Boulder Amateur Television Club
TV Repeater's REPEATER

April, 2024
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BATVC web site: www.kh6htv.com

ATN web site: www.atn-tv.com

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23 cm PATCH ANTENNA

Jim, KH6HTV

We have just discovered another great antenna to add to our collection of recommended antennas for ATV service. It is made by the Linatcho company in China. The model number is LC120012BG. It is sold via E-Bay. The price is $66 which includes shipping from China.

The key specs. for the antenna are: Vertical polarization, 12dBi gain, 55 deg beam-width, 1.1 to 1.3 GHz, 25cm x 30cm x 6cm, N connector.

We have tested this antenna and found that this particular Chinese manufacturer actually knows what they are doing and have honest specs. We did a return loss swept frequency test from 1 to 1.5 GHz and found that it was extremely broad-band. It had >10dB RL (i.e. < 2:1 vswr) from 1.045 to 1.348 GHz. >14dB (1.5:1 vswr) 1.111 to 1.336 GHz and >20dB (1.22:1 vswr) 1.134 to 1.234 GHz.

We also tested it for gain across the 23 cm ham band (1240-1300 GHz). We used the same DATV method previously described in issue #155 and in full detail in KH6HTV application note, AN-67. The source was a 23cm, DVB-T transmitter running 6 MHz band-width. The power level was set to +10dBm. The source antenna was a Directive Systems loop yagi. The receiver was a TinySA spectrum analyzer set up to measure the full channel power in a 6 MHz wide TV channel. The reference antenna was a 1/4 λ ground plane with +2.2dBi gain. We found that the gain was very

uniform across the whole band at about +12dBi which was the manufacturer's spec. Our measured antenna gain results were: +12.1dBi (1243), +12.4dBi (1255), +12.6dBi (1267), +12.4dBi (1279) & +11.8dBi (1291 MHz). In the azimuth plane, we measured the -3 dB beam-width to be 48° close to the mfgr's spec. of 55°

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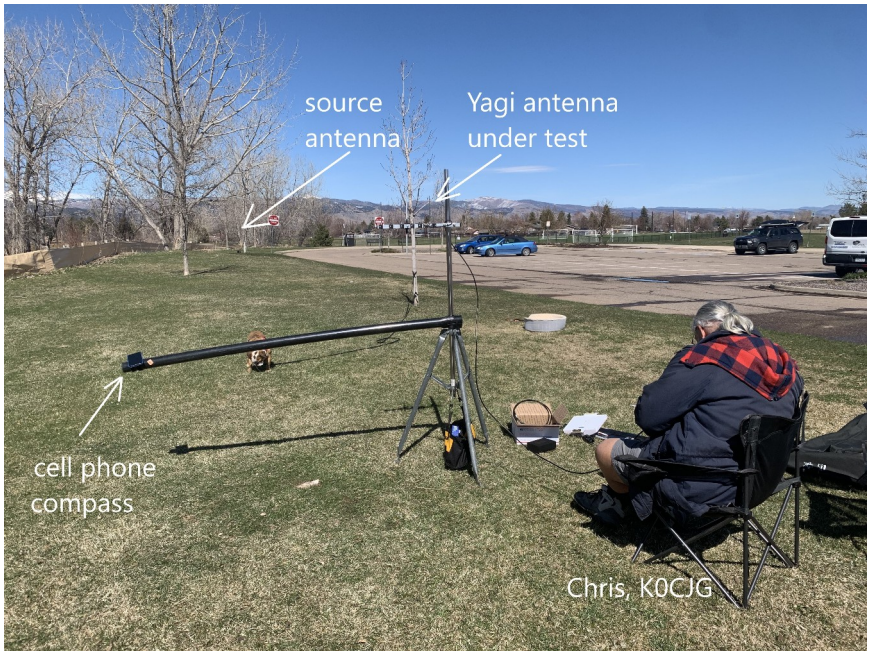
ANTENNA PATTERN MEASUREMENTS



Chris taking antenna data with TinySA spectrum analyzer

After Don & Jim talked on our weekly ATV net about measuring the gain of various 70cm and 23cm antennas for ATV service, Chris, K0CJG, said he would like to do some follow-on experiments to actually measure the complete patterns of some of those antennas.

