2004 10 GHz and Up Cumulative Contest Memoirs

47 GHz World Record - Apollo 13 Style

Thought Experiment

Two weeks before the August weekend of the ARRL 10 GHz and Up Cumulative Contest, Gary AD6FP and I were talking on the phone as we often do in the evenings, discussing technical issues related to microwaves and millimeter waves. I had been in a slump for several months, not really building anything, and just vegetating in the evenings after work. We started talking about 47 GHz, and all of the potential long distance paths that exist in California. He recently did a path plot of the Shuteye peak to Frazier path, which is a 290 km line-of-sight shot between two 8,000' peaks – enough to break the world record. We both postulated it would be cool to build 47 GHz rigs and break the world record during the August weekend of the contest. With the available surplus parts found in the area and abroad, it would not be too difficult to cobble something together in time. Plus, Gary pointed out that he has a 30 watt TWT which I should be able to hear quite easily at that distance, and would enable us to get our dishes pointed properly so he could then copy my much weaker signal. Of course, I had absolutely nothing assembled on this band at that time, and sort of laughed it off. After we hung up, I reflected on the situation, and decided I needed to do something exciting, and get back into the homebrewing game. I called back and said I was in. I was going to build a 47 GHz rig and break the world record in August!

Putting Theory to Practice

After two weeks of not leaving my bedroom (where I maintain my RF "lab"), I emerged with the rig pictured below. A block diagram is also shown.

