Boulder Amateur Television Club
TV Repeater's REPEATER

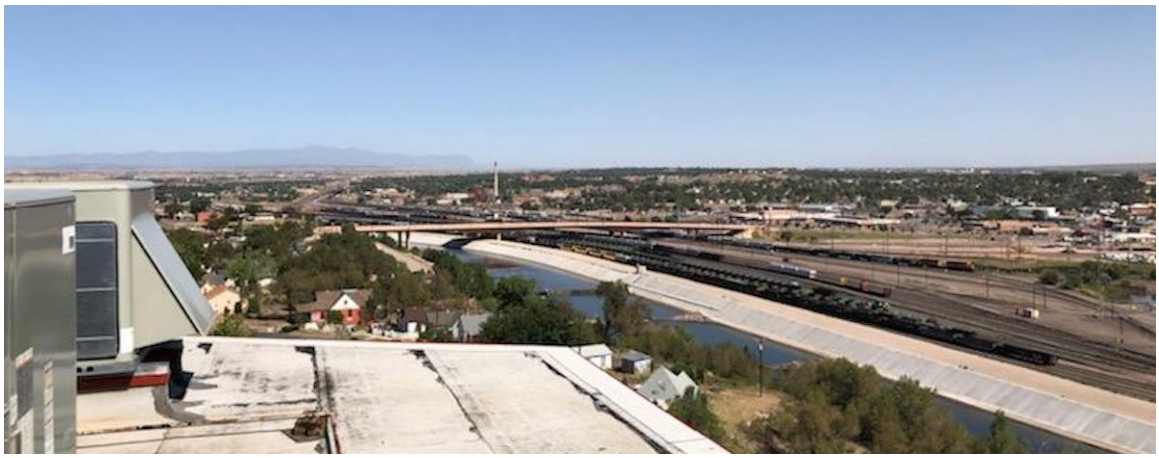
September, 2020
2ed edition

BATVC web site: www.kh6htv.com

ATN web site: www.atn-tv.com

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

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/ We hold an ATV net on Thursday afternoon at 3 pm MDT. ATV nets are streamed live using the British Amateur TV Club's server, via: https://batc.org.uk/live/kh6htvtvr or n0ye.



