J1 pin 1&2**

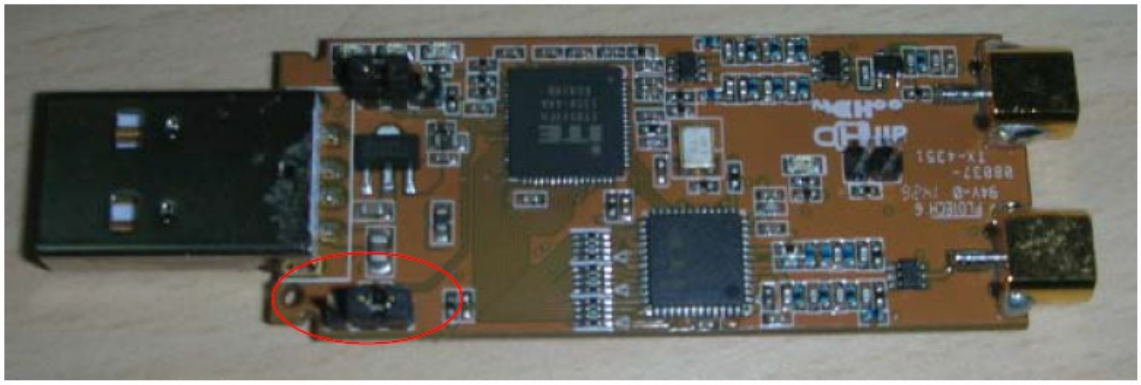


Fig. 2 BR-101EH with covers removed.

INITIAL SET-UP: As the BR-101 comes from the factory, it has been programmed to the default settings of RF-in = 474MHz / 8MHz BW and RF-out = 666MHz / 8MHz BW. Assuming you want to use it on different frequencies/bandwidths, etc. -- you will need to re-program it. To do this, it is necessary to first remove the top cover of the unit as there are several pc board jumpers that need to be set properly. This requires that you pry off the top cover. See Fig. 2. After setting Jumper J1 to Configuration Mode, then connect the unit to your PC and run the program "DTV Bridge Controller". Two green LEDs will light up on the pc board. The first screen that will appear, Fig. 3, has a high-lighted button labeled "Connect". Click on this. Next click on the "Configure" button. This brings up a configure screen with factory default settings.

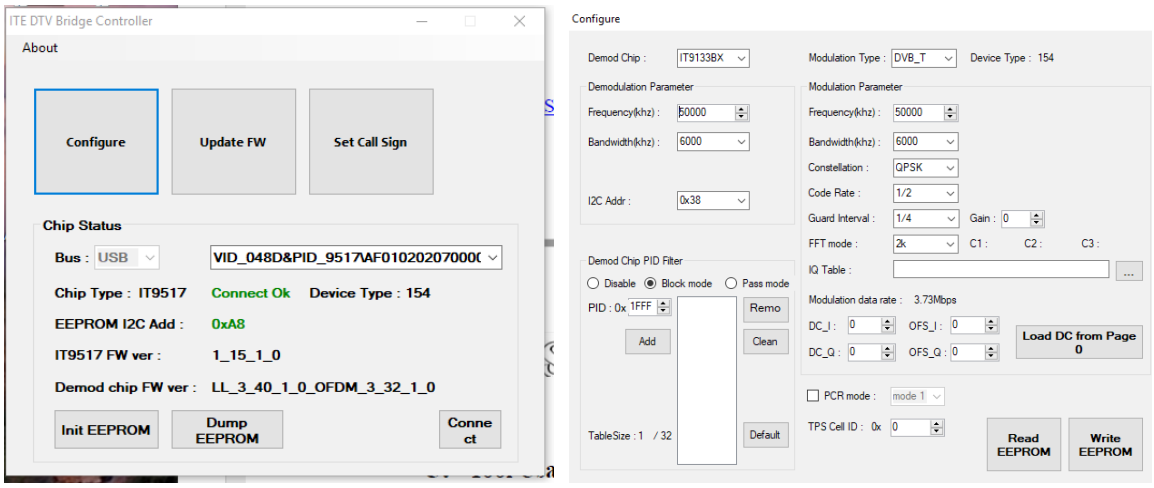


Fig. 3 Start up screen (left) and Configure screen (right) for DTV Bridge Controller

Every time we connect the unit to our PC for set-up, we will always get this default configuration screen. Next we need to click on "Read EEPROM" to down-load the current settings in the unit, which we will then modify as needed. We will always get some error message warnings. Just ignore them and click "OK". At this point, we are now ready to start programming the BR-101 to work on our desired frequencies, etc.

