Q5

North Bristol Amateur Radio Club.
S.H.E.7, Braemar Crescent, Northville,Bristol.

JUNE 2009

I have not done much on the radio this month only been on the local nets but I hope to go to the rally on the 28th of the month.

Notes on Ground / Radial, Systems for Vertical Antennas.

Ground Mounting.

A vertical antenna in its simplest form is an electrically equivalent to one–half of a dipole antenna stood on end. When mounted close to the ground the earth below acts like the missing half of the dipole.
If ground conductivity is fair to good, a short metal stake or good rod may provide a sufficiently good ground connection for a resonant and low SWR operation on the bands for which the antenna is designed. In almost every case, however, the efficiency of a vertical antenna will be greater if radial wires are used to improve ground conductivity. Wire size is unimportant, and in most ground-mounted installations, the radials may be any convenient lengths. They need not all be the same length, nor do they have to be laid in a straight line. It is generally convenient to bury the wires, but they may be left on the surface if they are not a hazard. A large number of long radials will naturally be more effective in reducing losses than a small number of shorter ones, but one should remember that the greatest loss would occur in the earth near the base of the antenna where current flow is greatest. For this reason, it is generally better to use a larger number of radials of a shorter length than a smaller number of longer ones for a given amount of wire.
In some cases wire mesh may be used as a substitute for radial wires and/or a ground connection, the mesh or screen acting as one plate of a capacitor to provide coupling to the earth beneath the antenna.
It should be noted that A GROUND ROD IS USEFUL ONLY AS A DC GROUND OR A TIE POINT FOR RADIALS. IT DOES NOTHING TO REDUCE RF GROUND LOSSES, REGARDLESS OF HOW FAR IT GOES INTO THE GROUND!

Above Ground Mounting.

It is possible to operate a vertical antenna at any height above ground provided that something is done to supply the equivalent of a ground connection. It is not enough to run a long lead to a ground stake or cold water pipe, for a current will flow in the lead, making it part of the overall antenna length and detuning the antenna on one or more bands. The usual approach to the problem is to install 3 or 4 resonant quarter-wave radials at the base of an elevated vertical and to them to the braid of the coaxial feedline as well as the supporting mast. Unlike the ground-mounted case, the length of above ground radials is important, and the proper length(s) for any band may be found from the formula:

Length (ft) = 240 / Frequency in Mhz.

Four such radials, equally spaced, would be the equivalent of a highly conductive ground plane for any band at the antenna base heights of one-half wavelength or more. In addition to providing a ground plane, radials of the proper length act as decoupling stubs to choke off current flow on any DC ground lead or grounded mast, thus eliminating the detuning effect noted above. Regardless of the specific system used radials should be well insulated at their far ends and kept well clear of large masses of metal or conductors that could cause detuning.

Other Mounting Schemes.

The metal shells of camper trailers, vans, and mobile homes may also be used as ground systems for vertical antennas. Whenever possible, the antenna should be mounted with the base close to the top of the roof, and the shortest possible ground lead should be used. Even so, tuned radials may be required for low SWR on one or more bands.

A MODERN THERMOCOUPLE AMMETER.

Thermocouple ammeters are rare these days, but a job they are perfect for is measuring antenna currents. Still a modern requirement especially in respect to ground plane currents.

Ground systems, the famous QRP phrase ‘Less is More’ is unfortunately not true. However, by optimising a small ground plane system more of your power gets radiated. The thermocouple ammeter is useful for measuring antenna currents and finding resonance in antenna systems.

I made one for measuring the ground currents in my ground plane for a short vertical I have been working on. It has proved an invaluable aid in creating an effective system. Basically this piece of test equipment allows relative measurements of current running in the ground wire system.

Two crocodile leads make the coupling transformer. They are taped together to make parallel lines, they are then coiled about 3”dia, and taped together.

During a test of a ground wire, one lead is inserted into the ground wire, in series, and the other with a small diode (e.g. 1N4001, 1N914) inserted in one lead, is connected to a digital multimeter, or small meter. The transmitter is operated and a reading taken on the meter, adjusting the power to get a reading which is within the range of the meter. The ground lead is then altered in length and the reading recorded. The highest

reading on the meter indicates the highest currents in the ground wires, and therefore the higher effectiveness of the ground system.
It as been found that ground radials of 1/8th electrical wavelength produce the highest readings.

Research shows this. (John Stanley, K4ERO/HC1 and Roger Hostenback, W5EGS in QST 1976
Information from sprat No104. Article by David Reid PA3HBB/G0BZF.

I have made up a thermocouple and made some test with good results,
G8CKK/M0BUV.

THE Q MULTIPLIER.

