Boulder Amateur Television Club
TV Repeater's REPEATER

December, 2021
2ed edition, issue #94

BATVC web site: www.kh6htv.com

ATN web site: www.atn-tv.com

The Amateur Television Network

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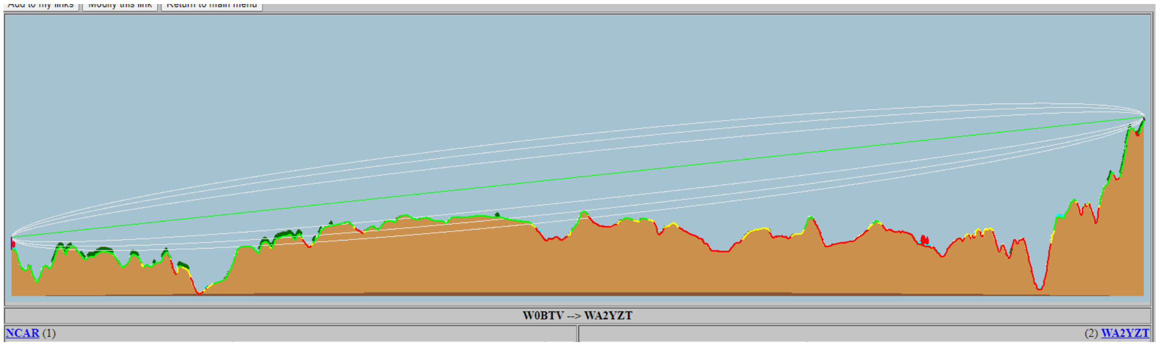
ATV Hams & ATSC 3.0

In general, ATV hams were slow to make the transition from the old NTSC, analog TV system to modern day digital TV. That is not the case now with the newest system, just now coming on the air here in the USA. It is called ATSC 3.0. In our previous Dec. 1st, issue # 93, we reported that Ron, W6RZ, in Silicon Valley has gotten a GNU radio on the air with ATSC 3.0. Well the folks in southern California, down in San Diego are not far behind. Yesterday, (12/12), we received this brief e-mail from Mario. We are looking forward to receiving more details in the future.

Greetings and Happy holidays!
The team and I have successfully tested a short range transmission of ATSC 3.0. Using a modified Thor modulator on channel 14 to 423 lower edge to upper edge 429. working on channels 15 and 16 for other outputs, 6 MHz bandwidth. More to come.
73 de Mario, KD6ILO, Oceanside, California

NEW CBS ATV VIEWER

We welcome a new viewer to our growing audience for the Boulder, Colorado, ATV repeater, W0BTV. Paul, WA2YZT, responded to our recent article about ATV and our repeater in the December issue of the Denver Ham club's Round-Table newsletter. Paul took us up on our offer of a loaner DVB-T, set-top box receiver. Paul lives on the top of Lookout mountain in Golden. On Saturday evening (12/11), Paul got set up with a Yagi antenna pointing north and called on the phone to ask for an ATV signal to be put on the air. Because Paul lives very close to the powerful commercial broadcast TV transmitters on the top of Lookout, we had also loaned him a 423MHz, 6MHz BW, band-pass filter. Without the filter, the receiver overloaded and would not receive the W0BTV signal. But with the BPF in place, Paul exclaimed "It Works !" We treated him that evening to a Rick Steves style, amateur travelogue video. It was Jim, KH6HTV & Janet's trip to the orient touring Singapore, Thailand, Vietnam and China. Paul has now made the commitment to purchase his own Hi-Des HV-110 receiver, plus a 423MHz BPF. We hope to then convince him to also get on the air with a DTV transmitter.



17 mile RF path from W0BTV to WA2YZT. -64dBm predicted signal strength

Paul is the transmitter supervisor for the Denver CBS TV station, KCNC. Their UHF, 50 kW (1 MW ERP) transmitter is also located on Lookout mountain, very close to Paul's QTH. Paul says he has worked there for 45 years and seen a lot of changes over the years. He was awarded an Emmy for technical excellence for his coverage of the Bolder Boulder, 10K races. He says he is quite busy there right now installing a brand new TV transmitter. CBS is replacing their old vacuum tube transmitter with a new solid-state rig. It consists of 40, 100 Watt modules, instead of the two high power tubes in the old rig which required 30kV plate voltage.

WB0NRV's Progress: Bob in Johnstown is 29 miles from the Boulder ATV repeater. He is making good progress. On Dec. 2ed, he was able to check into the weekly ATV net with his first successful transmission. He used his 40 watt, 70cm transmitter on 441MHz / 6MHz BW. The above photos were taken of Bob's video through the repeater. There were a lot of freeze frames and the S/N was only 8-9dB.

The repeater has an accurate S meter which is super-imposed on the output video. It showed that Bob's signal strength was -81dBm. The repeater's residual background noise level is about -102dBm with no input and a dummy load for an antenna. When connected to an antenna it shows about -97dBm. Tested on a bench, it's digital threshold is -94dBm for "normal" encoding parameters (1080P, 5/6 FEC, etc.) with a S/N of 8dB. Bob's signal was 13dB above this, but he still only showed a S/N of 8-9dB. Bob was using "normal" parameters. The reason for the poor performance is due to a lot of RFI from other ham users in the Ch 60 band (438-444MHz). From the repeater's location, it's antennas see everything happening up and down the Front Range and the Denver metro area. Bob will be re-programming his modulator to aggressive settings (720P, 1/2 FEC, etc.) for next week and hopefully this will allow him to get a good signal into the repeater without freeze frames. This RFI issue is why we encourage repeater users to not use the 70cm input, but instead use the 23cm (1243/6MHz) input. We do not experience RFI on 23cm.

Sat Dec 4th Update: Today, Bob tested things again, but now with aggressive FEC of 1/2. This time he was successful in getting P5/Q5 digital video and audio into the W0BTV repeater with no freeze frames and s/n = 11dB. See above photo as proof.

Thurs, Dec 9th Update: Good News - Bad News ! Yes, Bob was able to get into the repeater over the weekend, but for the 3pm Thursday afternoon ATV net, the RFI level seen by the repeater was again too high for his signal. Again a strong signal into the repeater, but poor S/N with lots of freeze frames and no audio.

We welcome Bob, WB0NRV, to our group of Boulder ATV hams. Bob has had quite a varied career background. He worked in aerospace, manufacturing, computers, storage networks and most recently small business in Wichita, Kansas. For retirement, he returned to Colorado and now lives in Johnstown. Bob's ham radio activities and interests are quite varied. They include all bands from 160m up through 13cm. His primary interests include VHF weak signal (SSB & CW), antenna design and circuit development, older radio repair & restoration, VHF design and testing. In the late 70s, he had an EME station until a Kansas tornado tore it apart. He has WAS on 6 meters. He has been active with Civil Air Patrol, MARS and Storm Watch. He did analog ATV in Wichita. Now moving to Colorado, we have introduced Bob to the latest & greatest digital ATV. His biggest current challenge is to somehow get up stealth antennas that will really work on a small city lot in a CC&R controlled neighborhood.

