Boulder Amateur Television Club

TV Repeater's REPEATER

June, 2020
2ed Edition

BATVC web site: www.kh6htv.com

ATN web site: www.amateurtelevisionnetwork.org

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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/ ATV nets on Thursday and Sunday afternoons at 3 pm MDT. ATV nets are streamed via: https://batc.org.uk/live/kh6htvtvr

National ATV Newsletter: This newsletter started out in the summer of 2018 as a local newsletter for the 20 ATVers in the Boulder area. It has since grown to become somewhat of a national ATV newsletter with a free, e-mail circulation approaching 200. We are now including news from around the USA from other ATV groups. If you have items of interest to other ATVers, we invite you to contribute them to this newsletter. Also if you have ham radio items to sell or want to buy, we run free ads.

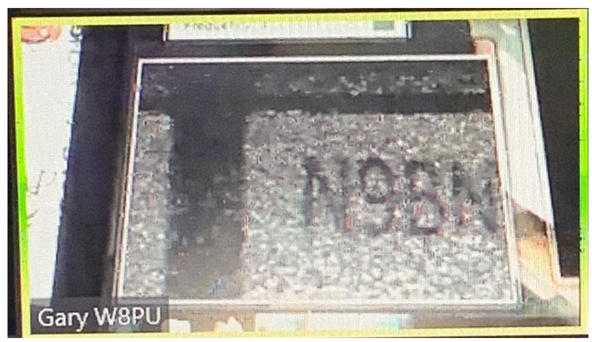
SUMMER TIME is MICROWAVE SEASON

Now that fine weather has arrived, the Boulder ATVers are now out trying out new ham bands. Now pushing into the microwave frontier. The extremely low cost of entry is now only $30 to start experimenting in the ham, 5.8 GHz band, using the FM-TV drone equipment. The latest hams to join in the fun were Debbie, WB2DVT and hubby, Pete, WB2DVS. On

The masked banditos, Pete & Debbie

Thursday, June 4th, they joined Don, N0YE, at the favorite high point above the city of Boulder, which is NCAR, on the mesa, south-west of the city. Others participating in the fun were Bill, AB0MY, at his home qth in north Boulder and Jim, KH6HTV, who set up portable in the parking lot at the 911 / EOC near the Boulder airport. It is a perfect, 4.5 mile, microwave, line-of-sight, path from NCAR to the EOC. Two way QSOs were accomplished with perfect P5 pictures & Q5 audio between WB2DVT, WB2DVS & NOYE with KH6HTV. Don brought along a step attenuator to put in his antenna line to determine the signal strength. He found that he had a 36dB margin above the blue screen, video squelch level (-100dBm) in his Haier 7", flat screen, video monitor. Don also took advantage of the really great rf path and strong signals from Jim, to do a "bake-off" comparing several of his 5 GHz antennas. The path was so good that we were able to use rubber duck antennas to receive P4 pictures at both ends of the path. Everyone started out using dish antennas with about +23dBi of gain and +28dBm transmitters. Jim was using an "After-Burner" amplifier on his to boost up to +33dBm of RF. We were all transmitting on 5.685GHz. Bill was not so lucky from his home QTH. He was unable to see any signals this time from NCAR. Last winter, he was able to receive Don's signals from NCAR. Now Bill is buried in a forest of very lush, green trees in his neighborhood. Sorry, Bill but it looks like for the summer at least, you will have to start "roving" with the rest of us.

