Experiments with 1mW on 1296MHz

I started to explore what could be done with 1mW using homemade equipment on the 1296MHz band.

A lovely Spring day for radio experiments on a nearby hilltop (by the way I am noting transmissions times on a pad while holding the pen lid in my mouth, not smoking a cigar!). The box mounted on the tripod contains the 1mW transmitter and dipole antenna.

In Part 1 last month, I described some experiments using 1mW on 1296MHz. Now we will look at some notes and thoughts about the 1296MHz band, which I hope will be useful for people relatively new to these frequencies and those who enjoy making radio equipment.

What does the 1296MHz band have to offer? It offers low noise, highly sensitive receivers and small yet high gain antennas that are still within the range of what can be made at home.

1296MHz transmit-receive paths are influenced much more than 144MHz paths by large buildings and other objects obstructing the signal path and by the weather. On long paths, water vapour can have an effect. Warm air tends to hold higher concentrations of water moisture than cold air, so winter days are often better than summer days (this is especially so on the higher frequency microwave bands).

A great band to experiment

As the 1296MHz band wavelengths are a tenth of those on the 144MHz band, the antennas are proportionally smaller. 144MHz band antennas that can only ever be the dream to the city dweller, can be realised on 1296MHz! You can see what I mean in Photo 5a and 5b of the two 4 x 5 element arrays for 144MHz and 1296MHz bands: the tiny one I am holding in my hands is the same antenna but for 1296MHz. Note: wooden booms are fine for 144MHz antennas but the moisture in the wood does not make it a good building material for 1296MHz antenna booms.

Although antennas are tiny on 1296MHz, they are not too tiny to hinder making your own designs and experiments – as long as you are careful with your measurements. A fantastic array of different types of antenna can be made on 1296MHz including: short, long and stacked Yagis, Rhombic and V-beams, colinear arrays, helical beams (with circular polarisations), slot antennas, parabolic reflector antennas and many others.

These high gain antennas help overcome the higher path losses at these frequencies, but one has to remember that very high gain antennas require precise alignment with the target. It's possible to miss a contact if you are not pointing correctly!

I worked a station in Normandy recently on the 144MHz, 433MHz and 1296MHz bands. He had different antennas and powers on the three bands and so it's difficult to make direct comparisons, but over this path we had good signal strength on all bands and the signals got stronger as we went up in frequency. It is often said it's worth going as high a frequency as possible to make a contact. This makes 1296MHz a very interesting band to have in addition to 144MHz and the 432MHz bands, without having to delve into the subtleties and complexities of the much higher frequency microwaves.

Feeder loss

A major issue at 1296MHz is feeder loss. A 20cm piece of cable does not look very long but it's about a wavelength (give or take the velocity factor). The equivalent on 3.5MHz would be 60-70m long! A 15m length of RG58 that might be practical (but perhaps not ideal) for a portable set up on 144MHz band, would be a disaster on 1296MHz. The cable would have very high loss (about 18dB for a 30m length at 1000MHz) and would effectively be a lossy noise source plugged into the receiver!

I have a 15m length of Andrew Heliax (approximately 20mm diameter) that has a low loss at 1296MHz but unfortunately, it's very heavy and quite inflexible cable to experiment with. I use a 15m fibreglass mast on my home location that is fixed / supported at the base (no space for guy wires) but running approximately 10kg of Heliax up the mast just does not work – the weight curves the mast.

I currently use a 12m length of CLF-400 coax between antenna and transverter, which is a good compromise between loss, weight and flexibility.

For receiving experiments, my ideal set up is to use a very small 1296MHz to 144MHz converter (see PE1CMO further on), which is so small and lightweight it can be fitted directly onto the antenna (with a very small coax lead). Then I can 'pipe' the converted signal down the mast cable at 144 MHz (where the losses are far less) using RG58 or mini-8.

1296MHz gear

The ICR7000 is fairly old now (approximately 1990s) but is a very well made and well regarded receiver that covers all modes (AM, FM, SSB and CW) from approximately 25MHz to 1.999GHz. The radio even has a spare phono socket on the back that you can use to take a signal from the receiver for a particular purpose. I tapped into the S-meter circuit so that I could feed this to a data logger.

The S-meter circuit creates a fairly linear relationship between its voltage (0-2.5V) and the S-scale S0 = 0V, S1 = 0.2V ….. S9 = 1.4V,

PHOTO 5: As the 1296MHz band wavelengths are a tenth of those on the 144MHz band, the antennas are proportionally smaller.