LOW COST DVB-T MODULATOR

Bob, KV4PC, has alerted us to a low cost ($130) DVB-T modulator from China. It is the SatLink model WS-6990, available from Ali-Express. It covers 50-860MHz. But it only does commercial broadcast bandwidths of 6, 7 or 8 MHz. Thus not usable for those ham groups using narrower bandwidths. RF power out from 70 to 100dBµV (i.e. max. -9dBm, 75Ω). It has both HDMI and composite video + line level audio inputs. Runs on 12Vdc.
Disclaimer: We have not tested this unit. The specs. come from the web site. If any ham should buy one of these, we welcome your comments, good or bad.

1/3 Million $$$ Given to Rocky Mtn. Hams ! ! !

The Dec. 9th ARRL e-letter reports that the Amateur Radio Digital Communications (ARDC) has made a grant of $374,233 to Rocky Mountain Ham Radio. It is to be used to expand their 5 GHz microwave network in Colorado and New Mexico.

A Failed 900 MHz Project

You might ask "Why write about a failed project?" The answer is to help other folks avoid wasting their time on a similar project.

Last fall we had a lot of microwave goodies donated to us to be given away. In the lot was this Motorola 150 Watt, 900MHz amplifier. Bill, K0RZ, said "They started appearing in quantity on the surplus market as the cell services transitioned to 4G. They were readily available at local swapfests about 10 years ago."

Well, I got the idea that with such a powerful amplifier, I might just be able to make a DVB-T repeater extender. Pick up the 423 MHz repeater from our W0BTV repeater at my QTH and then re-transmit it on the 33cm (900 MHz) band with a yagi antenna pointed to the north-west to beam a usable signal up into the mountainous regions in the western part of Boulder County.

The amplifier requires +24Vdc. So I purchased for only $32 from Amazon a Meanwell, 24V, 15 Amp switching power supply. As soon as I received the power supply, I then did some tests on the amplifier. A swept S21 test showed a quite broad response centered at 888 MHz with a gain of 32dB. At 915 MHz, the gain was down to 28dB, but still usable. I then did Pin vs. Pout test at 915 MHz and found the -1dB gain compression point was 91 Watts. OK so far.

My next test then was the "acid test", to try it with a DVB-T signal. OPS ! No Good ! At any respectable output power level, the IMD non-linearities were horrible with really nasty, high level, out of channel spectrum skirts. I kept dropping the RF drive level down until I reached our normal acceptance level of skirt break-points being -30dB below the in channel power level. What was it ? A whopping output power of only 800 milli-watts ! Worthless. Conclusion: Use these amplifiers for FM or SSB service, but not digital TV.

73 de Jim, KH6HTV, Boulder, Colorado

Application Note AN-62

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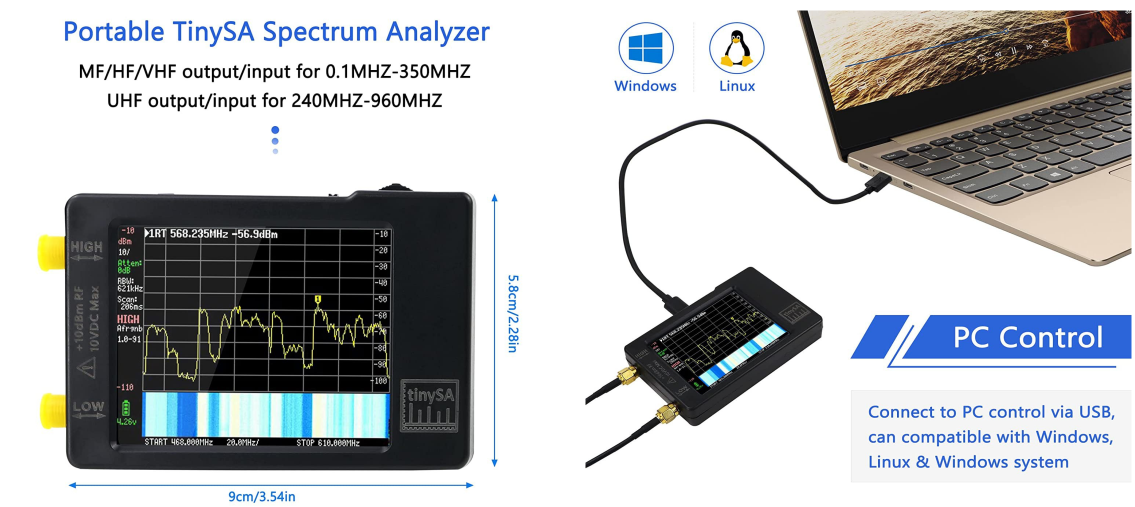
TinySA - an Inexpensive Test Instrument for Digital Transmitters

Jim Andrews, KH6HTV



The success of the **NanoVNA** led the folks who developed it to follow it with the companion **TinySA**, a Spectrum Analyzer, with equally impressive performance. While it is billed as a spectrum analyzer, it is also an RF signal generator. The basic performance covers from 100 kHz to 350 MHz. It can also be used up to 960 MHz but with poorer performance. The price is astonishing low for what you get in this tiny package. I got mine from Amazon for about $70 with next day delivery.

The best place to go for information, specs., instruction manual, PC program, etc. is the TinySA wiki web site: (www.tinysa.org/wiki/) I highly recommend you download the ***tinySA-App*** for your Windows PC. See Fig. 3 on the next page. It greatly increases the ease of use and capabilities of this fantastic instrument. The spectrum plots in this app. note were obtained using the PC. The wiki site is quick to point out that it does not have all of the capabilities of name brand spectrum analyzers and they do list the limitations you need to be aware of. But the price is right ! They also caution you to be careful and not purchase imitation "clones" as they have inferior performance.

