

I've created a monster

After many months of planning, creating, designing and testing, VK3RWO is on the air.

After moving to Wodonga with my lovely bride to be, in June 2018, I had nothing for Amateur radio. I had moved into an RF poor area – We struggled to receive TV stations. Not far from my new QTH, there is McFarlane's hill. It is a lovely piece of dirt over 350M tall. Great for blocking RF signals, or sending signals from the top of it.

While taking my poochies for a walk up this hill (of course with some radio equipment to play), I ran into the farmer who leases it. We got talking about farming, working dogs, etc., and then the subject came up of what radio I was playing with. I explained it, in a brief fashion, and then said one day I'd like to find a bit of dirt on top of a hill I could install some remote, experimental equipment on.

After mentioning this, he said, I've got some high dirt, would you like to come and have a look and see if it is suitable. I think I answered yes before he finished the question. A couple of days later, I went to visit him, and he took me for a tour around the property, and then up on top of the hill. The view was magnificent, with a great look to the west, around to the North. The first hill you run into in that arc is our other magnificent site, VK2RWD. Then looking to the east, you look straight down into High street in Wodonga, and Dean St. in Albury. It was perfect.



Illustration 1: Looking North West from the site

After negotiating a lovely price for the hill, what I can put there, access to the site, insurance, and ensuring the site is commercial free, we shook hands and it was a country deal. The best kind. Country people tend to put a lot of weight onto a handshake, and I am no different.



Illustration 2: Looking into the Albury Wodonga Basin. Look close enough you can see the airport

Almost as soon as I came down the hill, I started the monstrous amount of paperwork required to obtain a 2m and 70cm licence for the hill, and off to the WIA it got sent. 3 Days later, the WIA office had taken my money and issued the VK3RWO callsign, and given me an email stating that there is a backlog of applications in the ACMA and could take 6 months.

Unfortunately, for 3 months, the paperwork sat somewhere. It wasn't in the WIA office, and hadn't made it to the ACMA....

The ACMA is the most pleasant government department I have ever dealt with. They are great and really do help you out if you are genuine with them. I always compliment them on their service. The only issue I have with ringing them is the long winded 1 minute and 3 second privacy message before you can talk to a human.

Despite the "could take 6 months" email from the WIA, I was greeted by an email from the ACMA 2 ½ weeks after they had received it, saying, your licence has been approved, can we have some money. There was about 30 seconds between receiving that email and ringing the ACMA with my credit card.

We were legal. I have been issued a licence for 2m at a frequency of 146.975 with a 600 kHz offset, and a 70cm frequency of 438.600 MHz with a 7 MHz offset, with matching pairs at my QTH to allow linking. The licences had also been allocated, at my request with a F9W emission designator, meaning I can play analogue, digital, or a mixture of both. At the time, the only licence of that kind in this immediate area.

Now I could start planning. The main aim of this repeater, was to build it without spending any money and make it out perform everything. I almost achieved this goal. The only things that had to be purchased were some barbed wire, star pickets, and some misc. steel for brackets. The only requirement for the star pickets and barbed wire is to stop

cows chewing the repeater. The rest I have gathered over the years, along with some bits Gary, VK2VU had lying around.

Another article will be written in due course of the detailed construction of all the repeater and its housekeeping. For now, a brief description of how it all went together.

Fitting it out

Starting with the cabinet. I had kept, long ago a 1970 Kelvinator fridge to use as a cabinet. It is waterproof, made from real steel, is very strong, weighs a tonne and is insulated. I painted it green to camouflage it a little. This I had done 4 years ago in preparation then for this day.....

First thing I had to do was get all the equipment I was going to use, lay it out and then try and stuff it into the cabinet to see if it all was going to fit. A bit of mucking around, it all fitted. Beautiful.

