



INTRODUCTION

An antenna similar in design to the Army Loop, developed by KH Patterson at the US Army Limited War Laboratory in the 1960's, is a very attractive proposition to many radio amateurs with limited space or other restrictions. The catch being that this type of antenna requires special care to achieve results comparable to those achieved by Patterson's design. However, it is still possible to obtain good results if some precautions are taken.

My "QRP LOOP TUNER 80-20m - G8ODE iss 1.32" is based on the Patterson Army Loop's matching unit design. In operation it worked reasonably well based on the 40m contacts I made using 5 watts, so it seemed natural to scale up the design to handle 100 watts for a 40M "Safari" mag loop made from either;

i). Thick heavy duty insulated 15mm wide tinned copper braid.

ii). A 3m length of waveguide 22mm approx. diam,

and compare the two loop's characteristics using a computerised SWR-Analyser.



High Power Mag Loop Tuner, Avair 20 SWR meter, Yaesu FT817, external 12v battery box, FoxDelta SWR-Analyser, Acer One netbook

40M HIGH POWER MAG LOOP TUNER TEST SET UP

The photograph on the left shows the mag loop's set up using heavy-duty insulated copper braid in the "Safari" location (aka in my back garden). The "Army Loop" tuner is at the bottom of the loop, with the Yaesu FT817 and external battery pack next to it. I often use the FT817 for testing my antennas because I can do this safely without having to use 230v mains power in the garden. The Acer One Windows net book is connected via a USB cable to the blue sided SWR-Analyser (SWR_A) that is on top of the white 12volt rechargeable battery box I designed. This enables me to operate at 5watts.

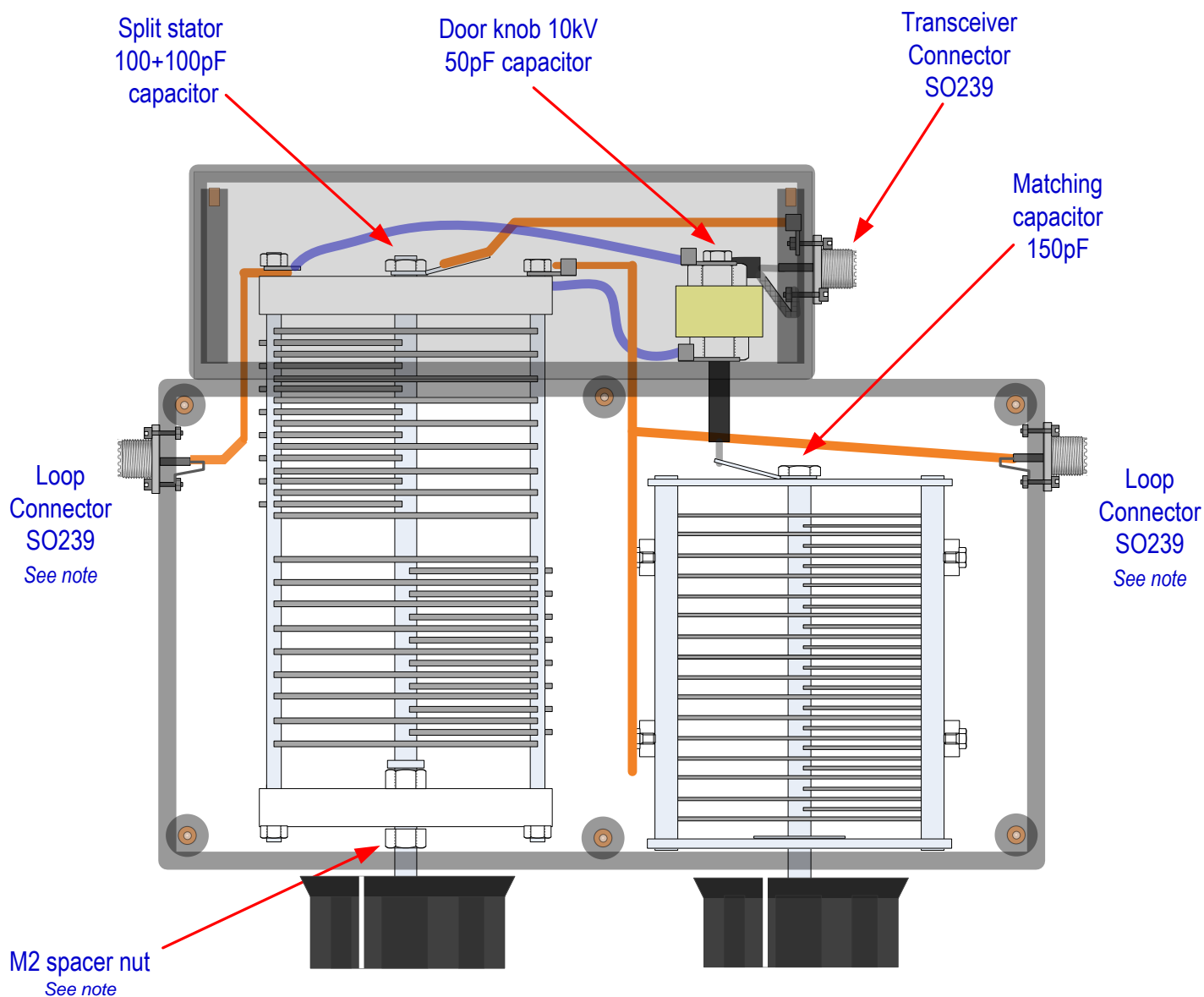
To measure the loop's SWR across the 40m band, it is tuned using the SWR-A signal generator & SWR bar graph function. The tuner's left hand control brings the loop into resonance and the right hand control is adjusted for minimum SWR. There is some interaction between the two controls, so some adjustments are necessary to obtain the lowest SWR reading.