ATV - DX Indiana to Ohio



Mike N9BNN in Lebanon, Indiana closed the link with Gary W8PU in Midland, Ohio for a one-way contact (Gary currently does not have an ATV transmitter in-place). The photo below was taken from Zoom, and although Mike's call sign video was only around P-1 to P2, conditions held up for about 20 minutes or so during the past weekend's MidWest ATV DX Zoom Session net. This represents a contact of 148 Miles on 70 cm. As a side-note, Mike has been able to detect the DARA ATV repeater's spectrum using his SDR, and it will likely be just a matter of time when he will be able to bring up the W8BI ATV repeater. The summer months bring more opportunities for Tropo conditions, so more ATV DX will hopefully follow!

tnx -- from Dave Pelaez, AH2AR, Dayton, Ohio, 26 May

NanoVNA Technical Evaluation

Jim, KH6HTV

The May issue of QST included a product review of the NanoVNA Vector Network Analyzer. Based upon this review, I decided to purchase one. For the claimed capabilities of this device and it's extremely low price of approximately $50, for an instrument to test S21 & S11 from 50 kHz to 1.5 GHz, how could one go wrong ?

Upon unpacking the NanoVNA and turning it on and running a few quick tests, I was impressed. I have made some careful evaluations. The following documents my various tests. All of my tests were for transmission, S21, (insertion loss in dB) and reflection S11, (return loss in dB) in the log Magnitude display mode

Calibration: For awhile, I had issues getting the VNA to maintain a proper calibration. One step in the calibration process is extremely vital and easy to overlook. After performing the complete Open, Short, Load, Isolation & Thru calibrations, one hits the Done button. But you are not really done at that point. You must first SAVE the calibration in one of five Calib files. Then recall the Calib file and run some tests on it to verify it is valid. Put the Short back on at the reference plane. The S11 plot must be a flat line at 0dB RL. Next connect the THRU connection again. The S21 plot must also be a flat line at 0dB IL. If there are any deviations from these flat 0dB lines, you have an invalid calibration. You need to repeat again your calibration process.

Calibration Standards: NanoVNAs use SMA connectors. Most NanoVNAs come with a pair of short RG-174/U coax cables and a set of Cal standards. They are all with SMA plugs (male) connectors. They are a Short circuit, Open Circuit and a 50 Ω termination (Load). Also included is a short SMA jack/jack (f / f) barrel adapter for connecting these and also for making the Thru connection. It should be noted that a short circuit is a much better cal standard than on open. On open is really not a true "open" circuit, because there is fringing capacitance from the end of a coax cable, and if not shielded radiation also. Thus for testing purposes, always use a Short.

I immediately discarded the RG-174 cables and replaced them with higher quality RG-316/U, SMA, 12" cables.

For evaluation purposes, I also then used some other calibration standards. I also had some precision Anritsu Open/Short calibration standards with K connectors. (note: K connectors are mechanically compatible with SMA, but have a higher frequency range extending to 40 GHz). My other standards were a set of DC-18 GHz, SMA attenuators ranging from 1dB to 30dB. These all had extremely flat responses across the 1.5 GHz range of the NanoVNA. An obvious use of these attenuators was to check the S21, insertion loss calibration of the VNA. Another not so obvious use is to check the S11, return loss calibration. To do this attach the attenuator to the reference plane test port, but do NOT connect the other end to the S21 (Ch1) test port. Instead screw the SMA Short onto the other end of the attenuator. Now as the incident rf signal passes thru the attenuator of Y dB loss, it will then strike the short circuit and be totally reflected back to the input, again passing thru the attenuator and again losing more power. The return loss will thus be 2 x YdB. For example, with a 3dB attenuator, in this setup, the measured S11 return loss must be 6 dB. With a shorted attenuator, the return loss plot should be a completely flat line, if the analyzer is properly calibrated.

I performed evaluation tests over 3 distinct frequency ranges using the SMA attenuators. 1. HF 1 to 30 MHz, 2. 70cm band and 3. the full range 10 MHz to 1.5 GHz. I obtained extremely good calibration results on the narrower HF and 70cm bands. There was more ripple on the full 1.5 GHz sweep, but it appeared to be OK up to 1.2 GHz. Beyond there I would deem the results to be questionable, using the full sweep. It would be OK, if one used a narrower sweep at the very high frequencies.

