**78 GHz in VK – New Distance Records.**

To date, unlike Europe, the activity on our 76/78 GHz Amateur segment in Australia has been in it’s infancy meaning that activity is a bit sparse. It’s perhaps not surprising with the obvious technical challenges, the limited availability of hardware and of course the $costs. Aside from my homebrew equipment, I’m aware of a few Australian Amateurs who are building gear but I’m unsure if there have been any (other) successful QSO’s claimed.

My 78 GHz gear is based on the popular DB6NT hardware. I’m not currently on the usual 76032.1 MHz Call Frequency because I did not have a suitable LO to get me there. Besides, in Australia we have Secondary access all the way up to 81 GHz.

The critical element, an OCXO Locked Microsource 13.03 GHz LO is tripled to 39.09 GHz at circa +20 dBm and it pumps a single Diode (MA4E-1317 Mixer) on a small PCB within a purpose built metal housing. The 78180 MHz LO is then mixed with a 432.1 MHz IF signal of about +7 dBm or 5 Milliwatts. The Output from this “bare” Mixer is a Double Sideband Signal (DSB) at circa -1 dBm.

This relatively standard Mixer hardware format is in fact a complete 76/78 GHz Transverter. Then you couple the RF via Waveguide to a small Splash Plate fed Dish/Reflector or simply mount a Horn on the Waveguide aperture. In average conditions, with this “bare mixer” one can expect to achieve SSB QSO’s out to 30 Kms or more. I’m hoping to inspire some of you enthusiasts out there to build up gear like this and get onto this Band.

So then… QRZ on 76/78 GHz ?

Around the time I was collecting parts for my 2 Transverters (there’s no point building only one unit because there was no one else to work) I became aware that Tom Williams – WA1MBA was doing a small Production run of moderate $cost 76 GHz LNA’s for Amateur Radio Operators worldwide. Subsequently, I purchased 2 units to incorporate into my Transverters.

To integrate an Amplifier requires additional RF Componentry. Firstly, I select the LSB of 77749.90 MHz with a homebrew 3 Screw Waveguide Filter. This Filter works “best” at “passing” the LSB and attenuating the LO & USB each by circa 20 dB. The Filter’s Insertion Loss of around 10 dB is quite high but it’s not really a problem. The LNA has a Gain of circa 28 dB and a Psat of +10 dBm. So, it can be used as a Power Amplifier too !!

To achieve this requires a 4 Port Waveguide Switch (WR-15) to reverse the LNA on RX and turn it into PA on TX. The Transverter is coupled via this 4 Port Waveguide Switch to a 300 mm Dish with integrated Cassegrain sub Reflector. The latter makes it very easily to illuminate the Dish.

The current VK 78 GHz SSB Distance Record of circa 32 Kms was set in December, 2013 at a site west of Melbourne (Port Fairy) with Russell – VK3ZQB as the other Operator. Signal Reports were huge at 5+9 plus 20 over 9 !! Interestingly, the current World SSB Record is 252 Kms set over an “ideal” path in the northern California desert by USA Amateurs Goran – A6IDW and Bob – KF6KVG.

During recent testing on the bench, I was monitoring the Frequency stability of my gear on both 47 GHz & 78 GHz. I found the 47 GHz gear was always well within one KHz of where it should be. It’s DRO based LO was adequate for SSB albeit with some ongoing thermal drift up/down - depending on local ambient temperature and breezes.

However, to my surprise I found the 78 GHz gear with it’s precision OCXO Reference had “single Hertz” drift after about an hour of warm-up. This exceptional Frequency stability immediately opens the door to the wonderful Digital Modes of WSJT.

After some discussions regarding the possibilities with a friend David – VK3HZ… we decided to try extending the current 78 GHz National Record on SSB. There was no Digital Record at the time.

As part of our planning for this activity, we firstly needed to identify suitable Line of Sight (LOS) paths. The reason... unlike the lower Microwave Bands (10 GHz & down) where Ducting Propagation allows signals to travel well beyond the visual Horizon… it has been found that 78 GHz signals do NOT travel well in an “Over the Horizon” scenario due to very high Path losses. This means we need high vantage points that can “see” beyond the normal visual Horizon. Another factor is the Relative Humidity. Again, 78 GHz signals are degraded by high atmospheric losses due to high Humidity whereas 10 GHz & down often benefit from periods of warm conditions with high Humidity.

Now you may think it would be easy to find longish LOS Paths in Australia. Unfortunately, we’ve found that is not the case. Our terrain in VK may have quite a few high mountain ranges however, we found that many of these Ranges tend to block each other from “seeing” distant vantage points. And then there are the ever present obstructive trees that block our views and the Locked Gates and Walking Tracks only.. that deny us vehicular access to many desirable Summits.

After many hours of pouring over the Maps of southern Australia (VK3) looking for clear unobstructed Path Profiles, we finally settled on the popular tourism site at the Mt Dandenong Observatory, East of Melbourne. This site provides excellent views to successively longer LOS Paths West towards the rural city of Ballarat. David would operate from this Observatory site but unfortunately he would also endure the many “visitors” that frequent this popular Lookout. A small price to pay for such a prominent location I guess?