The SWR-A's "One Shot" is selected to sweep across the whole of the 40m band and plot the results in the graph area on the net book screen. The results can be seen further on in this article. Details of the "Army Loop" 40m Tuner are shown on the next page.



Plan View

NOTE:- The plastic boxes are shown semi-transparent to show the internal wiring interconnections

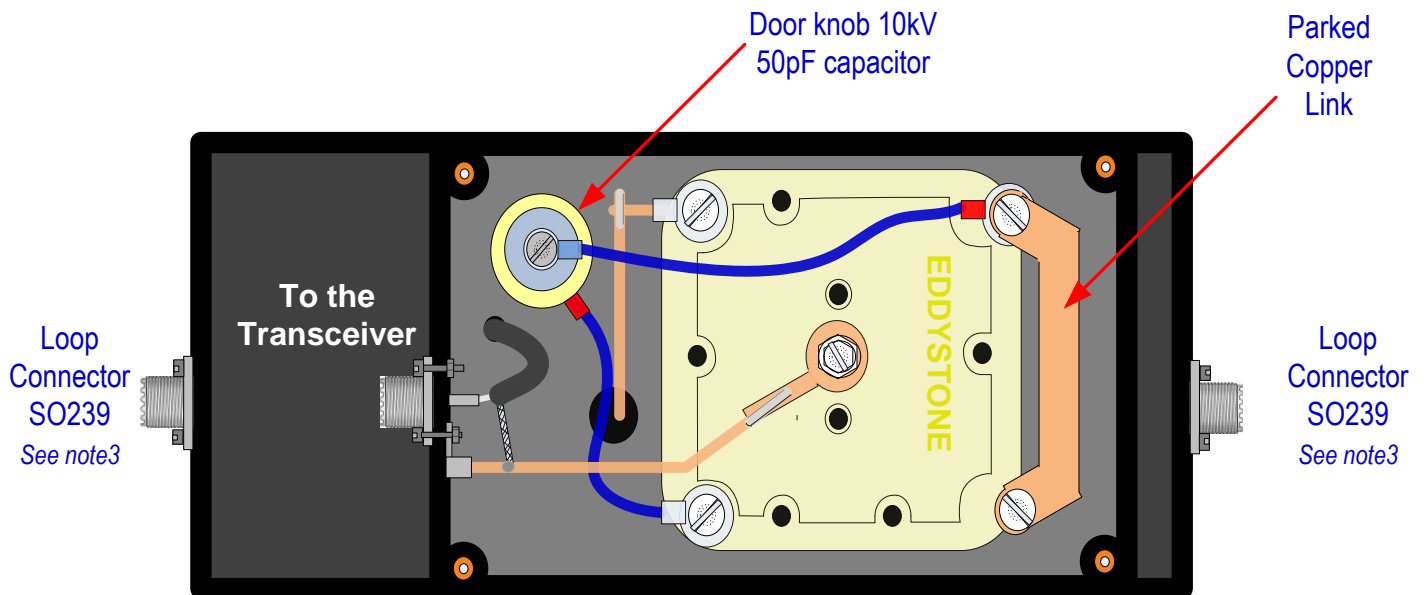


Construction Notes:-

1. Two ABS plastic cases are bolted together to accommodate the longer 100+100pF split stator Loop tuning capacitor.
2. The second 150pF capacitor is the impedance matching capacitor 150pF.
3. The SO239 (chassis mount type) connectors each side of the larger box have the inner shorted to the outer.
4. A 50pF 10kV door knob capacitor is connected across the tuning capacitor. This increase the overall capacitance and enables 3m or 4m loops to be tuned on the 40m band.
5. An M2 nut acts as a spacer to compensate for the ABS boxes taper to keep the capacitor horizontal.



Rear View



Construction Notes :-

6. The diagram shows the cross connections in the rear ABS plastic case.
7. The "C" shaped copper link is in the unused position - originally used to parallel both sides of the split stator capacitor to make it into a variable 15 - 200pf capacitor.
8. All solid wire links are 2.5mm hard drawn copper.
9. The Flexible blue links are 2.5mm flex.
10. Heavy duty solder tags are used to connect the link to the capacitors screws.

Important:

1. This 100 watts version will have voltages in excess of 2000v across the ends of the loop. The tuning capacitor requires wide-spaced plates (approx. 2.5mm), similarly the matching capacitor is a "transmitter" type.

2. The loop operating at these power levels has intense radiation fields close to the mag loop antenna. Please refer to Guidelines for Human Exposure to Electro Magnetic radiation in your country where you intend to operate.

Constructors copying this design do so at their own risk.

