

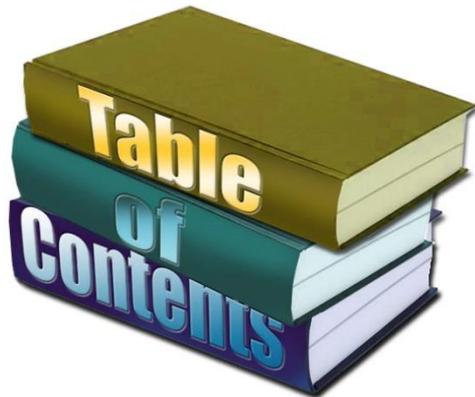
# North Texas Microwave Society Presentation 10 GHz Experiences in the West 10-Dec-2022



**Kevin Jacobson AD7OI**  
**Tammy Jacobson KI7GVT**

From Mt Ord, CA.

4x4



- **Introduction**
- **The “RIG”**
- **Reaching Out (TX Power)**
- **RX System Health**
- **Phoenix Beacon**
- **Mountain Top Operations in Arizona and California**
- **Mishaps**



**This presentation was put together to document some of the more advanced topics on Amateur Microwave Operations as experienced by Myself AD7OI during a 13-year period from 2009 through 2022.**

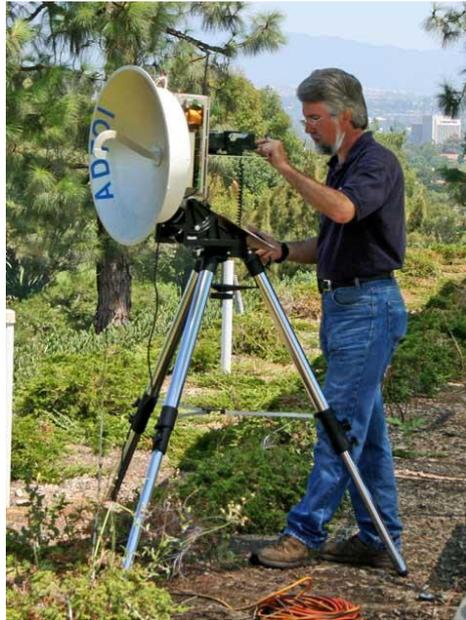
**As I lived in Phoenix, AZ until May of this year, the operations experiences are generally mountain top to mountain top between New Mexico, Arizona, and California.**

# The “RIG”

The photo below shows the rig in it's 2021 configuration ready for transport to our operating site. Rig is ready to operate with the exception of the tie down straps and the wood dish support. We drive it to the operating site which in some cases is over 600 miles away. The Word RIG is in quotes because the hardware changes virtually every year as will be seen on the following slides.



# The "RIG" (Continued)



1<sup>st</sup> rig Based on MA-COM Whitebox parts  
90 mW TX and 2ft dish. 2009



2<sup>nd</sup> rig Based on Kuhne Transverter, 2 Watts TX, LNF LNA  
and 2ft dish. 2010. Light weight version being operated from 11,300 ft  
Had to hike the dish to this elevation.



2<sup>nd</sup> rig Showing packaging, IC-706 Radio  
Rubidium Standard and a GPS for maidenhead  
grid during portable operation. Also 2010.



At right and Left, 3<sup>rd</sup> Generation  
RIG Based on Kuhne Transverter  
and LNA but with 40W TWT TX  
and 4ft dish. Both in 2013.

Operation at left was from Frazier  
mountain in California at 8000  
feet in September 2013. The  
temperature was around 50  
Degrees. At right, August 2013 in  
Arizona, Temperature was 108.



# The “RIG” (Continued)



4<sup>th</sup> Generation Truck Mounted AD7OI station using the 6ft dish and a 50W TWT. Total EIRP = 1.02 MW From Bald Mountain Lookout above Shave Lake, Ca. Elev 7730 feet

Contest Weekend September 15th and 16th, 2018

# The "RIG" (Continued)

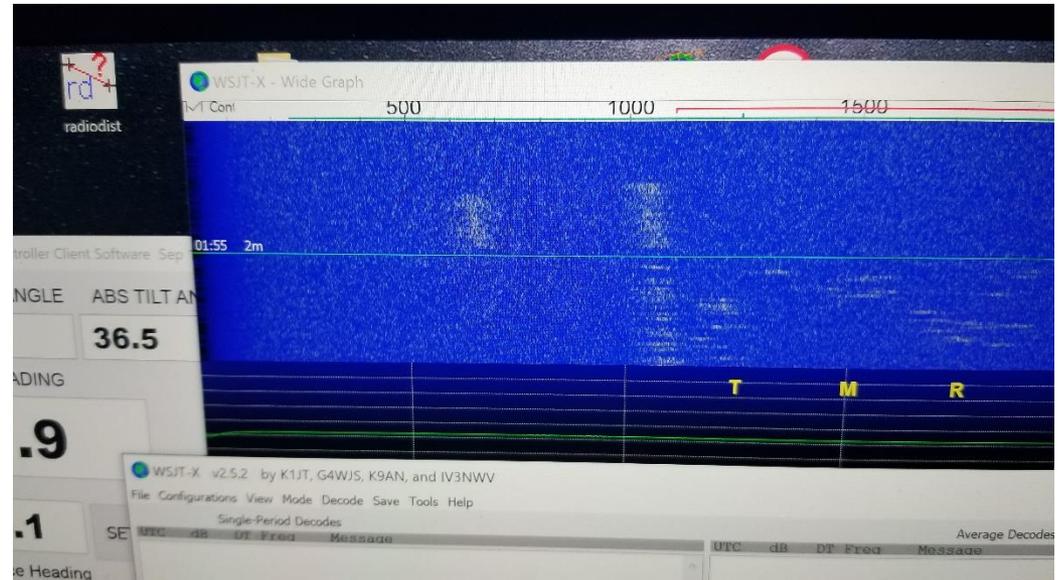
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# The “RIG”(Continued)



5<sup>th</sup> Generation Roll Around station using the 6ft dish and a 60W Solid State Amplifier listening to EME from the German Beacon DL0SHF



