Boulder Amateur Television Club
TV Repeater's REPEATER

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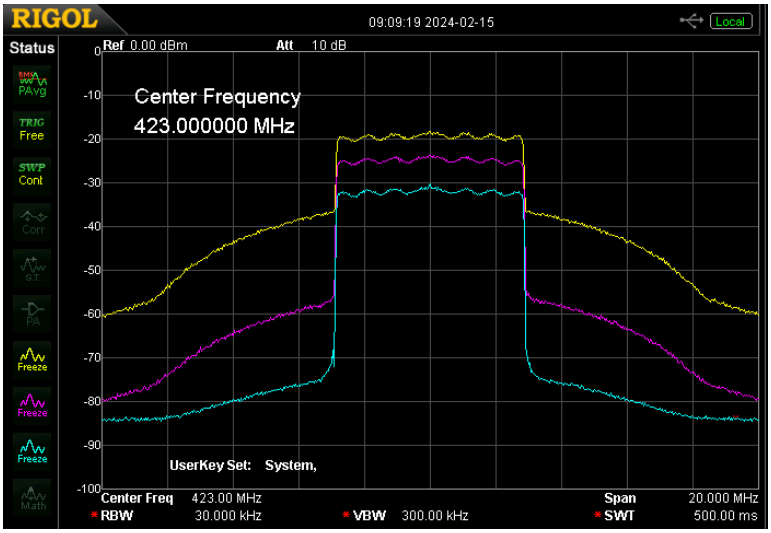
BATVC web site: www.kh6htv.com

ATN web site: www.atn-tv.com

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



Impact of Amp Over-drive on DATV ?

Recently one of the Boulder ATV hams posed the question --- ***"Why when I over-drive my amplifier don't I see a degradation in the S/N at the repeater?"***

We have always preached the DTV rule that we don't want to drive our rf power amplifiers any harder than that level which creates the out of channel inter-mod spectrum growth with a shoulder break-point at -30dB below the in-band rf power level. (note: This measurement is made by first measuring the rf

power at the center frequency. Then measuring the rf power on the shoulders at a point 200 kHz beyond the TV channel band-edges.)

So, this called for still yet another experiment. I set up a bench test using a Hi-Des HV-320E modulator driving a model UWB-103 broad-band amplifier (250kHz-3GHz, 20dB gain, +22dBm (sat) to various levels of saturation creating the spectrums shown above in the photo. By over-driving this amp, the out of channel, inter-mod spectrum grew very rapidly. The worst case shoulders I was able to create was with a -16dB break-point. This gave me the ability to test a DTV receiver with various levels of shoulder break-points. I then attenuated this signal by 60dB to avoid overloading the front end of the DTV receiver. I used a Hi-Des HV-110 because of it's capability to measure and display both the received signal strength in dBm and also the received signal to noise ratio in dB. There are three types of constellations available with DVB-T, namely QPSK, 16QAM, and 64QAM. The respective max. S/Ns for these are: 23dB, 26dB and 32dB. I set the modulator's digital parameters to HDMI in, H.264 encoding, 1080P resolution, 5.5 Mbps, 5/6 FEC and 1/16 Guard. At this setting, the min. required S/N was 8dB (QPSK), 14dB (64QAM) or 21dB (64QAM). I then tested for all three constellations.

Here are the conclusions from my over-drive tests:

QPSK --- The s/n stayed at max. 23dB until the shoulder break-points dropped below -21dB. The receiver continued to decode successfully with s/n = 12dB at -16dB shoulders.

16QAM --- The s/n stayed at max. 26dB until the shoulder break-points dropped below -25dB. The receiver stopped working at -17dB shoulders.

64QAM --- The s/n stayed at max. 32dB until the shoulder break-points dropped below -30dB. The receiver stopped working at -23dB shoulders.