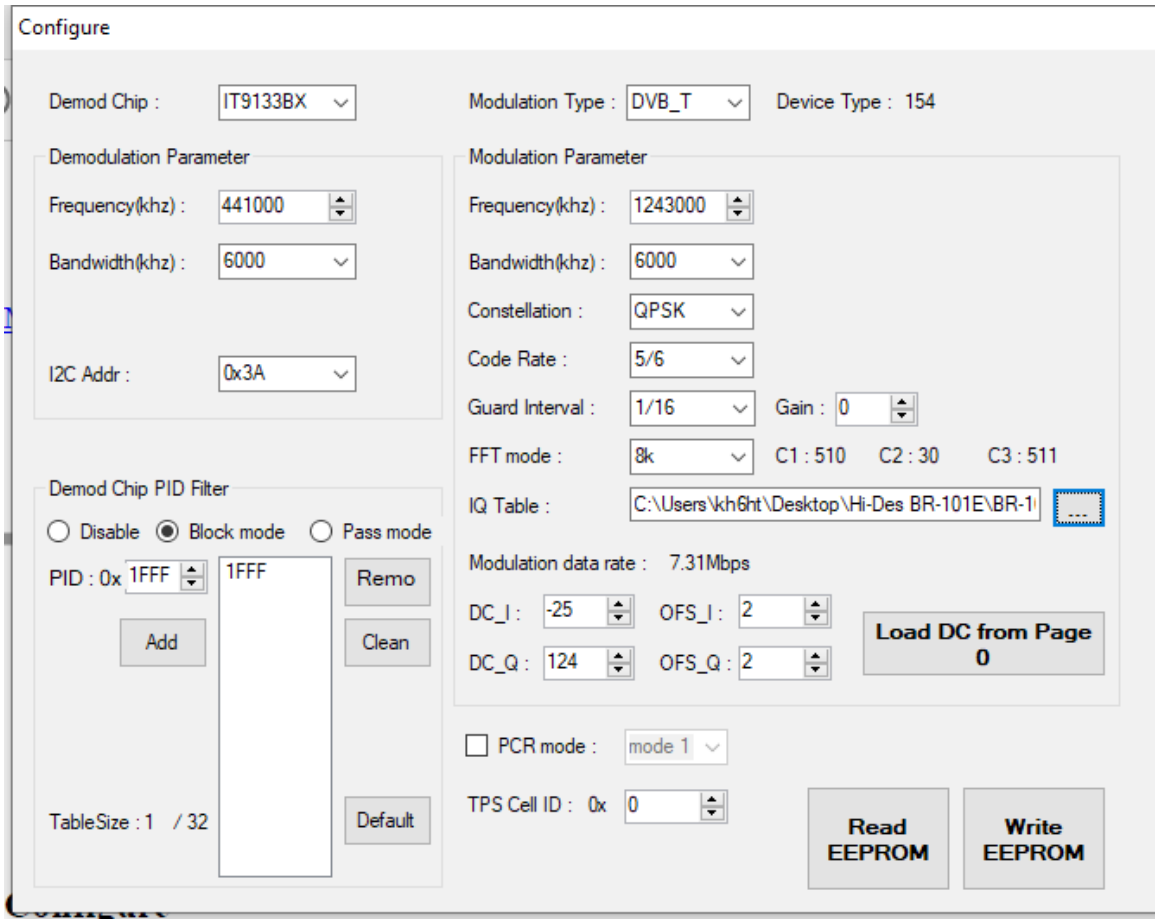


Fig. 4 BR-101EH set-up for operation as a cross-band, 70cm to 23cm DTV repeater.

Fig. 4 shows the setup used for initial testing of the BR-101 as a cross-band, 70cm to 23cm repeater. The receive frequency was set to 441 MHz and a bandwidth of 6 MHz. The transmit frequency was set to 1243 MHz again with a 6 MHz bandwidth. For the other transmission parameters of constellation, code rate (FEC), guard interval & FFT, the "Normal" settings for amateur DVB-T were used. See reference [1] for details.