The Q multiplier when used with a communications receiver provides both additional selectivity and signal rejection. Because the peak or null effect of the Q multiplier may be tuned across the receiver's IF band pass, its operation is more flexible than that of a fixed frequency IF filter. The Q multiplier may be used with a receiver which already has a filter to obtain two simultaneous functions. For example, the receiver's filter could be set to peak the desired signal and the Q multiplier used to null an adjacent signal.
When properly connected and adjusted, the Q multiplier will not decrease receiver sensitivity, and may even increase it. In the peak function , an audible gain will be noted on cw signals; on phone signals a carrier gain will be noted on the S meter. However, the audio will be attenuated slightly due to the narrowing of the side bands. The reduced side band reception will tend to attenuate the higher audio frequencies. This is more than compensated for by the increased readability against the surrounding QRM.
The Q multiplier functions as a very high Q circuit. For peaking a desired signal, the circuit is coupled in parallel with the input IF transformer of the receiver; for nulling an unwanted signal, it is coupled in series with the IF transformer.
Any high Q circuit tends to have a very sharp point of resonance. This is true for both parallel and series tuned circuits. At resonance, the parallel tuned circuit has high impedance, while the series tuned circuit has low impedance.
As the Q of a tuned circuit is increased, the side slope of the resonant peak or dip becomes steeper. As stated above, a parallel circuit has a very high impedance at resonance while a series circuit has a very low impedance. Consequently, when circuits of this type are connected in shunt across the receiver IF circuit, the following action takes place. As a parallel circuit, any signal passing through the IF at the resonant frequency of the Q multiplier sees a very high shunt impedance and is not attenuated; signals slightly off the resonant frequency fall along the slope or "skirt" low impedance, are shunted to earth. By means of the variable capacitor in the Q

multiplier, this peak can be tuned to any place in the IF band pass to peak one signal and attenuate all others.
In the null position, any signal passing at the series resonant frequency of the Q multiplier sees a very low impedance to earth and is, in effect, rejected at this point. The series resonance can also be moved across the IF band pass, consequently a heterodyne adjacent to the desired signal can be dropped into the notch and eliminated.

.S – UNITS.

One S – unit is a change of 6dB in signal strength, which corresponds to double the VOLTAGE or four times the POWER at the receiver input.

S – METER – VOLTS – POWER –CHART.

S – METER.	VOLTS.	POWER.
S9 + 20dB	500 uV	= - 53dBm
S9 + 6dB	100 uV	= - 67
S9	50uV	= - 73
S8	25uV	= - 79
S7	12.5uV	= - 85
S6	6.2uV	= - 91
S5	3.1uV	= - 97
S4	1.6uV	= - 103
S3	.77uV	= - 109
S2	.39uV	= - 115
S1	.19uV	= - 121

An S – METER is calibrated by connecting a signal generator to the antenna terminal and setting the output power to 50uV, or – 73dBm, and adjusting the S – meter calibration pot for a reading of S9.
Since the S – meter is usually derived from the receiver AGC line, it is relatively linear from about S3 – S4 and upwards (since a good AGC usually “kicks in” around – 100 to – 105dBm). This linearity is also due to the diodes used for the AGC detector, once they are conducting in the linear region (again, around S3 – S4). Statements that “S – meters are totally worthless” or a change in 2 S – units means nothing are actually quite incorrect. An S – meter is a fairly good RELATIVE power indicator for received signal and noise levels.

SO WHAT IS AN S - METER GOOD FOR ?

The purpose of the S-meter is not to provide absolute indication of power or voltage, but a RELATIVE indication between received signal strengths, such as between two different signals, or between a signal and the "noise floor" of the band.

Example: On 40M, "noise" S4, or about –103dBm. If your receiver has an MDS (minimum detectable signal) of –133dBm, it means you're loosing 30dB of your dynamic range to the noise! (133-103=30dB). In this case, the S-meter is giving more-or-less absolute power DIFFERENCE between it's MDS and the noise floor, in dB.

Example: A station claims his beam antenna has 12dB gain over his dipole. So switches between the two and asks for a comparison. His signal goes from S7 to S8 a 6dB change. That is not 12dB! 12dB should have shown 3 S-units of change.

An S-meter makes it convenient to make internal adjustments to your receiver, such as peaking any IF cans, filters, etc. You can tune a carrier or QSO in the S8 range, then tune above and below and mark the frequency where the S-meter drops 1 S-unit (6dB), 2 S-units (12dB), etc. to make a rough graph of your overall selectivity/filtering of your receiver. If the RF amplifier provides 12dB of gain, you should clearly see about 2 S-units change. So an S-meter makes it quite easy to verify some of the specs and claims.

WHAT ABOUT THIS QRO vs QRP THING?

You have to QUADRUPLE (X4) your signal to DOUBLE your signal strength at the receiver end.
Likewise, if you drop your power by one-fourth, your received signal strength will be one-half less, or 1 s-unit. You are working a station running 100W, and he is S-8. If he drops his power to 1/4th, or 24W, his signal should drop about 1 S-unit, or to S7. If he drops another 1/4th, to about 6W, he should drop another S-unit, or to S6.
Therefore the difference between 100W and 5W QRP is about 2 S-units. Dropping to 1W about another S-unit, to 250mW another S-unit, etc. OK, now your getting down into the S4 noise level on 40M. Now you're hoping the guy on the other end has only a S3 noise level on is end.
(Sprat 110. Paul Harden. NA5N).