For my final acid test of the NanoVNA, I compared it's results to those obtained by much more expensive Network Analyzers. The first one was a Wiltron model 5447A Scalar Network Analyzer. It covers from 10 MHz to 20 GHz. This was an extremely expensive instrument. My company Picosecond Pulse Labs purchased it in the early 90s for $20,000. It had calibration traceable to NIST and was recalibrated every year while it was in service on the production line. (note: Wiltron was subsequently purchased by Anritsu).

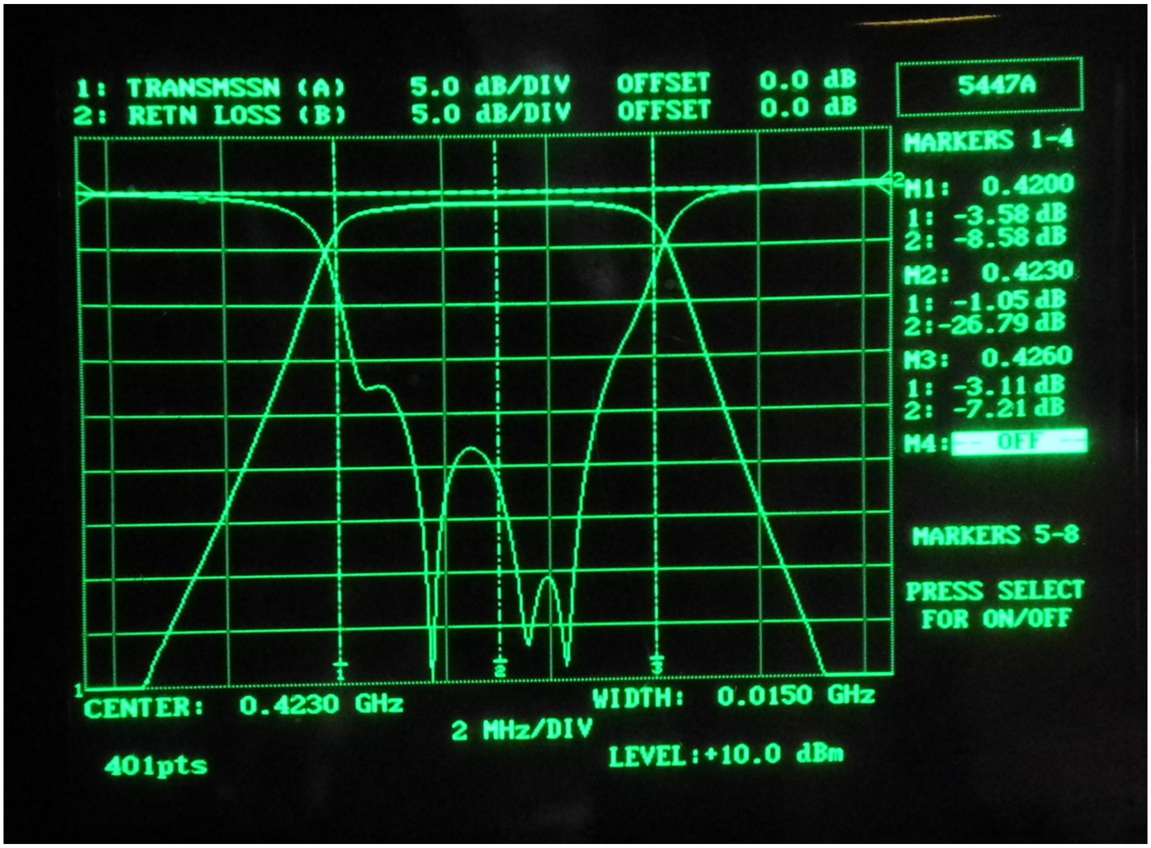
The second test instrument was a new Rigol model DSA-815 Spectrum Analyzer with a built-in tracking generator. It covers from 9kHz to 1.5 GHz and costs about $1,500. The Rigol makes S21, insertion loss / gain measurements directly using the tracking generator output passing through the device under test into the spectrum analyzer input. The S21 setup is calibrated by a Thru connection and then pushing the "Normalize" button. It is also possible to make S11, return loss measurements with the Rigol using a directional coupler on the output of the tracking generator. The coupled output from the coupler then goes to the spectrum analyzer input. The S11 setup is calibrated by attaching a short circuit at the reference plane at the end of the coax cable connected to the directional coupler, and then pushing the "Normalize" button.

