A Guide to building your own Portable Station Incorporating a ¼ Wave Vertical Antenna and a Ground Tuning Unit or GTU

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Credits: I was introduced to the GTU by Dave G4AKC who to my knowledge perfected the GTU and applied it to his pedestrian mobile and portable stations. Dave is well known by Stations worldwide as the Pedestrian Mobile from Blackpool UK with the huge signal and the founder of the "Realhfmobile Yahoo Group". You can join this group on the link below:
https://groups.yahoo.com/neo/groups/REALHFMOBILE/info?tab=

Introduction: When I get on the air invariably I am a Portable or Pedestrian Mobile Station. I usually set up in parkland or when I get the opportunity about 5 meters from the edge of the ocean. These location afford much lower noise levels then in suburbia. My portable station puts out about 80 watts. In many cases stations are amazes at my signal strengths both local and DX, 5 by 7-9 reports are common place all over the world. I get many enquiries on my station equipment especially the antenna. My answer is simple, I report I am using a ¼ wave vertical with a ground tuning unit or GTU. In most cases operators simply don't understand what a GTU is or how it works and ask for an explanation. To try and explain on the air is simply impossible so below I have prepared a simple explanation on what a GTU is and how it works.

***Note: The following is a simple explanation not an in depth study**

¼ wave Vertical Ground Plane Antenna: Most operators would already know what this antenna is, there is a lot of information that can be accessed on the net on how to make one and how it works. Many people simply dismiss this simple antenna as being a basic antenna and turn their efforts to other more sophisticated designs hoping for better results. Actually the ¼ wave antenna is a very high performance antenna that is underutilised but is perfect for the portable station application because of its simplicity, low angle of radiation and omnidirectional characteristics. What turns many people off is the installation of radials and the never ending debate on how many radials are required for the perfect installation somewhere between 4 and 120! And of course what is the perfect length?? Whether the radials should be elevated from the ground or laid on the ground, the downward sloping angle of the radials to obtain the 50 ohm matching impedance.
Imagine having a perfect ¼ vertical with no radials. The advantages to a portable station are huge!

Enter the Ground Tuning Unit or GTU.

Ground Plane or Counterpoise: When we step back and look at a ¼ wave vertical antenna it is in fact a simple dipole turned 90 degrees into a vertical position with one half sticking straight up and the radials or counterpoise making up the other half. In

theory the currents in both halves should be equal. The top half current radiating the signal and the bottom half current forming the ground plane. If the ground plane current is insufficient caused by a poor grounding system the radiated energy of the overall antenna will be reduced.

The GTU: This is a device that replaces the radials or counterpoise and can be tuned to allow the maximum grounding current to flow thus ensuring maximum radiation from the top half of the dipole.

The current in the top half element is maximised by resonating or tuning its physical length.

The bottom half current is maximised by tuning it to resonance by a tuning circuit, the GTU.

A GTU is installed between the normal counterpoise feed point of the installation and a small sheet of metal called a grounding foot insulated from earth by any thin insulator laid on the ground just below the feed point. The RF grounding current flows from the feed point through the GTU and into the foot and is radiated into the ground.

The GTU can be adjusted to resonate the RF ground current for differing ground conductivity.

GTU Circuitry: Basically a GTU is made up of two circuits. A tuning or matching circuit to resonate and maximise RF ground current and a RF current measuring circuit to monitor the current and enable adjustments for maximum current flow.