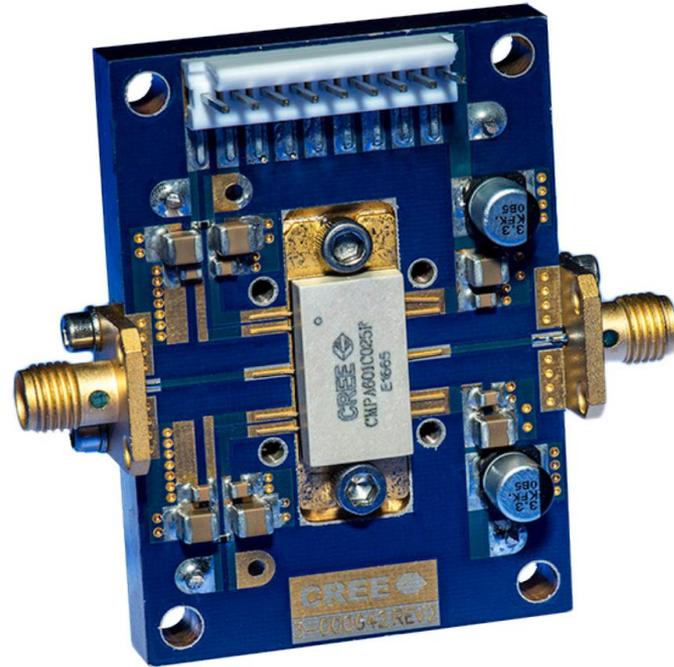
A link to some info on the beacon.

[https://www.bobatkins.com/radio/DL0SHF\\_10GHZ\\_beacon.html](https://www.bobatkins.com/radio/DL0SHF_10GHZ_beacon.html)

# CMPA601C025F

25 W, 6.0 - 12.0 GHz, GaN MMIC, Power Amplifier

[https://assets.wolfspeed.com/uploads/2020/12/Wolfspeed\\_CMPA601C025F.pdf](https://assets.wolfspeed.com/uploads/2020/12/Wolfspeed_CMPA601C025F.pdf)



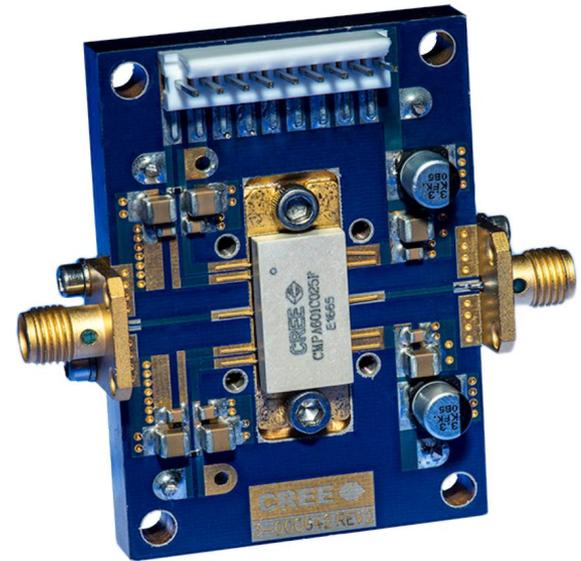
**SOLID STATE POWER AMPLIFIER**  
**aka**  
**Can you Hear me now?**

# 60W Solid State PA

- I had been running a Semens TWT for about 6 years I had gotten it fine tuned and putting out right at 50 watts.
- After a very sad event on Potosi Mountain in Nevada during the 2020 contest (more on that in the mishaps section later) I found myself in need of a replacement for my nearly 35-year-old TWT.
- Kuhne had 50W Solid State Amps available for around \$5K at the time, but now you can get a 60W for around \$4,300.
- I couldn't afford that then, but could afford to perhaps do something more homemade. I started looking into possible solutions.
- Wolfspeed (owned by CREE) had a very nice GaN module available that was rated at 25W but that was the linear rating. It was actually speced to 40 watts at 10GHz at Psat, and was capable of 46 watts.

## 60W Solid State PA (continued)

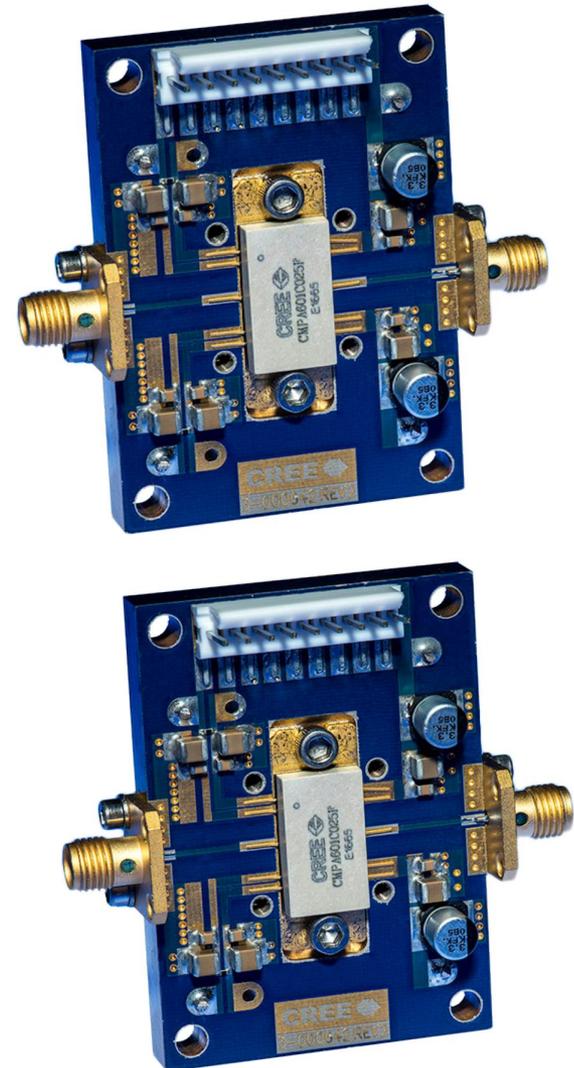
- The device also had an eval board with the part. I purchased one and found that I could get right at 40 watts out of it with about 150 mW drive
- The cost at the time was about \$1700 for the parts and eval board. They are still this cost but listed as 26-week lead-time at the time of this writing. The part itself (no eval board) is in stock at Digi-Key available for \$1140
- The eval board was way overpriced and could be reproduced easily as it is not Teflon nor is it tuned. It is mainly a way to get power to the part with some simple bypassing.
- Another interesting fact was that the module was wideband (6 to 12 GHz). This can be a problem if yours is a spur generating machine. Some filtering may be required.
- I put one of these in my rig and used it for a year at 40W and it worked great.