QPSK works better than QAM in much the same fashion as FM outperforms AM. QPSK being purely phase shift keying is independent of amplitude variations, is much more like FM. QAM adds amplitude modulation on top of phase shift keying and thus starts to suffer the well known limitations of AM.

So why should we stop at -30dB shoulders? As hams we always are wanting to put out the absolute most RF power possible. At -30dB shoulders, we have an acceptable compromise between putting out a strong, in channel signal and keeping to a minimum our pollution of the spectrum in the adjacent TV channels. Plus, as we saw above, if we were using 64QAM, we would start to degrade the quality of the DTV signal if the shoulders got any worse than -30dB.

73 de Jim Andrews, KH6HTV, Boulder, Colorado

DUAL-BAND, DVB-T TRANSMITTER

Wife & Husband Ham ATVers, Doshia and George Kretke [KB0NAS & N0RUX] were early adopters of DVB-T ten years ago when we first discovered it. They have been really committed members for many years of our local ARES group, BCARES. In particular, for providing ATV coverage of events. They built one of the first analog ATV Go-Kits and outfitted their van with an extendable mast and yagi antennas for ATV. They could always be counted upon whenever our public service agencies called for ATV coverage of some event.

70-7B Amplifier (left), 23-12A Amplifier (right) & HV-320B modulator (front)

Doshia & George's DATV setup was strictly for 70 cm band. Their basic 70cm transmitter put together back in 2014 consisted of a Hi-Des model HV-100EH Modulator and a KH6HTV model 70-7B, 3 Watt, 70 cm, RF linear power amplifier. Once our W0BTV ATV repeater was moved to it's

current location on the mesa south-west of the city of Boulder and it then later started having severe RFI issues on it's 70 cm input (Ch 60, 441 MHz), they were no longer able to access the repeater from either their home qth, nor going mobile with their equipment.

So, when Jim, KH6HTV, announced recently that Colin, WA2YUN, and he had come up with a new, improved, lower cost power amplifier for the 23 cm band, Doshia and George decided it was time to upgrade their system to add 23 cm capability. So they ordered from Jim a new model 23-12A amplifier. They requested that it be setup to be compatible and easily switched back and forth with their 70 cm amplifier simply by switching channels on the Hi-Des modulator and turning on the power on the appropriate amplifier.

Well, the first complication arose when trying to work with the old 2014 vintage HV-100 modulator. It was so old, that it was not designed to accept a custom TV channel table. To switch frequencies on it, one had to first attach a PC Windows computer via the USB port and go into it to reprogram it's single operating frequency. Doshia & George had typically always used it on 441 MHz and rarely ever tried to change frequencies. Attempts to install newer HV-100 firmware were unsuccessful. So, Doshia & George decided to bite the bullet and asked that a newer modulator be purchased for them. So now their new transmitter is using a new Hi-Des model HV-320B modulator. They will be using their old 70-7B amplifier along with the new 23-12A amplifier, as shown above in the photo.

The key to interoperability on two bands with one modulator and two amplifiers is to carefully balance the rf input drive powers when switching bands. We do not want to have to be changing the internal attenuator setting in the HV-320. It needs to be set once and left there. To provide a drive signal to both amplifiers without needing to move cables, we put an SMA, 3 dB Power Divider on the output of the modulator. We used a Mini-Circuits model ZESC-2-11 rated to work from 10 MHz to 2 GHz. The max. RF power output from the HV-320B is not the same at 23 cm as at 70 cm. (+8 dBm vs. +10 dBm for QPSK). Also the gain of the two amplifiers is not the same. For the 70-7B, it is typically about 53-57 dB. For the 23-12A, the gain is of the order of 45 to 50 dB (depending upon serial number).