The test object used to compare the various Network Analyzers was a KH6HTV VIDEO, 70cm, 6 MHz, Band-Pass Filter, model ATV-BPF-XXX.

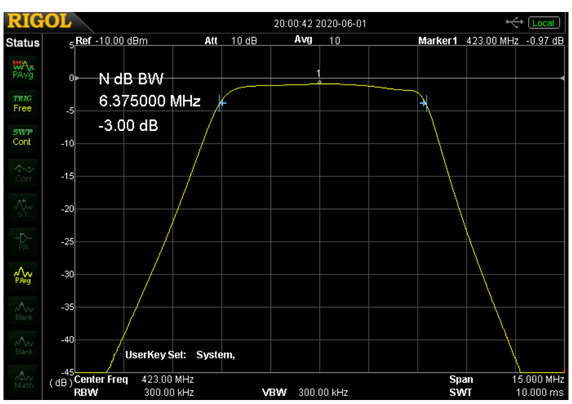
The BPF was first tuned to channel 57, 423 MHz, using the Wiltron 5447A. The first photo shows the results. It was then tested using the Rigol and finally the NanoVNA.

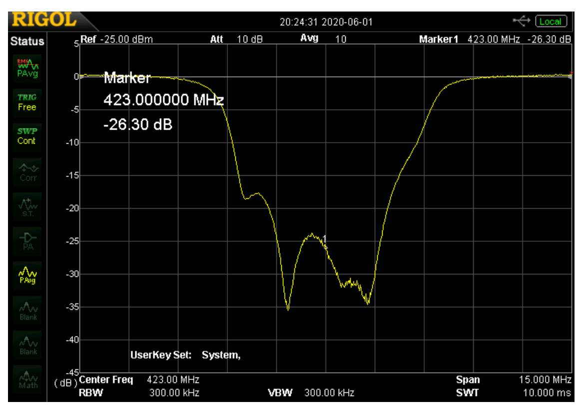
This table compares the results of the measurements made with each network analyzer

Network Analyzer	**S21** (423 MHz)	**-3dB Bandwidth**	**S11** (423 MHz)
Wiltron 5447A	-1.05 dB	6.2 MHz	-27 dB
Rigol DSA-815	-0.97 dB	6.375 MHz	-26 dB
NanoVNA	-1.08 dB	6.450 MHz	-29 dB