# 60W Solid State PA (continued)

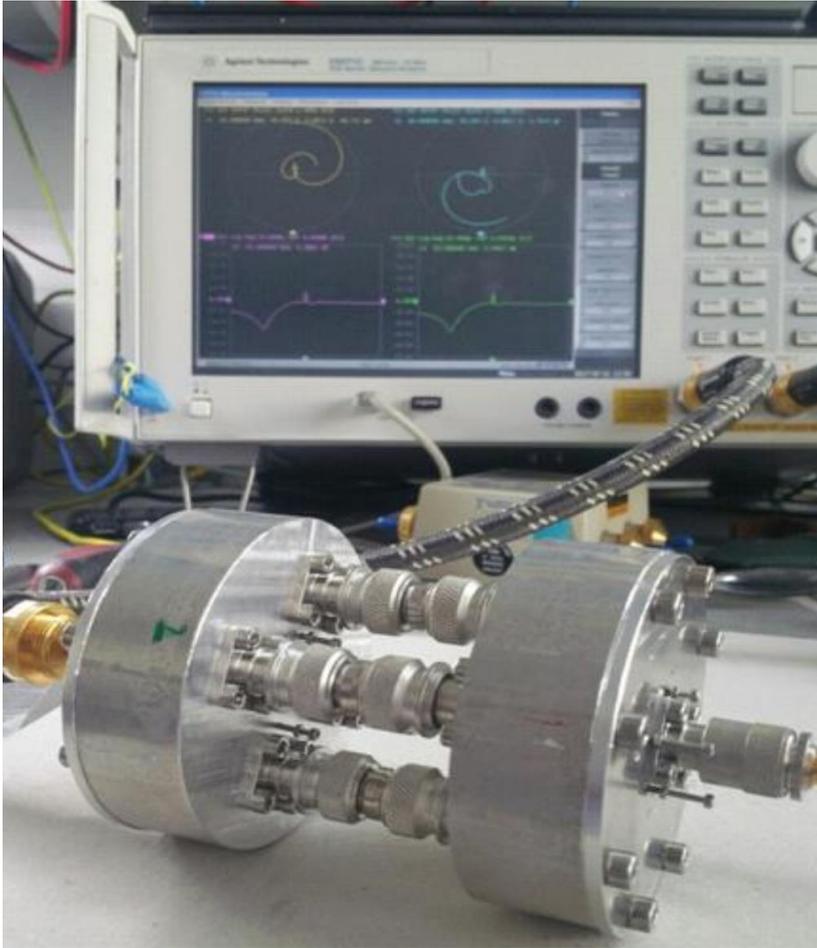
“Anything worth doing is worth overdoing”

- So, If one module was that good, two had to be a lot better right? Of course!
- I began to put together a dual module version of the SSPA. Theoretically I would get 80 watts at 10 GHz.
- I was going to need a power combiner capable of 80 watts out.
- The power combiner solution was purchased from Dominique Fässler HB9CW of Switzerland.



# 60W Solid State PA (continued)

“Anything worth doing is worth overdoing”



- The solution was a 2-port cavity combiner purchased from Dominique Fässler HB9CW of Switzerland for around 200€. There is a whole presentation on it's own and is at:

<https://moonbouncers.org/Orebro2019/%C3%96REBRO%202019%20Combiner.pdf>

# 60W Solid State PA (continued)

“Anything worth doing is worth overdoing”