Hi-Des recommends using PID BLOCK Mode and only blocking the null-packets with PID = 0x1FFF. --- thus leave set as "Block".

DC Calibration: This definitely needs to be loaded as it helps the modulator to perform properly. Follow Hi-Des instructions. It was found that it only needed to be loaded once. It was then retained in the EEPROM.

I-Q Table: Again, this definitely needs to be loaded as it helps the modulator to perform properly to achieve a good spectrum with minimal out of channel distortion products. We did find however, that it had to be reloaded every time the BR-101 was reconfigured. The I-Q Table required is supplied by Hi-Des on the CD. It is labeled as: IQ_TBL_BR101V03.bin

After you have entered all the necessary data for your desired operation, then click on the "Write EEPROM". At this point you may then close out the program and remove the unit from your PC. Before using the BR-101, you must first reset the jumper J1 to the Normal Mode (J1 pins 2-3 shorted). The table and photo on page 2 of the Hi-Des instructions shows the proper settings for the three pc board jumpers. The BR-101 is now ready for testing or operational use as a DTV Repeater.

REPEATER TEST: The first test was to see if it really functioned as a **cross-band, 70cm to 23cm, repeater**. A Hi-Des HV-100EH modulator was set on 441 MHz / 6 MHz bandwidth and input "live" HDMI, audio/video from a DVD player . A lot of attenuation on the output of the modulator was used to control the rf input to the BR-101. The rf output from the BR-101, was sent to a Hi-Des HV-120 receiver with an HDMI video monitor. A 30dB, SMA attenuator was used on the HV-120 receiver input. The receiver was set to 1243 MHz / 6 MHz bandwidth. **Bottom Line -- IT WORKED !**

Dave, AH2AR, had expressed concern about whether the BR-101 would also work as a **70cm in-band repeater.** He was worried that due to the very close proximity of the on board receiver and transmitter, there would be too much cross-talk for close in channels. The BR-101 was tested again, this time with rf input of 441/6 MHz and rf output of 423/6 MHz. Bottom Line -- **IT AGAIN WORKED !** More specific details to follow.

DC CURRENT: Hi-Des's spec. is 5Vdc @ 390mA. We measured 320mA when transmitting, 160mA in stand-by mode and 70mA in programming mode.

FREQUENCY COVERAGE: Hi-Des specifies the receiver will cover from 50 to 950 MHz and the transmitter will cover from 50 to 950 MHz plus 1200 to 1350 MHz. We tested this and found the receiver did work over this range. However, in the initial testing, there was a failure in the transmitter's coverage. It worked from 50 up to 880MHz and again for the amateur 23cm band. It would not work for the amateur 33cm band (900-928 MHz). After contacting Hi-Des, they supplied us with new firmware which resolved this problem.

RF OUTPUT POWER: Hi-Des specifies the output power will be 0dBm for 50-950 MHz and -12dBm for the 1.2 GHz band. (Note: there are inconsistencies in this spec. between the web site and spec. sheet provided on the CD) The rf output power was measured using an HP-432A power meter with a model 8478B thermistor power head (0.01-18GHz). The BR-101 was set to 6 MHz bandwidth and the internal attenuator to it's highest output setting (i.e. Gain = +6dB).

Frequency (MHz)	50	100	250	423	700	915	1243	1300
Pout (dBm)	0.5	2.2	0.0	2.6	2.0	-0.7	-5.8	-6.6

Thus the unit was in spec. for the 50-950 region. It was 6dB stronger than spec. for the 23cm band. When the bandwidth was changed to 2 MHz, the rf output power remained essentially the same. At 1249 MHz, we measured -6.2dBm.

The internal rf attenuator in the BR-101 was also spot checked using the HP power meter. The Hi-Des's spec. is 0 to -15dB in 1dB steps. It was tested at settings of +6dB, 0dB & -4dB for a range of 10dB. The delta changes were quite accurate within 0.2dB.