PUEBLO, COLORADO ATV News: Bill, K0CGQ, of the Pueblo amateur radio club reports --- "Hi Jim -- I am pleased to tell you that we finally have a home for our DTV repeater, on top of Mesa Tower here in Pueblo. The top picture is a view of the city and the Arkansas river below. Next are Mark, W0AOK (r) and Brian, KE0KEP (l) . Then the steep steps leading to the elevator equipment room at the top of the tower where the radio equipment is located. And finally the repeater mounted in it's rack with Mark behind it. The next step for me is to drive around the area, testing reception. I will send a further report later. We tested everything before we left the tower and it was working well."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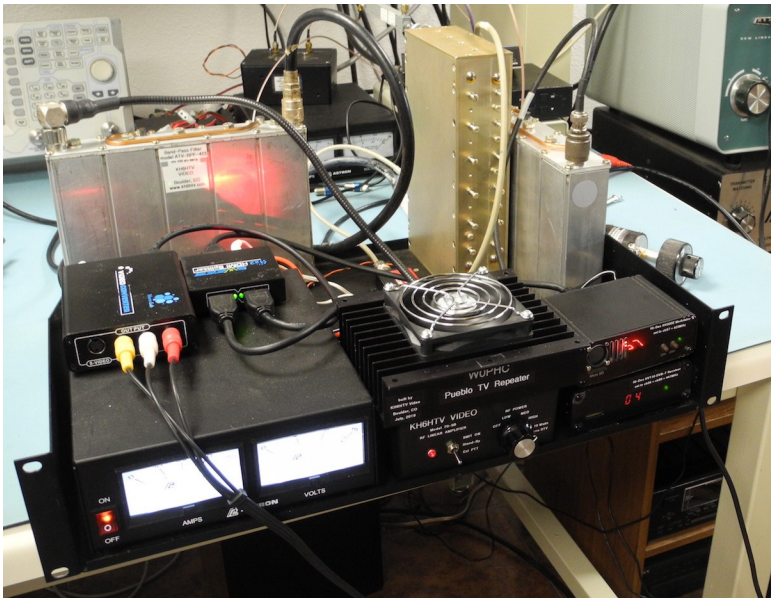