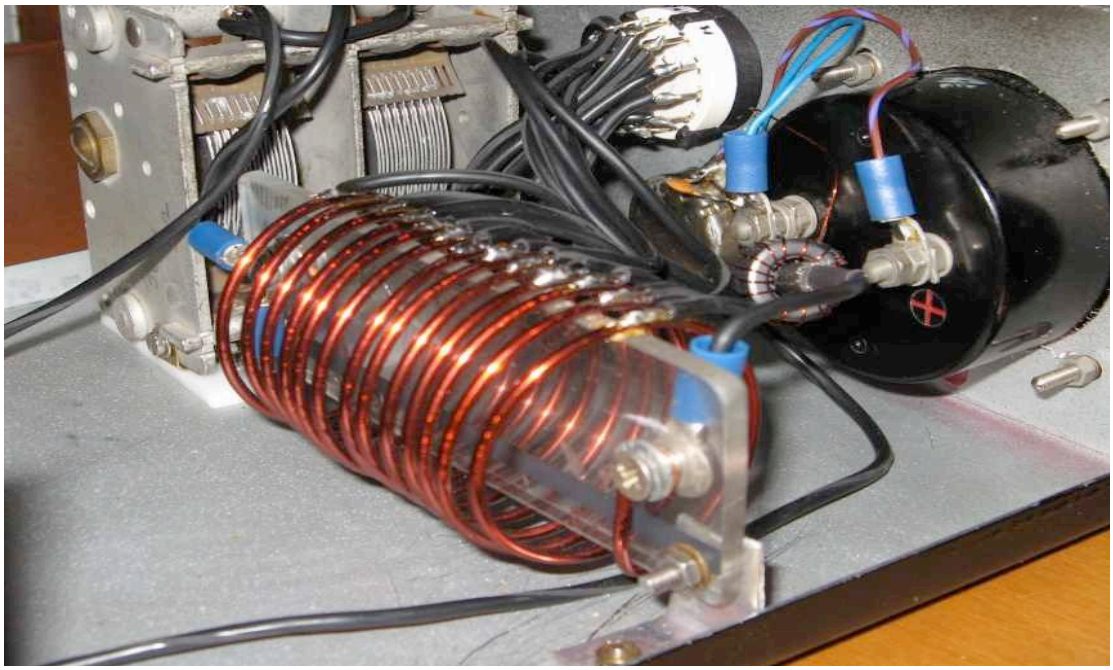
GTU Tuner or Matching Circuit: This is simply a variable inductor in series with a variable capacitor.

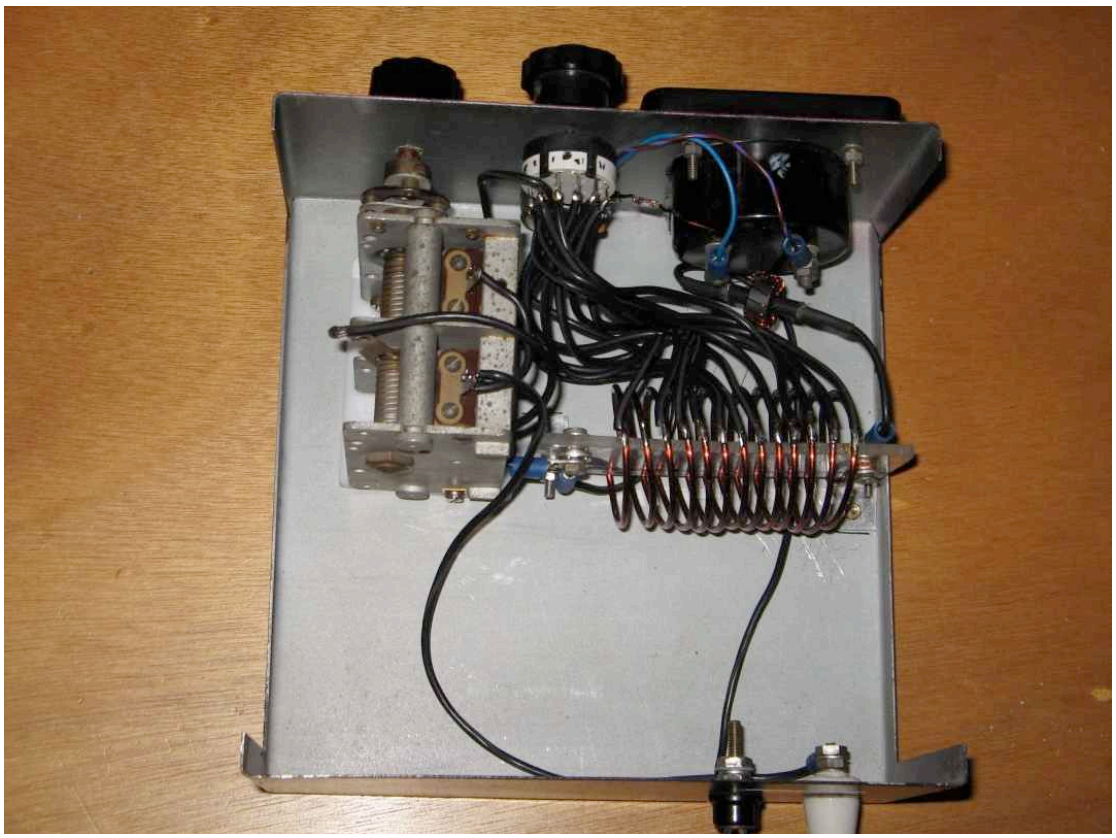
The inductor can be made from a large 2 inch toroid with 20 turns tapped every second turn and switched by a 12 position selector switch or an air wound inductor coil also tapped. Both are very successful.