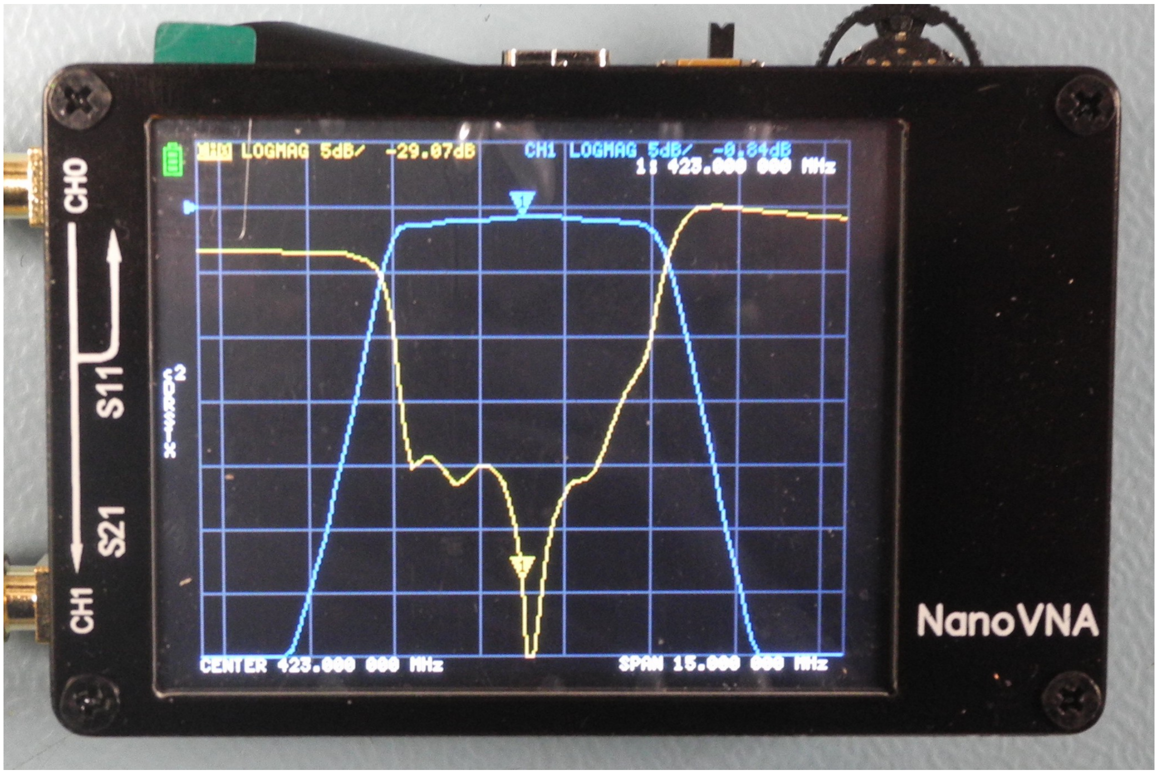


Ch 57 Band-Pass Filter -- measured with **Wiltron model 5447A,** 10MHz-20GHz, Scalar Network Analyzer..   S21 & S11   center frequency = 423 MHz, span = 15 MHz, 5dB/div markers are at 420, 423 & 426 MHz





Ch 57 Band-Pass Filter -- measured with **Rigol DSA-815 1.5 GHz Spectrum Analyzer** & tracking generator.   S21 on left. S11 on right   center frequency = 423 MHz, span = 15 MHz, 5dB/div & 1.5 MHz/div.

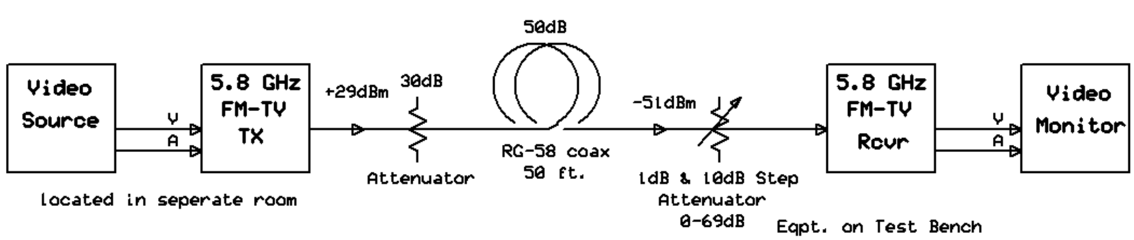


Ch 57 Band-Pass Filter -- measured with **NanoVNA** Blue trace is S21 Yellow trace is S11 center frequency = 423 MHz, span = 15 MHz, vertical scale is 5dB/div. Note: the insertion loss was corrected by the initial calibration offset of 0.25dB. The S11 shown on the lower stop-band seems questionable, as it should be about 0dB rather than the indicated -4dB.

Note: The major drawback to the NanoVNA for tuning narrow band devices, such as this filter, is the relatively slow sweep time for the 100 point scan data acquisition and processing. It makes it difficult to make fine tuning adjustments.

