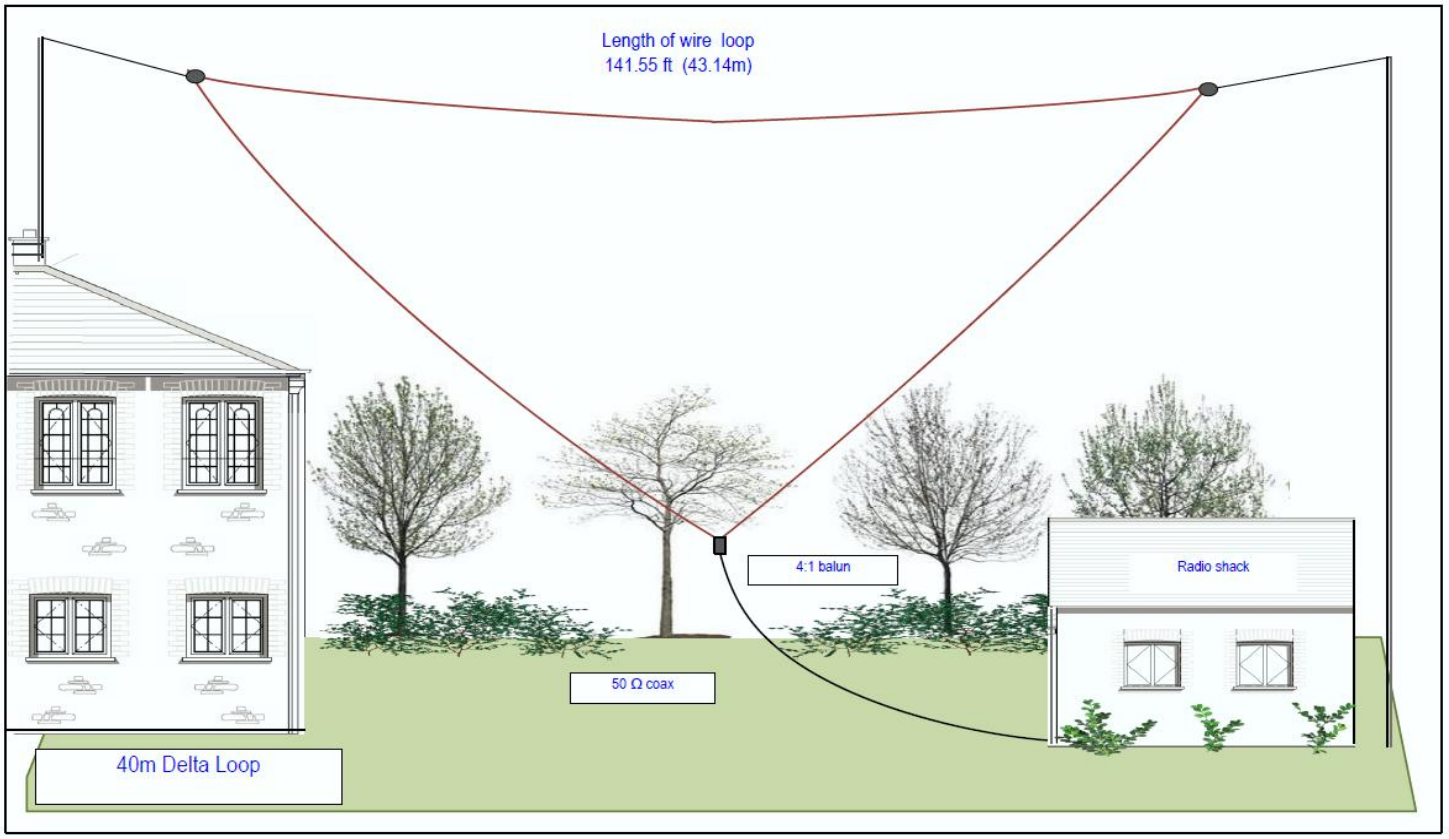
40m-10m DELTA LOOP ANTENNA - GU3WHN



This simple broad band antenna is easy to build, has gain similar to that of a dipole and is tolerant of nearby objects. It can be erected in almost any configuration provided the wires are well separated otherwise it acts as a singe band broadband dipole. I generally feed it in the centre at the bottom but a side can be used to give vertical polarisation, as in a 4 sided quad. The gain over a dipole is claimed to be about 2db.