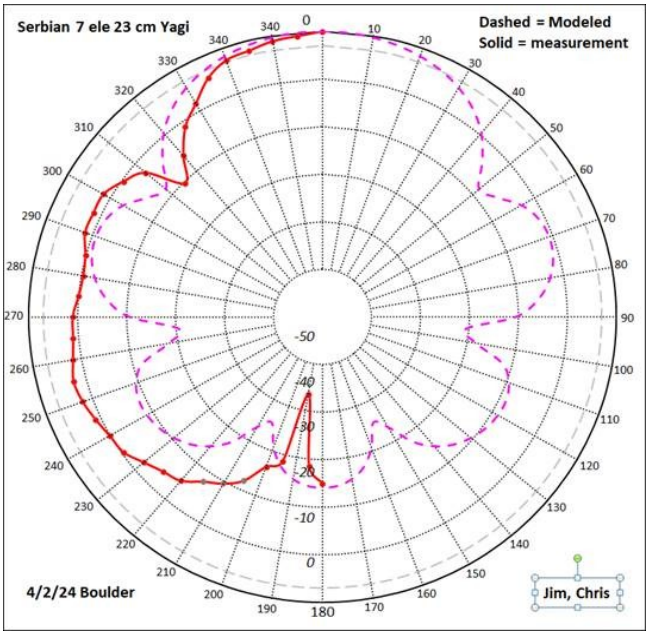
So, recently Chris set up a first pass experiment to do pattern measurements at 23cm in the south parking lot at the East Boulder recreation center. It was in a fairly open area and a rarely used parking lot. Jim, KH6HTV, helped out by bringing along a 23cm, 10mW, CW source and a DSE loop yagi antenna to be used as the signal source. He also supplied a TinySA-Ultra to be used as the calibrated receiver. Chris had devised a means of making accurate angular measurements using the internal digital compass in his cell phone. He had previously determined that he needed to isolate the phone from any nearby metal objects as they degraded the compass accuracy. He devised a long PVC arm to attach to the antenna tripod mast at one end and using velcro, strap his cell phone to the other end. See the above photo.

For Chris' first experiments, he opted to measure the new dual-band (70cm/23cm) yagi antenna from Serbia which Colin, WA2YUN, had recently discovered. It was the model 70cm23WB11. It has 4 elements on 70cm and 7 elements on 23cm. Specs. are: 1240-1310 MHz, 11.4dBi gain, 30dB F/B, 46o 3dB horiz. BW. Price is 139 €. We have written about this excellent antenna is a few earlier issues of

this newsletter recently. We found that the manufacturer, Antennas-Amplifiers (***www.antennas-amplifiers.com***) published a lot of reliable data about their products. So this gave Chris a good data base to work with for comparing his results with theirs.

Because our ATV in Boulder uses vertical polarization, the test antennas were mounted for vertical polarization. Before testing the yagi, a 1/2 λ ground plane, reference antenna was mounted on the receive antenna tripod. A signal strength reading was then recorded for this reference gain(2.2dBi) antenna. The yagi antenna to be tested was then mounted on the antenna tripod at the same height as used for the reference antenna. Chris then took data at 5 deg increments over the southern hemisphere of the antenna pattern and also a few spot checks on the northern. The data was then corrected knowing the signal on the reference antenna to give the actual antenna gain in dBi.

On his PC, Chris developed an Excel program to create a polar plot of his antenna data. His first pass was to plot his data along with the mfgr's published data. Ops ! -- he then realized, the published data was for the opposite polarization. So, instead, Chris decided to instead try comparing his measured results to a theoretical model of the antenna. We used actual dimensions from the test antenna and created a 7 element yagi antenna model on EZNEC. The measured and predicted gains were quite close.



Chris was not totally happy with the results, especially measuring the side-lobes on the back side of the pattern. In hind-sight, we realized that the selected antenna test site was not completely ideal. There was a metal barn nearby which no doubt was giving us an error due to reflections.
So, we do plan to repeat the tests in the future. We do have some other possible sites in mind to try out.

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Our ATV Repeater has Cataracts !

We have had concern for quite sometime now that our Boulder, Colorado DATV repeater does not "See" as well as computer predictions say it should. We suspect it has "cataracts" and cloudy vision for our ATV signals.