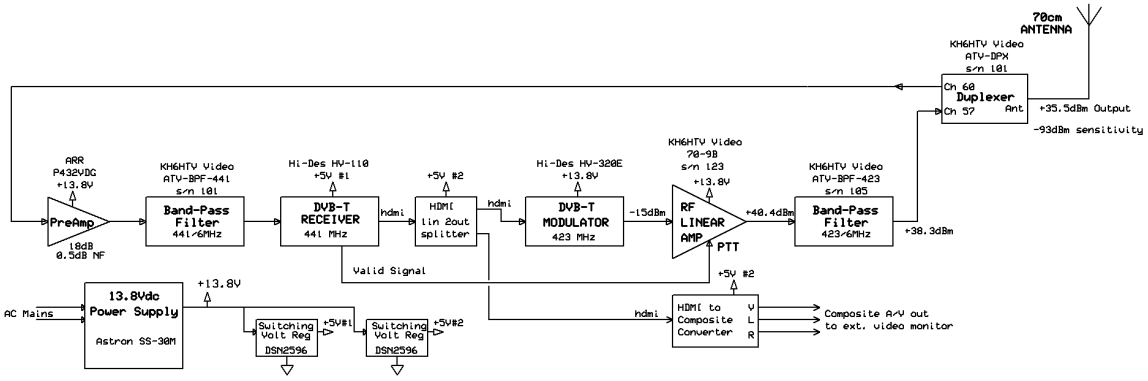
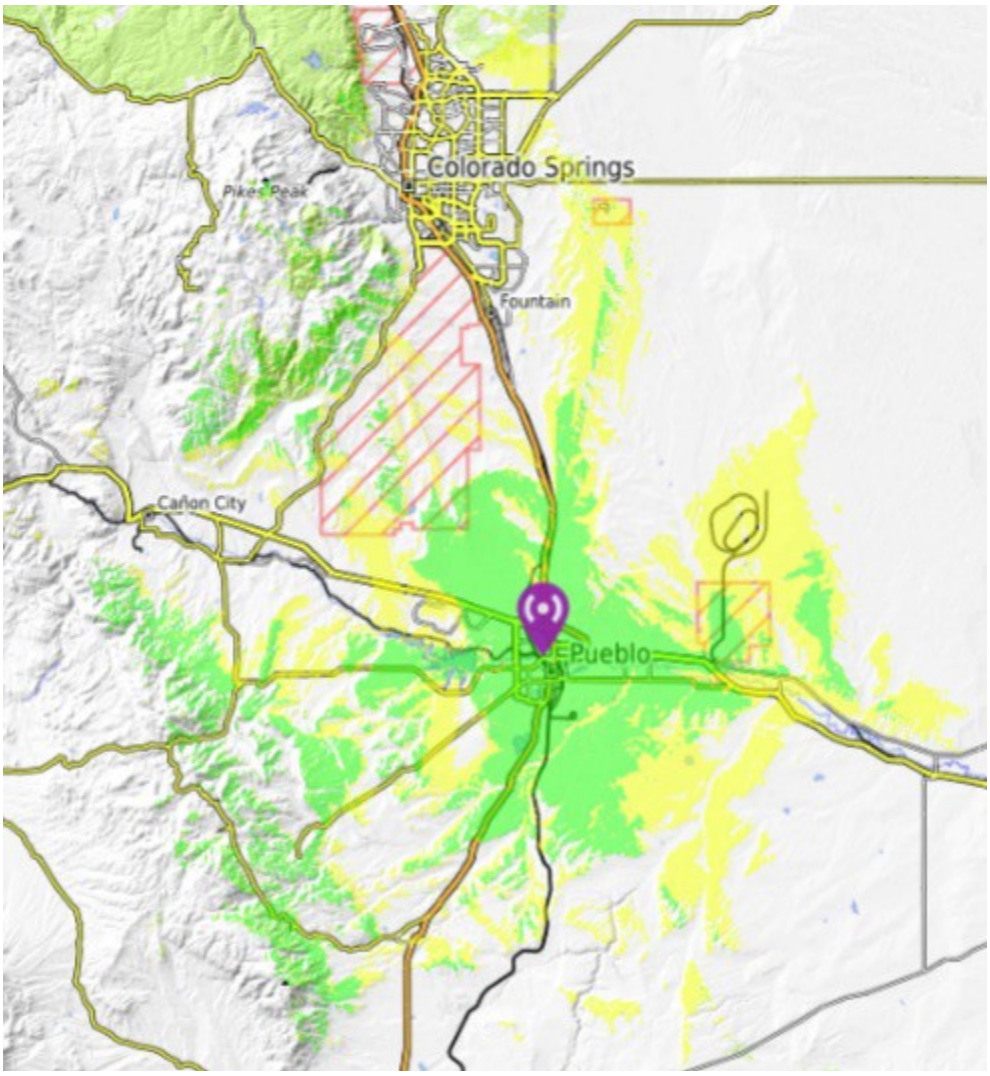
Editor's Notes - Ref. Pueblo Repeater: I built the DTV repeater orginally in 2019 for Pueblo. It was documented in app. note, AN-48 "Building a Basic 70cm, DVB-T, Television Repeater". (available at www.kh6htv.com) Bill, K0CGQ, then encountered issues with finding a suitable location for the repeater. Several sites he had identified vaporized on him. This past spring, Bill, contacted me and said he had finally found a suitable site, but he could only install a single antenna there. The original repeater design required two, 70cm antennas. One for receive and one for transmit. Bill asked me to please modify his repeater to use a duplexer for a single antenna.