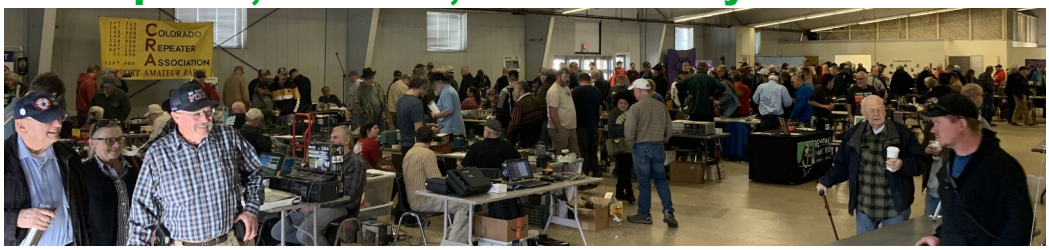
The modulator, 3 dB divider and both amplifiers were cabled together as shown in the photo. The HV-320B's internal attenuator was then adjusted to provide the proper drive level for the 23 cm amplifier. It was adjusted until the spectrum shoulder break-points reached -30dB. This was done with the power turned off on the 70 cm amplifier. Then the TV channel was switched down to the 70 cm band, the 23 cm amp. was turned off and the 70 cm amp turned on. At this point the 70 cm amp was being severely over-driven when horrible spectrum shoulders. Extra SMA attenuators were attached to it's input until it's spectrum shoulders were also placed at -30 dB. Now to avoid the need for extra cost, external SMA attenuators, a permanent attenuator of the appropriate value was then installed inside the amplifier. In the original design of the 70-7B, space had been provided on the pc board for installing just such an attenuator. The custom attenuator was made using 1/4 W, 1206 SMD, 1%, chip resistors. In Doshia & George's 70-7B, a 10 dB attenuator was installed.

Simple enough ! Now they will be able to once again return to the air waves with their smiling faces on the the W0BTV ATV repeater, plus be able to again provide ATV coverage for BCARES operations.

73 de Jim, KH6HTV, Boulder, Colorado

Big Ham Radio Swap-Fest, Feb. 18th, Adams County Fair Grounds

www.rmham.org



Lots of tables with a bewildering assortment of new, old, used, etc. ham radio gear + lots of front range, smiling Colorado hams buying, selling and renewing friendships

Rocky Mtn. Ham's emergency comm trailer (right) and Edge of Space Sciences balloon tracking van (left)

Edge of Space Sciences (EOSS) (***www.eoss.org***) had their balloon tracking van on display at the swap-fest. EOSS was formed in 1990 and has been launching high altitude balloon experiments on behalf of universities, colleges, high schools and middle schools ever since. Their charter is to "Promote science and education through high altitude balloons and amateur radio."

Jeff, N2XGL & Marty, WA0GEH - EOSS

In recent years, EOSS has conducted 13 or more flight-days in a year, sending radio-equipped payloads deep into the stratosphere over eastern Colorado. Balloons reach a typical apogee of 95,000 feet. VHF and UHF radio signals transmitted from this height may be received as far as 400 miles away!

Jim, KH6HTV, struck up a conversation about ATV with EOSS vice-president, Jeff, N2XGL, and Marty, WA0GEH who were representing EOSS at the swap-fest. Many years ago, EOSS used to fly an ATV transmitter on their balloons, but not in the recent past. They had been disappointed with the video results. They were unaware of the fact that now ATV hams were doing high-definition, digital video. So maybe the conversation will lead to EOSS once again trying ATV from 95,000 ft, but this time with DATV.

Art's New HD, DVB-T, DVB-S Receiver Development is Nearing Completion

Art, WA8RMC, is in the final stage of development of a ATV receiver with some really innovative features. He is calling it his Versa-Tuner. Art will be showcasing a working model during the upcoming Dayton Hamvention at the ATV Forum.