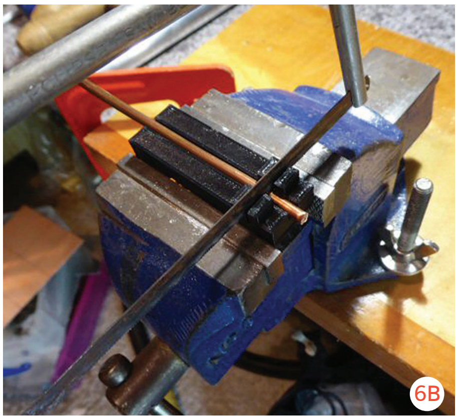

PHOTO 6A-C: I have also used the 3D printer to create jigs for bending just the right amount of wire to create folded dipoles for 23cm band Yagis, as well as a handy cutting jig to help saw semi rigid coax.

to S9 + 30dB = 2.1V, which can be logged by my data logger (0-10V input).

Receive converters

PE1CMO produce some very nice 1296MHz band gear [1]. In particular they produce a tiny state-of-the-art 1296MHz to 144MHz receive converter, perfect for backpack portable experiments with a FT-817 receiver or for putting on the top of a mast.

The PE1CMO converter has good band pass filtering on the input and seems to work very well indeed. It is so small and light it can easily be fitted right at the antenna and the converted signal (144MHz) sent down the coax with far, far less loss and noise.

Transverters – LT23S

This is an old but good SSB Electronics transverter that converts from 144MHz to 1296MHz, which claims receiver noise figure of 1.8dB and 10 watt output power on the 1296MHz band. I use this to convert the 1296MHz signal from the receive antenna down to 144MHz and log the ICR7000 (tuned to 144MHz) S-meter circuit.

AR 8200 MKII v ICR30

Many amateur radio handhelds receive on 1296MHz, for example my TH-F7 covers the band but only for AM or FM modes. I have tried making a BFO, so I can listen to CW (eg beacons) when set to AM, but I could not get this to work well.

A few years ago I brought a second-hand AR8200, which is a wide frequency range handheld receiver that covers 1296MHz and has CW and SSB modes. However, the one I purchased did not receive well on 1296MHz – high noise and instabilities – which was disappointing.

One has to be careful buying second-hand gear.

Recently I purchased an ICR30, which really is a fantastic portable radio that covers all modes from 100kHz to 3GHz. Even though it's quite a recent radio, Icom is no longer producing the radio (one of the main IC manufacturers used for components in the radio has gone bust).

A note on band pass filtering

The pulses from nearby mobile phone masts can cause havoc with UHF equipment and so some sort of input band pass filter is a must (especially if you are going to go portable on hills close to cell phone masts etc.). If you buy a wide band hand-held receiver, such as the amazing ICR30 (which covers 100kHz to 3GHz) bear in mind that there is no room in this tiny marvel to have the required 'stack' of band pass filters that you would need to actually receive reliably over such a large range! So, for ideal reception you either you have to select the attenuator(s) or fit a band pass filter between antenna and receiver (or both preferably).

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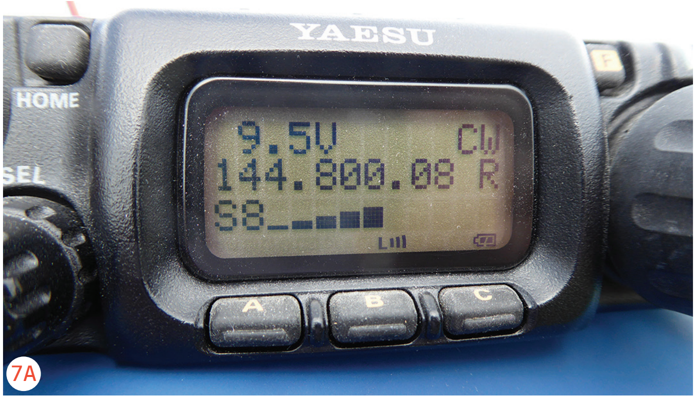