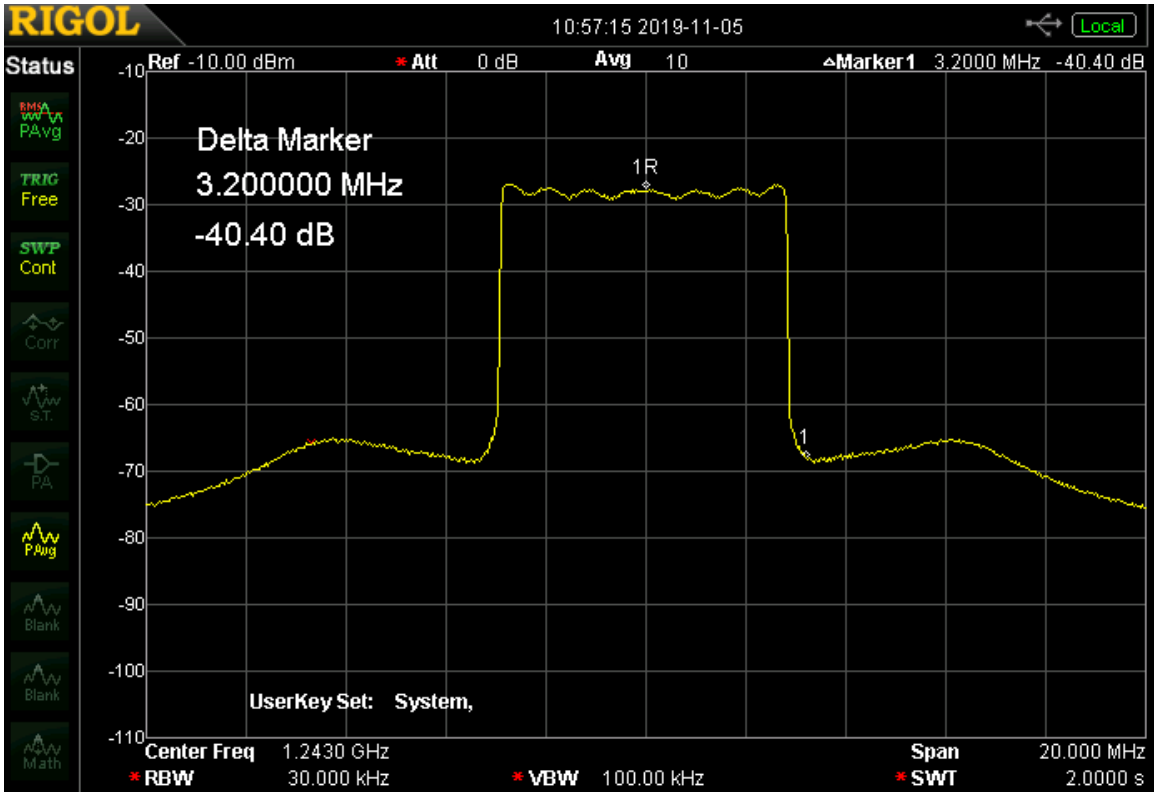


Fig. 5 BR-101EH's spectrum at 1243 MHz, 6 MHz bandwidth. 10dB/div & 2MHz/div

RF SPECTRUM: The Hi-Des spec. for spectrum shoulders is better than 40dB for the low band and better than 35dB for the 1.2 GHz band. Figs. 5 & 6 show the measured spectrums for 23cm outputs with 6 and 2 MHz bandwidths.. These were measured with the maximum rf output power setting.

Spectrum Analyzer settings were per the ITU recommendations for measuring DVB-T signals. See W. Fischer, reference [2]. Center Frequency = center of channel, Span = 20 MHz, Resolution Bandwidth = 30 kHz, Video Bandwidth = 300 kHz, Detector = RMS, Sweep = 2 seconds Spectrum shoulders are measured using markers at ±200 kHz beyond channel edge, i.e. ±3.2 MHz from center frequency for a 6 MHz bandwidth.

For 6 MHz bandwidth, the spectrum shoulders were measured at each frequency tested for rf power from 50 to 1300 MHz. In every case they were -38dB or better at 200 kHz beyond the channel edge. At every frequency tested the spectrums were essentially the same shape as seen in Fig. 5. It should be noted that there was always a peaking in the out of channel spectrum at ±6 MHz from the center frequency. This was noted for both 6 and 2 MHz bandwidths. This peaking was typically about +3dB above the measurement at the channel edge.