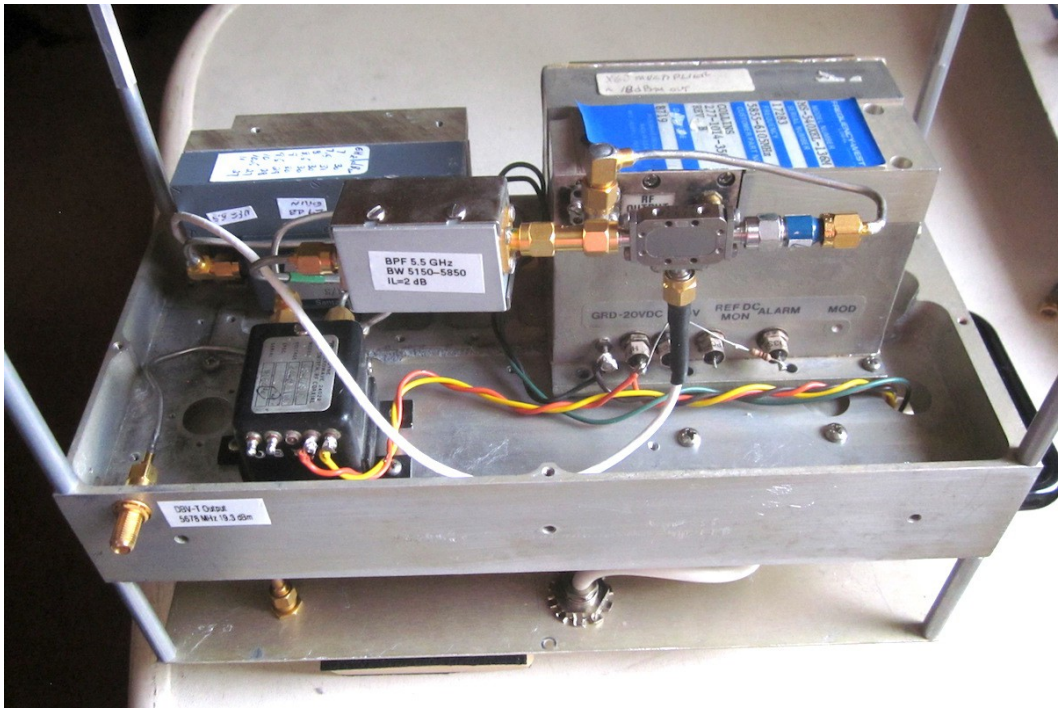


This is the block diagram of the resultant 70cm, DVB-T, repeater with a duplexer. The photo above is the finished repeater undergoing final testing on my bench. The duplexer by itself did not have sufficient isolation to prevent the 10 watt transmitter from getting back into the receiver and de-sensing it. Thus it was necessary to retain the original band-pass filters for both receive and transmit. This compromise added additional insertion loss and lowered the rf output power. The resultant rf output was +35.5dBm (3.5 Watts rms). The threshold sensitivity to turn on the repeater was -93dBm. This was measured for "normal" digital parameters of 6 MHz BW, QPSK, 1080P, 8K FFT, 5/6 FEC (code rate), 1/16 guard, & 6 Mbps.



This past June, Bill also asked me to run a coverage map for his new, rebuilt repeater. I used the program Radio Mobile. It is documented in app. note, AN-33a, "TV Propagation". The new site for the Pueblo repeater is on top of a tall, ten story, apartment building in downtown Pueblo. It is called the Mesa Tower and has a height of 135 ft. above ground level. Bill's first photo shows the view from the top of the building. The Rocky mountains can be seen in the far distance. Pueblo lies out on the prarie of eastern Colorado. A large assortment of coverage maps were generated for Bill for various locations and antenna situations. The map shown above is the coverage area for a radius of 100km. The receiving station is assumed to be using a 6 element yagi antenna with 11dBi gain and mounted at a height of 20ft. The green shaded areas are strong signal areas with > -80dBm. Reception is more "iffy" in the yellow shaded, weak signal areas with power (-90dBm < Prcvd < -80dBm). The repeater is predicted to provide coverage into the eastern slope of the Rocky mountains to the west and north-west. Weak signal coverage is predicted even 45 miles north into portions of Colorado Springs.

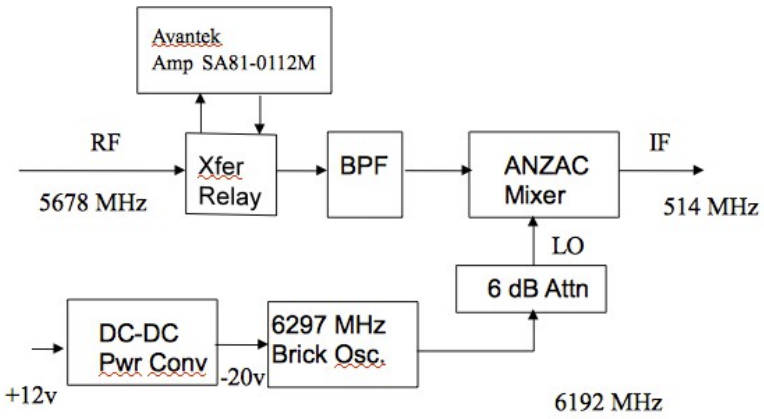
Jim, KH6HTV



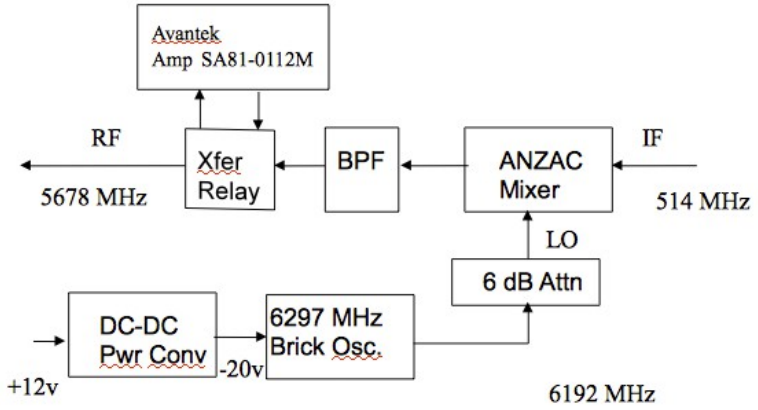
N0YE - 5.7 GHz TRANSVERTER In a previous newsletter, issue #54, we presented a 5.8GHz transverter developed by Jim, KH6HTV. So Don has provided us with some details on how he designed and built his home-brew, digital TV transverter for the 5cm band. Don has taken a totally different approach. Key was having in his microwave junk box a coaxial cross-over relay. This allowed him the freedom to use all of the major components for both receive and transmit modes. As seen in the block diagrams, the only difference is the direction of the signal flows.