The Variable air capacitor can be in the order of 320 to 500 uf similar to that found in old fashion radio tuners.

If you are using a metal mounting box both components must be insulated from ground. Plastic boxes are best suited for constructing a GTU.

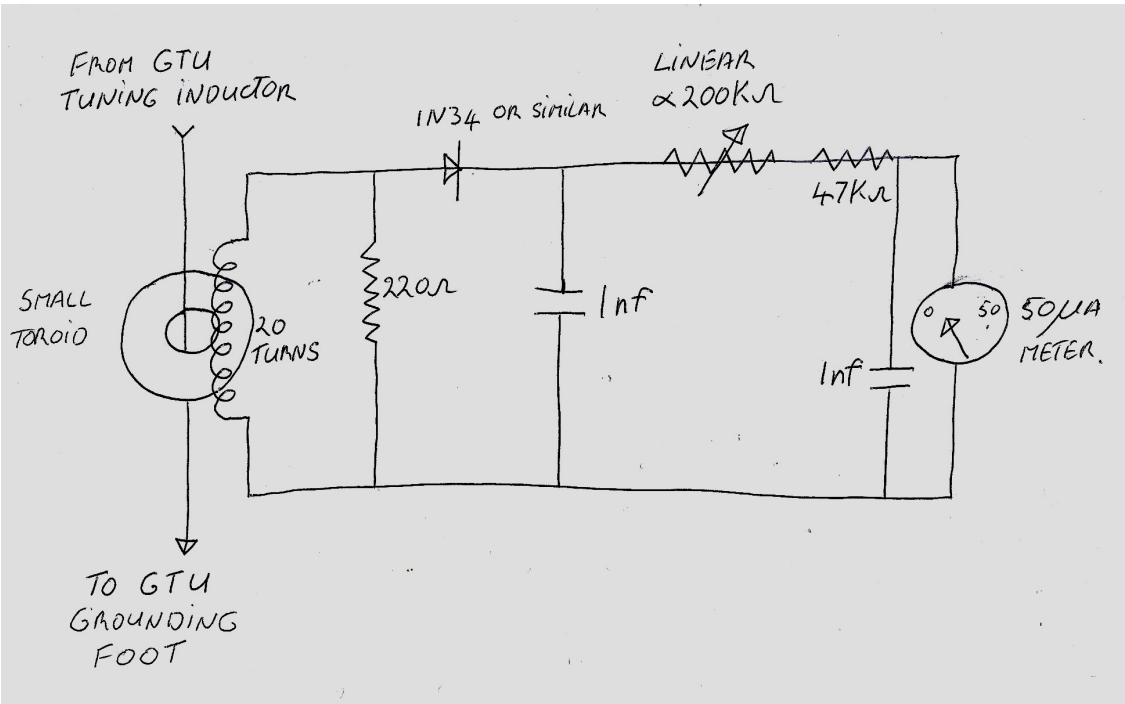
Below are 2 photos of a GTU. Note the variable air capacitor, the air wound inductor and the 12 position selector switch.