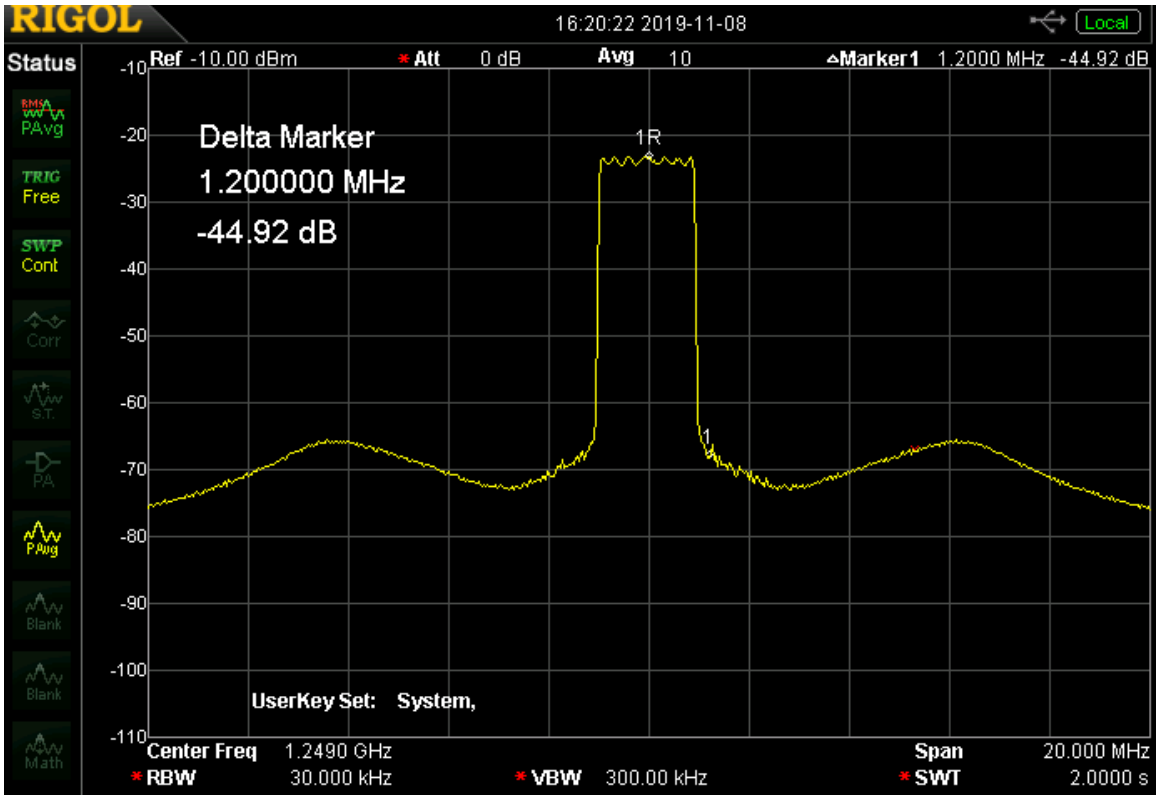


Fig. 6 BR-101EH's spectrum at 1249 MHz, 2 MHz bandwidth. 10dB/div & 2MHz/div

SPECTRUM SPURIOUS: We did discover that the BR-101 does put out a very low level carrier when in the stand-by mode. It is at the center frequency and is -62dBm in amplitude and 10 kHz wide.

RECEIVER SENSITIVITY: The test setup consisted of using a Hi-Des HV-320E modulator with input "live" HDMI, audio/video from a DVD player. To minimize leakage and to be able to precisely control the rf test signal level, the modulator and DVD player were placed in another room. A long run of RG-58 cable was used to bring the rf signal to the test bench. An HP-432 power meter was used to measure the rf signal from the coax cable at the test bench. Two, 20dB, SMA attenuators along with a Weinschel, step attenuator (0-69dB, 1dB steps) were then used to get a known, extremely weak, rf signal into the BR-101 receiver. The rf output from the BR-101 was sent to a Hi-Des HV-120 receiver driving an HDMI monitor.