MEASURING ATV RECEIVER SENSITIVITY & RECEIVED SIGNAL STRENGTH

Jim, KH6HTV

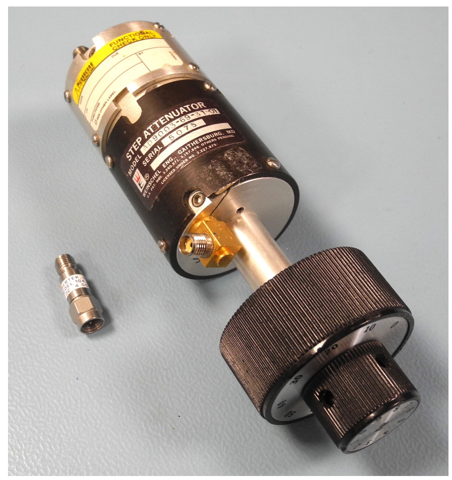


How to measure your ATV receiver's sensitivity ? ---- The key to a successful measurement is preventing rf leakage from the test signal source getting into your receiver, except via the desired rf path. RF Signal Generators from companies such as

HP, Agilent, Rhode & Swartz, etc. are extremely well designed with multiple layers of rf shielding to prevent any radiation leaking out from the box, except via the rf output connector. With such an rf generator, it is ok for it to be sitting on the same test bench as the receiver to be tested. For our ATV gear, we don't have such suitable TV test signal generators. We instead will be using our own ATV transmitters, or exciters as our test signal source. Our ATV transmitters do not have the same level of rf shielding in them that is found in professional test equipment.

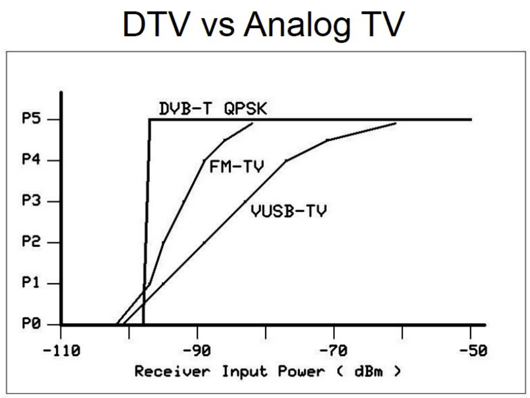
The above block diagram is how I do it. For my example, I am measuring the sensitivity of a 5.8 GHz, FM-TV receiver and it's associated video monitor. I physically remove my ATV test signal generator from my ham shack. I place it in another room and then run a long coax cable from there back to my test bench. I am thus relying upon the radiation path loss to severely attenuate any rf leakage from my signal source.

5.8GHz, FM-TV Receiver & Transmitter



SMA fixed & rotary, step attenuators

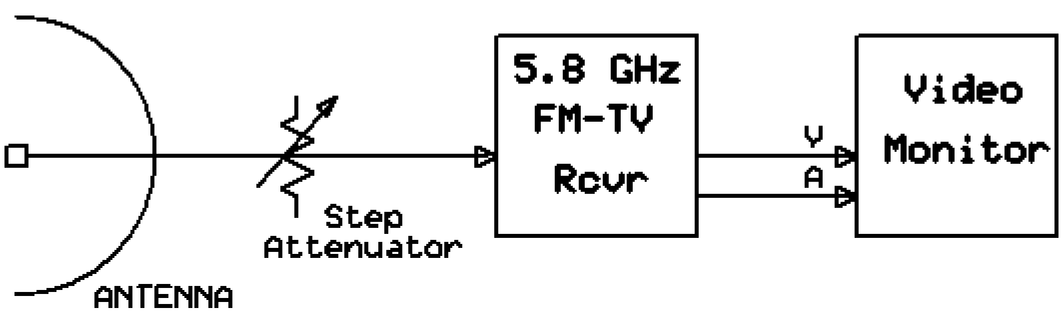
For accurate measurements of sensitivity, one needs to calibrate all of the components in the rf signal path. I first measured the rf output of the TS832 transmitter using my HP-432A RF Power Meter. It put out +28.8dBm. I then measured the loss in the 50 ft. run of RG-58/U, SMA, coax cable. I used my Wiltron 5447A, 10MHz - 20GHz scalar network analyzer. At the operating frequency of 5.685 GHz, the loss was -49.7 dB. I put a high quality, DC-18GHz, SMA, 30dB attenuator on the output of the transmitter. Thus the signal arriving at my test bench at the end of the 50 ft. cable was about -51dBm. To adjust the rf signal level into the RC832 receiver under test, I used a Weinschel, DC-18GHz, SMA, rotary step attenuator. It has 1dB and 10dB steps for a total attenuation of 0 to 69dB.