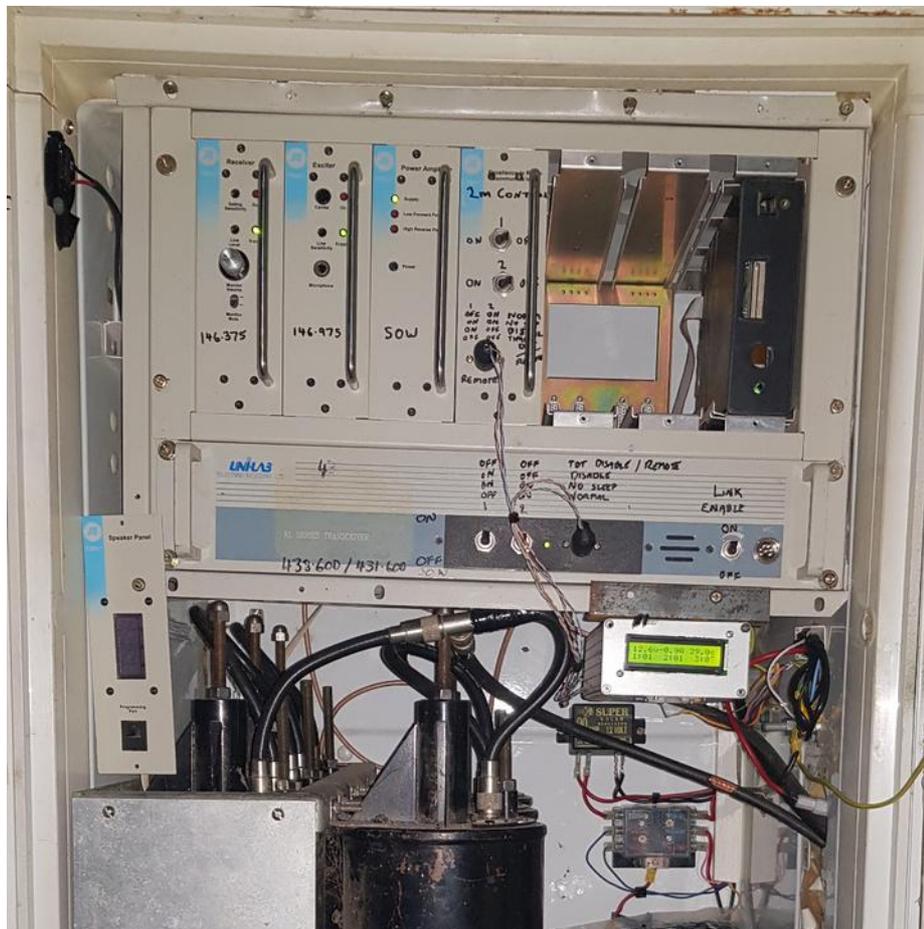


Illustration 3: All the bits and pieces that makes it run

The next thing to do was to design how the solar panel and antennae were going to fit. I decided to make a solar panel bracket that held the panel at the most efficient spot for the winter sun, as this is when it is needed the most. That designed and built, and made bulletproof, I manufactured the antenna mount. This involved brackets on the top and bottom of the fridge to mount the pole. It had to be strong. The lower bracket had to be gusseted to stop it from flexing.

Now all that fitted, it was a case of building it. The antennae consists of folded dipoles, with the UHF one having a reflector to allow it to favour the Wodonga basin a little. These were chosen as they are at DC ground, and will help in the event of a lightning strike. Given the repeater is the only piece of metal on top of this hill, it's a case of not "if" it gets hit, but when....



Illustration 4: The antennae, complete with bird proofing.

The 2M repeater

For the 2m repeater, I chose to use a T800 repeater. I have several of these, so spares is not an issue. The front end is vari-cap tuned so it is quite selective and sensitive. The transmitter is an exciter with a separate PA. The whole lot has heated crystals for the reference, so it is very stable.

The downside. They draw enough power to heat a house on standby. I modified all this for lower current draw, as I'll mention later.

The 70CM repeater

The 70cm repeater is a heavily modified KL450. When I say modified, the main circuit board has been removed and tossed into the parts bin. Again this has been done to clamp

the current draw as required. As with the 2m repeater, this was tuned to gain the maximum sensitivity and selectivity as well as streamline the PA for maximum output at lowest current consumption. I also installed a heated crystal for stability.

Duplexers

The duplexer for 2m is a 6 can pass/reject setup tuned for 1.5db loss, with over 100db isolation. This allows for a very sensitive receiver, with a good amount of output power with no TX noise going into the receiver. Great, a full set of cans that fit in the fridge.