The modulator was set to transmit with "normal" amateur DVB-T digital parameters. They were: modulation = QPSK, 8 K FFT, 5/6 code rate (i.e. FEC), 1/16 guard interval. The data rate was always set, per Hi-Des' recommendation to be about 80% of max. modulation data rate. For 6 MHz bandwidth, the data rate was set to 6 Mbps and resolution to 1080P. For 2 MHz bandwidth, data rate was set to 1.8 Mbps and resolution to 480i.

Sensitivity was defined to be the lowest level rf signal that gave solid, reliable, pictures with full motion and audio. Dropping the level one more dB resulted in freeze frames.

Dropping one more dB and the picture totally disappeared. Another good indicator was the on-board, green receiver LED which indicated receiver lock. It flickers with freeze framing and is solid green with a P5 picture.

For 70cm repeater service, the ARRL' band plan recommends the input be cable channel 60 (438-444 MHz) and the output be Ch 57 (420-426 MHz). Thus for 6 MHz bandwidth DTV, the center frequencies are 441 & 423 MHz. Thus the BR-101 receiver frequency was set to 441 MHz. The first test was operating as a cross-band repeater with the output on 23cm (1243 MHz). The second test was as an in-band repeater with the output on 423 MHz. The measured sensitivities were:

cross-band, 70cm to 23cm	=	-97dBm
70cm in-band 441 to 423	=	-97dBm

Thus, the conclusion is there was no desensing when using the BR-101 as an in-band, 70cm, 6 MHz bandwidth, DVB-T repeater. The sensitivity values measured compared favorably with previous measurements on other DVB-T receivers [3].

These tests were then repeated using 2 MHz bandwidths for both input and output. For 6 MHz bandwidth we only used the standard 18 MHz split for a 70cm repeater. For 2 MHz bandwidth, we tested splits of 18, 12 and 6 MHz. The measured 2 MHz bandwidth sensitivities were:

cross-band, 70cm to 23cm	=	-99dBm
70cm in-band 441 to 423	=	-100dBm
70cm in-band 435 to 423	=	-100dBm
70cm in-band 433 to 423	=	did not work
70cm in-band 429 to 423	=	did not work

Thus a narrower, 12 MHz split is workable for 2 MHz bandwidths. It should also be noted that going to a lower bandwidth of 2 MHz buys us another 2 to 3dB in receiver sensitivity. The BR-101 was also tested for 441, 2 MHz BW input with 1243, 6 MHz BW output. This configuration would not work

FCC ID & TIMER: The BR-101 does not have the ability to insert it's own embedded "Service Name" which we are able to do with the Hi-Des HV-100 & HV-320 modulators. However, it does pass directly through on it's transmitter output the embedded Service Name of the incoming DVB-T signal. So, if the input signal carries an amateur radio call sign as it's service name, then the outgoing rf transmission from the BR-101 is automatically identified with that same call sign.

The Hi-Des instruction manual has a separate section on "Call Sign". (section 7, pp. 18-19). It is not very informative. What the BR-101 is capable of doing is attaching a sign-off trailer at the termination of an incoming DVB-T signal. The trailer can consist of only a few video frames with your repeater's call sign. You need to create your own

video file. See Appendix. A timer is started when the incoming signal drops. At the end of the designated Period, the transmitter is then turned off.

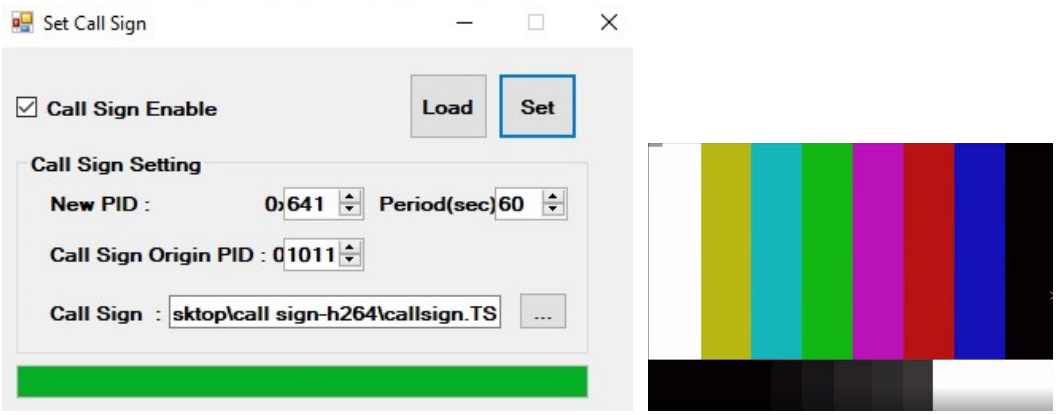


Fig. 7 DTV Bridge Controller -- screen for setting Call Sign (left) & Hi-Des' CallSign.ts file (right)