The formula “1005 / Freq (MHz)” is used to calculate the size of this inverted Delta Loop using either, a 4:1 balun for a multi-band antenna, or a 75ohm quarter wave section from the feed point to the 50 ohm feeder for mono-band operation."

The bottom of an inverted delta loop makes it easier to support the fairly large 4:1 balun to match the nominal impedance of 90-112 ohms. The addition of the balun allows the antenna to be used on several HF bands.

Mike GU3WHN

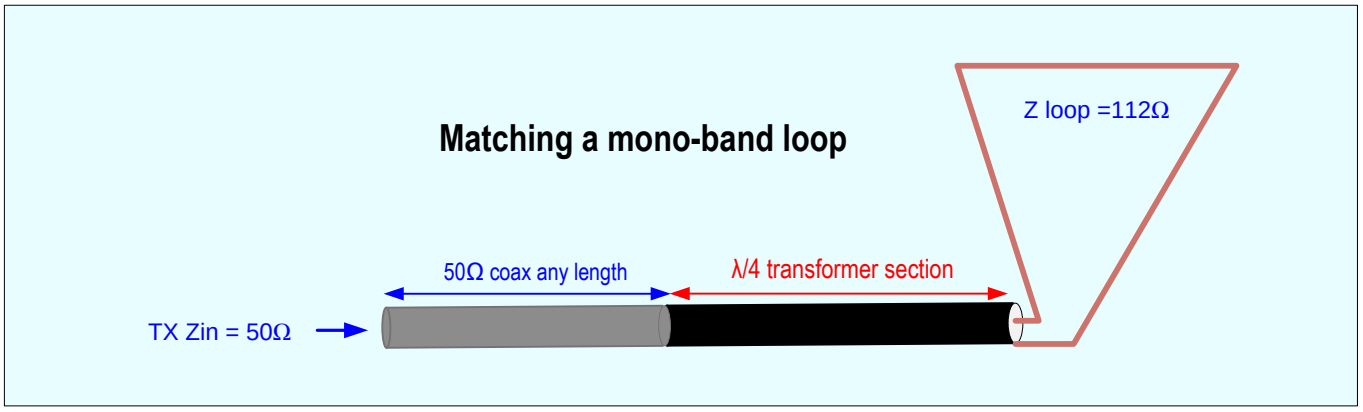
GU3WHN Delta Loop Installation Details

Wire	1.5mm PVC covered solid core electrical wire (100m drum)
Length	approx 141 feet (PVC alters the Velocity factor)
Balun	Commercial 4:1 rated at 4kw
Feeder	Random length RG8
Earth System	Domestic earth changed from PME to TT earth (Ground stake)
Shack(shed)	12 off 18" stainless steel rods bonded together and to equipment earth
Configuration	Inverted Delta loop Top approx 60ft (18m) at a height of 30ft(9m) and sides approx 40ft (13m)
Feedpoint	Via 4:1 balun at 10ft (3m) above ground

Proof reading by G3YEU

Graphics By G8ODE Apr 2008 iss 1.3

40m-10m DELTA LOOP ANTENNA - GU3WHN



The Full Wavelength Delta Loop .

As the loop's characteristic impedance is about 112 ohms, the transceiver is presented with an SWR of about 2:1 if no matching is included. For multi-band operation matching can be achieved using a 4:1 balun and a tuner in the radio shack. A mono-band version of the antenna can also be constructed by replacing the balun with a ¼ wave transformer section using 70 or 75 ohm coax, as shown in the diagram above to provide the matching to the 50 ohms impedance of the transceiver ..

Calculations:-

Assuming the Delta Loop's is to be used on 40m – the centre of the UK band is 7.100MHz

(1) Wire length (feet) = 1005 / Frequency(MHz)

$$\lambda \text{ loop} = \frac{1005}{7.10\ (MHz)} = 141.55\ ft\ (43.14m)\ (\text{for mid-band}$$

(2) Value of series section transformer coax

$$Zo\ (\text{of the } \tfrac{1}{4}\lambda \text{ section}) = \sqrt{Zin \times Zout} = \sqrt{50 \times 112} = 75\ ohms$$

75 ohm coax can be used for the series section transformer.

(3) Since we have already calculated the full wave l length, and know the VF of the coax to be 0.66 (RG213);

$$\text{Actual Transformer length} = \lambda/4 = \frac{(\lambda \text{ loop}) \times VF}{4} = \frac{141.55 \times 0.66}{4} = 23.36ft\ (7.12m)$$

N.B. To convert feet to metres multiply by 0.3048

By using a transmission line with a characteristic impedance of 75 Ohms, the 112 Ohm load is matched to 50 Ohms, and the transmitter's 50 Ohms impedance will deliver power to the antenna with no power being reflected back to the transmitter.