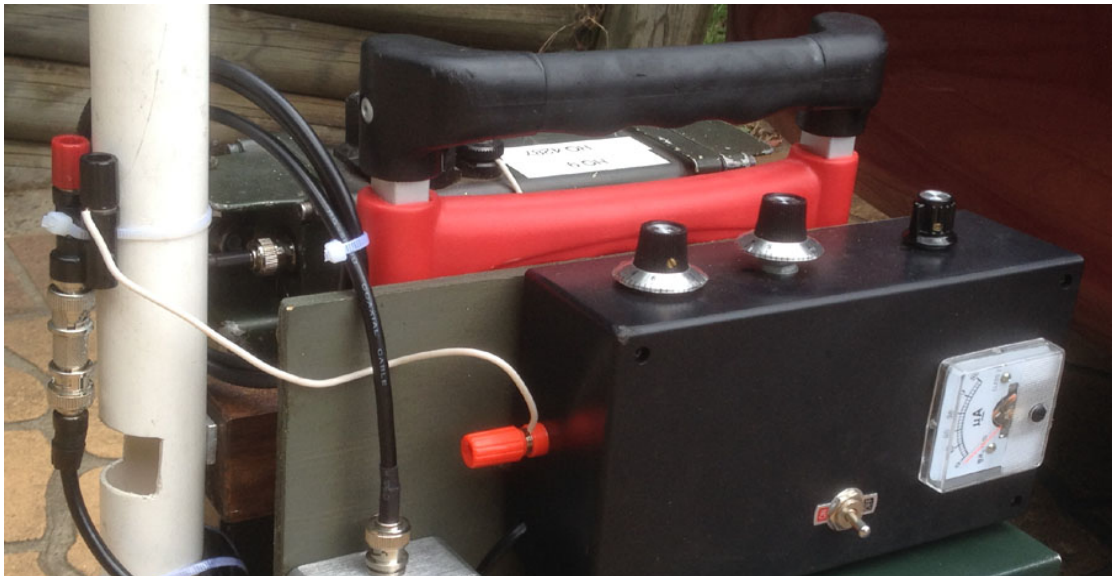




GTU RF Current Measuring Circuit: There are many designs for this circuit. They are all based around a small toroid sensing transformer producing a RF current which is rectified and displayed on a meter. Because we are only interested in a maximum reading calibration is not necessary. The only meter adjustment required is to keep the needle off the end stops. Central reading is good! This is achieved by a 200K linear pot in series with the meter.

Below is my favourite circuit for the RF ground current meter.





GTU mounted on trolley. Notice the wire connecting the coax antenna braid or screen to the GTU!

Ideal connector for connecting your antenna and GTU. Red antenna, Black Screen.
Note: Test that the red and black terminals are correct. I have seen them reversed!