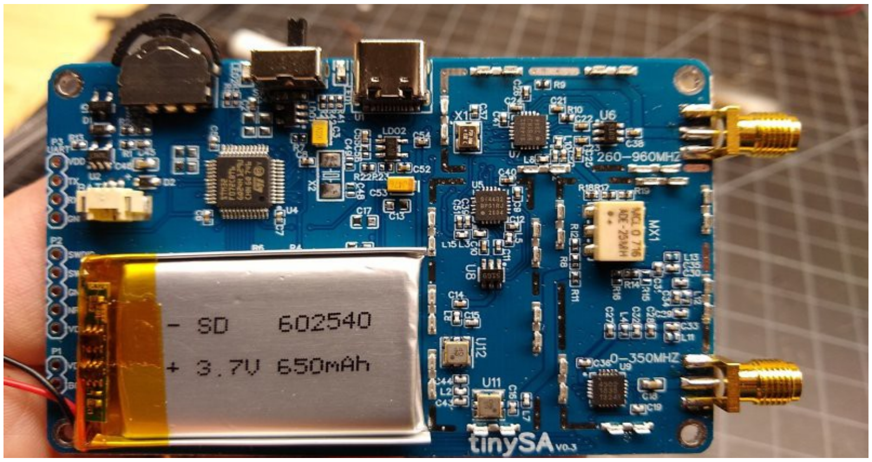


Fig. 2 A peek inside of the TinySA, Spectrum Analyzer

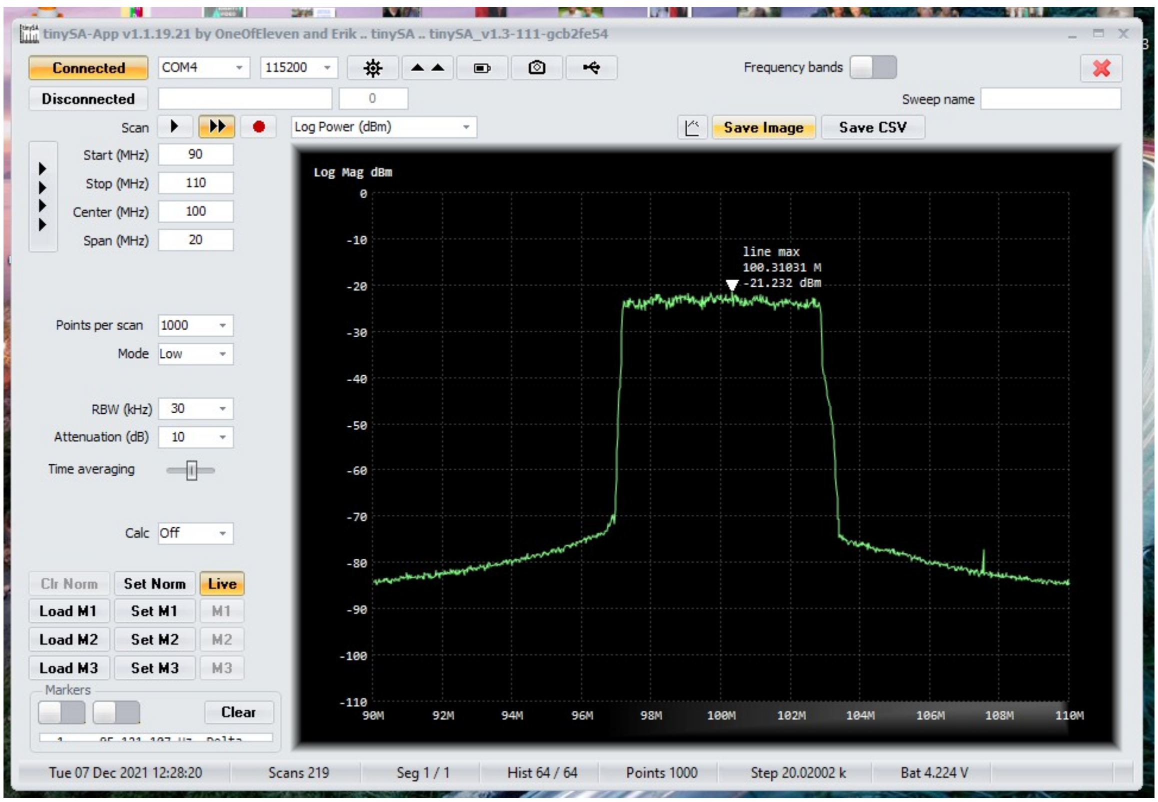


Fig. 3 This is what the TinySA-App control screen looks like on a Windows PC.

Googling "TinySA", you will find a lot of reviews of it's performance by hams. These reviews mainly deal with classical sine wave performance, with modulations such as AM, FM, etc. The focus of KH6HTV Video is on Amateur Television (ATV) and in particular Digital Amateur Television (DATV). So it was natural for me to ask, how well can I measure the spectral performance of a digital TV transmitter. The rest of this application note will address this.

ITU Specification: The ITU has specified how the spectrum of a digital TV signal should be measured. The analyzer settings, per the ITU, are: center frequency = DVB-T channel center frequency, Span = 20 MHz, Resolution Bandwidth = 30kHz, Video Bandwidth = 300kHz, Sweep Time = 2 seconds, Detector = RMS, Signal Averaging = 10. The shoulder attenuation is measured at ±200kHz beyond the channel edges, i.e. ±3.2MHz from center frequency for a 6 MHz wide channel. For further details, I refer the reader to the DTV "Bible" --- *"Digital Video and Audio Broadcasting Technology*", by Rhode & Schwarz engineer, Walter Fisher, page 426. [1]

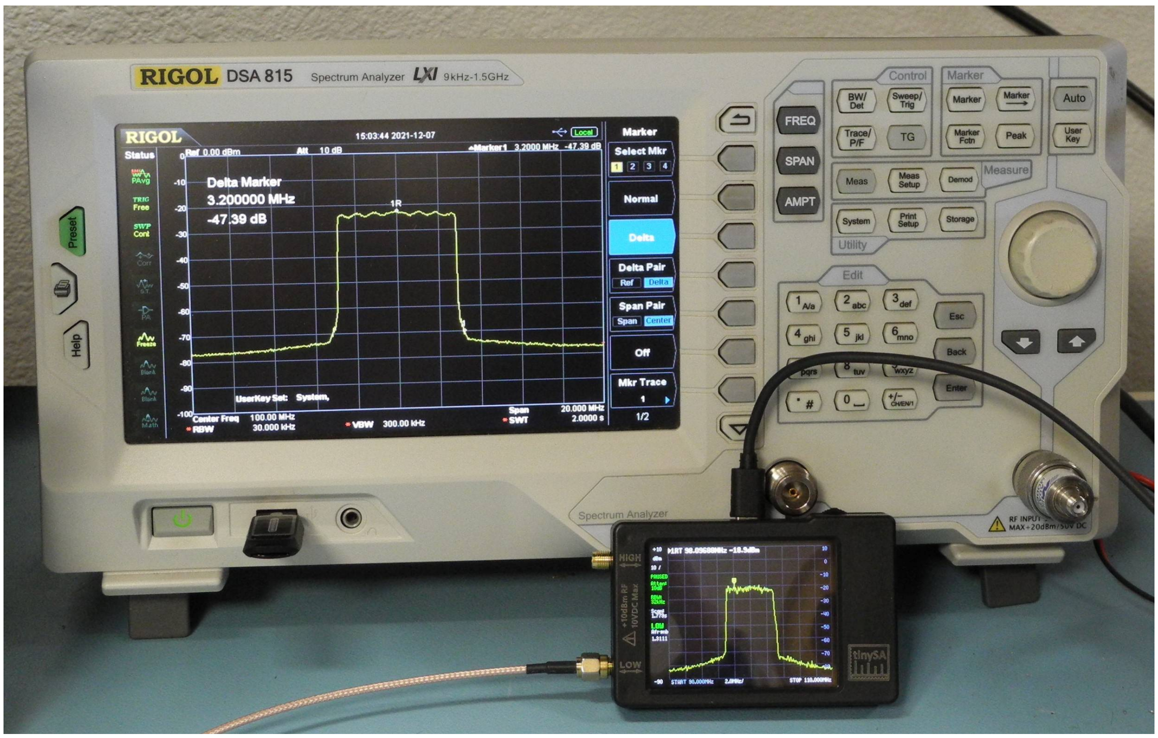


Fig. 4 The TinySA and the Rigol DSA-815 Spectrum Analyzers measuring a DTV signal.