The local oscillator (LO) is a Frequency West brick operating on 6.297 GHz and outputting +13dBm of rf power. The RF frequency is 5.678 GHz and the IF frequency is 514 MHz. The mixer is an Anzac model MDC-171 which requires +7dBm of LO drive power. It is rated for RF/LO (4-18 GHz) and IF (DC-4GHz). The mixer has 6dB conversion loss. The amplifier is an Avantek model SA81-0112M. It is a C band amplifier with 29dB gain. The band-pass filter is an unknown commercial filter with a pass-band from 5.15 to 5.85 GHz and -2dB of insertion loss.

So how well does it perform ? Don set it up with sufficient IF drive power to maximize the rf output with the out of channel, spectrum shoulder break-points set at -30dB. The required IF drive at 514 MHz was thus -4dBm rms from his Hi-Des HV-100EH modulator. The resultant RF output power was +17dBm rms (50mW). The gain of the transverter is 21dB for both transmit and receive. The noise figure of the Avantek amplifier is 5.9dB. It obviously works, as Jim, KH6HTV, and Don exchanged DVB-T QSO contacts on August 18th over a 5 mile rf path with Don set up at NCAR. See the previous newsletter, issue # 54, p. 9. Both Jim & Don received P5 pictures with perfect 23dB S/N.



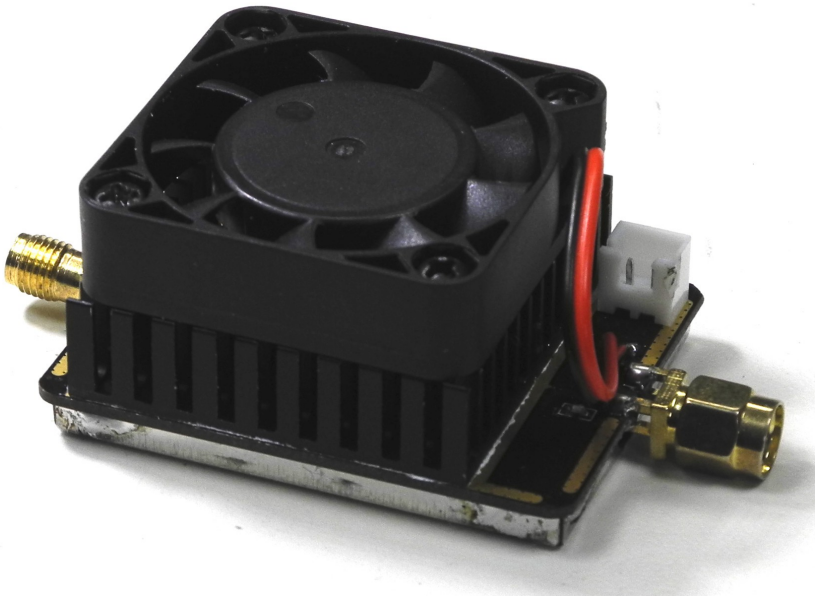
N0YE 5.7 GHz Transverter -- Receive Mode Block Diagram



N0YE 5.7 GHz Transverter -- Receive Mode Block Diagram

SURPLUS MICROWAVE COMPONENTS: If you don't find what you need at ham radio swap-fests, then doing a google search on E-Bay might turn up something. I recently needed a C-band mixer and found it on E-Bay. As it turned out it was a surplus company in Israel, called **Surplus Tech Mart.** They have microwave goodies listed on their own web site (https://www.surplustechmart.com/) plus other electronic items. The price they charged for the mixer I needed was quite reasonable and it included shipping. I was shocked at how fast I got the part from them. The E-Bay site promised delivery in 1 1/2 months. I got it within a week, via air mail from Israel.