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40m-10m DELTA LOOP ANTENNA - GU3WHN

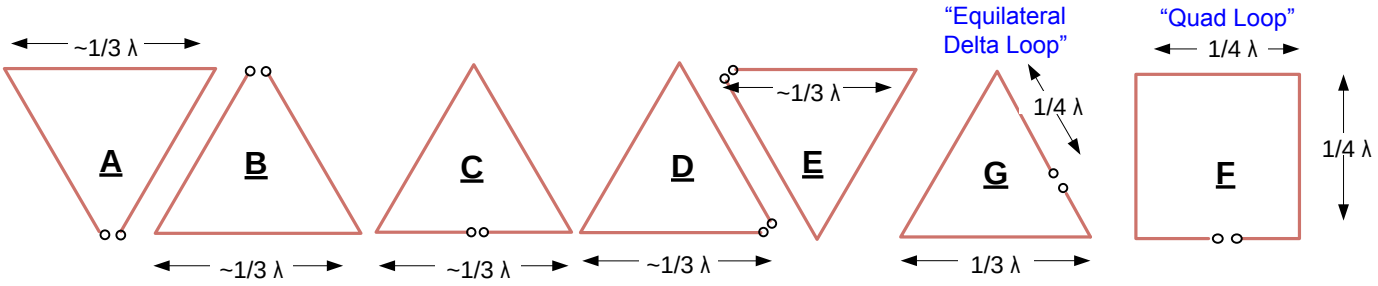
Full Wave Loops Peformance

The larger dimensions of the loop compared to the half-wave dipole increases the radiation efficiency.

The feedpoint impedance of a full-wave loop in free space is approximately 100-120 Ω with a gain over a dipole of 1.35 dB. However when installed close to ground the feedpoint impedance can vary from 50-240 Ω depending on configuration, orientation, and choice of feedpoint. Hence in practice some type of feedpoint matching system is required.

The loop can be arranged as square(quad) or diamond, equilateral triangle with apex up or down, feedpoint on the bottom, side and corner. Each variation changes the characteristics slightly regarding the impedance, gain, polarization, pattern, and from the DX point of view the take-off angles. The horizontal radiation pattern looks like a"figure-8" and is perpendicular to the plane of the loop.

The variety of one wave length loop shapes that can be deployed to suit the QTH .



Note:- *Loops A -E have sides approximately (~) 1/3 wavelength but overall circumference delta loop is the same as an equivalent quad on the same frequency, i.e. 1005 /F(MHz) feet or 306.31 /F(MHz) metres.*

Loop	Polarisation	Far Field Radiation Angle	degrees
A	Horizontal	Moderately High	47
B	Horizontal	High	80
C	Horizontal	High	80
D	Vertical	Low	27
E	Vertical	Low	20
F	Vertical	Low	27
G	Horizontal	High	80

Loops "B,C,G" are very good for short skip communications and loop "A" for the first skip of 400 miles (650kms). Another point to note is that if height is a restriction then the loops will work if the are sloping, but it is best to keep the bottom of loop at least 2m off the ground.