Here are some of its design features: Receives both both DVB-T and DVB-S,
1 - 6 MHz bandwidth 50 MHz to 1000 MHz
Scanning function allows a mix-and match of seven DVB-T and DVB-S Scanning Channels
Stand-alone receiver... Does not need a computer to receive.
Is completely audio and Video PID agnostic. PIDs do not have to be loaded into the receiver to receive incoming signals.
Art is working on an added feature that will have a Graphical User Interface so the receiver will allow you to view incoming received video remotely through the Internet

reported by Dave, AH2AR

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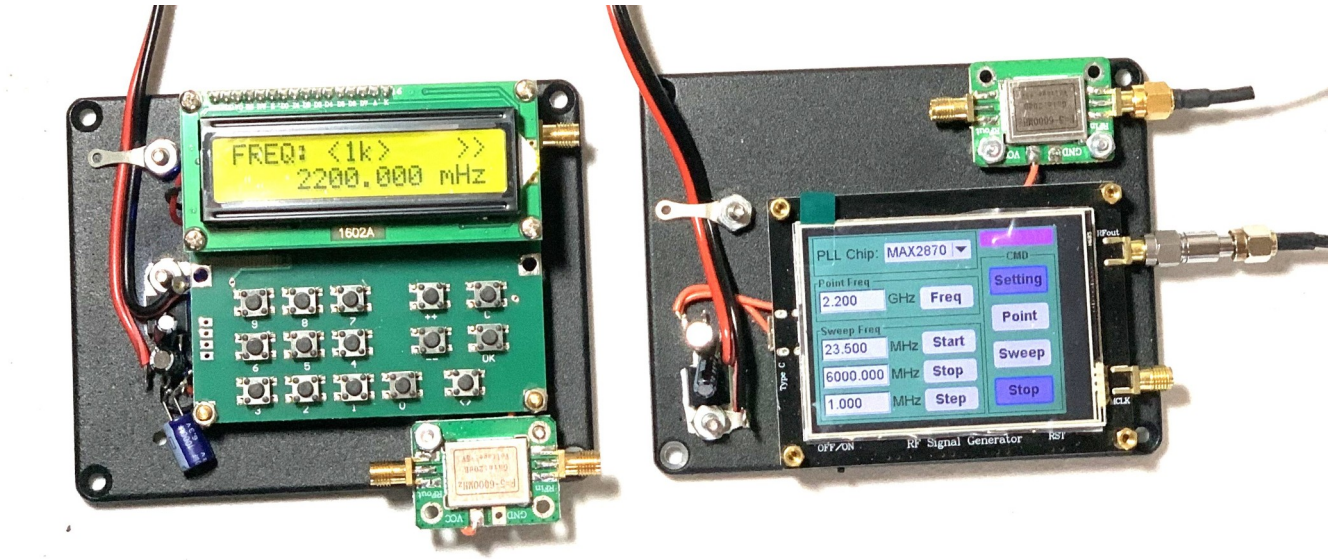


ADF4351 (left) & MAX2870 (right)

Low Frequency Noise from Frequency Synthesizers

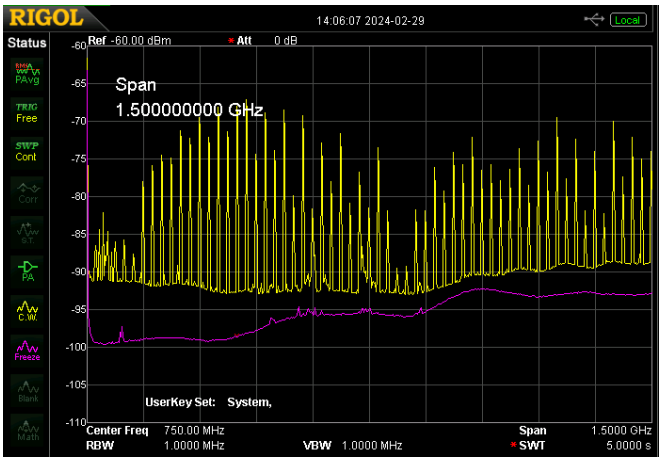
Jim, KH6HTV

Recently, on our weekly ATV net, Steve, WA0TQG, mentioned that he had recently purchased one of the Amazon low cost frequency synthesizer boards to experiment with. But he was quite disappointed in the low frequency noise that it put out. I too had recently commented here in our newsletter about the need to carefully select one's choices of the LO and IF frequencies to avoid having one's down-converted signal land on some of the LO's low frequency noise spikes. Knowledge about this noise is important as it would feed-thru our mixers and appear on the IF output. Thus compromising the