The 70cm duplexer is nowhere near as special. It is merely a mobile set of cans with about 65db isolation and around 2db of loss. I would have loved to use better, but they wouldn't fit in the fridge. I still have no TX noise with the repeater set to 30W. It will do.

Powering and controlling it

The batteries and solar. The solar panel came surplus from a job, and the batteries have all come out of jobs where they couldn't quite do the job they were intended to do (ie start a car), but they will run a 50W PA until they go flat.

The controllers. A full article will be written on this in the future. The controllers are designed by myself. They are unique in the fact that they allow the repeater to sleep. By sleeping, I mean, the repeater goes to sleep for 3 seconds, wakes up checks the input for 1 second, and then sleeps again. Whilst you may find this annoying, the standby current goes from 300mA to 75mA. Much better overnight when the Sun is sleeping, as are most operators, and by default, so is the repeater. It takes a 5 Second PTT press to wake it up and lock everything back up, a small sacrifice for a major gain. It goes to sleep 20 minutes after the last ID, and identifies so by sending out Morse "SL"

The controller also allows the TOT to be disabled, not for our local rag chewer VK3CM to use to his advantage, but for the WIA news broadcasts. I am betting that the WIA broadcast will be shorter in duration than a CM transmission when he knows the TOT is turned off.

This is all controllable via the internet, meaning no DTMF tones to be copied by those inclined to cause trouble.

As it has turned out, with near a week of flogging the backside of the repeater, the repeater is generating more power than it is using, it is even doing so when there is cloud cover. I think we have the balance just right. According to the telemetry, the repeater is getting around 4 hours of TX time every day.

Both the 2m and 70cm repeaters have a link into the VKLink network. Meaning we have connections, at this stage, to Mildura/Swan Hill and all over Tasmania. Again, one day a full article will be written on this.

Welcome to the VK3RWO page.

This page will progressively grow as the new VK3RWO repeater grows.

The data is sent to the Internet with a few bytes of data, via a Class licenced piece of gear. The controller at the site takes a reading every 30 seconds, then after 300 seconds, averages it and sends it down the hill via a 24 byte packet. It is in a fire and forget type configuration. If the door gets opened or closed, it gets fired straight away.

Voltage, Current and Temp at VK3RWO at 21:42:

12.66v -0.3A 29.6°C

24 Hour Min/Max min:12.19v max:13.36v

Function	Status
Door Switch	HUT SECURE
Fan	FAN OFF
Error Status	NO FAULTS
2M repeater	NORMAL
2M RF Link	OFF
70CM repeater	SHUTDOWN
70CM RF Link	SHUTDOWN
10M Repeater	OFF

LV cutout 11.48v, Fan on: 39.3°C, High Temp cut: 58.9°C

VK3RWO Repeater control

2M

Sleep, no link

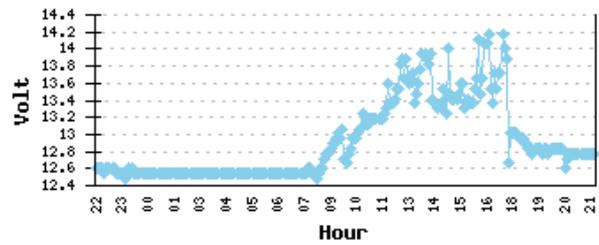
10m rx off

Go

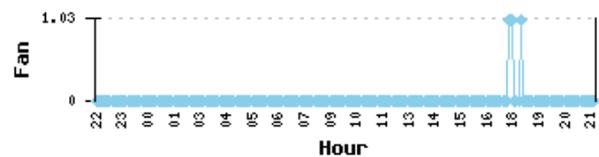
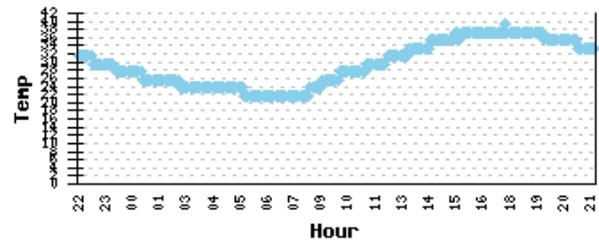
[Volt control](#)