So recently, an experiment was run doing mobile field strength measurements. We setup a 23cm DVB-T transmitter and 70cm DVB-T receiver in an automobile and used a Diamond NR2000NA (2m/70cm/23cm) mobile antenna with a Diamond MX3000N triplexer. With this arrangement, we were able to transmit continuously while in motion on 23cm (1243 MHz) while simultaneously

monitoring the 70cm (423 MHz) output from our W0BTV repeater. We set the W0BTV repeater in the On mode with the quad display. This mode displays at one time the signals received by all three receivers (1243/6, 441/6 & 441/2 MHz) without the repeater being constantly keyed up and down by fluctuating signal strengths. Each of these receivers is setup to always display as an on-screen-display, the received signal strength in dBm and the signal/noise ratio in dB. Plus the 70cm receiver in the car also displayed the repeater's transmitted signal strength and S/N.

We drove over the eastern part of Boulder County and also into the Boulder valley and city of Boulder. Observations were made while in motion. We also stopped at about 40 different locations and recorded the signal strengths and S/Ns for both 70cm and 23cm. Later we used the RF propagation prediction program, *Radio Mobile*, to then compute what signal strength we should have expected.

CONCLUSIONS:

1. In general, there was good agreement within perhaps ±5 dB between the measured and calculated field strengths on the 70 cm band for transmissions from the repeater to a mobile receiver. Especially for those obvious locations with a visual line of sight path.

2. In general, the measured field strengths most always came in -10 to -20 dB weaker than predicted by Radio Mobile for most all of the 23 cm band transmissions from the mobile transmitter to the repeater.

These results were discussed at length on our weekly ATV net. The general consensus was that our present receive antenna is not appropriate for our particular situation. We are presently using a Diamond X6000, 2m/70cm/23cm omni-directional antenna. It is mounted on the roof top of the govt. building where our repeater is located. This building is sitting alone on the top of a mesa about 800 ft. above the city of Boulder. But also immediately behind it are the Flatiron mountains which rise a couple of thousand feet above the city. They work as a great reflector for rf signals, thus creating multi-path. Thus, an omni-directional antenna receiving equally the backside reflections from the Flatirons is not a suitable antenna. On transmit, the BARC 70cm antenna has a cardiod pattern and thus does not send as much energy to the west towards the Flatirons, but instead directs most of it out over the prarie to the north-east.

Also of concern is the fact that the X6000 elevation pattern has a narrow beam-width and is looking more out towards the horizon, rather than down into the Boulder valley. Some downward tilt is thus

needed also for our receive antenna. During a recent trip to the roof-top, Don, N0YE, tried relocating the X6000 antenna. He was using Bill, AB0MY's signal for test purposes. A new location didn't help. It actually made things worse by several dB. Conclusion: We need different antenna(s) for our repeater's receivers.

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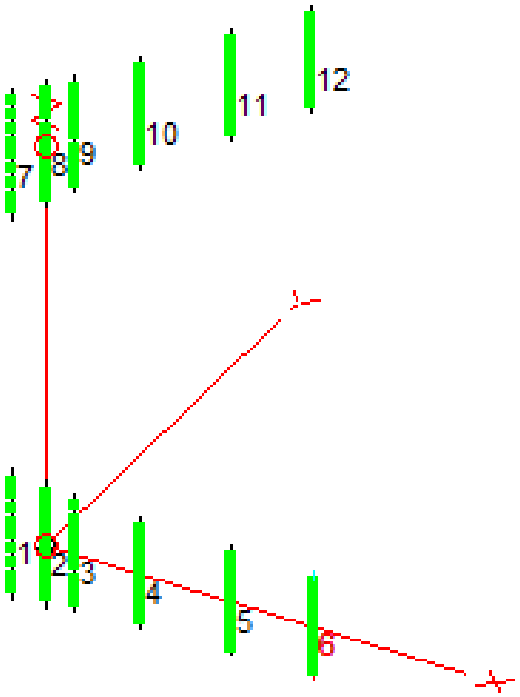
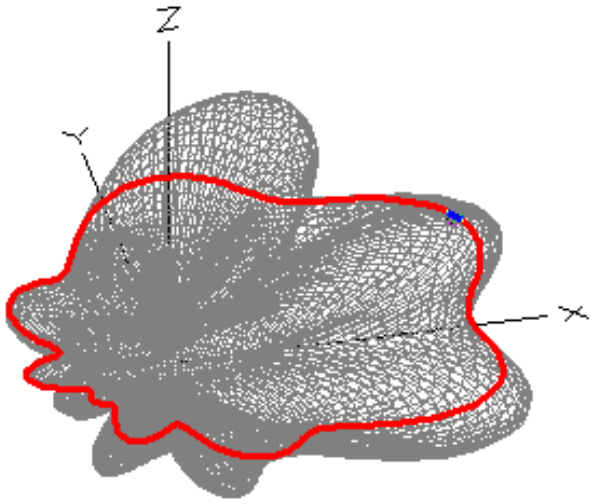
New 23cm Receive Antenna for W0BTV-TV Repeater