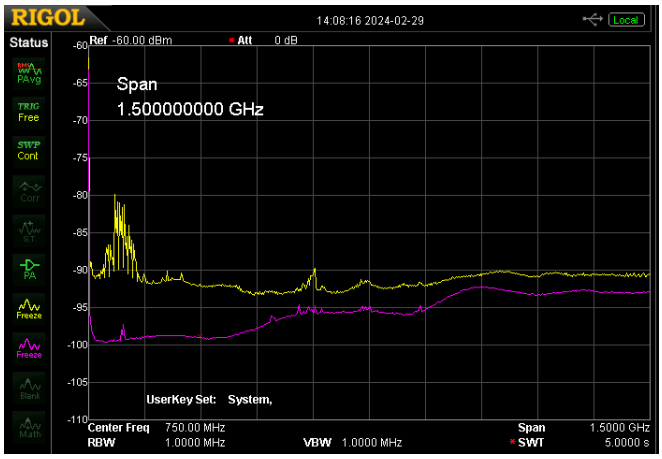
resultant receiver sensitivity. So, I guess it is time to show our readers what we are talking about. I have several of these frequency synthesizers kicking around the ham shack to experiment with. The photo above is of two of the Amazon pc board types. The one on the left is an Analog Devices ADF4351 (35 MHz - 4.4 GHz). It cost about $30. The one on the right is a Maxim MAX2870 (25 MHz - 6 GHz). It cost about $75.

We have written about these and other synthesizers in earlier issues of this newsletter. In those articles, we were concerned with the phase noise occurring around the actual desired CW frequency output and how to tame it. (see issues 93, 103, 115, 117, 118, 121, 122, & 127).

I used my Rigol DSA-815, 1.5GHz, spectrum analyzer to look at the low frequency noise coming from these oscillators. One needs to be careful and not overload the front end of the analyzer with the fundamental CW output. Overloading the front end creates artificial spurs that were really not part of the original signal. I found that the CW frequency needed to be 2.2 GHz or higher to avoid overloading the Rigol. It no doubt has a 2 GHz low pass filter in it's front end. When running the oscillators on frequencies < 2 GHz, I used my Diamond MX3000 triplexer to filter out the oscillator's CW signal to be able to observe the low frequency noise. It's 2 meter output was a low pass filter (up to 200 MHz). It's 70cm output was a band pass filter (300-470 MHz). It's 23cm output was a high-pass filter (600- >1500 MHz) and thus not useful for this purpose.