Another more local source is Phil Schnabel's company, **Western Test Systems** in Cheyenne, Wyoming. (http://westerntestsystems.com/) Phil specializes in microwave components and electronic test instruments. He has a really large inventory of both coaxial and waveguide microwave components. For Boulder hams, you might find it interesting to take a drive to Cheyenne and just wander through Phil's warehouse. Be careful, you might easily come home with a lighter wallet and a trunk load of goodies !



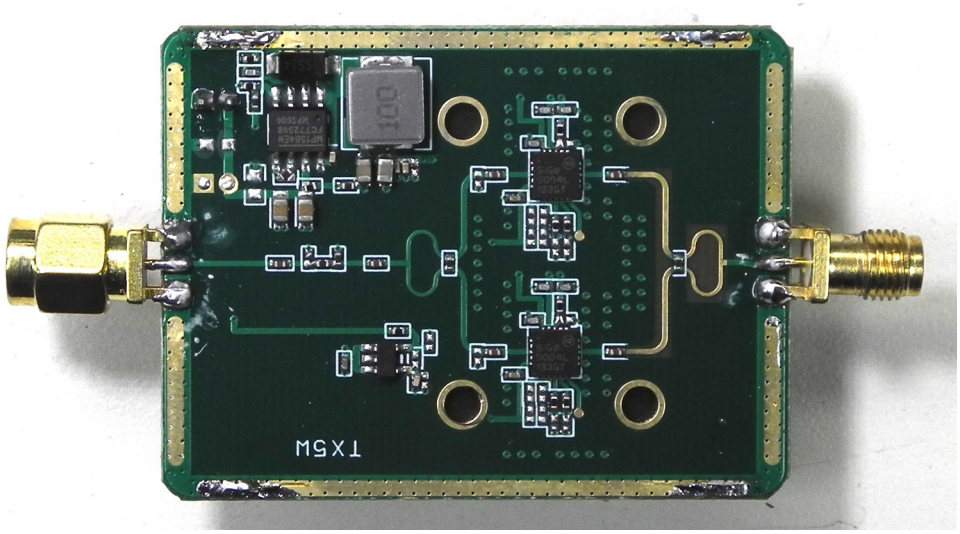
5.8 GHz, 2 Watt AMPLIFIER
Reliability Issues & Fixes

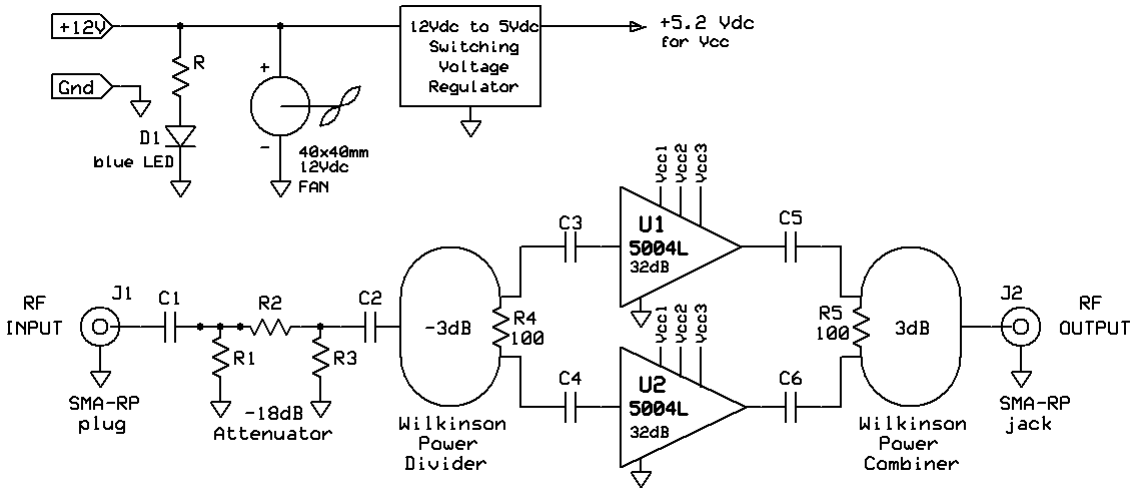
Jim, KH6HTV, Pete, WB2DVS, Bill, AB0MY & Don, N0YE
Boulder, Colorado

We have reported in several previous issues of this newsletter, using a low cost ($25), 5.8GHz, 2 watt amplifier from China for our microwave, FM-TV propagation experiments, and also as the final power amplifier in a DVB-T transverter.