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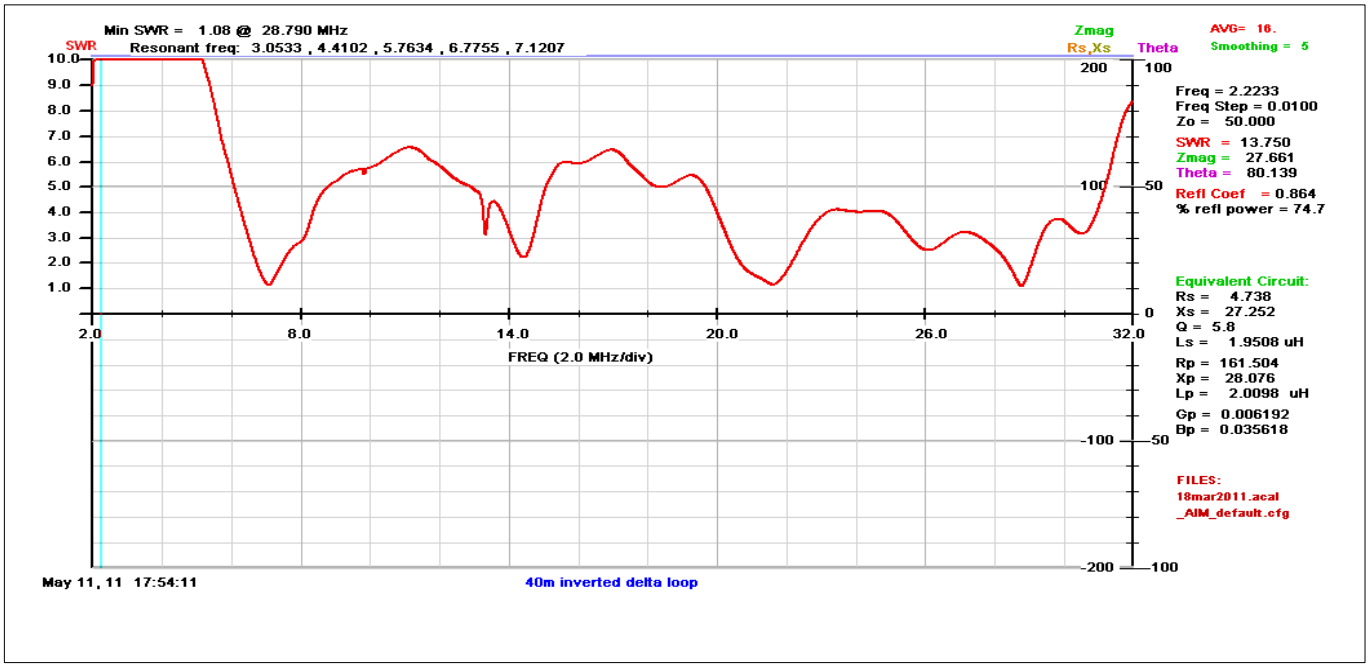
40m-10m DELTA LOOP ANTENNA - GU3WHN

AIM 4170C Antenna RF Analyser SWR plot for the GU3WHN 40m Loop



Interpreting the SWR Plot

At 7 MHz the full wave loop is resonant – and with the 4:1 balun produces a SWR of 1:1. The actual reading is 1.071 on side panel - since there is very little reactance - the load looks much like resistance Theta angle is small. Since the antenna is "matched " the return loss is zero or extremely small.

At 14MHz the loop is 2 wavelengths long and presents a high impedance. SWR is HIGH and the reactance is very high therefore theta is small. As the antenna is "no longer matched " the return loss is very high.

At 21 MHz the loop is now 3 wavelengths long and is matched again with a low SWR - as there is very little reactance the load looks like pure resistance and the theta angle is small. As the antenna is "matched " the return loss is zero or extremely small."

At 28 MHz the loop is four wavelengths long and the SWR is fairly low but there is a return loss because the impedance has increased.

About the AIM 4170C Antenna RF Analyser

It's packed with a host of features all in a small black box interfacing to a computer. As can be seen from the plot above and those on the succeeding pages the Aim4170 can provide readings for the SWR referenced to any impedance, return loss, reflection coefficient, the resistance and reactance and phase angle of the antenna, and much more.