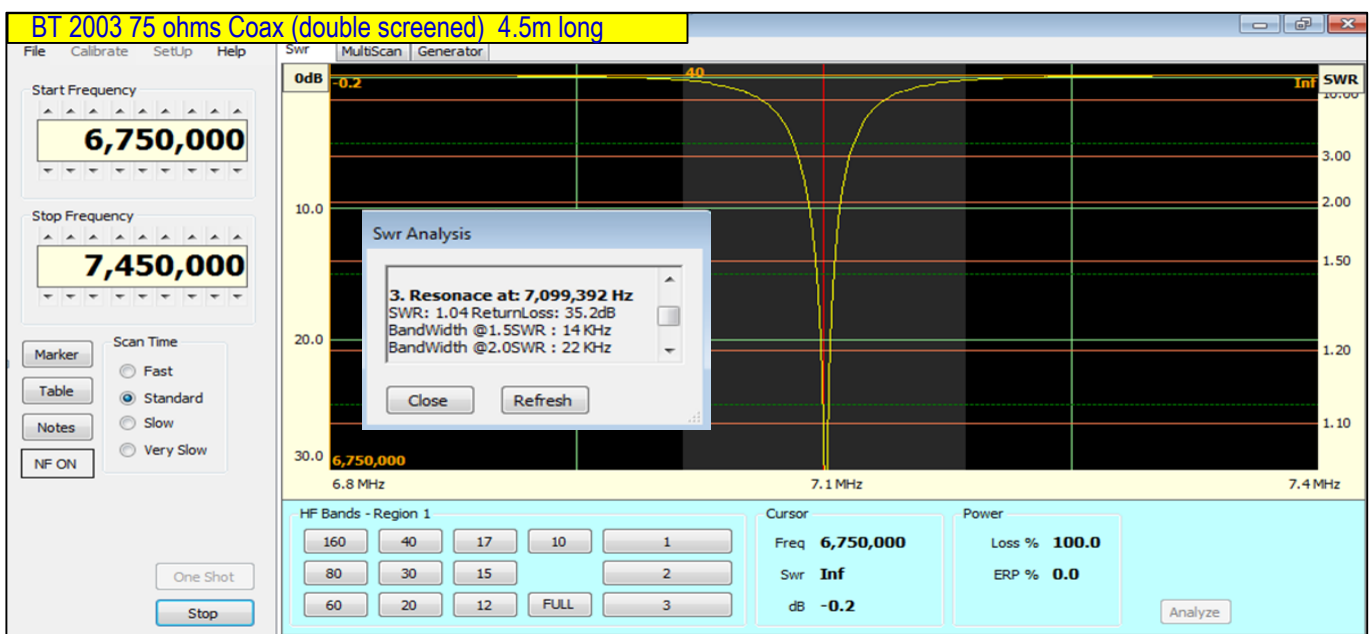
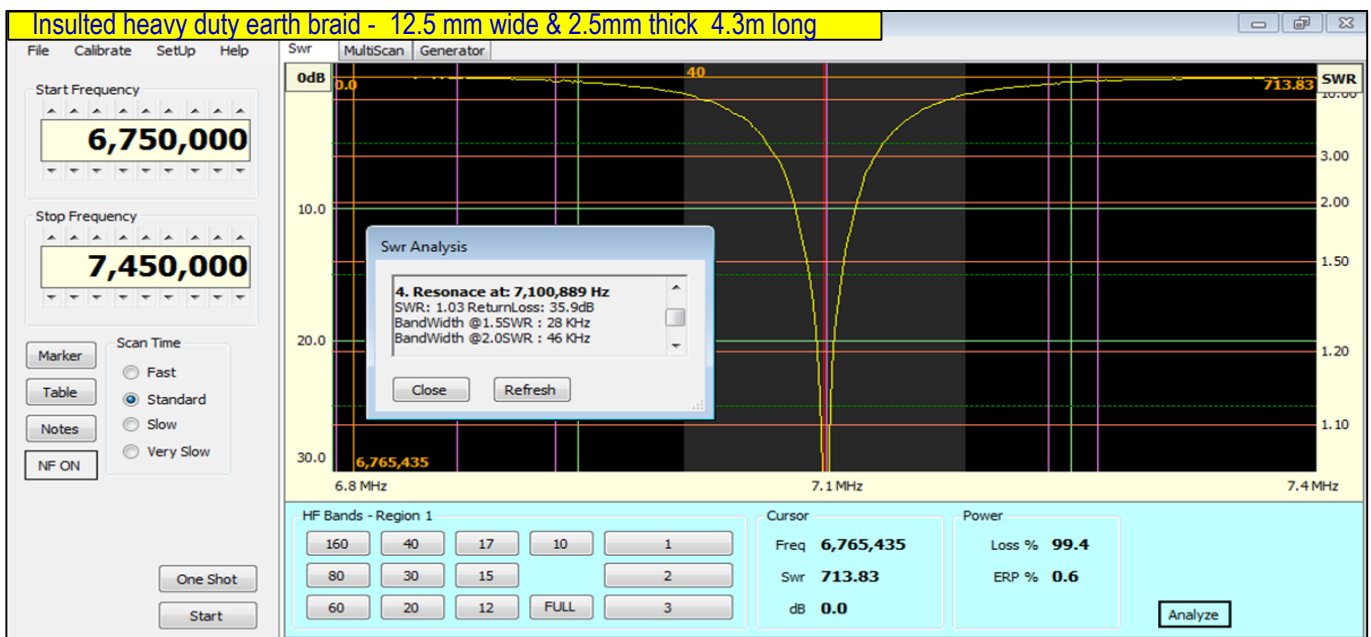


LOOP COMPARISON MEASUREMENTS

The following two screenshots were obtained from a PC based SWR-Analyser that I was beta testing.