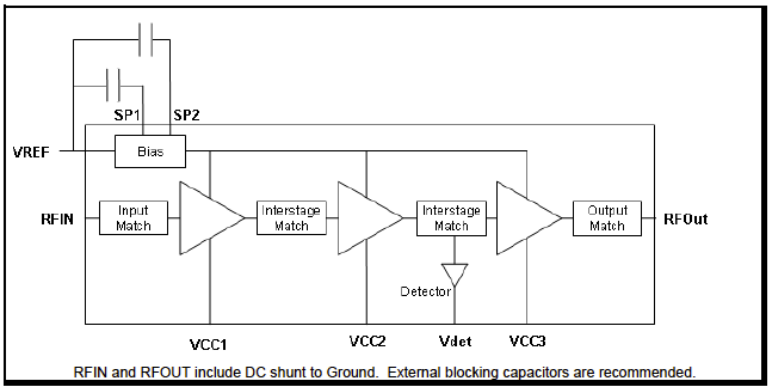
The amplifiers were purchased from the Chinese, Amazon style vendor, Banggood.com. They cost about $25 with shipping from China. The link to them is:
https://www.banggood.com/Signal-Enhancement-Board-Booster-Extended-Range-for-The-Transmitter-Below-600mW.....
The amplifiers have the model number TXPA58002W5. The model number alone implies operation at 5.8 GHz with 2.5 Watts power. The web site says the amplifier will operate from 5 to 6GHz. DC input voltage 12 to 16Vdc. The web site further claims the amplifier will put out 3 Watts with 200mW drive and 4.5 Watts with 600mW drive. They say do not exceed 600mW of rf drive power.

We have also mentioned in previous newsletters having reliability issues with all of us experiencing burning out at least one or more of these amplifiers. We have jointly done autopsies on our dead amps. In the process of opening up our amplifiers, we have discovered what the internal workings are of these amplifiers.



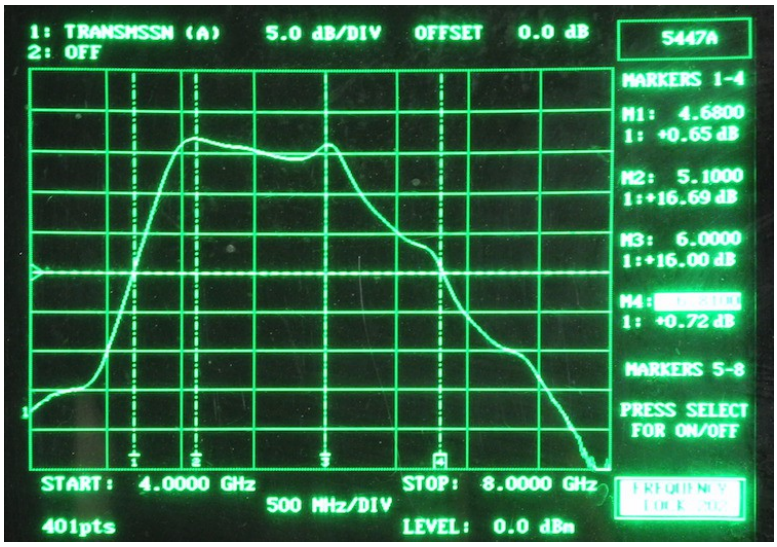


What we discovered is shown in the above photo, and simplified schematic diagram. There are two paralleled RF ICs as the key active devices. They are labeled as SiGe 5004L. Pete has found that these are made by Skyworks and the complete model number is: SE5004L. This is a high gain, high power, RF MMIC for the 5-6 GHz, WLAN service. This is the block diagram of the SE5004L.



The key specs for the SE5004L are: 5.15 - 5.85 GHz frequency coverage, 32dB gain, Pout = +26dBm (for 64QAM Wi-Fi), +34dBm (-1dB gain compression), Vcc = 5 Vdc, idle current = 300mA.