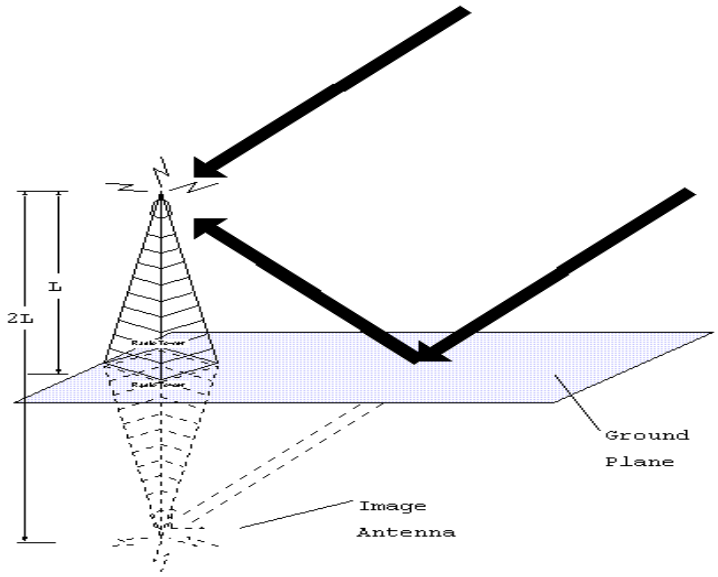
Ground conditions

Ground conditions dictate how well a vertical antenna operates as mentioned above. The ground forms the "other half" of the vertical antenna.

With this in mind a vertical antenna working at ground level over ideal ground conditions such as in close proximity to the ocean will produce a far better results than the same antenna working against a poor conductivity ground such as dry earth or rock away from salt water.

Operating your GTU station near the ocean:
When operating close to the ocean, the "ideal ground-plane" is already present in that the salt water of the ocean provides the perfect medium for the vertical to work against. The purpose of the GTU when operating over salt water is to provide a very low impedance down to the salt water on the operating frequency. This area is called the Fresnel zone. Your station is best located either over the ocean (or as close to it as possible). Note. The performance enhancement of the salt water diminishes rapidly as we move out or away from the "fresnel zone".

The final radiated pattern does not develop until a distance of several wavelengths away from the centre of the vertical antenna. The benefits of being close to the ocean are many, both reflected and refracted signals off the salt water enhance both receive and transmitted signals as shown in the diagram below:
Be aware setting up your portable station some distance (the car park) from the fresnel zone will result in dramatically reduced performance, think in terms of a ½ wave length from the salt water effected area.



Operating your GTU station away from the ocean:
When operating over poor ground the adjustments of the ground tuning unit will be different. Over poor ground the GTU will produce a balanced resonant counterpoise for the vertical antenna to work against. This will still result in good performance. The GTU works in quite different ways depending upon the type of ground conditions it's working over!

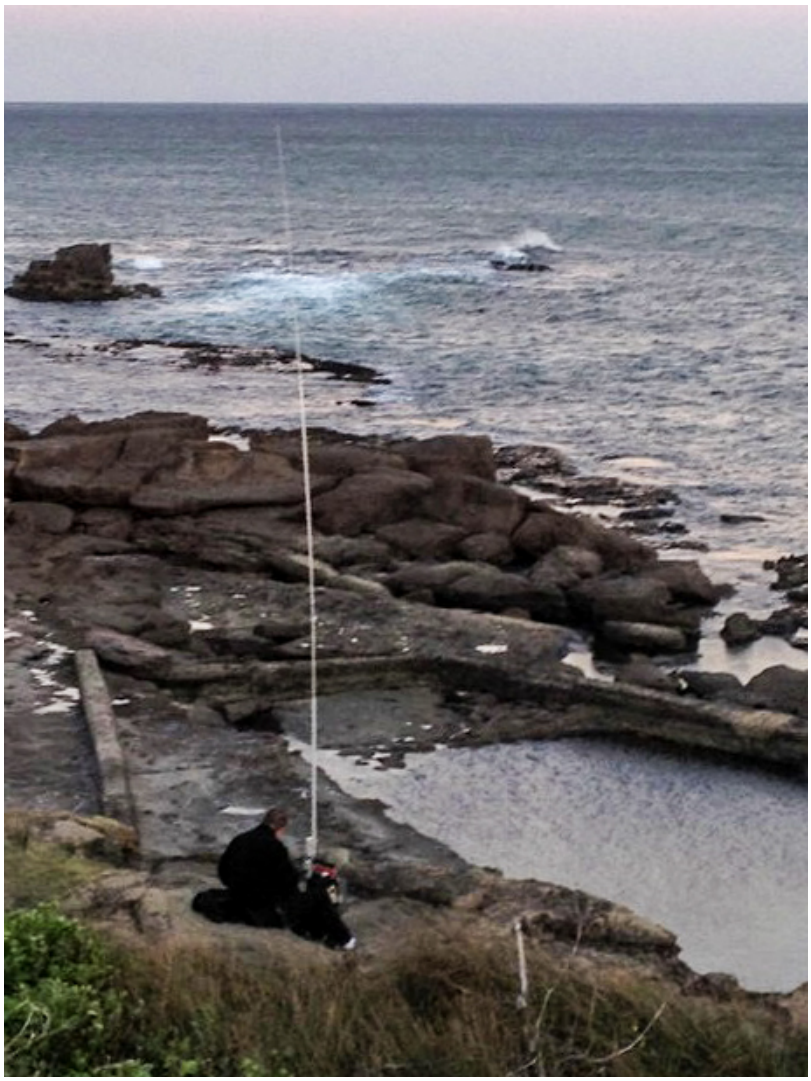
Typical Portable Station Incorporating a GTU: A typical station is a complete unit that can be carried in the boot of a car and can be lifted out and set up in a few minutes. It will be battery powered and have a telescopic ¼ wave resonant antenna made from a telescopic fibreglass pole and a length of wire or aluminium sections. It will have wheels or be light enough to be moved to a suitable set up location.
I use a small aluminium trolley sold for carrying a medium sized suitcase with wheels.