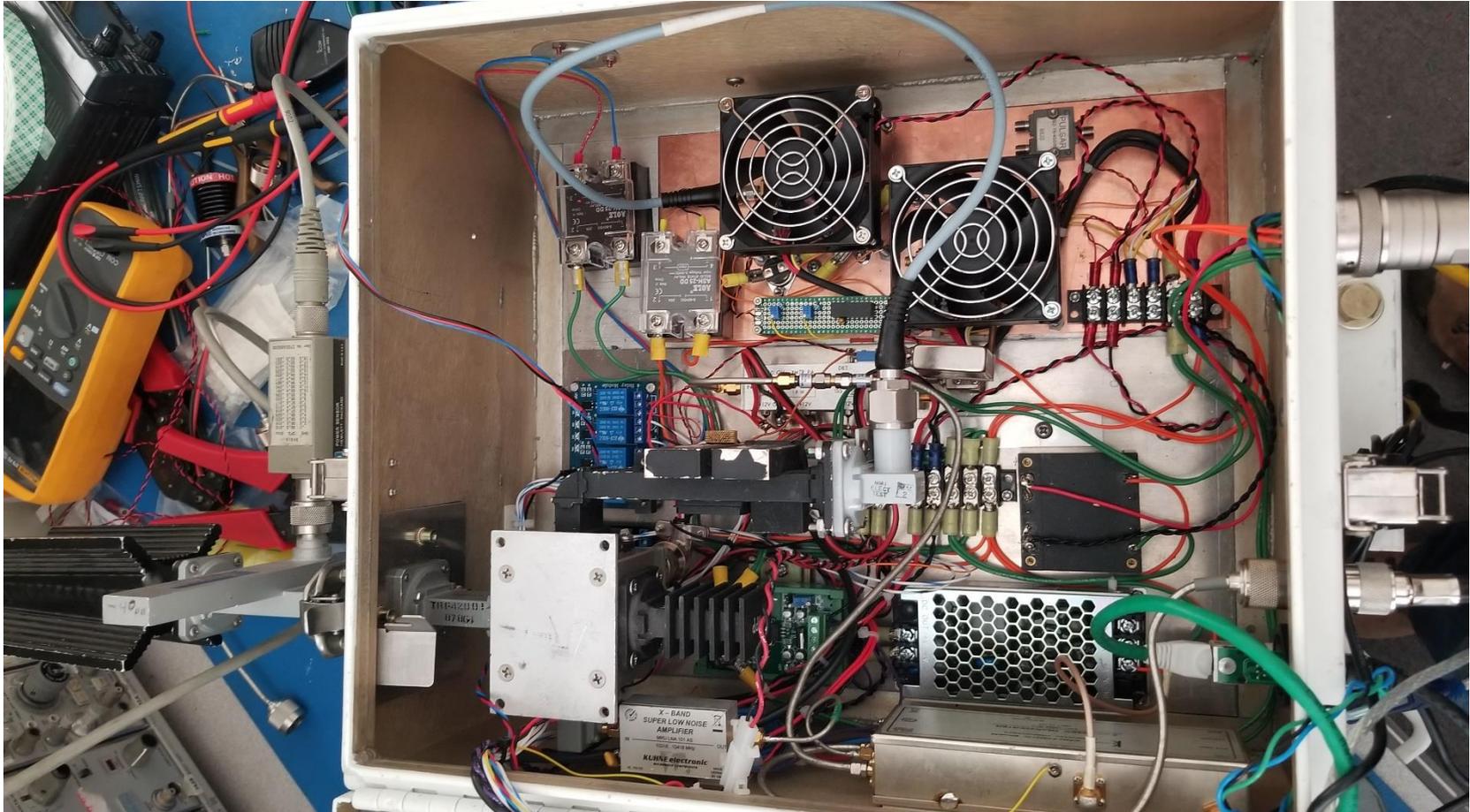


- I started with 2 modules thermally mounted on a solid copper heat spreader.
- Fans were added (right)



# 60W Solid State PA (continued)

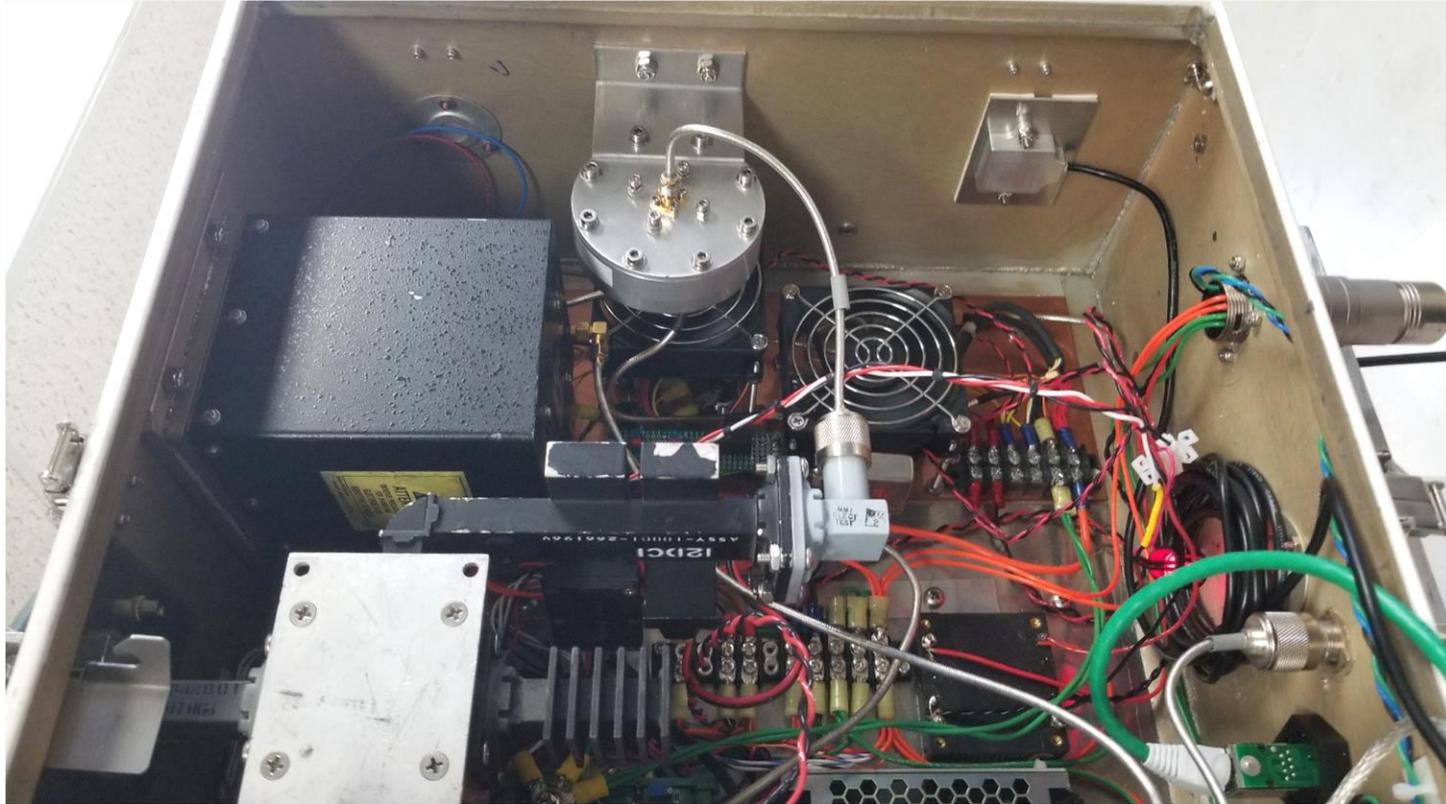
“Anything worth doing is worth overdoing”



The copper heat spreader can be seen in the rig with the input power divider (gray) a small Bias supply PWB with dual pots (green) and a Solid-State DC Relay. In the picture shown above the output of only one module is connected to the output waveguide transition.