As explained above, we decided we need to at least try some different antenna(s) to improve our reception of 23cm signals. At this point, due to the extreme RFI at the site on 70cm, we have about given up on doing anything more for that band. Our desired service area is #1 priority the eastern, prarie, half of Boulder County. We need about 120º coverage from North to the South-East. We would prefer to find an antenna with a 120º cardiod pattern. We didn't find any, so the next idea was to try to synthesize the desired pattern with a pair of lower gain yagi antennas.

While searching for a suitable antenna, we stumbled onto the Chinese 1.2 GHz patch antenna discussed earlier in this newsletter. The first step was to do EZNEC modeling with this antenna to see if it just might work. EZNEC doesn't model patch antennas, but works well with simple wire model antennas. So an EZNEC model of a yagi antenna was created which had a gain and beam-width similar to the Chinese patch antenna, i.e. 12dBi and 55º A 6 element yagi gave a good match.

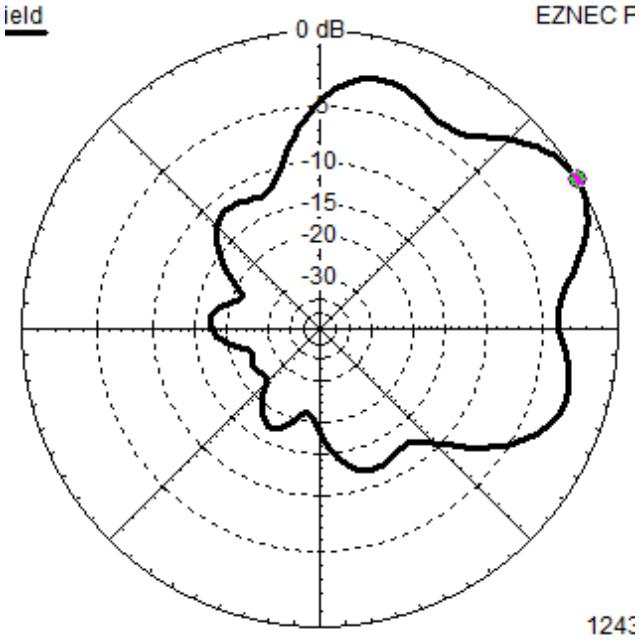
The next step was to create a model with two of these yagis stacked one above the other at the minimum possible separation of 35cm possible between two of the patch antennas. Then in the EZNEC modeling, the top antenna was rotated relative to the bottom antenna and watching what happened to the azimuth pattern. As expected, at 0º the two antennas are in phase and the gain actually increases by 3dB and the beam-width narrows. But as the angle is increased, the gain starts to drop and the pattern broadens out. It does get a bit lumpy, but still has acceptable gain flatness. Going past 65º, the pattern started to have unacceptable deep nulls. For this simulation, it appeared an angle of about 60º was optimum. The figures on the next page show the results.