All of the equipment mounted on the trolley will be insulated from the trolley!!!!
The foot of the trolley or in fact the entire trolley frame will act as the GTU grounding foot and will have a thin piece of wood mounted under it to insulate it from ground.
There is NO direct connection of the foot to ground just capacitive coupling!

Typical equipment on board the trolley will include: Radio, GTU, an antenna tuner (ATU) fitted with a SWR and power meter, a battery possibly a deep cycle model, 18 to 33AH works well depending on you TX power. A mount for your resonant antenna and interconnecting cables. You may also incorporate a linear amp, additional battery required!

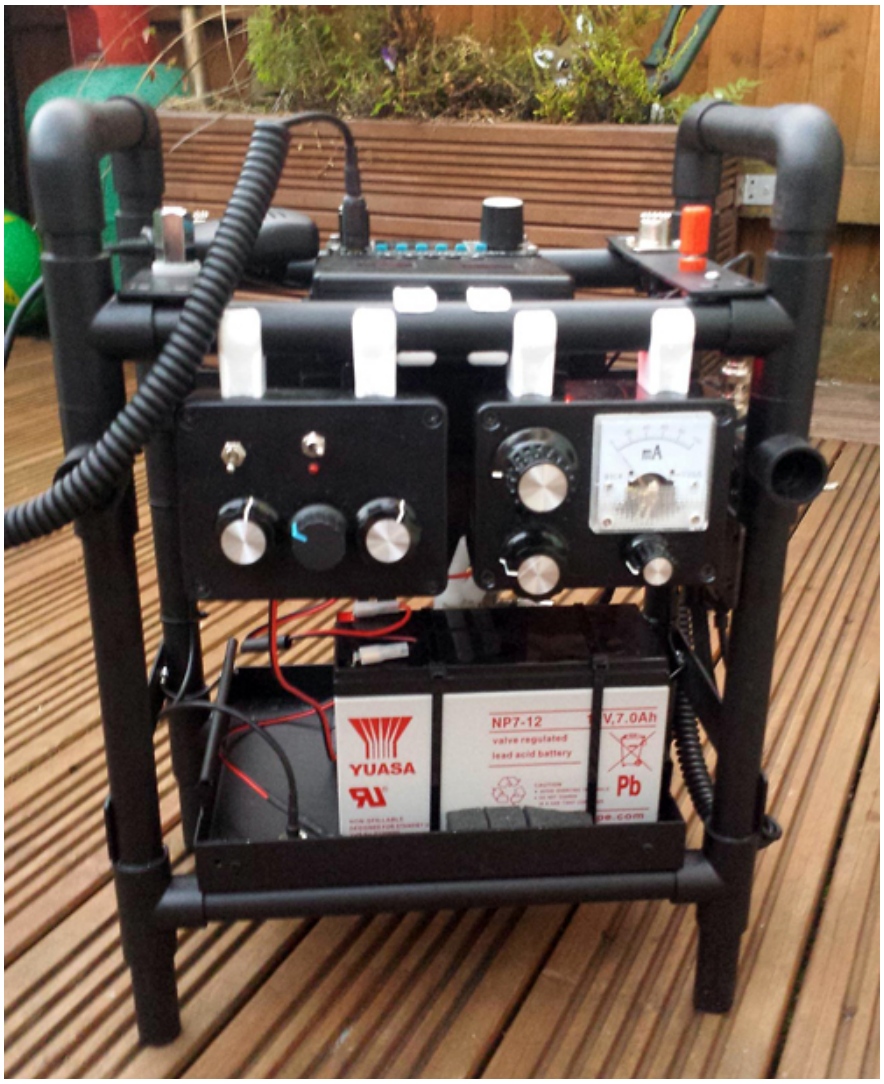
Below are some examples of Mobile Stations incorporating GTU's