# 60W Solid State PA (continued)

“Anything worth doing is worth overdoing”



In the final application, the cavity combiner can be seen connected to the output waveguide transition. The large black box to the left of the combiner is the Rubidium Standard as a 10 MHz reference. You may have noticed that I should get 80 watts but keep referring to 60 watts. Well, the amp will in fact put out 80 watts, but requires around 300 Mw of drive to do so. The typical Kuhne transverter will only drive this to around 62 watts.

# 60W Solid State PA (continued)

“Anything worth doing is worth overdoing”

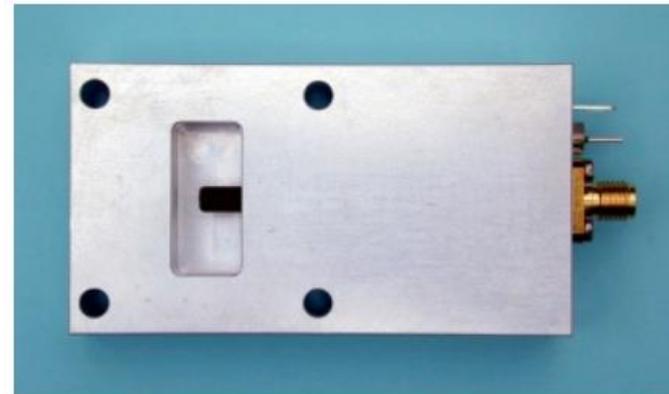
- In practice having over 60 Watts on 10 GHz is great, but you still cannot work a station that you cannot hear in return. Most RX systems are limited in just how far you can “perfect” them due to background radiation noise and the noise figure of the overall system.
- What I do find very useful on making a contact is going first on putting up a carrier. It really helps if the person on the other end is getting a big signal to line up on. If their station is weak, I at least want them on heading when I listen for them. I will have 10 dB more output over a 6-watt station and many stations are not even 6-watts.
- 62 watts versus 80 watts. Yes, I could have 80 watts by simply increasing my Kuhne drive level with an inline amp, but frankly this really doesn’t do anything for other than EME contacts. Will I go to 80 Watts? Well maybe, when I am doing more EME, but for terrestrial contacts, 60W is overkill and requires caution when keyed up and other folks are nearby.

# RX System Health

- I think that perhaps the most overlooked part of my rig and the majority of the rigs I have seen in the field has to be the RX front end.
- My first rig had 2ft of coax in front of the LNA. One of the guys in the field says to me, you really need to move that closer to the antenna waveguide feed. You are just introducing more noise; you could take that LNA out and still hear just as well. You know what, he was right!
- I have also seen many rigs, my own included, showing S9 noise on the IF radio. That's totally wrong, you are just overloading the front end of the IF radio. Back down the RX gain in the Transverter and / or place an attenuator after your LNA.
- One fairly easy test of your systems RX performance is the measurement of your cold sky to ground noise measurement. This number is unlikely to exceed 6db of difference even on a large dish (6ft or so), but it is a better way to measure the overall performance of your RX path. I make this measurement with a very sensitive power meter in the IF RX path. It can also be measured from the audio path of your IF rig using the WSJT software.
- My initial measurements on the version of the rig that I thought was working well, was just 2.2 dB difference between cold sky and ground noise. By changing LNA position, and type, and by checking and replacing every part in the RX path, I was able to bring this up to 6 dB on my current rig. 2.2 dB was completely inadequate for EME work.

# RX System Health (Continued)

- Don't underestimate the performance effect of some time spent on the RX path can have. Even if the other station can hear you, you can't work unless you can hear them.
- Stay with waveguide to the LNA if possible. After the Waveguide switch and LNA you can switch to coax. The noise will be significantly lower this way. If possible, use one of the Kuhne EME LNAs with the waveguide interface. On my rig this was worth a full dB over an SMA LNA with a Waveguide transition. Once your RX signal has been amplified by the LNA, then you can use coax or hardline to the Transverter.
- On my present rig, I am seeing 6 dB ground to cold sky noise differences and am able to see just shy of 1 full dB of moon noise and it has made a world of difference.



Link: <https://www.kuhne-electronic.de/kuhne/en/shop/empfangsverstaerker/MKU+LNA+102+S+EME+Super+Low+Noise+Preamplifier/?card=571>

# Phoenix Beacon

W7ATN ATN Beacon 10,368.375 2 Watts & 1296.275 20 Watts.



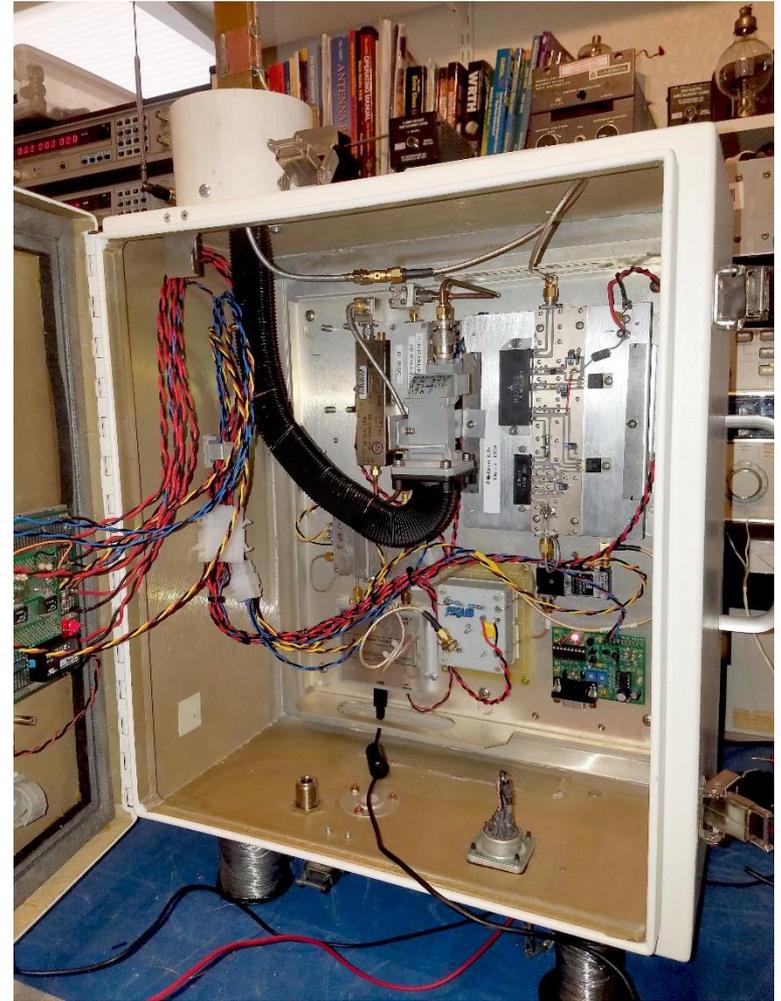
Completed and ready for the mountain top.