[Temp control](#)

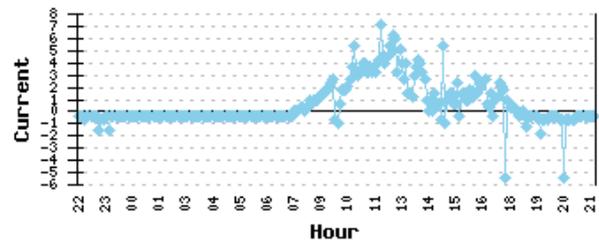
Mean voltage over the last 24 hours: 12.86



Mean temp over the last 24 hours: 29.4°C



Mean current drawn/generated over the last 24 hours: 0.61A



Voltage at the vlink node hut over 24 hours
It has an internet connection, so it reports every 120 seconds. It also uses a 10 bit ADC, vs an 8 bit ADC so the voltage steps are 4x more accurate (it also takes 2x the airtime...).

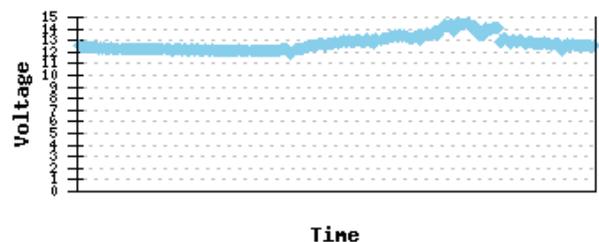


Illustration 5: Combined screenshot of the telemetry and control

Installing it

On Saturday, 17th February, the Authors hard work finally came to fruition. The repeater, after being tested in his back yard for 3 months, finally got dismantled. The weather was good, the track to the site was dry and clear, and I had a free day.



Illustration 6: Pulling it all apart, ready for transport



Illustration 7: Putting it all back together again

I made the appropriate access phone calls, and up the hill I went. The repeater was dismantled at 12pm, and was going on the hill at 7pm that night, after shovelling rocks, bashing star pickets and well, having the regulation beer afterwards.



Illustration 8: The finished product, on air and making noise

Problems

This build wasn't without its problems.

- Mixed audio levels from different manufactures needed fixing so the controller could, well, control it.
- Jamming everything into the cabinet.
- Bird proofing it. The sawtooth on the solar panel is made from an old computer cabinet and 20 minutes with my angle grinder.
- RF path problems for the telemetry and control
- Intermodulation – squeezing everything into a case this size was going to have its problems
 - First the MPPT controller, its oscillator mixed with the 2m transmitter and ended back on the input. Changed it to a pwm controller, fixed that.
 - Next doors house solar would cause havoc with BOTH receivers just as the sun was going down, it was pulsing its panels to check they were there. This had me pulling out my hair, as it wasn't coming from my cabinet, and finally,
 - When installing it on the hill, the 2m TX sounded like it was running away. I disconnected everything except it, and the problem was there. Almost getting to the stage of pushing it down the hill with my bullbar, I turned the stereo off in my vehicle. The problem went. Turned it back on, intermodulation returned, the 2m TX was mixing in the front end of my stereo and coming back out, well everywhere. A 200 kHz wide signal from the FM station, mixing with a 455 kHz oscillator has to equal 600 kHz somewhere.

- And, Navigating back down a cliff on dusk, having been there only once before.

After a week worth of testing

I'm happy to report that after a week of testing (read flogging), even with a couple of days after no Sun, the batteries and everything is holding well. The telemetry has shown that not once over a 24 hour period have we been in the red with charging. It has always shown an average in the positive, even if at one stage it averaged out to 100mA.

One little tiny problem has shown its ugly little head up. The 2M antenna is a folded dipole. It is a commercial VHF High band unit, centred around 160Mhz. Whilst the VSWR is fine, it has shown that it has a less than ideal radiation pattern, working out to roughly 5 degrees of upwards tilt. This explains why it can hear a lot better than it can be heard. The radiation pattern has a very minimal effect of RX, but wrecks the TX greatly. It is shooting over everyones head. An antenna improvement will have to be done sooner rather than later.