The heavy-duty earth braid and the BT type coax were recovered from a computer room during a refurbishment. The idea was to use these for a “Safari” mag loop using this 40m “Army Loop” tuner as all the items can easily be packed away for travelling. The second choice was the BT type 2003 75 ohms coax used in PCM transmission systems to deliver 2MB services. Both loops were supported from a horizontal pole at 2m above the ground.

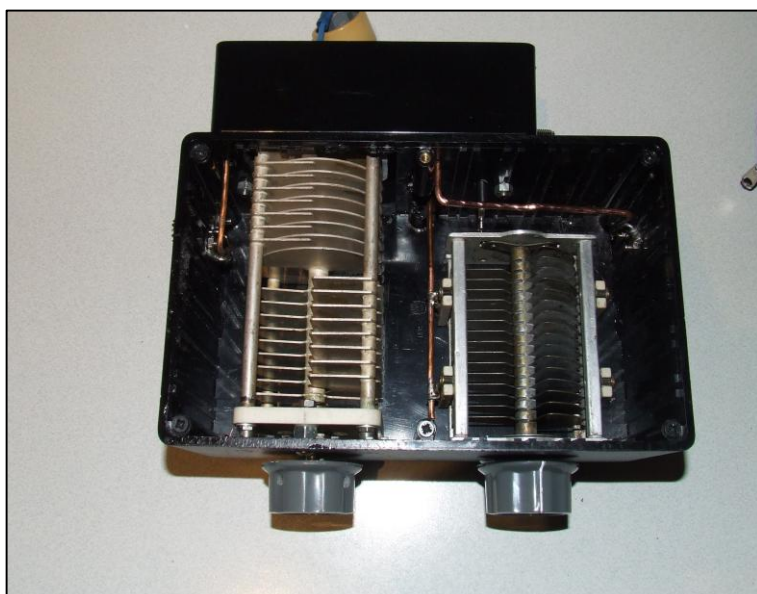
(See photo on the first page)



Rather surprisingly the thinner BT2003 coax has a narrower bandwidth than the heavy duty earth braid, suggesting that there are fewer resistive losses as the Q of the tuned loop is larger



Measured Performance & Conclusions



This design was successful in that it easily operates at the 100-watt level. On the 40m band an SWR of 1:1 was easily achieved.

QSO's on 40m, using an indoor antenna positioned some 12 feet away from the transceiver, were made to Manchester and Doncaster in the northern part of England. With a further QSO was to Belgium some 15km from Antwerp International Airport.

Perhaps less satisfactory was the fact that the loop's output is not a balanced feed and the S/N ratio is higher than for my 40m OCFD dipole.

Attempts to use the tuner on higher bands were less successful. With the doorknob 50pF capacitor disconnected (just visible in the bottom photo), the loop could be tuned to 20m & 17m with some difficulty, because only the slightest movement on the left hand tuning control changed the SWR reading considerably. With practice, the loop could be tuned on 20m more easily than on 17m with the right hand matching capacitor set to minimum capacitance.

An attempt to tune a 3m length of 22mm waveguide proved fruitless on 20m, but it was possible to tune it on 30m. The bandwidth @ SWR 1.5:1 (14KHz) and @ SWR 2.0:1 (24KHz).

However, the tuning was very sensitive to minor movements of the two controls.

CONCLUSIONS:-

This version of the "Army Loop's" tuner appears to work best on the lower bands. KH Patterson, in a letter to QST Technical Correspondence May 1968, states he would not recommend a single individual loop for use over more than a 2 to 1 frequency range. Therefore, the expectation that the tuner would operate over 40-17m was perhaps not such a good idea.

The "Army Loop" tuner does not have a balanced output and is thus susceptible to noise pickup on the feeder. Temporarily converting the mag loop to a Faraday fed coupling and by just using the split stator capacitor to resonate the loop produced an improved S/N ratio with clearer sounding and stronger signals on receive.

The tuner, with loops of 4.3m to 4.5m in circumference works satisfactorily, was easy to deploy at relatively low height and did not require a good ground or counterpoise to operate. The narrow bandwidth may prove useful in noisy locations.