Figure 1 - 36" Cassegrain Dish Feed and Subreflector

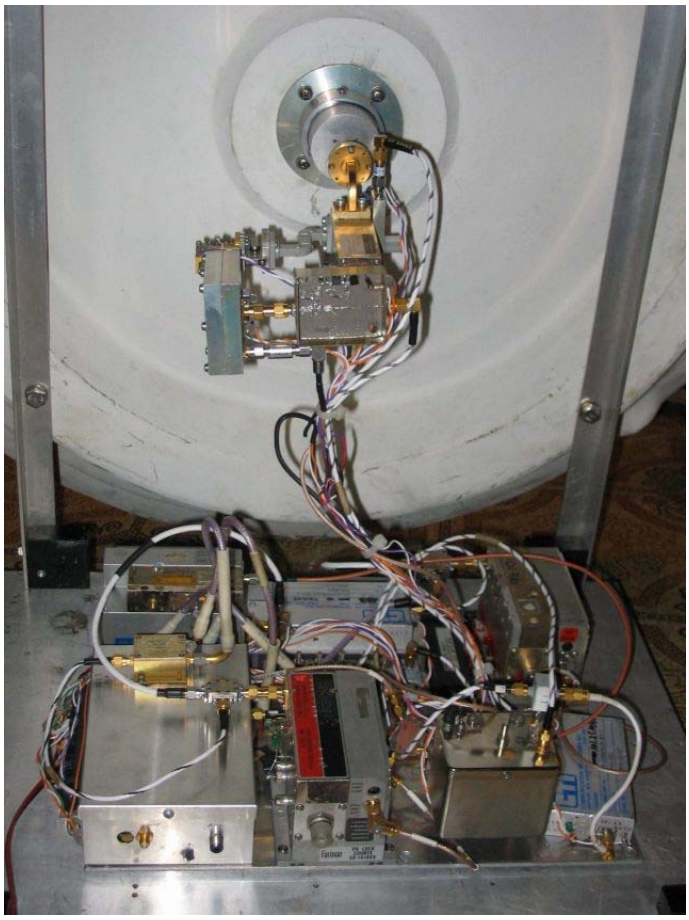

Figure 2 - 47 GHz Rig

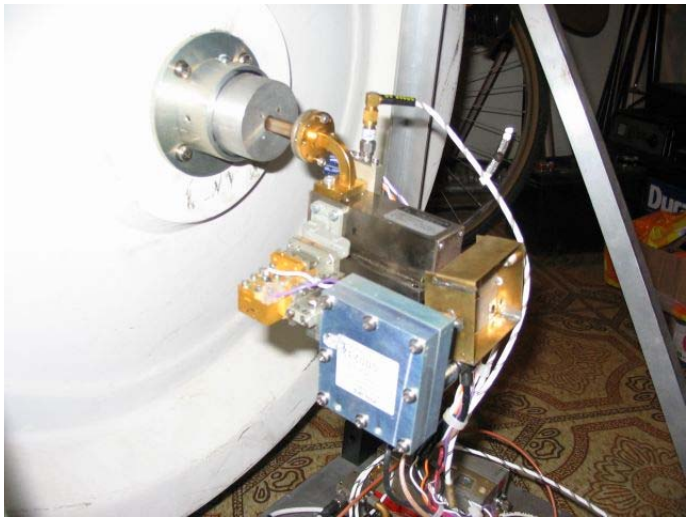

Figure 3 - High Frequency Electronics

All local oscillators are phase locked to a 10 MHz OCXO - the venerated HP 10811. I got away with using only three bricks and two ~100 MHz CTI lock boxes. All parts were obtained surplus, except for the power supplies. Rare items in this rig include a WR-28 waveguide switch available from New Zealand, two pieces of WR-22 having exactly the right bend for this geometry, and a Philips downconverting mixer having only 10 dB conversion loss. Gary and I used completely different IF and LO schemes, so there was no chance of IF feedthrough deceiving us. This rig as an 8 dB noise figure and +10 dBm output power.

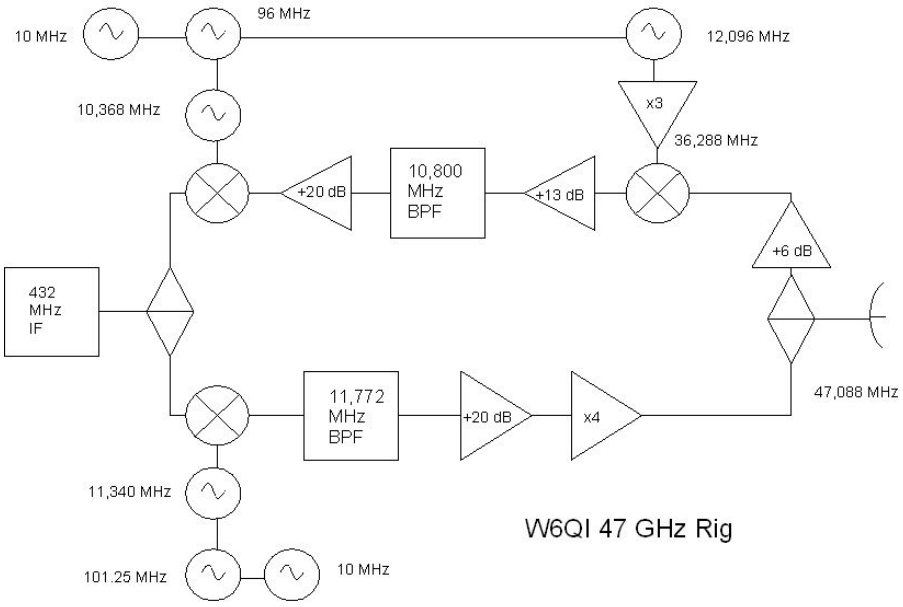

Figure 4 - 47 GHz Rig Block Diagram

We went to the Stanford foothills to test our rigs the week before the contest. Gary has a 47 GHz beacon at Lars' AA6IW house which is ideal for this purpose, as it looks to the W6YX Stanford Radio Club site. My RF electronics tested out fine, but the 3 foot Cassegrain dish I was using (borrowed from Gary) had two distinct main peaks, indicating a seriously defocused feed. We realized that we knew nothing for certain about the hyperbolic subreflector installed on the dish, which was obtained surplus anyway. So we then removed the subreflector, put it on Gary's milling machine XY table, and took precise measurements of its surface. I then wrote a Matlab script to perform a nonlinear least squares curve fit to the surface, fitting it to a hyperbola. Below is a plot of the theoretical surfaces of the main and sub-reflectors, showing the two focal points of the hyperbola which fell out of the analysis.