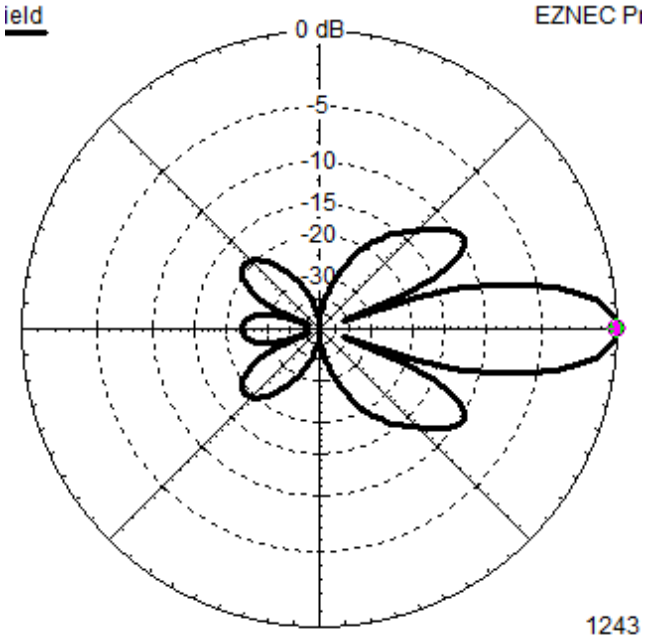




60 degree rotation -- 3D Antenna Pattern

Stacked Antennas, 35 cm separation, 60 deg rotation





Azimuth Pattern: Gain = 10.7dBi, 40 deg BW Elevation Pattern: -3dB BW = 18 deg

EZNEC Stacked Yagi Model: Max. Gain = +10.7dBi, Average Gain is approx. +8.7dBi with ± 2 dB ripple over angle of 116 degrees. -3dB BW = 40 deg -6 dB BW = 126 deg -10 dB BW = 148 deg

Based upon this model, the decision was made to thus purchase a pair of these Chinese patch antennas for evaluation. As discussed earlier in this newsletter, we were very pleased with the preliminary tests of both return loss and gain. They were right on spec.

The next step was to then test the pair in the stacked, rotated configuration previously modeled. A pair of 3 ft. LMR-240 coax cables were used along with a Mini-Circuits model ZESC-2-11, 3 dB splitter/combiner to connect the two patch antennas in phase. The return loss of this combo was not quite as good as a single patch antenna. We saw a flat -10dB RL (i.e. 2:1 vswr) across the 23cm band.

On April 2ed, Chris, K0CJG, and Jim, KH6HTV, set up an antenna test range at the East Boulder recreation center and made some pattern measurements. As Chris explained earlier, the first test to verify his technique was to measure the pattern of the Serbian 70cm/23cm yagi antenna. We then tested the pattern of the proposed dual stacked / rotated patch antennas. We made the measurements at 1243 MHz using a CW signal and the TinySA-Ultra spectrum analyzer. We were pleased with the results as they tended to verify our yagi model. Here is what we measured.

Max. Gain = 9.5 dBi -3dB BW ≈ 90^{o} -5dB BW ≈ 104^{o} -6dB BW ≈ 118^{o} & -10dB BW ≈ 140^{o}

The next step ahead for us will be a trip back onto the roof of the repeater site and install these new patch antennas and then test their performance in place. We presently have a request into our site host for permission to install the new antennas. When we install them, we will also add a down-tilt to the pattern to try to fill in the close in locations in the Boulder Valley.

WISH US LUCK ! ! !

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Narrow Bandwidth DVB-T Experimentation

Rick Peterson, WA6NUT, Buena Vista, Colorado

Reduced bandwidth operation for DX is common in Europe, especially at 70 cm and lower frequencies. I've provided links to PDF documents showing how I've implemented DVB-T at 500K and 125K bandwidths. There are many ways to do this -- this is only one way to do it -- not necessarily the best way. I've found that, with my setup, operation at 125K requires less tweaking (no retuning) than at 500K. All my operation has been on 70 cm, using Pluto (TX) and RTL-SDR V3 (RX) SDR hardware. Here are some links:

"Digital Amateur Television On a Budget: A Software Approach": This PDF is from a PowerPoint presentation, with local references. Includes block diagrams of my setup.

https://www.qsl.net/wa6nut/WA6NUT%20DATV%20Presentation.pdf

"Operating Instructions DVB-T ATV Setup": Shows TX and RX setup at WA6NUT. I'm currently using a different RX setup, using software from F4FDW (see next PDF below).
https://www.qsl.net/wa6nut/DVB-T%20Operating%20InstructionsB.pdf

"Operating Instructions F4FDW DVB-T Receiver v.4.2 (Python)": F4FDW's receiver software uses a combination of GNU Radio and Python.
https://www.qsl.net/wa6nut/F4FDW%20Python%20RX.pdf

I provided links instead of providing them as attachments because I can update the online documents as I discover new information.