To use this feature, see Fig. 3, the left "start-up" screen. Click on the "Set Call Sign" button. This brings up the screen shown above in Fig. 7. To activate this feature, check the "Call Sign Enable" box. Note, if this box is unchecked, then the transmitter will never turn off, even when there is no incoming signal. Set the desired duration of the trailer in the period box. It is recommended that you set the New PID as shown to 0x641 and the Call Sign Origin PID to 0x1011. For the box "Call Sign" you need to tell the program where on your computer to find the video file with your call sign. The blue outlined box allows you to browse your computer to find this file. Hi-Des includes on the CD a sample video file. It is called "CallSign.ts" It is a simple color bar display with no text on it. See Fig. 7 right. We suggest you use it first to verify you can make it work. Then create your own call sign video screen. See the Appendix for instructions from Hi-Des on how to create your own call sign video screen as an h264.ts file.

When we first tested this feature with the old 2015 firmware, the trailer and time out timer worked, but the video call sign was not displayed. Now with the new firmware, the feature does work with H.264 DVB-T transmissions.

REPEATER SERVICE: Jim, KH6HTV, has previously written a couple of articles about DTV Repeaters, both in QST [4] and as the application note, AN-23 [5]. Where these showed using a separate Hi-Des receiver and modulator connected with an HDMI cable, they could certainly be simply replaced by the BR-101. The very low, 0dBm, rf output power from the BR-101, if used alone would only allow for a DVB-T repeater covering a very small service area. For wider area coverage, one needs to add an rf linear power amplifier to the transmitter.

A cross-band, 70cm to 23cm repeater would be extremely simple to implement with the BR-101, even on the fly as a temporary repeater. Just connect two separate antennas and you are up and running. An alternative cross band arrangement is to use a single, dual-band (70cm/23cm) antenna along with a duplexer. Good tri-band (2m/70cm/23cm)

antennas suggested for this would be either the Diamond X-6000 base station antenna or the Diamond NR-2000, mobile antenna along with the Diamond MX-3000 triplexer (2m/70cm/23cm) [6].

An in-band, 70cm, DVB-T repeater is also possible. However, more rf engineering will be required due to the necessity of keeping the transmitter power out of the receiver with the narrow channel spacing, especially when using rf linear power amplifiers. Good sharp cut-off, band-pass, channel filters with two separate 70cm antennas or a good ATV duplexer with a single 70cm antenna will be required.

REFERENCES:

1. "DVB-T Recommended Parameters", Jim Andrews, KH6HTV Video Application Note, AN-39, June, 2017, 9 pages
2. "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"
3. "DVB-T Receiver Sensitivity Measurements", Jim Andrews, KH6HTV Video Application Note, AN-29, June, 2016, 5 pages
4. "Digital ATV Repeaters", Jim Andrews, KH6HTV, QST, Sept. 2019, pp. 40-41
5. "DVB-T Television Repeater", Jim Andrews, KH6HTV Video Application Note AN-23e, rev. Sept. 2019, 7 pages
6. "70cm Antennas for ATV", Jim Andrews, KH6HTV Video Application Note AN-40, Aug. 2017, 6 pages

APPENDIX:

Instructions from Hi-Des - How to Create a Call Sign .TS Video Image

from Calvin Yang calvin@hides.com.tw

1. Prepare image files with your call sign
    a. The image files must be in JPEG format, resolution in 640x480.
    b. The image files should be named sequentially as callsign_01, callsign_02, callsign_03,callsign_04,...
    c. The file number determines the final output TS file size
    d. The file size must be limited to under 20 Kilo-Bytes(KB).
2. Use any one of many video applications to create a .ts file from your .jpg images.
3. Find the output file "callsign.TS"
4. Use BR-101 tool to program the callsign TS file to BR-101, refer to Chapter 8 of BR-101 installation guide.
5. Note: remember to change the "CallSign Original PID" to 0x1011 in the tool.