10 GHz mobile operation using waveguide slot antennas
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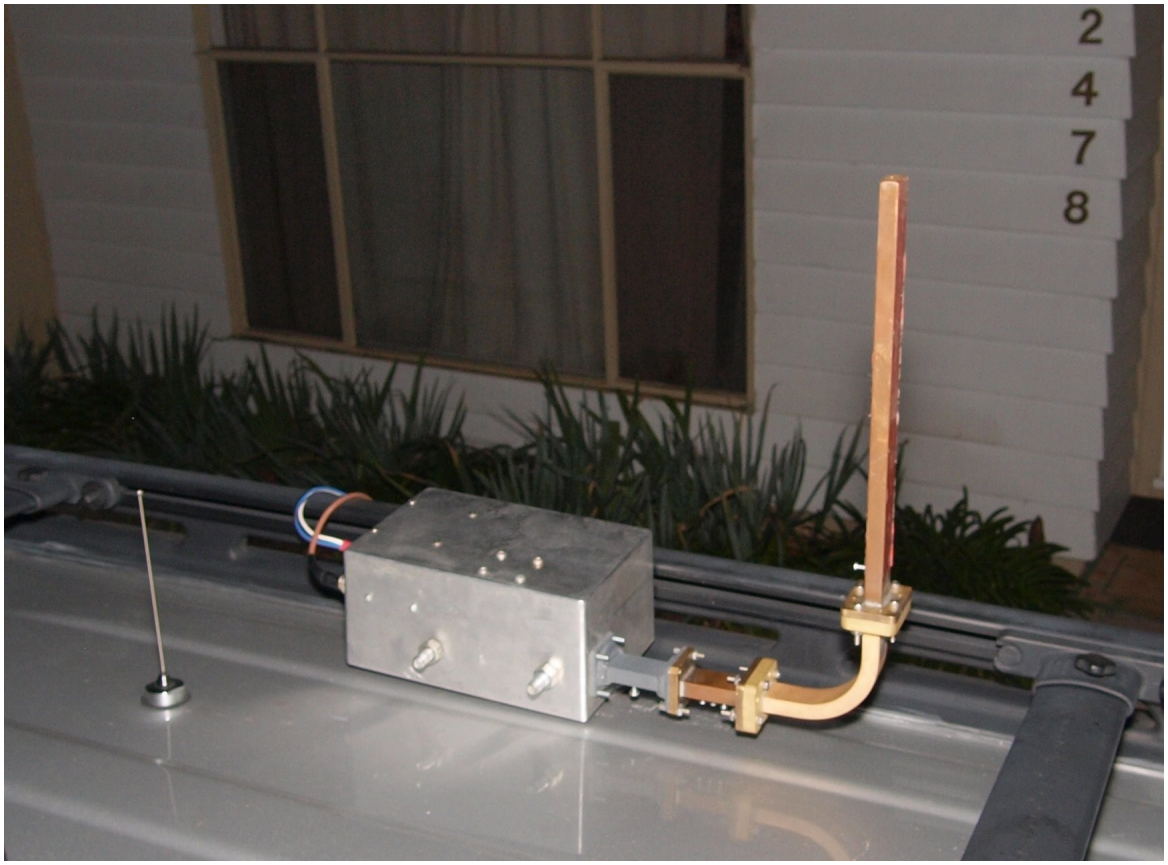

1. Introduction

I was asked by Dan Welch, W6DFW to assist in the evaluation of some of his prototype 10 GHz slot antennas. My role was to provide a scalar network analyzer and evaluate resonant frequencies and return loss on various iterations of prototype antennas, while W6DFW tried various calculations, and programming instructions on his CNC milling machine. As compensation for my efforts, I was provided with several 24-slot omni antennas. These were all from various batches of prototypes. This provided sufficient motivation to try rover operations using one of these slot antennas. The following is an anecdotal account of these antennas in actual operation.

2. Construction

During the time these antennas were being designed and evaluated, I was also engaged in the construction of a new 10 GHz transverter. One of the goals was to build a transverter that was reconfigurable to fit various needs. During contest operation, I enjoy roving with a small tripod mounted dish, as well as parking on a mountaintop with a larger dish, so I wanted a transverter capable of being configured to operate at high power using a TWT amplifier, medium power using a 5 watt solid state amplifier, as well as having respectable performance as a "barefoot" transverter, with a 1 watt output.