# Phoenix Beacon

W7ATN ATN Beacon 10,368.375 2 Watts & 1296.275 20 Watts.



10 GHz Slotted Waveguide Antenna and WA5VJB  
1296 "Big wheel" PWB antenna



All beacon electronics in an MA COMM  
repurposed "White Box" Only power is provided up  
the tower on a single coax.

# Phoenix Beacon

W7ATN ATN Beacon 10,368.375 2 Watts & 1296.275 20 Watts.



# Mountain Top operations in the Western US



at DM45ef and 9100 feet Mt Elden overlooking Flagstaff Arizona. Roughly 300 Degrees visibility from one spot. I have worked Sana Fe New Mexico (340 miles east) to Frazier Mountain California (410 miles west) standing in the same spot and no rain scatter.

# Mountain Top operations in the Western US 78 GHZ 128.8 miles (207 km) Path. W7QQ – VE4MA White Tanks Mountain to Mt Lemmon AZ. DM33rn – DM42ok December 2019



Barry, VE4MA/K7, Al, W5LUA, Tony, K8ZR, Mark, N0IO, and Bill, W7QQ, completed QSOs between Mount Lemmon, Arizona and White Tanks Mountains, Arizona a distance of 207 kilometers – on 10, 24, 47 and 78 GHz with notably S8-9 signals on 78 GHz.

# Contest Weekend August 15<sup>th</sup> and 16<sup>th</sup> 2009

DM45dh (Agassiz Peak, AZ 11,500 ft)



# Contest Weekend August 15<sup>th</sup> and 16<sup>th</sup> 2009

DM45dh (Agassiz Peak, AZ 11,500 ft)

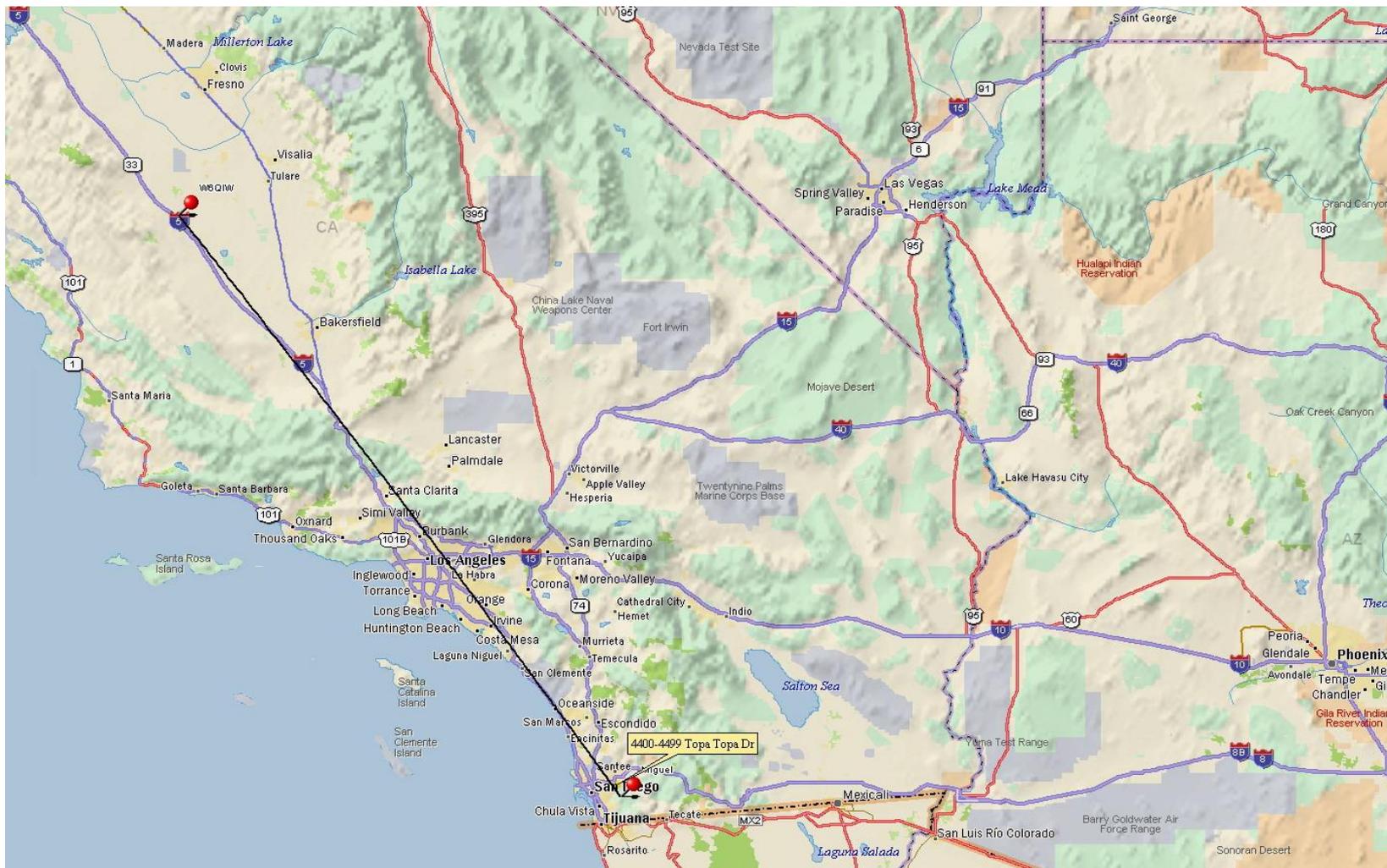




# Contest Weekend September 19<sup>th</sup> and 20<sup>th</sup> 2009

This Slide has Audio

**DM12mq (Miguel Mountain) to CM95xv Kettelman City with W6QIW 283 Miles and Knife Edge over an 8000 ft Frazier Mountain in the middle.**