The p.c. board, block diagram shows the presence of a pi network resistive attenuator. I made measurements on it and found it to be about -18dB. Thus the overall gain of the TXPA58002W5 is degraded to be about +14dB. The input attenuator was obviously added by the Chinese engineers to enable the amplifier to be directly driven by moderately powered FPV, FM-TV transmitters. The MMIC amplifiers are operated in parallel by the use of Wilkinson 3dB power dividers / combiners.



S21 of TXPA58002W5 amplifier: Vertical = 5dB/div. center line = 0dB, Sweep from 4 to 8 GHz, 500 MHz/div.

So, how well do they work ? The above plot of small signal, S21 vs. frequency was measured on a Wiltron 5447A, 10MHz - 20GHz, network analyzer. S21 is seen to be fairly flat from 5 to 6 GHz at about 15dB gain. The gain drops to 0dB at 4.6 & 6.8 GHz. The first amp purchased in Dec. 2019 was operated at 5.685 GHz with +37dBm (5 Watts) output for several days, before burning out. (see Jan. 2020 issue # 30a, p. 5). Mike, WA6SVT, then recommended that we never run them over +33dBm due to the small size of the heat sink and fan (issue #31, p. 9). Since then, it has been our policy to follow Mike's advice and keep the output to a max. of +33dBm (2 watts).

Reliability Issues: So why have we still lost so many of these amplifiers?

Issue #1 - Heat --- From our mutual autopsies, we have all come to the conclusion that the unknown Chinese manufacturer(s) have skimped on their production line(s) in not adhering to good heat sink practices. The basic engineering design of the pc board was good. Four holes were provided to mount a heat sink. Plus there were lots of tiny vias in the ground plane under the power MMICs to help conduct heat from the MMIC to the opposite side of the pc board where the heat sink is located. However, the builders only used two screws, not four, to attach the heat sink. Plus it was a dry mount, i.e. they

did not use any heat sink grease. In one case we found a heat sink mounted with only one screw even and in some other cases the screws were loose and not tightened properly.

The solution to this is simple. First un-solder and remove the cover shield. Then remove the fan and heat sink. Drill and tap four new holes in the heat sink for 2-56 screws. Apply a good coating of thermal joint compound to the heat sink and reattach to the pc board. Use lock washers on the screws and tighten firmly. Remount the fan and re-solder the cover/shield in place. We have done this as a preventive measure on several new amplifiers and then burned them in for many hours at +33dBm RF output, with no failures. Plus the cover shield and heat sink are now just warm to the touch.

The amp draws about 0.5 Amps at +13.8Vdc when idling. At +33dBm RF output, it pulls about 1.2 Amps. The -1dB gain compression point was found to be +33dBm.

Issue #2 - Excessive RF Input --- Examining the Skyworks data sheet for the SE5004L, we find that the spec. for the max. RF input power is +6dBm. If we work back from the input to the MMIC through the -3dB of the Wilkinson power divider and the -18dB input attenuator, this computes to a max. allowable input to the TXPA58002W5 of +27dBm (500mW). The Banggood web site advertises a max. allowable input of 600mW (+28dBm). Thus, it is likely that anyone trying to whack the amplifier with anything greater than 500mW stands a very good chance of blowing out the MMICs.

S21 of TXPA58002W5 amplifier with input attenuator removed
Vertical = 5dB/div. 0dB is 3ed line from bottom Sweep from 4 to 8 GHz, 500 MHz/div.

Extra Modification: An optional modification while having the cover shield removed, is to also remove the input 18 dB attenuator. This gives one a much more versatile amplifier with 32dB of gain. Otherwise the performance is essentially unchanged. Caution: the max. allowable rf input power now needs to be kept below +9dBm (i.e. the +6dBm spec. + the 3dB input power splitter). This mod needs to be done with care. The

resistors used for the 18dB attenuator are tiny 0204 surface mount. Remove all three resistors. I then soldered a tiny piece of bare wire-wrap wire across the R2 pads. Plus, if you really feel brave, you could replace the objectionable, reverse polarity SMA connectors with conventional SMAs.

ATN HAS A NEW WEB SITE

Check it out at **www.atn-tv.com**

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