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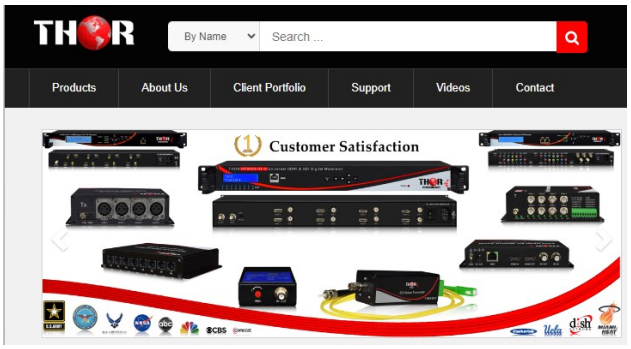
DATV Modulators

We have asked Mario, KD6ILO, what modulators they are using in San Diego for their digital ATV network. Mario says they are using commercial broadcast modulators from the THOR company. ***www.thorbroadcast.com***



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Source(s) for Band-Pass Filters for ATV Repeaters ?

A major headache these days for anyone wanting to build an in-band, ATV repeater is where to find suitable, TV channel band-pass filters (BPFs) for the transmitter and receiver. In years past, our primary suppliers were Spectrum International in Concord, MA and DCI in Ontario, Canada. Unfortunately, both companies have since gone out of business and attempts to reach them fail. The local Boulder, Colorado ARES group (BCARES) has expressed an interest in building more ATV repeaters to enhance the coverage of Boulder County. They want them to be 70 cm, in-band, repeaters. Thus, we need to come up with 70 cm ATV -BPFs.

Back in 2019, I had discovered an E-Bay source of used, surplus 70 cm BPFs suitable for 6 MHz BW ATV service. I had purchased a bunch of them. They were originally intended for 455 MHz service. I tuned them down to our 70cm ATV frequencies. I thought other hams would be interested in getting them for building ATV repeaters. Wrong ! Nobody wanted to pay my price for them. I ended up having a "fire sale" to get rid of them. I did build one DATV repeater for the Pueblo, Colorado ham club using those filters. Now, the E-Bay source of those filters has disappeared because it was in Russia and we can no longer buy items from Russia due to their invasion of the Ukraine.

Now, following up on a lead from Tom O'Hara's web site, I have checked out the **Microwave Filter** company in East Syracuse, New York (***www.microwavefilter.com***) I have been in contact with them and they can be a source for us ATV hams. They do in fact make BPFs for commercial broadcast TV transmitters. One product of their's comes close to what we need. It is their model 18100-XX DTV-UHF Mask Filter. They make them for UHF channels 14-36. 1.5 dB max. insertion loss. -6dB BW = 7 MHz,-24dB BW = 12 MHz., 250 watts power rating. They have told me they would be willing to build a similar BPF, custom designed for our ham 70cm band frequencies for about $1,800. They also suggested we consider their line of receive BPFs, model 4930. It is available for all CATV channels, including our channels 57-61 on the 70cm band. Four pole filter. Rated at 2 Watts. Sells for $400 each.

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What is our next step forward for Amateur Radio Television in the 21st century?

KD6ILO™ LABS
ATSL 1550 Laser Optic Network

Our goal for our San Diego DATV Society, is to further develop and experiment more with Optical Wireless DVB Communications through the Infrared optical spectrum through free-space.

Commercial Telecommunications, Private sector (i.e. SpaceX, Amazon), NASA, ESA and the Military are onboard full speed ahead.

[Why?] Because what we have now in place will not support the demands and capabilities we need for the next generation of communications network infrastructure. NASA had seen this coming when they realize how old and failing it's DSN-Deep Space Network is, and yet it still needs its' obsolete RF infrastructure because they have an ongoing operational equipment such as probes, rovers and satellites on RF. Their adding Optical receivers attached to for example, on their 30m dishes to test and receive laser optic signals from the LCRD test program.

Okay Mario, get to the point! We are seeing our Amateur spectrum being slowly taken, we are being placed in secondary position of greed. And so much closer to the higher spectrum, so what do we do,**"We Turn On The Lights!"** Optics to clearly see where we can go further and join the team and not get left behind in the dark. It's getting harder to find our rf components, parts and assemblies' required to maintain what you (we) have and depend on our Asian neighbors to the east.

OWC-Optic Wireless Communications components, are abundant and plentiful even surplus items as mine was integrated together from. We are Hams. We experiment. We create new avenues of approach. The new 6G will be partially optical tech Li-Fi, be warned you well need a new smart device 😉.