Another part of our planning for the longer non visible Paths (due smoke haze and Humidity etc.) was our intention to use 10 GHz as both FM Liaison and as an indicator of the Bearing we needed for “pointing” the very sharp 78 GHz Dishes. The 300mm Dishes I’ve used have circa 45 dBi Gain, so Dish Pointing and alignment accuracy is absolutely critical due to the extremely narrow Beamwidth.

Unfortunately, we failed to acknowledge our past experiences with this plan. On 10 GHz, there are usually numerous signal reflections from many different directions over these shorter circa 100 Kms Paths. This caused us some initial confusion and much frustration with our Pointing efforts. It was especially problematic over the longer (for 78 Ghz) paths. Even though I had deliberately modified my 10 GHz Transverter to deliver a mere 1 Milliwatt… my Signals at David’s Observatory site were still crushingly strong. I still had to “off point” my Dish to achieve a noisy FM signal at David’s end for him to optimise on. i.e. adjust his Pointing for best “FM Quietening” ! Next time we will use 24 GHz for this function because this Band is very much more LOS and less susceptible to Reflections.

And so on a fine sunny May 13th, I drove to my first spot west of Melbourne (near Mt Cottrell, south of Rockbank). This 64 kilometre Path has a stunning view of the Melbourne CBD with the Dandenong Ranges easily visible beyond. The 10 GHz Liaison was not necessary due the visual we had but we setup regardless to test our gear.

On 78 GHz we immediately “found” each other and after minor Dish Pointing tweaks we achieved 57/58 Reports on SSB. A “bare mixer” attempt yielded weak SSB signals.. not quite loud enough to complete a QSO. So we then setup for WSJT on JT65C. A “bare mixer” Digital QSO was quickly completed with Reports of -14 dB both ways. There was no real point repeating this QSO with the LNA/PA combo activated. So, 2 new 78 GHz Records over this 64 Kms path were achieved.

I then relocated further West to another high spot. The Dandenong Ranges were visible but a little hazy over this LOS Path of circa 90 Kms. This time, the LNA/PA in circuit yielded very loud signals with some noticeable QSB. At 1315 Hrs we completed our SSB QSO with 53/52 Reports. We then quickly completed the Digital QSO. So, another 2 Distance Records were Set/extended.

Travelling further West, the next high spot we had identified as a “possible” would give a circa 110 Kms Path. However, on arriving I found it was not as good as hoped so I continued on towards Mt Buninyong, south of Ballarat. A geographic embarrassment meant I drove to the nearer Mt Warrenheip instead of Mt Buninyong. After a quick drive to the more southerly Mt Buninyong, I setup on the Tourist road that runs along the eastern rim of this Mt.

At circa 1515 Hrs, I had a beautiful clear view to the horizon between the gaps in the large trees. The Mt Dandenong Ranges 127 Kms to the East were not visible to me so using the 10 GHz Liaison hardware we quickly had our Bearings sorted.

We had expected the SSB signals to be much weaker over this longer Path so for this QSO we decided to use the benefits of WSJT’s “weak signal” capabilities to “find” the signal and optimise the Dish pointing. To achieve this, we each in turn radiated the 1270 Hertz Sync Tone and adjusted the Dishes for the strongest visible signals on the PC. We quickly completed an easily audible -8 dB WSJT QSO. Our SSB QSO was as expected fairly weak but quite readable at 51 both ways.

So, at the end of this very productive day, we had Set/Extended the VK 78 Ghz SSB and Digital Records 3 times out to a maximum Path of some 127 Kms !!

But wait – there’s more !!!

Over the previous couple of weeks, I had been in discussions with various people seeking “access” to the Mt William Summit at 1162 metres ASL. A day earlier, this access was finally granted and so we immediately planned for a longer shot from Mt William over a LOS Path to the south east (near Colac).

On May 15th, with a warm, bright and sunny sky and high’ish Humidity… the type of conditions that are not really ideal for 78 GHz propagation... we achieved our longest distance yet of 139.8 Kms - firstly on Digital WSJT/JT65C with -10/-12 Reports. We then completed on SSB with marginal 4+1 Reports both ways.

With better more appropriate weather conditions, we believe there are still possibilities for extending these Distance Records even further. We just need the “right” conditions!

The time and effort in completing these Record setting QSO’s on 78 GHz was significant. But… that’s what Amateur Radio is all about. Reward for effort !

We are very happy with our achievements although it came at a personal cost when a wheel bearing on my 4X4 failed on the drive back from Mt William. I had to leave the Toyota at a “Gas Station” almost 200 Kms from home. Local Repairs were scheduled for a few days hence and then I had to get the missus (Wife) to drive two and a half hours to pick me up.

But... that is another story !

Thank you,

Alan – VK3XPD.

David – VK3HZ.