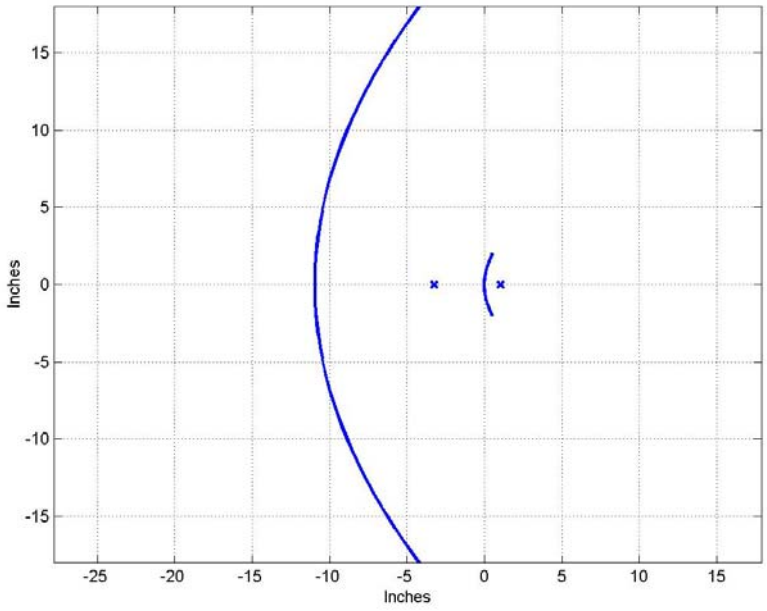

Figure 5 - Subrefelctor Focal Points

The right hand focus is co-located with the main reflector focus, while the feed is placed at the left hand focus. Armed with this result, I designed a new feed horn for this arrangement, and we re-installed the subreflector with the feed in the estimated optimal location. Another trip to Stanford revealed that our calculations were correct. Some slight tweaking of the subreflector and feed resulted in a very sharp, single peak. We were ready to hit the road!

August Contest Weekend

The August contest weekend arrived, and we were ready to try our luck. Below is a photo of me on Mount Frazier with my newly built rig.

Figure 6 - W6QI on Frazier in August, Chillin'

Gary made the trip up to Shuteye peak with a rented (!) 4X4. Unfortunately, Gary had transmit technical problems on Shuteye, and we did not make the 2-way QSO. In spite of this, I transmitted to him several times, hoping for a 1-way QSO, but he was not able to hear me. Things seemed pretty grim on 47 GHz at this point. ☹

September Contest Weekend – Why am I Doing this Again?

Along came the September contest weekend, and we decided to try again. This time, I would drive to Shuteye peak on Sunday, and Gary would be on Frazier.

After arriving at my Fresno hotel room Saturday night, I listened to the weather reports on TV. They said there would be record low freezing temperatures, 35 mph wind gusts, and a snow level dropping to 6,000’ in the Sierras on Sunday. Great. I was wondering, Why the hell am I going up to this God forsaken place again?

Mechanical Bull Ride

At 0600 Sunday I was in (slow) motion toward Shuteye. The road up to Shuteye was mostly a bumpy, annoying road. However, near the top, it became a technically challenging 4X4 route, with large trenches and boulders in the road. You are driving over granite mostly, and the path was marked with cairns to show the way. The shocks on my 4X4 are pretty much shot, so the vehicle was rocking back and forth like a mechanical bull during this last mile. I had white knuckles and a dry mouth during this last stretch, wondering whether I would ever get home again.