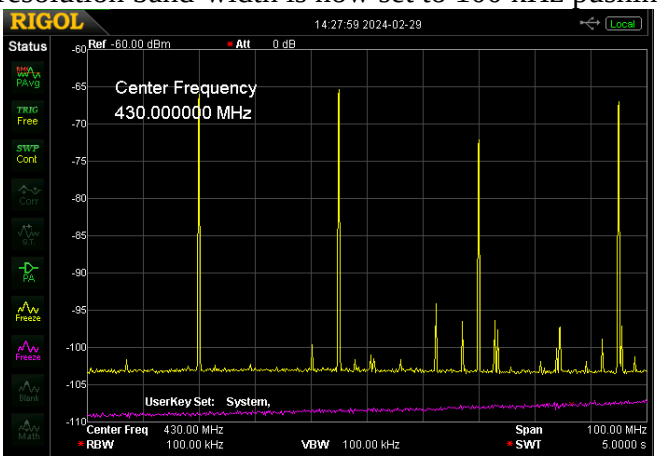
ADF4351



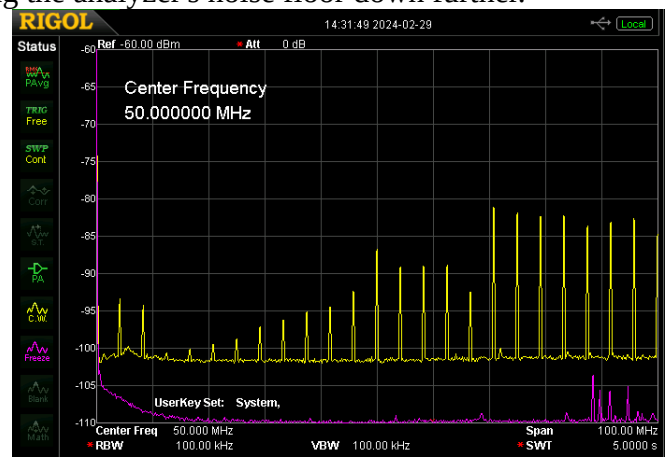
MAX2870

These two above spectrum analyzer screen grabs vividly demonstrate the low level, low frequency noise coming from these two frequency synthesizers. Both synthesizers were set to give an output of 2.2 GHz. The CW, 2.2 GHz signal was 0 dBm (ADF4351) & +3 dBm (MAX2870). The LNA on the analyzer was enabled. Resolution band-width is 1 MHz. The upper reference level is -60dBm and the vertical scale factor is 5dB/div. The horizontal span is from 0 to 1.5 GHz. The magenta trace is the baseline noise level of the analyzer with the synthesizer turned off. Note in both cases, there is a residual, broad-band noise coming from each anlyzer which raises the noise floor. In addition, there are many spurious spikes present. They are particularly bad for the ADF4351. For the MAX2870, they peak at about 75-100 MHz and are absent above 150 MHz.

The plots on the next page shown closed details of the noise. They are for spans of 100 MHz. For the MAX2870 it is from 0 to 100 MHz. For the ADF4351 it is the 70cm band (370 to 470 MHz). The resolution band-width is now set to 100 kHz pushing the analyzer's noise floor down further.



ADF4351, shown on 70cm band

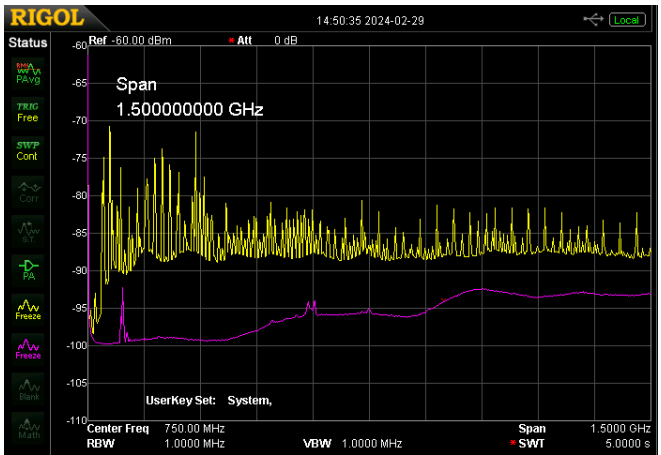


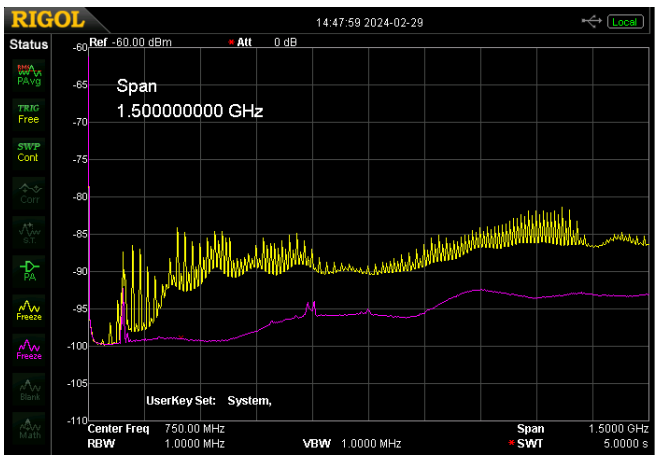
MAX2870 shown for 0 to 100 MHz

The synthesizers were programmed for several various, random frequencies and the low frequency spectrums were observed. There were some minor changes noted, but the overall general patterns remained the same.