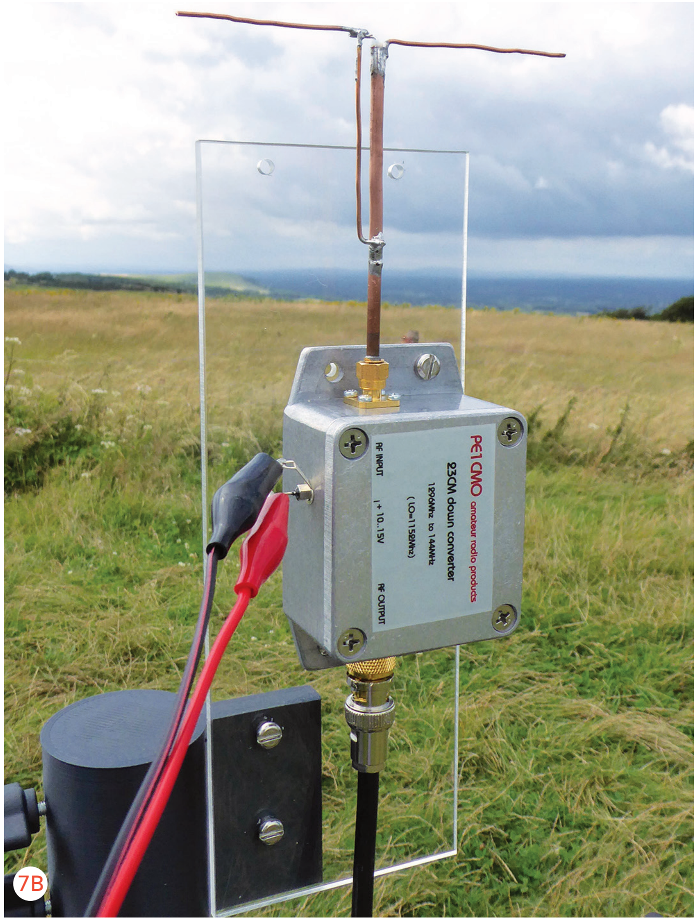

PHOTO 7A-B: On top of Ditching Beacon receiving the Isle of Wight beacon (1296.800MHz) S8 using a dipole on the PE1CMO receive converter and using a FT817 (tuned to 144.800MHz).

SWR and power measurements

SWR meters for 1296MHz are expensive and for most of us not something we might use enough to justify the cost (although a radio club might invest in one for members to use etc.). However, a few years ago DC6ZM wrote a nice article in *RadCom* [2] showing how you can make an economical UHF SWR and power meter using AD8318 demodulating log amplifiers and surplus coax directional couplers. I have built this design and it allows me check my transmitter and receiver antennas and also measure the power output of my low power transmitter [5].

Homemade Yagis

One can make metal boom Yagis at 1296MHz, but I have found insulating booms are preferable. You need to be very accurate when cutting the element lengths (fraction of a mm). It should be noted that water vapour can adversely effect 1296MHz antennas (eg rain water).

Many commercial Yagi designs don't place the elements through the boom, but use small plastic holders to raise the elements above metal boom. Unless you can braze the elements to a brass boom to get a perfect contact each side of the boom it can cause problems. I made a Yagi using a 10mm square cross section aluminium boom (taking care to take into consideration the shortening effect of the boom) and push fitting the elements into snug holes along the boom. I found the SWR was super sensitive to mechanical vibration. It seems that the elements were making and breaking contact either side of the boom effectively randomly adding 5mm or so to the element lengths and rendering the antenna useless. Redesigning the element lengths for a non-conducting Perspex boom solved the problem.

There are useful Yagi simulation web pages that seem to work well for designing 1296MHz antennas and some are listed on the folded dipole jig page on my 3D printing pages **[3]**.

Help from a 3D printer

I have a lovely 16m long fibreglass mast in my backyard that allows me to get antennas high enough to be above most of the houses and chalk hills in the immediate vicinity. However I don't have any space to put up guy wires for this mast, so I rely on the mast being supported from the bottom using TV type brackets. The antennas on this mast need to be very lightweight to avoid problems with the mast flexing. Thankfully, 1296MHz antennas are just this; small and light. However, commercially made rotators are quite heavy, so I 3D printed a very small lightweight rotator for temporary experimental use, which is working out well,

I have also used the 3D printer to create jigs for bending just the right amount of wire to create folded dipoles for 1296MHz band Yagis. There is also a handy cutting jig to help saw semi-rigid coax, **Photo 6a-c**. Details can be found on my 3D printing section of my website [3].

Isle of Wight beacon measurements

The Isle of Wight beacon G8MBU (62m asl, 1296.8000MHz) is located at one of the high spots on the island and is about 80km distant. The beacon runs about 2W into an Alford slot antenna giving about 10W ERP **[4]**. I can rarely hear the beacon from my home location in Brighton (60m asl) as there are too many chalk hills in the path to my west. However, I do occasionally get a signal rising above the noise near sundown on some days. If I walk just a few 100m up my road towards the local high spot (Hollingbury Hill), the G8MBU beacon can easily be heard. It just shows you how very important a high and clear take-off is for 1296MHz work, **Photo 7A** and **7B**.

The highest spot near my location is Ditching Beacon (approximately 248m asl IO90VT) and the Isle of Wight is clearly visible most days. Using the PE1CMO converter with just a horizontal dipole directly on the input I can hear G8MBU very strongly as a S8 signal with the gear sitting onto of the Ditching Beacon trig point (see photo). It's interesting to note that, in the car park, just a few 100m away from the trig point (only a few 10m less height in altitude, but to the East 'behind' the top) you can't even hear the beacon.

It is clear that antenna height and a clear line of sight is key to success on the 1296MHz band.

Acknowledgments

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Websearch

[1] PE1CMO converter: https://www.hf-electronics.nl/PE1CMO-Converters
[2] Measuring power, return loss and SWR at GHz frequencies, DL6ZM, *RadCom* March 2020, p. 30-32.
[3] G1EXG 3D printing web page: www.creative-science.org.uk/3D.html
[4] Personal communication with G8MBU, April 2022
[5] G1EXG radio web page: www.creative-science.org.uk/g1exg.html