Luckily, I made it to the top. After getting to a suitable operating position, I took stock of the situation. Opening the back of my truck, I found that everything had shifted to a new position or was upside down. I tried to eat my breakfast (some donuts), but found they had been pulverized to crumbs. The ride was so rough, the victory beers I had brought along had broken, and beer was sloshing around in my cooler. Even my cookies were

reduced to crumbs by the ride up. I then looked up at my spaceball, only to find it cocked at an odd angle, rotating freely on its axis. Clearly the motor gears had broken due to the rough ride. The cables leading to the spaceball were shredded from the thing rocking back and forth freely. Don't bring your BMW SUV up this road!

My Radios and I Don't Like the Cold

As predicted by the kind folks on Fresno TV, it was quite cold and windy on Shuteye Peak. The temperature was 31º F outside (measured) with strong wind and snow. Inside the cab it was a balmy 37º F and no wind. The cab was quite a relief after being outside for an extended period. The first step was to hook up my trusty 10/24 GHz rig to get the party started. However, I found that the PLL could not lock up due to the extreme cold. Next, I set up the 47 GHz rig. The wind gusts were blowing the big 3 foot dish around like a leaf in the wind. I had to strap it down to the tripod with a couple of bungee cords. Everything locked up to my 10 MHz OCXO frequency reference except for one CTI lock box. If we were going to set this record, I would need to get this thing locked up somehow.

Figure 7 - 10/24/47 GHz Setup on Shuteye Peak

My first thought was to simply adjust the trimmer on the CTI box to get it on frequency. However, I ran out of adjustment room on the capacitor, as I had to turn it all the way in. Next, I thought I could open the CTI box and squeeze the inductor in the feedback path to get it on frequency. I found that squeezing the inductor caused the oscillator to stop oscillating completely before lock had been achieved. So there must be a capacitor in the feedback path which is a bit too large. Since I had no spare capacitors with me, it was time to improvise. I tried to wind a new inductor (sacrificed one of my clip leads) but still couldn't get it to both oscillate and lock up at the right frequency in the cold. I noticed that if I had the CTI box inside the cab, it would lock. I knew I was close, but yet so far… My next thought was to try and get the tripod over to the truck window so I could leave the CTI box and associated electronics inside the truck, with wires and RF cables leading out to the dish feed. However, the wires and cables I was using for the dish were too short for this. At this point, I sat in my truck and was feeling pretty low. Did I actually blow it

after all of our planning and hard work? I would hate to miss this chance due to some technical problem with my rig. It was personal now.

Figure 8 - Shuteye Peak

Epiphany

I began thinking about my broken spaceball again, wondering if I could fix it, since I so enjoyed my high speed roving the day before. Then I came up with plan B – I have a thermistor on the crystal in that rig! I called Gary on Cactus to make sure he was still in the game, as it had been an hour or more since I had been trying to fix the oscillator. He confirmed he was still waiting for me, and wouldn't QRT until I gave up first. So up to the roof of my truck I went with screwdriver in hand, disassembling the spaceball rig. The snow began to accumulate now, and I couldn't feel my fingers, but still managed to rip out the LO box containing the crystal. At this point, my beloved spaceball rig was no more! I removed the thermistor and soldered it on the 47 GHz rig's CTI box crystal. I then fired up the 47 GHz rig and left it out in the cold for a good 5 minutes while I warmed up by the heater in my truck. I went back outside and found the CTI lock indicator LED a solid green. It was time to call Gary on Cactus.

Did This Really Happen?

I had Gary send me another FM transmission on 47 GHz with his grid as I peaked up on him again. He was still pinning the S-meter whenever the wind stopped and allowed the dish to settle. He then asked me to send him a carrier. Meanwhile I was looking to the west at the approaching storm clouds, fog, and snow, thinking - all that work, and these storm clouds are rolling in, screwing up the propagation. I am too late. I blew it. I depressed the mic button, preparing for a long wait followed by a message on Cactus "Nothing heard". Instead, Gary came back over Cactus with, "Send me your information NOW!" The urgency of the message was not lost on me, and I quickly sent him my info by keying the rig in FM. I didn't even have time to get my CW key for a proper transmission. Nonetheless, he copied the information in less than a minute in spite of the lousy CW. I then sent him rogers, and we met back on Cactus congratulating each other.