This is an essential piece of kit for anyone interested in building antennas

Proof reading by G3YEU

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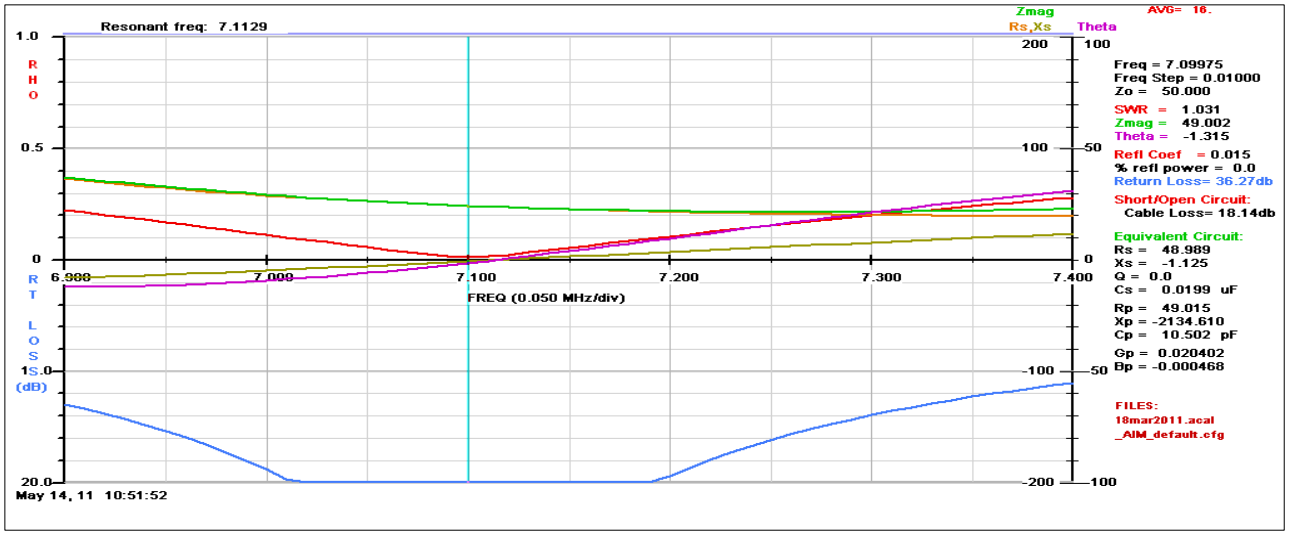
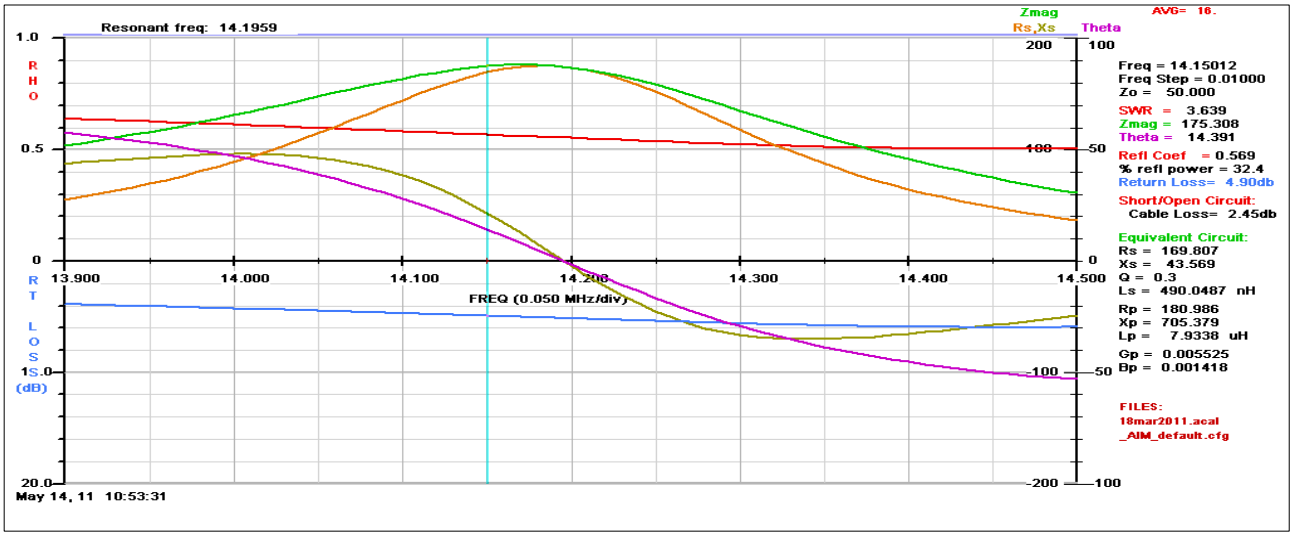
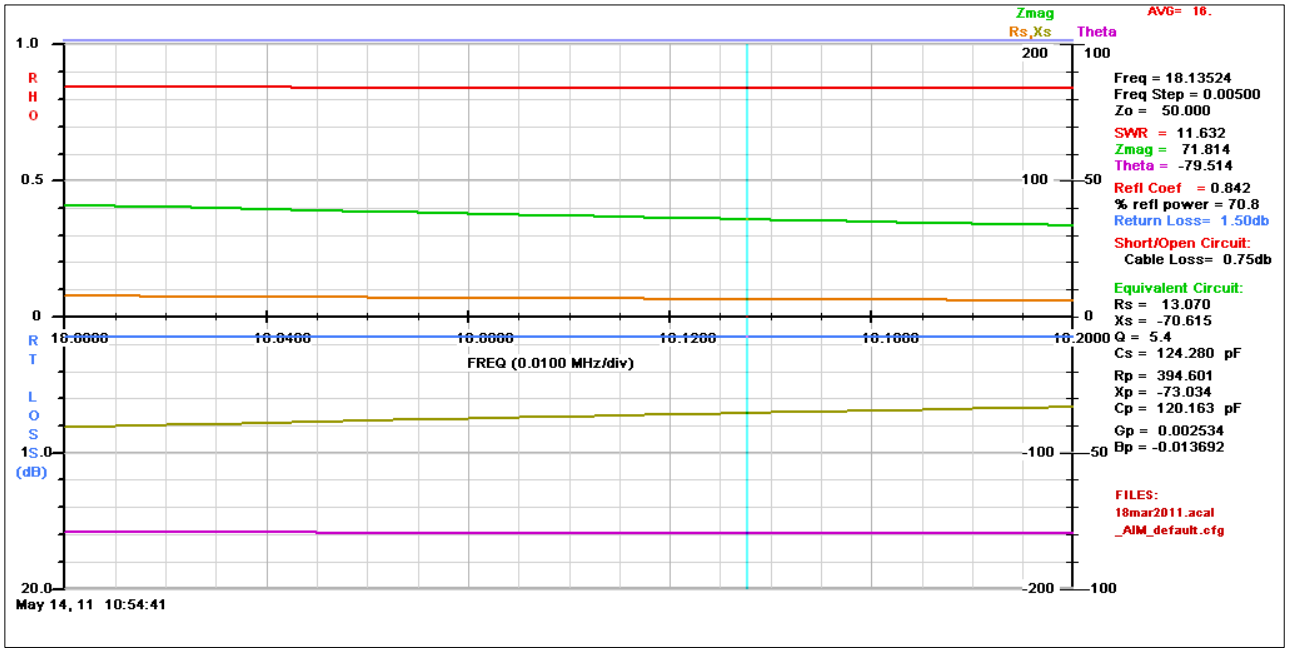
40m-10m DELTA LOOP ANTENNA - GU3WHN