# Contest Weekend August 21<sup>st</sup> and 22<sup>nd</sup> 2010

DM33ht (Harquahala Mountain, AZ 5680 ft)

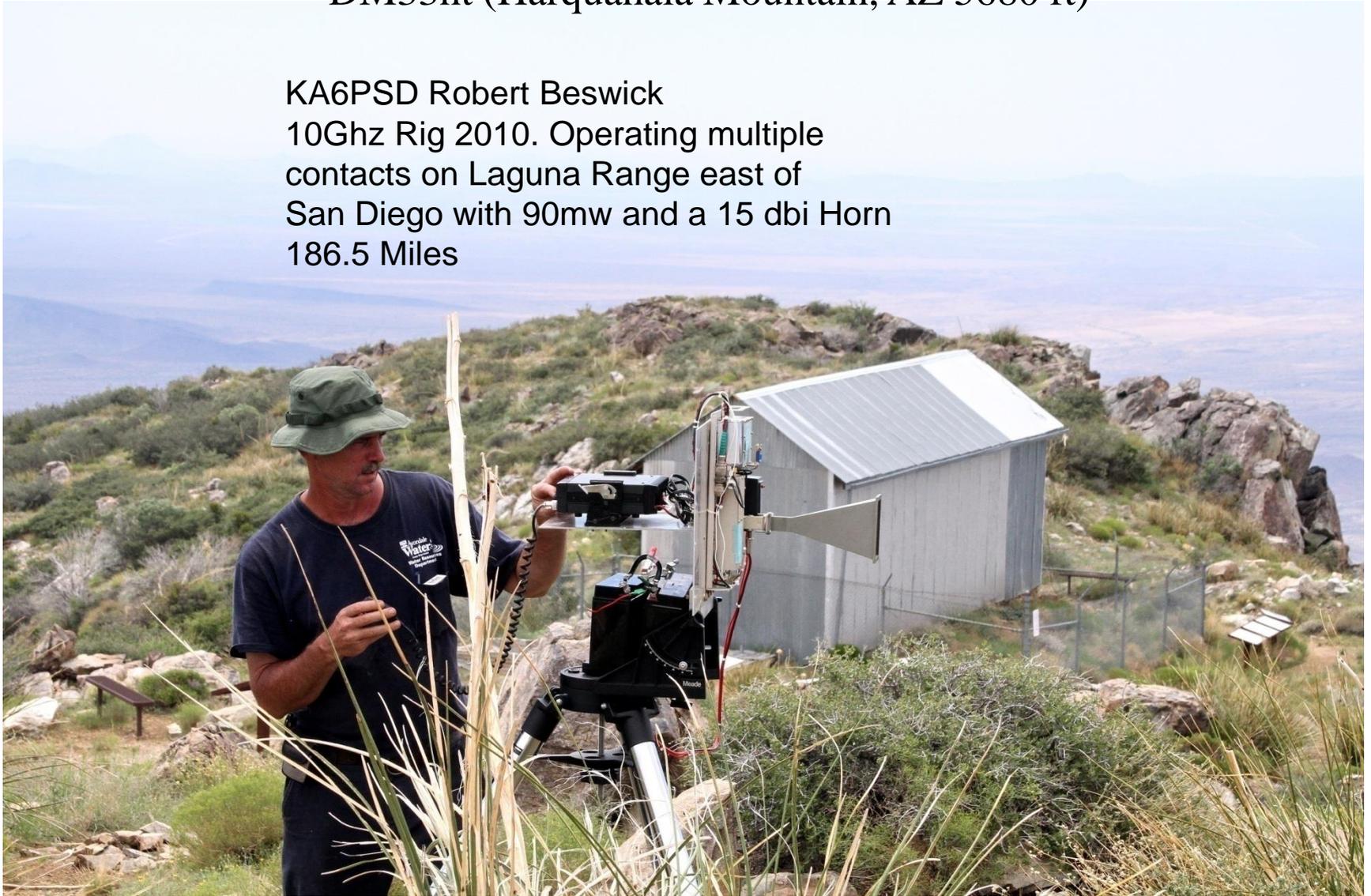


AD7OI 10Ghz  
Rig 2010. 24" Dish, 2W,  
.7db NF LNA, Rubidium  
Stabilized, Digital Modes  
Supported with DM780

# Contest Weekend August 21<sup>st</sup> and 22<sup>nd</sup> 2010

DM33ht (Harquahala Mountain, AZ 5680 ft)

KA6PSD Robert Beswick  
10Ghz Rig 2010. Operating multiple  
contacts on Laguna Range east of  
San Diego with 90mw and a 15 dbi Horn  
186.5 Miles



# Contest Weekend August 21<sup>st</sup> and 22<sup>nd</sup> 2010

DM33ht (Harquahala Mountain, AZ 5680 ft)



# Contest Weekend September 20th and 21st, 2013

From Frazier Mountain, California DM04MS 8013 Feet Elevation



W6YLZ Miguel (left), KK6MK Rex (Center) and AA6IW Lars (on right)

# Contest Weekend September 20th and 21st, 2013

From Frazier Mountain, California DM04MS 8013 Feet Elevation



AD7OI Operating in the cool Pines. The temperature didn't break out of the 50's)

# Contest Weekend September 20th and 21st, 2013

From Frazier Mountain, California DM04MS 8013 Feet Elevation



Fog and Low Clouds well below us in the valley Saturday Morning.

# Contest Weekend (EclipseOMainia) August 19th and 20th, 2017

From the very flat Midwest, South West Iowa and North West Missouri.



KI7GVT Operating in River Bottom fields in South Eastern Iowa.

# Contest Weekend (EclipseOMainia) August 19th and 20th, 2017

From the very flat Midwest, South Eastern Iowa and North West Missouri.