Reference for Comparison: I have been using now for several years a high quality spectrum analyzer to characterize my DTV amplifiers and transmitters. It is a Rigol model DSA-815, 1500 MHz spectrum analyzer with a built-in tracking generator. It cost about $1,500. This app. note will compare measurements made with the Rigol against the TinySA. The DTV signal source I used is a Hi-Des model HV-320E, DVB-T modulator. I set up the modulator to generate a 6 MHz bandwidth, QPSK signal of 0dBm signal strength. Fig. 5 shows this signal measured on the Rigol with the ITU settings. The center frequency was 100 MHz. The HV-320E covers frequencies up to 2.6GHz with an identical spectrum. Note the DTV energy is spread over a 6 MHz bandwidth. The analyzer's detector bandwidth is set to 30kHz and is only measuring the power in this narrow bandwidth. Thus the power level of the flat top shown in Fig. 5 is about -22dBm, but spread over 6 MHz. Thus when using 30 kHz BW for a 6 MHz BW DTV signal, an approximate power measurement can be made by reading the power at the center of the channel and then applying a +22dB correction factor.

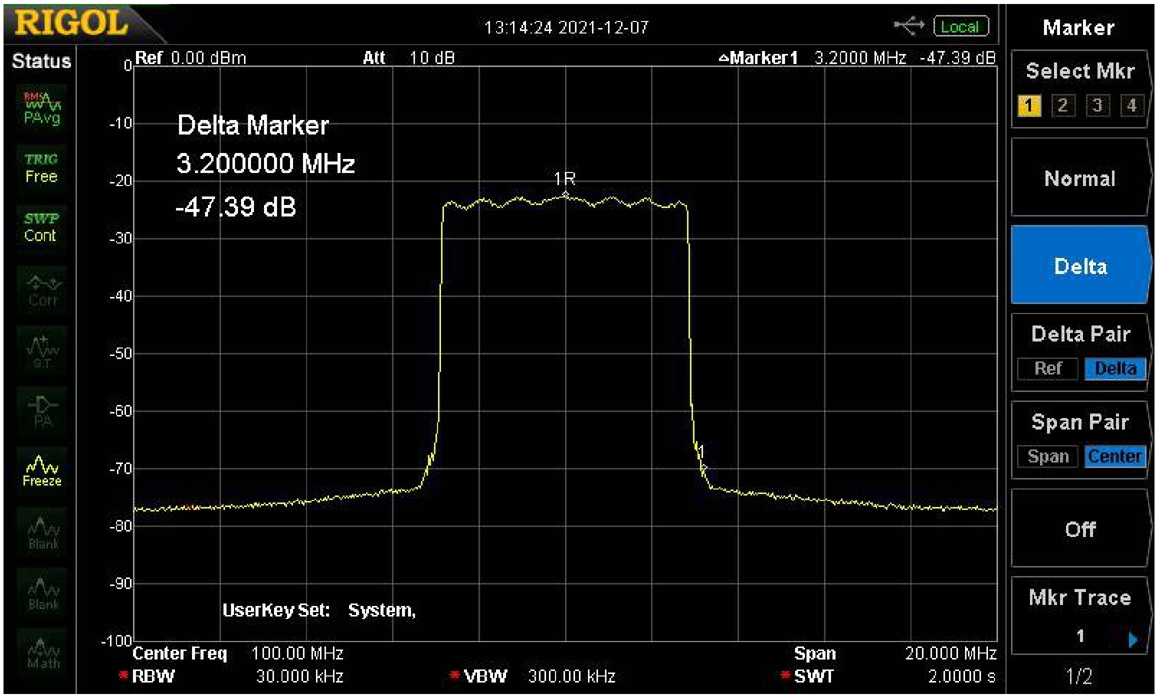


Fig. 5 HV-320E spectrum as measured on the Rigol DSA-815. Pin = 0dBm. Center frequency = 100 MHz, 20 MHz span, 30kHz resolution bandwidth, 300kHz video bandwidth, 2 second sweep time, RMS detector, 10 averages, 10dB/div & 2MHz/div.

MEASUREMENTS with TinySA: The first measurement performed with the TinySA was with the same HV-320E signal as shown above in Fig. 4, but at a higher, 70cm frequency of 435 MHz. The DTV signal was input to the HIGH port of the TinySA and it was put in the UHF mode. The TinySA was set to duplicate as close as possible the same settings used on the Rigol SA. The center frequency was set to 435MHz with a span of 20 MHz. The TinySA tries to always use "Auto" to set up bandwidth and input attenuation. I forced it into manual mode via the PC program. I set the bandwidth to 30 kHz and input attenuation to 0 dB. Data points were set to 1000, and signal averaging was set to 8.

In the UHF mode, the TinySA does not have a good input attenuator, so a 10dB SMA attenuator was placed on it's SMA input. A -10dB correction factor was entered in the "Gain" menu to account for the attenuator in the vertical calibration scale factor.

Fig. 6 below shows the result. This does not compare favorably with that seen on the Rigol, Fig. 5. The level of the flat top is approximately correct. But notice the horrible out of channel skirts on the spectrum. These are false artifacts not present in the DTV signal. They are generated by severe non-linearity in the TinySA's UHF circuit. This result is obviously unacceptable.

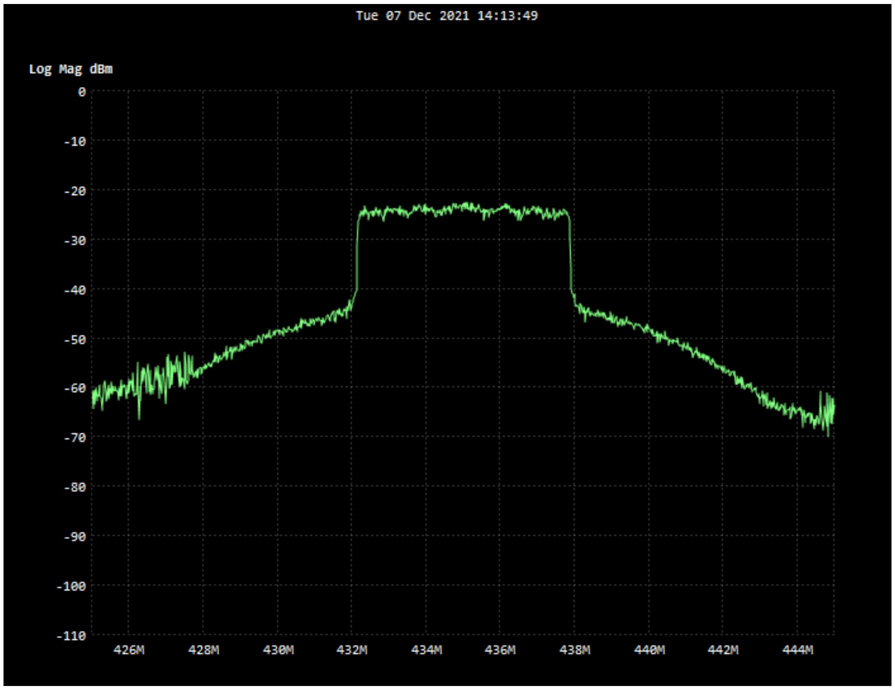


Fig. 6 435MHz, 6 MHz BW, 0dBm DTV signal measured directly on the TinySA, using the HIGH, UHF input.