The coverage

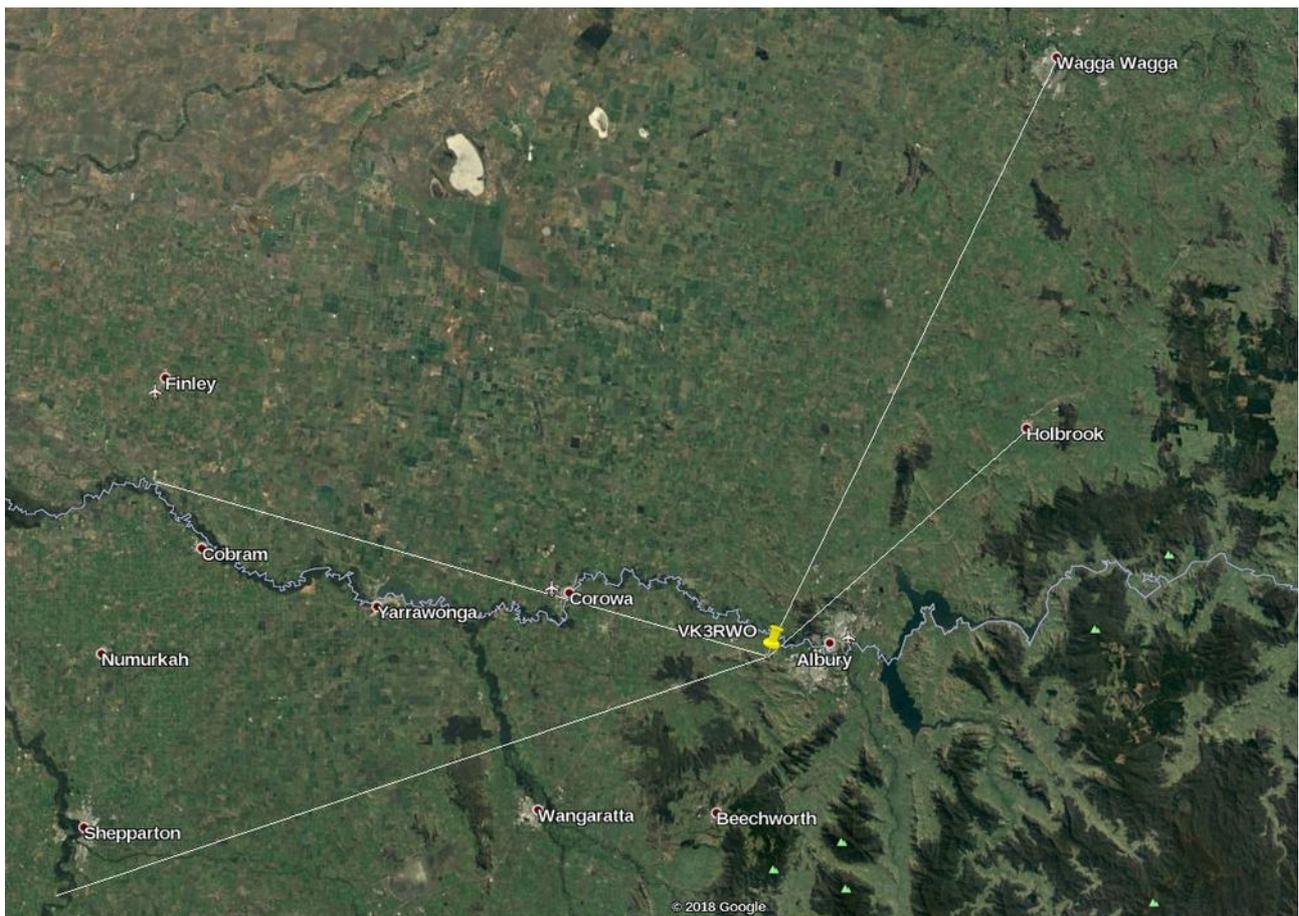


Illustration 9: Google maps showing actual contacts

Initial reports of the 2m repeater have been excellent. We have had Toby VK3P?? come up from south of Shepparton, John, VK2YW, come up from Wagga, and Gary, VK2VU was testing it mobile in Tocumwal, As well as several places in between.