However, the costs of the new ABS boxes, and high voltage tuning capacitors perhaps outweigh the benefit of the performance limited to 2-3 bands (40-30-20m).



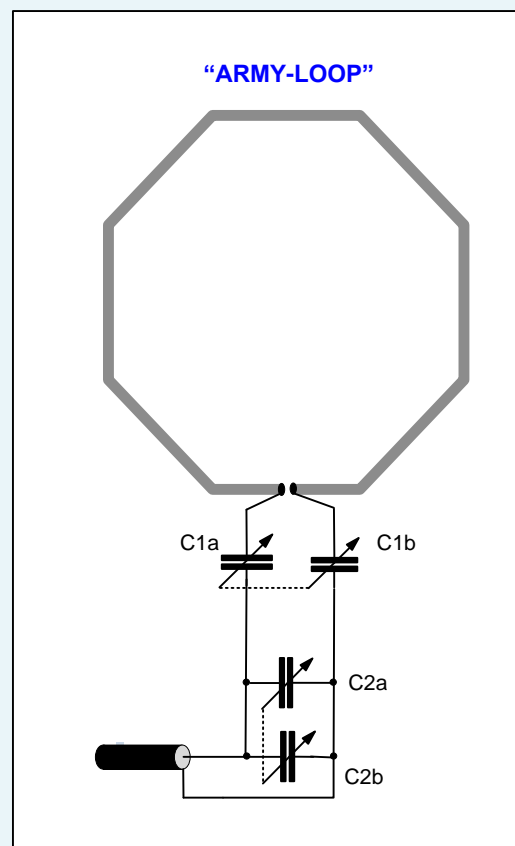
Background to the US Army Loop

The antenna was designed by Kenneth H Patterson, working for the Dept of the Army, US Army Limited War Laboratory, Aberdeen Proving Ground Maryland 21105, and first described in "Electronics" Aug 21 1967. The magnetic loop antenna was developed for South East Asia to boost MF & HF signals covering the 2-5MHz range to work out of narrow valleys and dense forests. Its was designed to be compact, just 12 ft wide, , easy to assemble or dismantle and pack away in a small space.

The diagram on the right shows the basic design of the "US Army Loop".

Since magnetic loop antennas are physically smaller than a quarter-wave, they also exhibit a smaller radiation resistance. The resistive losses in the radiating conductor were minimised by using large diameter aluminium tubing with gold plated ends and special clamps to ensure good "skin" contact at the joints. Using capacitors for impedance matching avoided further copper losses associated with inductors. The octagonal loop antenna was constructed with 5 ft sides made from 1.75 inch diameter aluminium tube. The gold plating kept the overall resistive losses to < 0.1 ohms and ensured that the loop's efficiency was high and comparable to a full-sized dipole at 40-60ft above ground.

The Army loop's basic tuning and matching circuitry employed two high voltage twin gang 468pF variable air-spaced capacitors as shown in the simplified diagram. To cover the whole of the 2-5MHz frequency range, an extra 450pF was switched across both C1a and C1b for coarse tuning. For improved fine tuning, capacitors C2a and C2b were provided with a 12-way switch to select one of twelve high grade mica capacitors (750 pF - 8250 pF) for additional impedance matching.



US ARMY LOOP references.

1. ARRL QST March p17-18 & 150 "Lewis G. McCoy, W1ICP "The Army Loop in Ham Communications"
2. ARRL QST May 1968 p49-51 "The Army Loop" where KH Patterson replies"
3. RSGB Antenna Topics P19-20 "US Army Loop, Nov 1967 Pat Hawker G3VA"
4. Very small transmitting and receiving only antennas chap. 5 "HF Antenna Collection" – Erwin David ,G4LQI

Theory References :- For a detailed explanation of the small mag loop theory and matching

5. <http://vaedrah.angelfire.com/antenna.htm> © Ian R Scott 2007 – 2008
6. Very small transmitting and receiving only antennas chap. 5 "HF Antenna Collection" – Erwin David ,G4LQI