The next test was to repeat the measurement but instead use the LOW input which covers MF, HF, & VHF bands (0.1 - 350 MHz). The measurement was done at 100 MHz. Fig. 7 below is the result. This now compares very favorably with the Rigol measurement, Fig. 5. The shoulder break points now at about the same level of > -45dB.

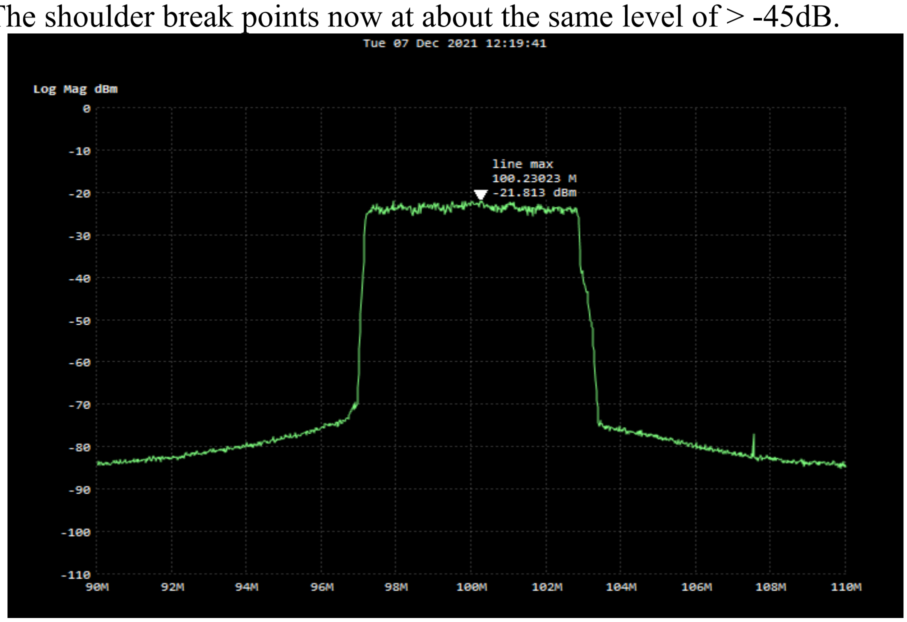


Fig. 7 100 MHz, 6 MHz BW, 0dBm DTV signal measured directly on the TinySA using the LOW, VHF input.

CONCLUSION: The TinySA will make accurate DTV spectrum measurements if the LOW, VHF input is used. The HIGH, UHF input should not be used.

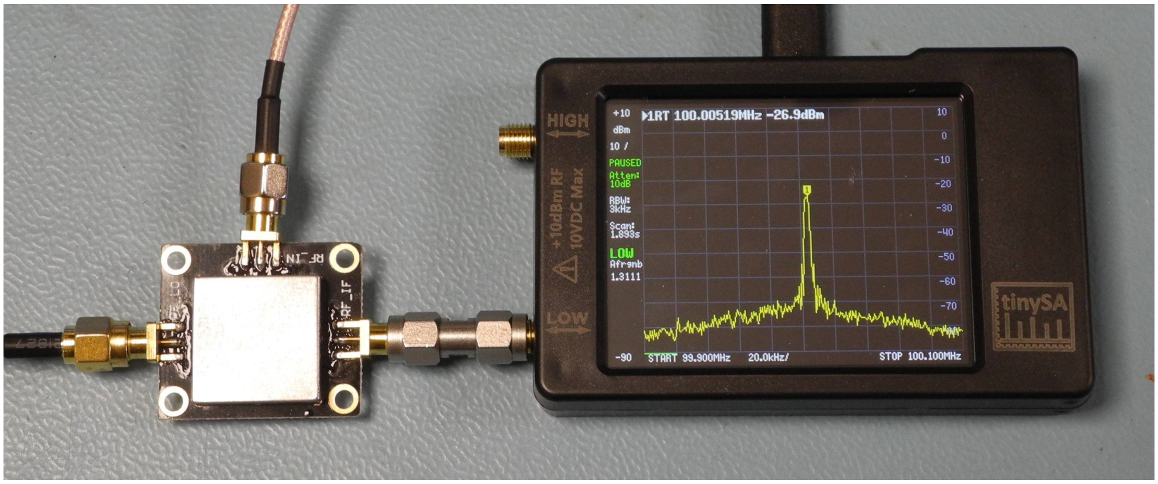


Fig. 8 The better way to measure frequencies higher than 350 MHz

MIXER MEASUREMENTS: So to be able to measure our 70cm and higher frequency DTV transmitters, we need to instead go to a mixer scheme. Low cost mixers are available on-line these days. Fig 8 above shows a $15, SMA mixer using a Mini-Circuits ADE-25MH double balanced diode mixer. The RF & LO are rated for 5 MHz to 2.5 GHz. The IF is rated for 5 MHz to 1.5 GHz. The LO requires +13dBm drive. I measured 7dB RF to IF down conversion loss. The TinySA vertical scale factor can be corrected for this loss by entering -7dB in the "Gain" menu.

There are quite a few, low cost choices for the LO. One possibility is to simply use another TinySA, not as a spectrum analyzer, but as a signal generator. Put in the HIGH-UHF OUT mode, it's frequency is programmable from 240 MHz to 960MHz. The output is a square wave. The max. output level per the menu is +16dBm. I actually measured it to be from +16 to +18dBm. The programmable level control was not very accurate. The LOW, MF-HF-VHF, signal generator is more accurate.

I ran some experiments with this mixer scheme to determine if accurate DTV measurements could be performed on the 70cm and 23cm bands. I used an IF of 100MHz for the 70cm band and set the LO to 335 MHz for an RF input of 435 MHz. For the 23cm band, I set the LO to the TinySA max. limit of 960 MHz. Thus for an RF input of 1243 MHz, the IF out was 283 MHz, which still fell with the LOW-VHF mode.

Fig. 9 shows the result of a test using a 23cm, 1243MHz, DVB-T signal. The RF power level was adjusted over a wide range to determine the limits of linearity. It shows the power stepped from 0dBm, to -3dBm to -5dBm. Note the improved skirts as the RF input power level is dropped. The conclusion drawn was that the input power should be kept below -3dBm and preferably below -5dBm. This experiment was also performed at 70cm and I obtained identical results.