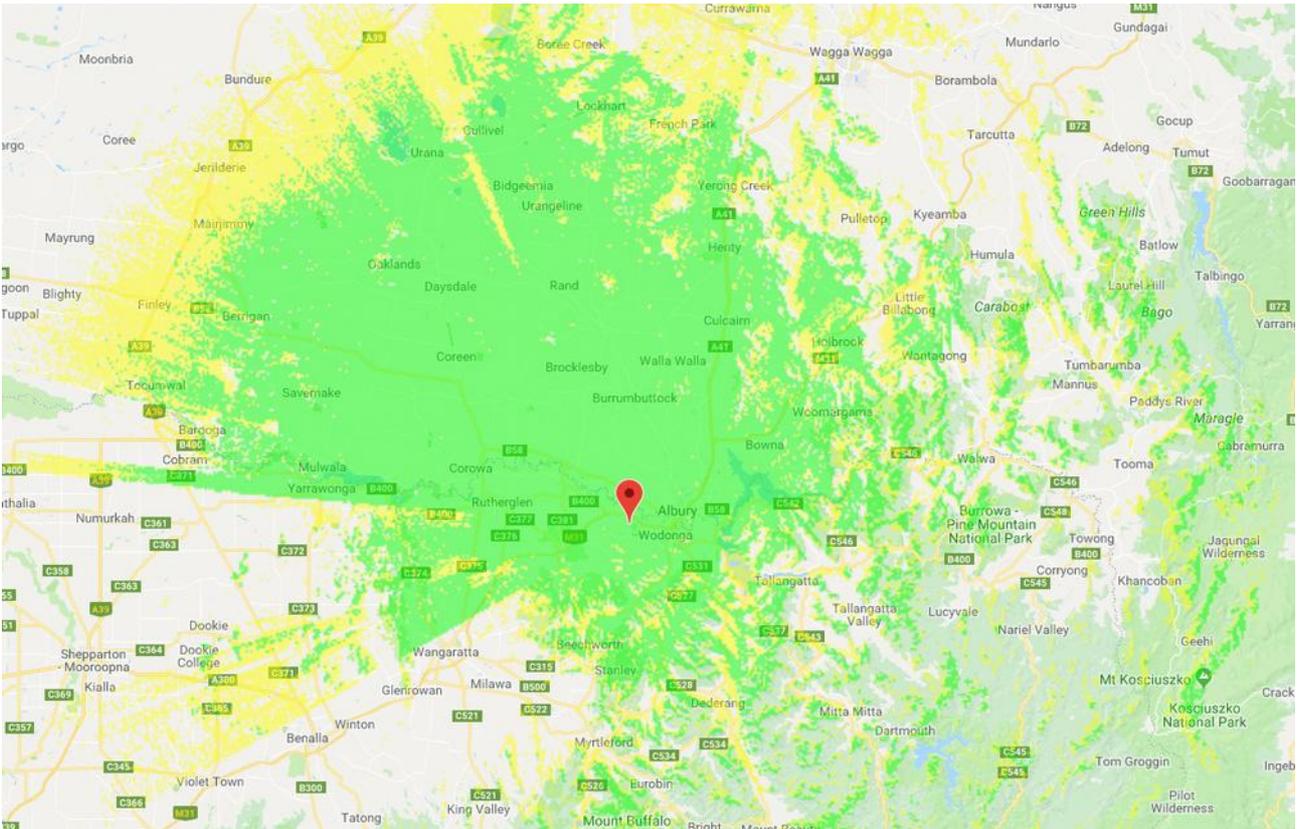


Illustration 10: Radio Mobile estimated coverage

It is the first time in Amateur History that a HT can be used in the main streets of BOTH Albury and Wodonga and have a Q5 copy both ways. 100mW is quite workable from QE2 square in Albury.

So if you're within 100km of Albury/Wodonga, throw a 123 Hz tone on, and give the repeaters a crack. If you hear nothing, give a 5 second PTT push to wake it up and try again.

The North East Victoria Amateur Radio Club run a net at 2000 Eastern Time every Monday night on the 2M repeater.

It is so satisfying to see something built entirely built from scrap perform so well.

73,

Matt, VK3VS



Illustration 11: Think I thoroughly earned this.....