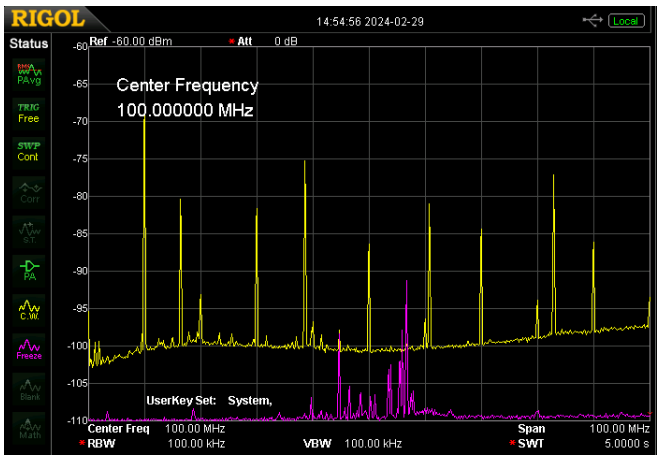
The next set of photos show two more Analog Devices synthesizers. They are the ADF4350 (140 MHz - 4.4 GHz) and the ADF5355 (35 MHz - 13.8 GHz). They are more expensive units in nice metal enclosures.

As before, they were also set to 2.2 GHz and measured under identical conditons. RF output was -1dBm (ADF4350) and +2dBm (ADF5355). Due to their noise spectrums, the narrow 100 MHz span was centered on 100 MHz. Disregard the spurious extra baseline noise around 100 MHz. That is feed-thru of ultra high power FM broadcast signals.

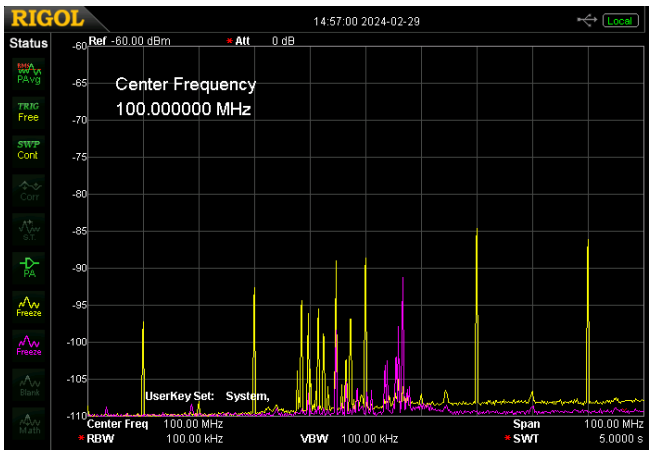




ADF4350 **ADF5355**



ADF4350



ADF5355

CONCLUSIONS: None of these are perfect oscillators. The spectrum signatures are unique for each model number. In addition to spikes, they all showed very broad-band noise which raised the overall noise floor. They all suffer from excessive low frequency noise which would compromise their performance in high quality receivers.

73 de Jim Andrews, KH6HTV, Boulder, Colorado

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ZERO RETRIES: Steve Stroh, N8GNJ, is the editor of **Zero Retries**, an on-line, electronic ham newsletter (***www.zeroretries.org***). We have exchanged several emails recently. Here are some of his comments, etc.