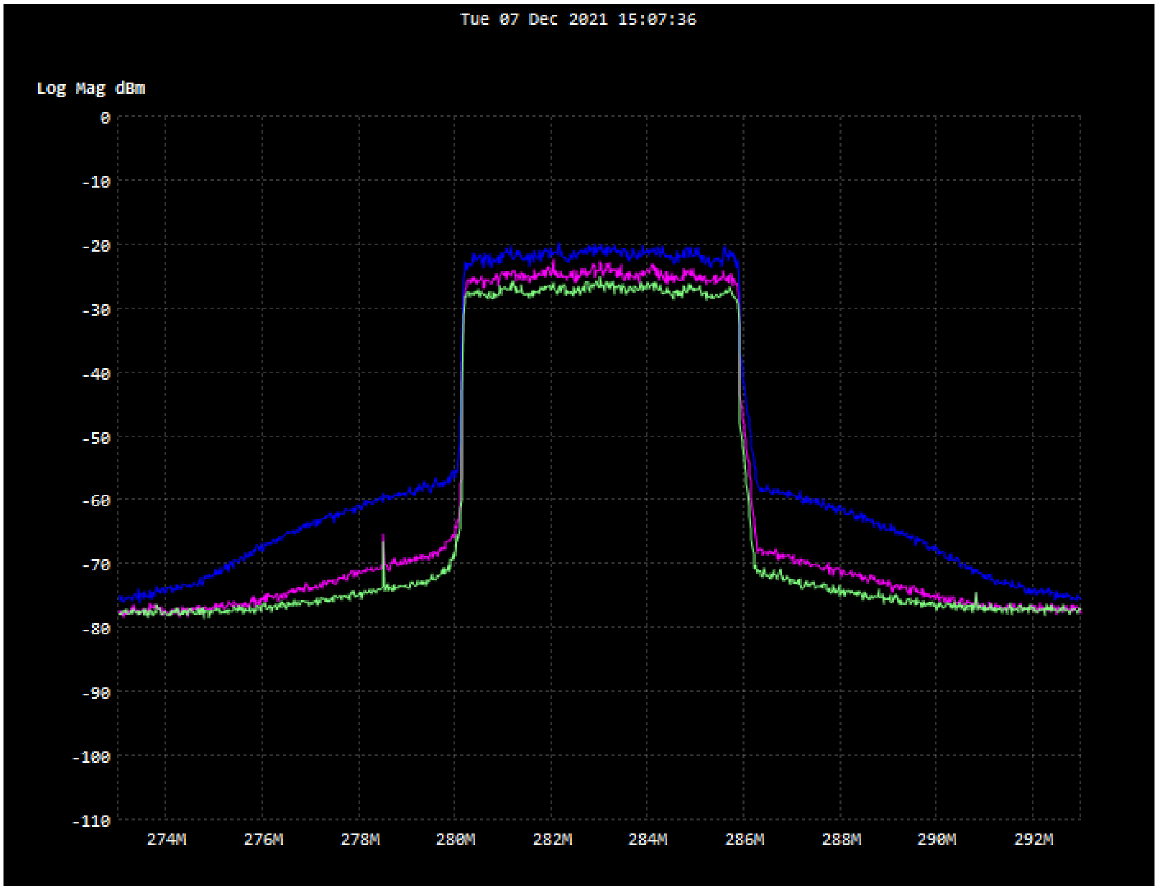


Fig 9 Test of the TinySa plus mixer to measure a 23cm, 1243MHz, DVB-T signal. RF input power level stepped to demonstrate non-linear compression at high input power. Blue trace is 0dBm, Magenta trace is -3dBm. Green trace is -5dBm.

EXAMPLE of USE: Fig. 10 below shows an example of using the TinySA with an external LO and mixer to measure the spectrum performance of a 70cm, RF linear power amplifier. The amplifier's output power was +35dBm (3.2 Watts). A high power, 30dB attenuator followed by a 10dB attenuator was used to drop the signal level to the mixer down to about -5dBm.

You might ask why the out of channel spectrum is higher than that of the modulator input signal, Figs 5 & 7 ? Nonlinearities in linear high power amplifiers generate these IMD spurious signals (noise) which land outside of the desired 6 MHz channel band edges. For DVB-T transmitters, Fisher [1], on pages 446-448 states that they have found that acceptable performance for commercial broadcast DVB-T transmitters, without degrading the S/N of the digital signal is obtained by driving the final amplifier until the out of channel spectrum shoulder break-point reaches -28 dB below the in channel power level. Then for their R&S transmitters, they then add digital pre-distortion as equalization. This buys them another 10 dB, driving the shoulder down to -38 dB. Then the output of the final power amplifier is passed through a channel mask, band-pass filter which drops the shoulder even further to -52 dB, thus meeting govt. regulations.