73 de Mario, KD6ILO, Oceanside, California

DUPLEXERS & TRIPLEXERS for ATV ANTENNAS

Diamond MX-72A

Diamond MX-3000N

We often find it useful to be able to use a single coax cable to handle multiple antennas, or multiple bands with a multi-band antenna. For this purpose both Diamond and Comet offer excellent filters called a Duplexer (1 in / 2 out) and a Triplexer (1 in / 3 out).

These contain either two or three filters with a common input port. A Low Pass Filter (LPF) which passes DC up to a higher cut-off frequency. A High Pass Filter (HPF) which blocks DC and low frequencies, but passes un-attenuated the high frequencies. For the triplexer, there is also a Band-Pass Filter (BPF) which has both low and high frequency cutoffs and only passes a narrow band of frequencies.

I am showing here in this newsletter actual measurements on the performance of the Diamond filters. The Diamond MX-72A is intended for service as a 2 m / 70 cm Duplexer. It sells for $55 at HRO. The Diamond MX-3000N is intended for service as a 2 m / 70 cm / 23 cm Triplexer. It sells for $90 at HRO. I did swept frequency tests on them. The dynamic range of the swept frequency test was not sufficient to show some of the really high insertion losses in these filters, so single frequency CW tests were also performed and tabulated below

Diamond MX72A 2m/70cm Duplexer -- Insertion Loss

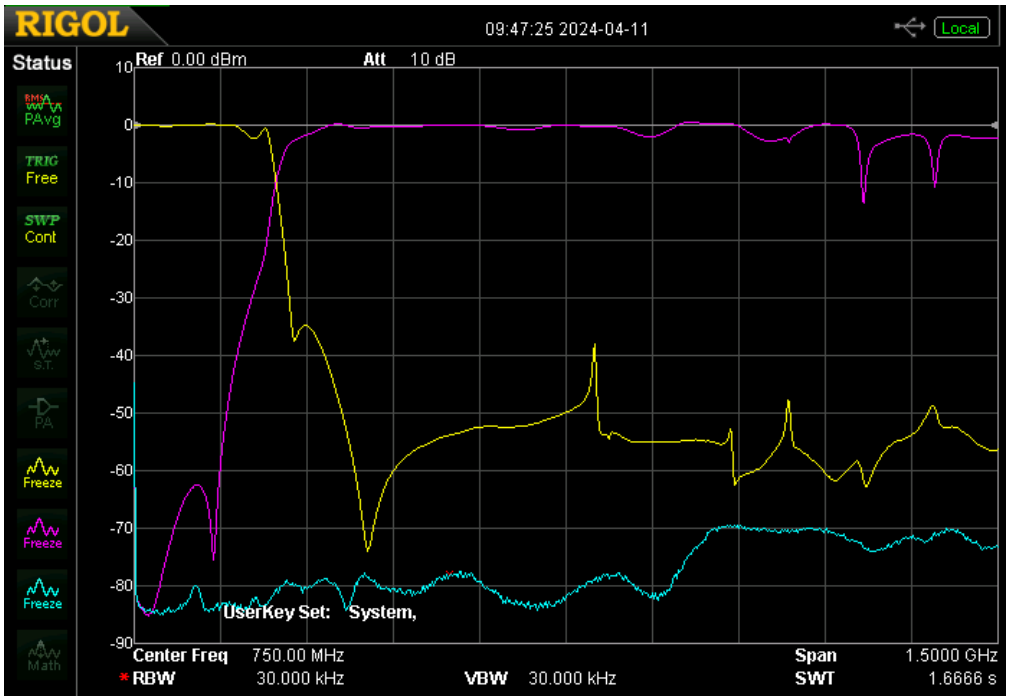
port 1 = input, port 2 = LPF, port 3 = HPF

S parameter	146 MHz	435 MHz	915 MHz	1270 MHz
S21	**-0.08dB**	-63dB	-50dB	-63dB
S31	-65dB	**-0.27dB**	**-1.67dB**	-11.6dB
S32	-67dB	-62dB	-59dB	-58dB