"First, I love your newsletter and have mentioned some articles in it in my newsletter Zero Retries, including this week's issue. The topics you report on about video operations in Amateur Radio is exactly the interesting, technical kind of content that should be showcased more in Amateur Radio to attract technical folks into Amateur Radio."

"I think one of the biggest needs in Amateur Radio is an amplifier that can accept the very low transmit power (10mW) of Software Defined Transceivers, such at the ADALM Pluto, LimeSDR Mini, & RedPitaya. There are many potential data modes that have been implemented in software defined transceivers, but they've basically been purely "benchtop" communications because of the very low power." (*at this point, I pointed out to Steve that my amplifiers had sufficent gain of > 50dB that they in fact were designed to work with very low power sources.*)

"The most interesting band for this work would be 70 cm as I really, really hope that the FCC will remove the bandwidth limits and let us really play with interesting data modes that require more than 100 kHz channels. Alternatively, 1.25 cm would also be of interest as a decent amplifier coupled to a SDT would enable real use of the 219-220 MHz band for P-P high speed communications. As for 1.25 meters, there's huge potential there for data usage especially if the 100 kHz maximum bandwidth

is removed by the FCC, especially in that interesting 219-220 portion. Many of the Software Defined Transceivers can generate RF at 219-225 MHz and if there was an amplifier that could generate reasonable levels of RF, with a wide channel, wow, that is an intriguing possibility."

2/23/24 --- after several back-n-forth emails, Steve has written a very nice article in his most recent issue of **Zero Retries** about KH6HTV rf power amplifiers. See his issue #0140 ***https://www.zeroretries.org/p/zero-retries-0140***

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FEED-BACK --- Favorite Antennas

Hey Jim --- Been out for awhile but I am still vertical HI ! HI ! The best 70cm antenna for me is a M-Squared 440-21TV. I have six. Two are stacked on the chimney. The best DX from the chimney mount was N2SMT in Lincroft, New Jersey. Distance about 170 miles NE to the west WA3BOQ the Monogahela national forest. Only could see carrier on the spectrum analyzer and W8RVH(SK) saw his carrier once about 275 miles over the mountains

73 de N3DC, Bill, Cheverly, Maryland

FEED-BACK ---- Newsletter Format

Hi Jim --- I always find it difficult to read PDF documents (I always use Adobe Reader) whose pages are in “portrait” format on my 15 inch laptop screen. I like looking at the whole page on the screen and not having to zoom in and then scroll down or up... So, may I suggest a couple of changes for your newsletter?

1. Use VERDANA 12 type style instead of Times New Roman
2. Use "Landscape" instead of "Portrait" page orientation.

best 73 de I2NDT, Claudio, Dalmine, Italia

Low Cost, NTSC balloon transmitter inquiry: Adrian, VE7NZ, writes --- "Hi Jim -- We communicated recently about sending video from balloons. The DTV suggestions you had would definitely work but at $800 out of our pockets and given we will probably lose the balloon we are trying to get creative on the cost side. Has anyone messed around with some of the really low cost UHF transmitters on AliExpress? I keep thinking that if I can get a high enough powered baby monitor type of modulator/demodulator, given the balloon is line of sight, I might be able to make something like that work, albeit lower quality than what you recommended."

Any of your ATV hams out there able to help Adrian ? -- if so, contact him at adrian@stimpson.ca

W0BTV Details: **Inputs:** 23 cm Primary (CCARC co-ordinated) + 70 cm secondary all digital using European Broadcast TV standard, DVB-T 23cm, 1243 MHz/6 MHz BW (primary), plus 70cm (secondary) on 441 MHz with 2 receivers of 6 & 2 MHz BW
Outputs: 70 cm Primary (CCARC co-ordinated), Channel 57 -- 423 MHz/6 MHz BW, DVB-T Also, secondary analog, NTSC, FM-TV output on 5.905 GHz (24/7 microwave beacon).
Operational details in AN-51c Technical details in AN-53c. 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/*** Select ***ab0my 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 over 700+. 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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