It was while building the medium power RF head that it occurred to me that it could be easily adapted to operate with one of W6DFW's slot antennas. So, provision was made to mount it on the roof of the car. The final configuration for mobile operation with the omni antenna is a 5-watt solid-state relay, with a 0.5 db NF preamp. Antenna switching is via a waveguide relay, and the entire assembly attached to the vehicle roof with magnets. Total waveguide length between the PA/Preamp and the antenna is several inches. The entire assembly can be seen in the photo.

3. Initial testing

Once the new 10 GHz rig was completed, testing with the omni was limited to reception tests of several of the 10 GHz beacons located in Southern California. I live within line of sight to one of them, located on Santiago Peak. The omni was fitted to the RF head while on the bench, and the beacon was heard at S9+ levels inside the house. Later, the RF head and omni antenna were located outside, where both the Palos Verdes and Frazier Mountain beacons were heard, indicating that the slot antennas were working ok. When it came time to pack for the contest, I threw it in the miscellaneous parts box and proceeded to rove.

During my first outing, most operations were conducted using the small 18" dish, and due to time constraints, my roving was limited to the local area. Towards the end of the day, I opted to attach the omni, and see what I could work while I made a few stops on the way home.

My first contacts were local, across the Los Angeles basin. Signals were strong both ways, so performance of the prototype omni was good. My next contacts were with a station operating over the border in Arizona, a distance of about 270km. Again, signals were quite strong, although that particular station was using a 6-foot dish.

Several more stops were made that night with the omni to the station in Arizona, resulting in a contact from my driveway in Upland, Ca to a hill near Quartzite, Arizona, 334 km away. All contacts were made using SSB while parked.

4. Mobile in motion

For the second weekend of the contest, I had planned on a longer expedition to Utah using the big dish and TWT, with the intention of being the sought after DX that everyone else was chasing. This turned out to be a bust for several reasons, so the next day I went to Mt. Potosi, Nevada, to operate on Sunday with another microwaver who was camped on top.

Prior to the drive, it was decided to configure the rig for operation with the omni antenna, with the intention of making periodic stops to work the Mt. Potosi station. Several stops were made as planned, but waiting while the other stations was busy working stations further west would delay the trip back from Utah, so several contacts were made while in motion

5. SSB vs. FM

At first, these contacts were attempted using the usual voice mode of SSB. The affects of Doppler shift and multipath with reflected signals shifting both high and low in frequency made strong signals almost entirely unusable, so we changed mode to FM.

Not only were signals almost full quieting, but very little noise was heard from reflections, and signal quality was frequently as good as, or better than, the UHF channel being used for liaison.

The second day was spent on Mt. Potosi, and at dusk, the vehicle was packed, and reconfigured for mobile operation during the drive home. The Potosi station was worked many times during the 4-hour drive, as were several other stations. FM was used in all contacts, with the exception of one station that was done via CW, due to a missing microphone.

The most notable highlight of this operation was several longer contacts made with other stations while I was in motion in the Cajon Pass, a mountainous area surrounded by 6000’ mountains. Communications were mostly solid, with some rapid flutter present. Distances worked under these conditions were 150-250 km, depending on the station worked.
Once through the pass and headed toward home, signals were too weak for mobile FM contacts, so an unmodulated carrier was transmitted while the station on Mt. Potosi tracked the signal. Amazingly enough, signals were heard both ways almost continuously. None of the paths were anywhere near approaching line of sight, and in fact were blocked by 1 or more substantial mountain ranges.

6. 2012 Contest

Several experiments were conducted during the August 2012 weekend of the 10 GHz and up contest. In one test, carriers were transmitted continuously while in motion driving along HWY 58 between Boron, CA and Mojave, CA. , while a station on the south side of the San Gabriel mountains attempted to track the signal. Using Spectran, signals were easily detected during most of the test transmissions.

On the second day of the contest, we traveled to San Joaquin Valley, where a number of contacts were made with other rover stations, with strong signals both ways. The highlight of this contest was several two-way contacts with another station operating at home with an identical omni. During several of these contacts, we were separated by two ranges of mountains, some higher than 8300'. Signals were weak, requiring cw to complete the exchanges.

7. Conclusions

While none of the tests were conducted in a scientific manner, it is quite clear that mobile 10 GHz operation can offer a lot to contest stations while roving. The appeal of a zero set up time, along with operation in areas where it may be socially unacceptable to stop for long and set up a dish and tripod can make for a contest strategy where many grid squares can be activated in a short period of time.

There is also some interest in getting more stations on the air from home, so that these expensive and lovingly hand-built 10 GHz radios can be used more than two weekends per year. In cases where SSB or FM signals are insufficient, tests indicate that digital modes such as WSPR and WSJT can provide reliable communications between omni equipped stations on non-line of sight paths.