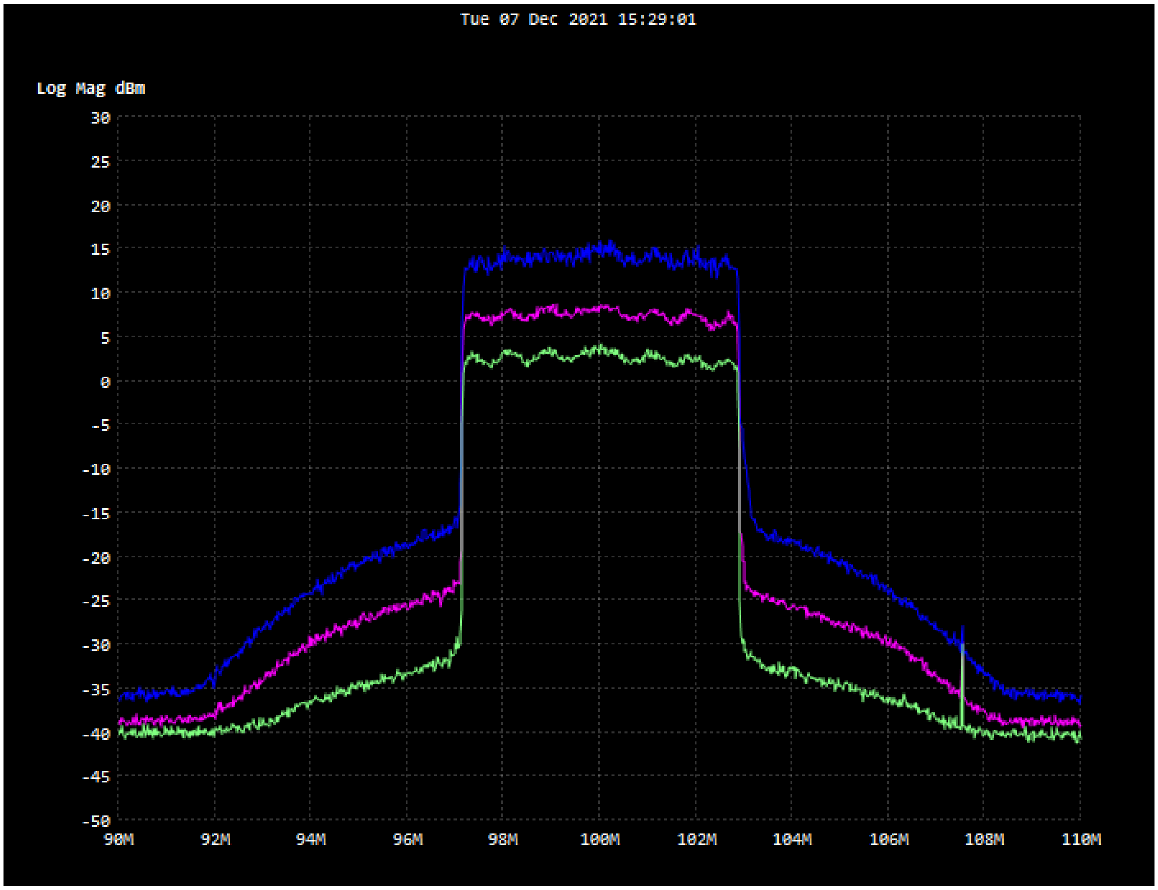


Fig. 10 TinySA measurement of a KH6HTV Video model 70-7B Amplifier. Center frequency is 435 MHz. 5dB/div & 2MHz/div. The amplifier's output was adjusted from High to Medium to Low in -5dB steps. Blue trace is +35dBm, magenta trace is +30dBm and green trace is +26dBm.

For our ham radio, DVB-T transmitters, I have found that a good compromise trade-off between maximizing the RF output power and minimizing degrading the S/N quality of the transmitted DVB-T signal is to run the drive power up until the shoulder break-point reaches -30 dB. At this point, I achieve a Crest Factor of about 8 to 10 dB. This means the average DTV power is -8 to -10 dB below the max. saturated power rating of the amplifier. This crest factor is required to avoiding clipping the peaks in the DTV signal and thus destroying it's S/N. Most DATV hams are thus content to use their transmitters, as is, radiating signals that look like Fig. 10. We typically do not have, nor can afford the cost of an exotic digital pre-distortion equalizer. For DATV repeater service however, the addition of a sharp cut-off, steep skirted, 6 MHz band-pass channel filter is absolutely required.

For additional reading on testing DTV transmitters, I recommend checking out the premier, German supplier of broadcast TV transmitters, Rohde & Schwarz's web site. www.rohde-schwarz.com They have a large collection of relevant application notes and newsletters there.

REFERENCES:

1. "*Digital Video and Audio Broadcasting Technology*", by Rhode & Schwarz engineer, Walter Fisher. Published by Springer-Verlag, Berlin, Germany, 2010. See chapter 21, *"Measuring DVB-T Signals"*, pp. 421-450

2. "*Digital TV Rigs and Recipes -- Part 4, DVB-T*", S. Grunwakl, Rohde & Schwarz, Broadcasting Division, Application Note DigitalTV4, version 3.0, 13 Aug. 2002, 66 pages --- available as .pdf files to be downloaded from:
https://www.rohde-schwarz.com/us/applications/digital-tv-rigs-and-recipes-application-note_56280-15676.html
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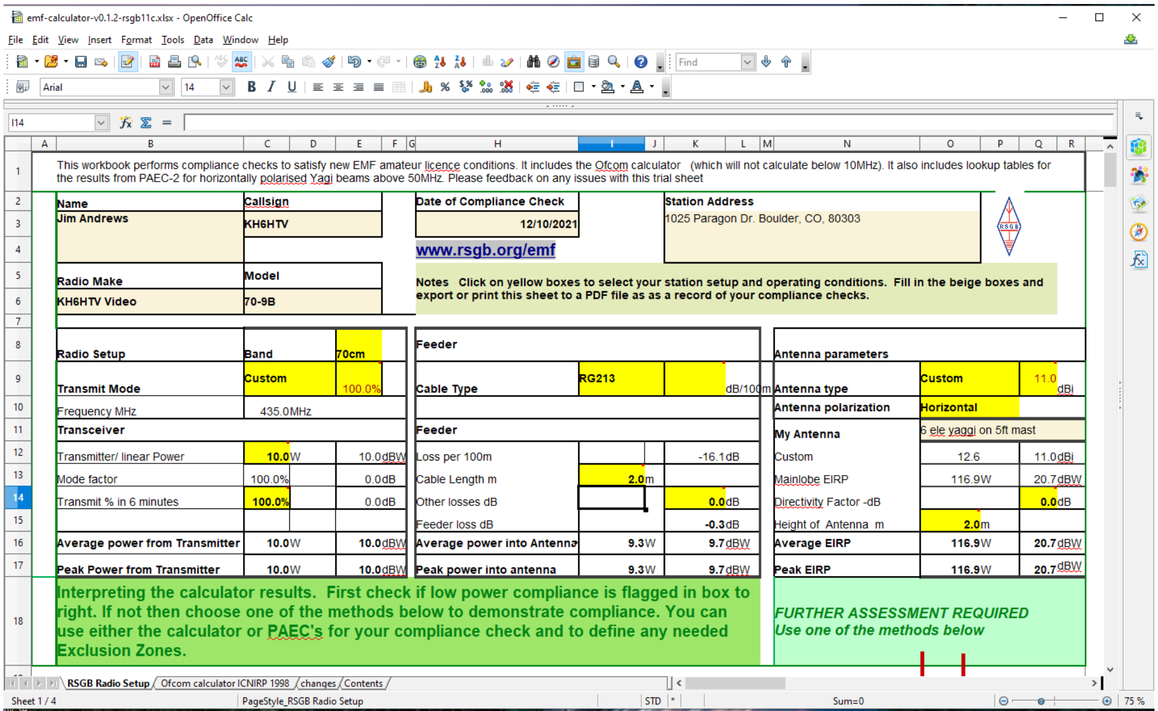
RF EXPOSURE CALCULATOR: The FCC is now requiring hams to perform station exposure evaluations to ensure that their stations comply with RF exposure rules. We discussed this in our August 2021 newsletter, issue # 85. The ARRL's web site provides a free simple, on-line calculator to perform this evaluation. (http://arrl.org/rf-exposure-calculator). We have recently found another calculator which provides a bit more information. It is from the Radio Society of Great Britain. (https://rsgb.org/main/technical/emc/emf-exposure/) The RSGB calculator is available either as a web application or as an Excel spreadsheet version. I down-loaded their Excel version. It includes instructions on how to use it.

I have run calculations for an example of using our digital ATV gear out in the field. I assumed operation on the 70cm band using a 10 Watt, DVB-T transmitter with a 6 element Yagi antenna (11dBi gain) on a 2 meter mast. I also assumed the worst case of 100% operating time.

Using the ARRL calculator, per the FCC requirements, the results were: Controlled environment --- max. allowed power density = 1.47 mW/cm^2, minimum safe distance = 4.34ft. Uncontrolled environment --- max. allowed power density = 0.29 mw/cm^2, minimum safe distance = 9.7 ft.