<u>Dave G4AKC Developer of the GTU</u>
Notice Dave is operating in the fresnel zone



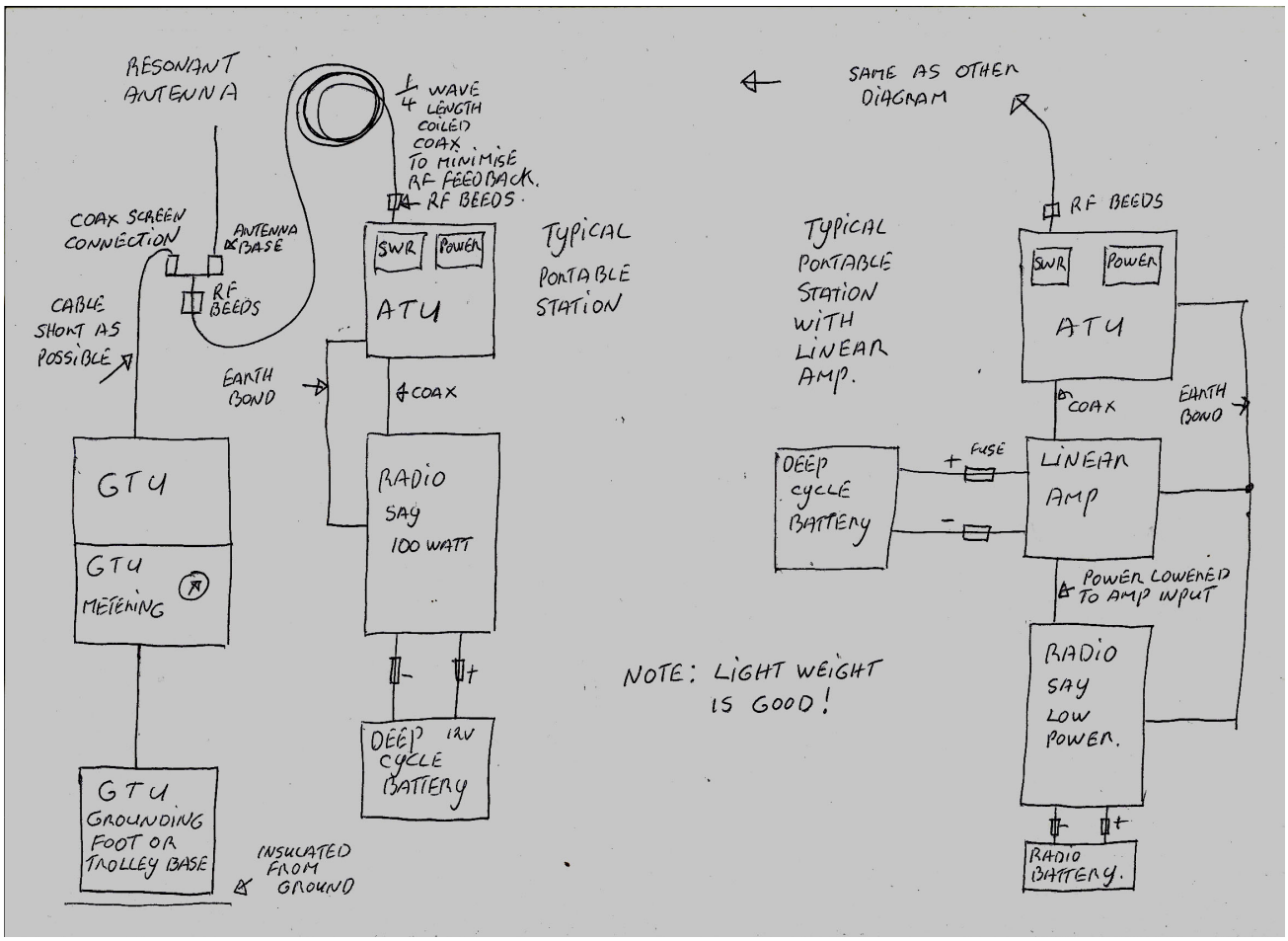
VK2BSY on his favourite rock at Wollongong Lighthouse