I have used this same basic setup to measure ATV receivers on the 70cm, 23cm, 13cm, and 5cm bands. I have used it for VUSB-TV, FM-TV and DVB-T receivers. It is how I arrived at the above plot of picture quality, P units, vs. RF input power. Note: for VUSB-TV, do not use a conventional power meter. You need to measure the peak-envelope-power. This can be done best with a spectrum analyzer. For a discussion of P units, see AN-5a, "P5 - TV Signal Quality Reporting" at www.kh6htv.com
https://kh6htv.files.wordpress.com/2019/09/appnote5a-p5.pdf

So, what were the results for the RS-832 receiver ? It was quite sensitive, coming in at about -101dBm for a P1 picture. It actually depended somewhat also on which video monitor I used with it. I tested it with two older, CRT TVs and three, newer, small, flat screen monitors. Two of the flat screen monitors had built-in, blue screen, video squelches. These were the results:

1. Toshiba 14", CRT TV receiver/monitor (last of the breed): P1 = -101dBm, P2 (color threshold) = -99dBm
2. JVC, 5", CRT, color studio monitor: P1 = -101dBm, P3+ (color threshold) = -92dBm
3. Unknown brand, 7" flat screen monitor, 12Vdc, no blue screen, video squelch: P1 = -101dBm, P3 (color threshold) = -93dBm
4. Haier, 7" flat screen TV receiver / monitor, 12Vdc, includes internal battery & video squelch: Video Squelch turn-on threshold = P2 (color) = -100dBm
5. Unknown brand, 7" 1080P monitor with HDMI, composite, & VGA inputs, 12Vdc, plus video squelch: Video Squelch turn-on threshold = P1/P2 (color) = -100dBm



The measured receiver sensitivity results can then be used for in the field measurements of received signal strength. Simply insert your step attenuator between the antenna and the receive input. It is especially easy, and more accurate, if you use a video monitor with a calibrated, built-in video squelch. Simply crank in attenuation until you reach the video squelch threshold. For example, the threshold of the two monitors tested above was -100dBm. If as with Don's (N0YE) field test reported earlier, he found he had a 36dB margin, then his received signal strength was -100dBm + 36dB = -64dBm.

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.**

For Sale: Hi-Des HV-320E, DVB-T Modulator

The HV-320E covers the 70cm, 33cm, 23cm and 13cm ham bands with synthesized frequency from 100 to 2500 MHz. The rf output power of an HV-320E is typically: +7dBm (70cm), +5dBm (33 & 23cm) and +0.5dBm (13cm). The bandwidth is adjustable from 1 to 8 MHz.. It runs on +12Vdc. A/V inputs are HDMI and also composite analog video plus stereo line level audio. It is programmed via a UART/USB cable from a Windows PC. This is the most popular DVB-T modulator in use today by USA - DATV hams.

This unit has been modified to add Vent holes and a cooling fan for improved reliability. The channel up/down buttons were trimmed below the face plate to prevent accidental channel change. UART cable and CD also included. Asking $300.00 Shipping included in the lower 48. Reason for sale, I have upgraded to the Hi-Des model HV-202. Any questions email K5OLA@usa.com or call (602) 885-7725 ----- Ed, K5OLA