Here now is the same 70 cm DATV setup evaluated with the RSGB calculator to meet their guidelines of ITU-T K.52. It actually gives two different calculations. The first is to meet their OFCOM requirements. OFCOM is the U.K. equivalent of our FCC. The second calculation deals specifically with beam antennas used at 50 MHz or higher. The OFCOM says that the horizontal separation required is 3.3 m (10.8 ft) which is a bit farther than our ARRL/FCC limit of 9.7 ft. The PAEC-2 exclusion zone calculation calls for an exclusion zone radius of 2.4 m (7.9 ft).



emf-calculator-v0.1.2-rsgb11c.xlsx - OpenOffice Calc

This workbook performs compliance checks to satisfy new EMF amateur licence conditions. It includes the Ofcom calculator (which will not calculate below 10MHz). It also includes lookup tables for the results from PAEC-2 for horizontally polarised Yagi beams above 50MHz. Please feedback on any issues with this trial sheet

Name	Callsign	Date of Compliance Check	Station Address
Jim Andrews	KH6HTV	12/10/2021	1025 Paragon Dr. Boulder, CO, 80303
Radio Make	Model	www.rsgb.org/emf	
KH6HTV Video	70-9B		

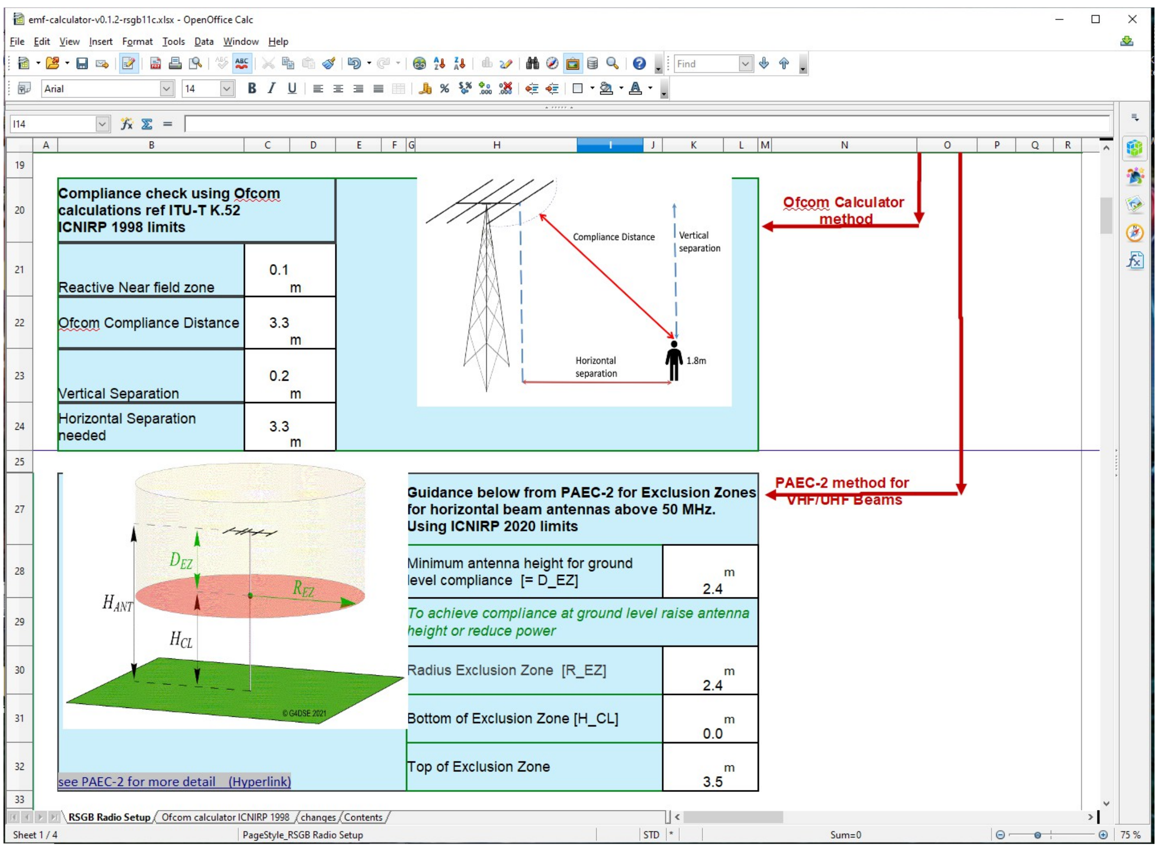
Notes Click on yellow boxes to select your station setup and operating conditions. Fill in the beige boxes and export or print this sheet to a PDF file as as a record of your compliance checks.

Radio Setup			Feeder			Antenna parameters		
Band	70cm							
Transmit Mode	Custom	100.0%	Cable Type	RG213	dB/100m	Antenna type	Custom	11.0 dBi
Frequency MHz	435.0MHz					Antenna polarization	Horizontal	
Transceiver			Feeder			My Antenna	6 ele yaggi on 5ft mast	
Transmitter/ linear Power	10.0W	10.0dBW	Loss per 100m		-16.1dB	Custom	12.6	11.0dBi
Mode factor	100.0%	0.0dB	Cable Length m	2.0m		Mainlobe EIRP	116.9W	20.7dBW
Transmit % in 6 minutes	100.0%	0.0dB	Other losses dB		0.0dB	Directivity Factor -dB		0.0dB
			Feeder loss dB		-0.3dB	Height of Antenna m	2.0m	
Average power from Transmitter	10.0W	10.0dBW	Average power into Antenna	9.3W	9.7dBW	Average EIRP	116.9W	20.7dBW
Peak Power from Transmitter	10.0W	10.0dBW	Peak power into antenna	9.3W	9.7dBW	Peak EIRP	116.9W	20.7dBW

Interpreting the calculator results. First check if low power compliance is flagged in box to right. If not then choose one of the methods below to demonstrate compliance. You can use either the calculator or PAEC's for your compliance check and to define any needed Exclusion Zones.

FURTHER ASSESSMENT REQUIRED
Use one of the methods below

RSGB Radio Setup / Ofcom calculator ICNIRP 1998 / changes / Contents



emf-calculator-v0.1.2-rsgb11c.xlsx - OpenOffice Calc

Compliance check using Ofcom calculations ref ITU-T K.52 ICNIRP 1998 limits

Reactive Near field zone	0.1 m
Ofcom Compliance Distance	3.3 m
Vertical Separation	0.2 m
Horizontal Separation needed	3.3 m

Guidance below from PAEC-2 for Exclusion Zones for horizontal beam antennas above 50 MHz. Using ICNIRP 2020 limits

Minimum antenna height for ground level compliance [= D_EZ]	2.4 m
To achieve compliance at ground level raise antenna height or reduce power	
Radius Exclusion Zone [R_EZ]	2.4 m
Bottom of Exclusion Zone [H_CL]	0.0 m
Top of Exclusion Zone	3.5 m

see PAEC-2 for more detail (Hyperlink)

RSGB Radio Setup / Ofcom calculator ICNIRP 1998 / changes / Contents

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*. 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).

Newsletter Details: This is a free newsletter distributed electronically via e-mail to ATV hams. The distribution list has now grown to about 500. 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. All past issues are archived at: *https://kh6htv.com/newsletter/*

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