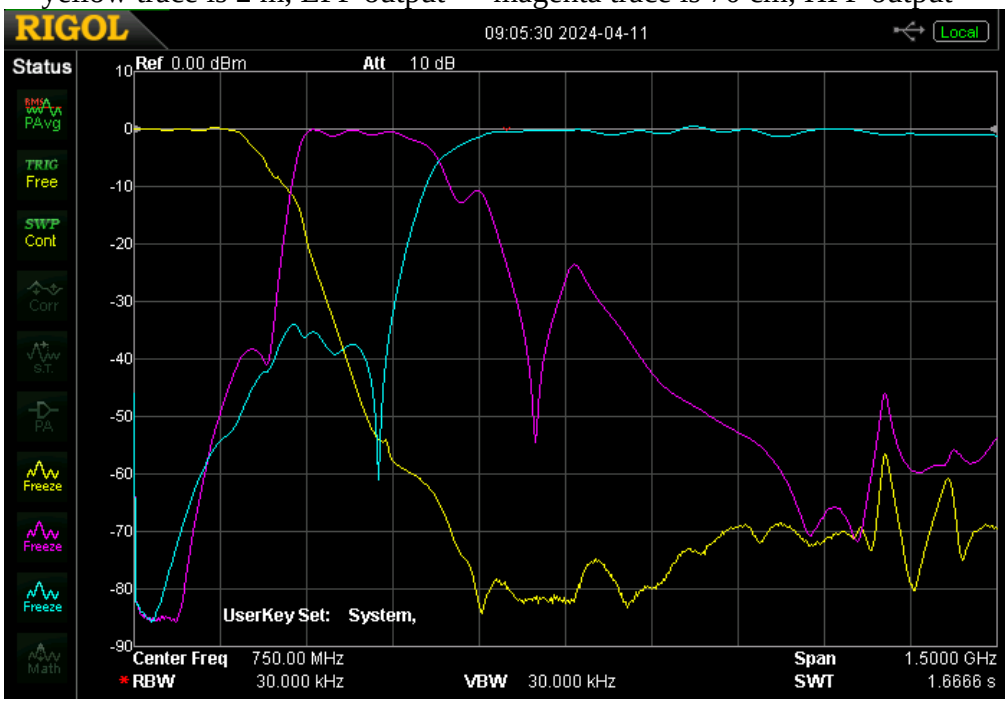
Diamond MX3000N 2m/70cm/23cm Triplexer -- Insertion Loss

port 1 = input, port 2 = LPF, port 3 = BPF, port 4 = HPF

S parameter	146 MHz	435 MHz	915 MHz	1270 MHz
S21	**-0.21dB**	-55dB	-91dB	-78dB
S31	-52dB	**-0.46dB**	-43dB	-63dB
S41	-56dB	-44dB	**-0.65dB**	**-0.63dB**
S32	-52dB	-54dB	-71dB	-66dB
S42	-55dB	-82dB	-93dB	-76dB
S43	-99dB	-46dB	-42dB	-65dB



Diamond MX72A 2m/70cm Duplexer *(note: cyan trace is system lower limit)*
yellow trace is 2 m, LPF output magenta trace is 70 cm, HPF output



Diamond MX3000N 2m/70cm/23cm Triplexer
Swept Frequency Test from 0 to 1.5 GHz. 10 dB/div & 150 MHz/div
yellow trace is 2 m, LPF output, magenta trace is 70 cm, BPF output, cyan trace is 23 cm, HPF output

Boulder Ham & Eggs Breakfast

Now that spring has finally arrived, the Boulder, Colorado ham radio gang are once again getting together in one location for their weekly ham radio breakfast. Colin & Allen have announced that we will be meeting at the Walnut Cafe - South, Tuesday mornings at 8 am. The Walnut Cafe is located in the south part of the Table Mesa shopping center close to Whole Foods. All hams are invited to join us. Many ham radio interests are represented from ATV, to SSB, CW, DXing, etc.

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/**

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

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SLATS

ST. LOUIS AMATEUR TELEVISION SOCIETY

Check out the SLATS web site (*www.slatsatn.net*) Click on "Want Ads" They have a lot of items listed there, either Wanted, For Sale, or to Give Away. The site is updated regularly. Here are a few of the items recently added to their list.

DIGITAL VOICE ADAPTER FOR SSB

HOT AIR SMD TOOL

SOLDER BATH (POT) WITH PROGRAMMABLE TIMER

8-PORT HDMI SWITCH