Over the Beans and through the Woods to South Dakota we QSO.

# Contest Weekend (EclipseOMainia) August 19th and 20th, 2017

From the very flat Midwest, South West Iowa and North West Missouri.



Operation in the Rain from Pump 16. Five 300 mile contacts via rain bounce into Nebraska.

# Contest Weekend (EclipseOMainia) August 19th and 20th, 2017

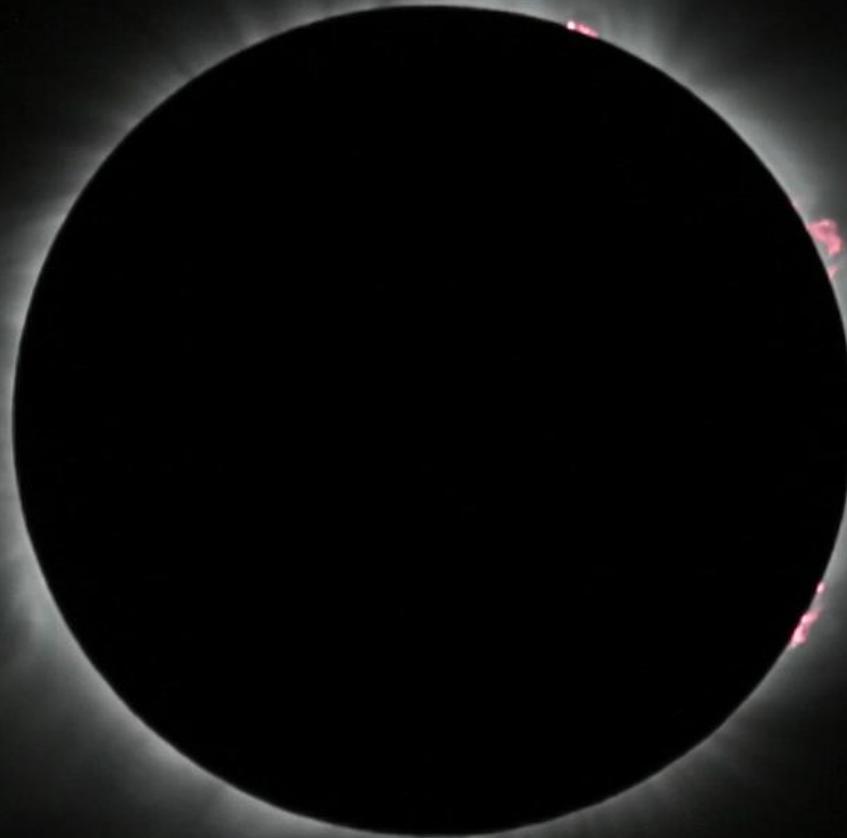
From the very flat Midwest, South West Iowa and North West Missouri.



AD7OI using the 2ft dish and 40W rig. Keeping the dish small had advantages for covering the rig during the frequent rains.

# Contest Weekend (EclipseOMainia) August 19th and 20th, 2017

From St. Claire Missouri, Yes, there was an Eclipse on Monday the 21<sup>st</sup>



# Contest Weekend (EclipseOMainia) August 19th and 20th, 2017

From St. Claire Missouri, Yes, there was an Eclipse on Monday the 21<sup>st</sup>



# Contest Weekend September 15th and 16th, 2018

From Bald Mountain Lookout above Shaver Lake, Ca. Elev 7730 feet



Latest AD7OI portable station using the 6ft dish and a 50W TWT rig. Total EIRP = 1.02 MW

# Contest Weekend September 15th and 16th, 2018

From Bald Mountain Lookout above Shaver Lake, Ca. Elev 7730 feet



4<sup>th</sup> Generation Truck Mounted AD7OI station using the 6ft dish and a 50W TWT. Total EIRP = 1.02 MW From Bald Mountain Lookout above Shave Lake, Ca. Elev 7730 feet

Contest Weekend September 15th and 16th, 2018



# Mishaps

# Mishaps, #1 Anchor the rig



The Good



The Bad



The Very Ugly



The Resurrection



# Mishaps, #2 Don't modify the rig between August and September weekends

- So, you have a great working rig in the August contest, and you just can't leave well enough alone and decide to make it better
- Adding a pan adapter to my ICOM 706 seemed like a worth while thing to do and should be easy with a cheap USB SDR dongle.
- Problem is that the IF from the 706 will kill the SRD if you key up, so it is important to isolate the RX and TX at the IF frequency.
- So, I added a small coax run capacitively coupled from the output of the VHF/UHF RX preamp in the IC706 to an SMA connector coming out the back of the radio. This worked great. All seemed swell. The pan adapter was working great and the rest of the rig "seemed OK"
- Travel 330 miles with Rig to Potosi Mountain Top Site in Nevada to work the California guys for a couple of days.



# Mishaps, #2 Don't modify the rig between August and September weekends

- Set everything up early Saturday morning, Listening for Frazier Beacon in California, yep, loud and clear and seen on that fancy new pan adapter.
- So ready for the first contact. They were already on Frazier, so all I have to do is key up. I am on heading already. So I key up, and I have a power detector in my TX path and I see that I am putting out around 50 Watts from my TWT.
- They guys listening report nothing heard. What! That can't be. The radio is set to the correct frequency. So what gives? About 3-4 minutes into the Carrier up, I notice that I no longer have any TX output.
- I spend a couple of hours on the mountain trying to fix the rig, but to no avail. So, the XYL and I pack up and head home for zero contacts in September 2020 and better than 12 hours round trip driving.
- After getting home, I find out that the modification I did to the IC706, while working great on RX, actually made the radio break into an oscillation during TX. Not only was the oscillation not on 432 where the radio was tuned (it was on 440) the output level that was set to 1 watt but was in fact putting out closer to 15 watts. So, after about 4 minutes of key down, the Kuhne transverter was blown up on TX but still working on RX. The TWT was also gone now. It was still putting out 3-4 watts, but not the 50W it once did.
- I took the mod out of the IC-706 and it functioned fine again. I really should have left well enough alone 😞



**That's All!**

**Any Questions?**