It’s funny how quickly that moment passed. I had worked in freezing snow and wind for two hours to fix a stubborn oscillator, totally focused like a laser beam. The rest of the world didn’t exist. The suddenness of the QSO was overwhelming, and I felt very strange. I just had to sit for a while and enjoy the moment, since I knew this sort of thing may never happen again. After all of our planning and hard work - making terrain profile plots, testing mixers for lowest noise figure, worrying about relative humidity levels, arguing over the efficiency of reflector antennas at 47 GHz – we were rewarded with a unique experience I will not soon forget.

It’s also interesting that I had all the right tools and spare parts with me to make this thing happen. It was like the Apollo 13 mission, where duct tape and paper clips brought those lucky astronauts back to Earth. While this QSO doesn’t nearly compare to that situation, I find it interesting that I packed my soldering iron as an afterthought on Friday night, and just happened to have a spare rig along with a thermistor installed.

Gettin’ out o’ Dodge

It was after this introspection period that I realized how cold I really was! In spite of the four layers, winter cap, and hood, I was uncomfortable, and totally blew off Al WT6K when he wanted a 10 GHz QSO from Frazier. It would have required me to leave the cab though – unacceptable unless Mother Nature required it. In addition, the accumulating snow and increasing fog had me worried - I wanted to get off that mountain.

Figure 9 - WX Getting Bad on Shuteye

Figure 10 - Packed up and Ready for Descent

Slight Obstacle

I quickly packed up and started the long decent back to civilization. It seemed that the way down was much worse than the way up, since gravity was helping to bounce my truck down pretty hard on the rocks.

Figure 11 - Bumpy Descent

I had just driven up a 50 foot long granite slab at about a 30º slope when I came across a woman walking back along the road. She stopped me and told me her vehicle was bottomed out on the road 30 yards ahead, and I couldn't get past. I drove ahead and found a Nissan Pathfinder buried in a sea of rocks. The rear differential was resting on a particularly large rock which seemed to be preventing the tires from gaining any hold on the road.

Figure 12 - Pathfinder is Free!

The three female passengers were working to get the truck jacked up and rocks under the wheels for traction. Well, now was my chance to be hero! I casually stepped out of my 4X4, donned my leather gloves, and began helping to place big rocks under the wheels of their vehicle. I put some nylon straps around the large boulder under the differential, and used my 4X4 to pull it out. That was quite impressive, I thought. Finally, I helped push while they gunned the engine and broke free of the trap. I was quite pleased with myself at this point, and the women were grateful too. ☺

Deflated Ego (& Tire)

Back on the road (!?) we went, down the treacherous slope with blowing snow. It was so foggy that the road was difficult to see directly ahead. I was feeling pretty studly though, and was casually rolling along trying to judge the best route to take in advance. I came down particularly hard one time, and heard a hissing sound outside. Gee, I thought rattlesnakes preferred hot days to cold ones? This was one of the few times I wished there were a rattlesnake nearby. It turns out a rock punctured one of my rugged 31 X 10.5 tires in a rather steep spot. I had to drive on the rim a bit to find a flat spot for changing.

Figure 13 - Bad Day

I had the distinct pleasure of totally unpacking my truck again (the 3 foot dish rests on the spare tire in the back), changing the tire (with help from the ladies, as my jack handle was stripped!), then repacking the truck. So much for being “da man”. Thanks for the help Camille and Renee! Fortunately, the rest of the trip out to the main road was uneventful, and I made it to Kettleman City in time for a celebratory dinner with Gary and Steve KB8VAO. I couldn’t believe how pleasant the valley WX seemed after being on that peak. I couldn’t really feel sorry for the guys complaining about a rain shower or two in the valley while roving! ☺

Figure 14 - Heading Home