Myself VK2HAS with my Suitcase Trolley Station.



The design of your station can come in many forms

To help you constructor your own station I have added some block diagrams and notes.



Setting up and getting on the air: After constructing your station you will need to learn how to tune it. Set yourself up in a clear area away from any structures and start the tuning process.

It pays to have a pre resonated ¼ antenna for the band you wish to tune but it is possible to tune the antenna with your portable station.

Tune your radio midway on the desired band and switch to low power and AM or FM transmission. This will give you a nice continuous carrier signal to tune with.

The aim in tuning is to get the highest power into your antenna with the lowest SWR and the highest GTU current.

After successfully tuning your station to the best values switch your ATU to bypass, this should give you an indication of how resonant your antenna is and give you the opportunity to change its length to resonance.

After doing this switch your ATU back in circuit and retune, all should be good!

Now you are ready to switch to SSB and get on the air.

An analogue or digital voltmeter connected to your battery is a good addition for monitoring your battery state. I prefer analogue as the voltage fluctuated during transmission.

A valuable item in tuning your station is a Field Strength Meter. By setting it up a short distance from your station you can monitor your transmitted signal strength while tuning for maximum output.
Note: Every time you set up your station you will have to retune it because of differing ground conditions below the foot. You will learn which ground conditions work best and of course if your operating frequency band changes the GTU will also need to be re-tuned to optimise the ground current.

I have found dry beach sand to be poor but rocks near the waters edge to be good. Wet soil to be better than dry soil. You will see the results quickly when you compare different locations.

Six key points about the "ground plane" to finish:

1) The ground plane for any vertical antenna is just as important as the antenna itself! It will dictate the overall performance of the antenna system! It's the "other half" of the antenna system. The use of a GTU will enable you to couple to the perfect ground plane without any trailing wires.

2) The complete radiated beam only forms several wavelengths from the antenna so a large ground-plane like the sea is ideal.

3) Multiple reflections from the sea in the "fresnel zone" dramatically improves performance.

4) The salt water of the ocean creates a perfect ground-plane for the antenna to work against much like a sheet of copper stretching for many miles.

5) Operating near to the ocean increases the ground wave and decreases the angle of radiation, this enhanced effect is only truly effective where the tide covers the sand even at "low tide"

6) Location: Operating close to the ocean can see a 15-20dB increase to "low angle" receive and transmitted signals compared to locations even a short distance away from the ocean.

Good luck with your station, if constructed correctly you will not be disappointed. When a distant station asks you what antenna you are using you will have the opportunity to try and explain all this over the air, enjoy!

Thanks to Dave G4AKC for his help and input into this article.

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