AIM 4170C Antenna RF Analyser results for the GU3WHN 40m Loop





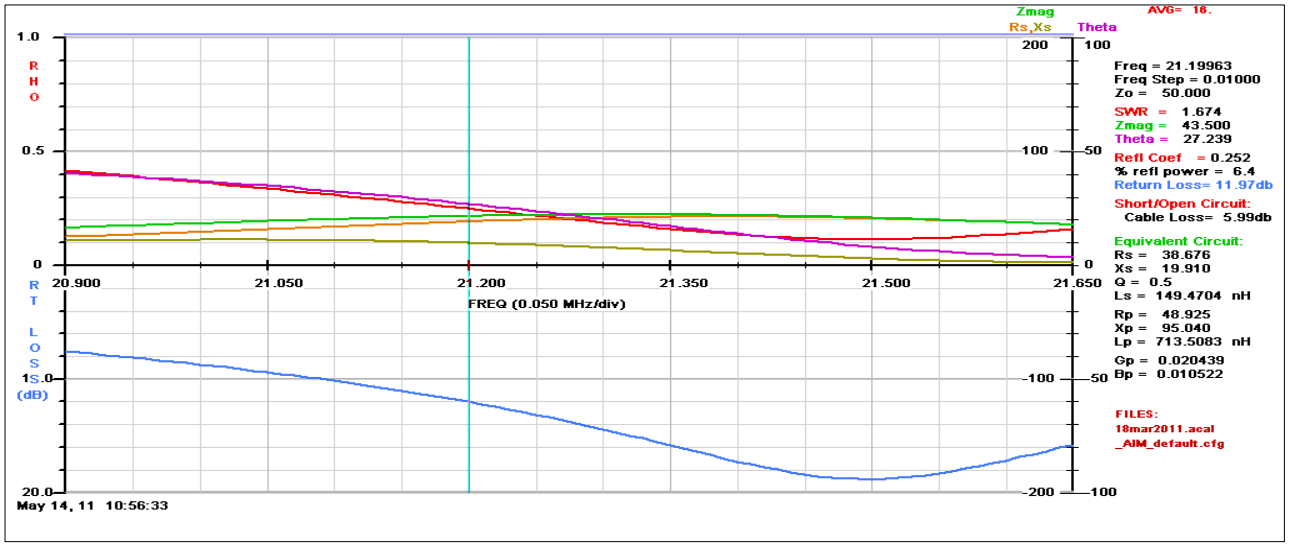


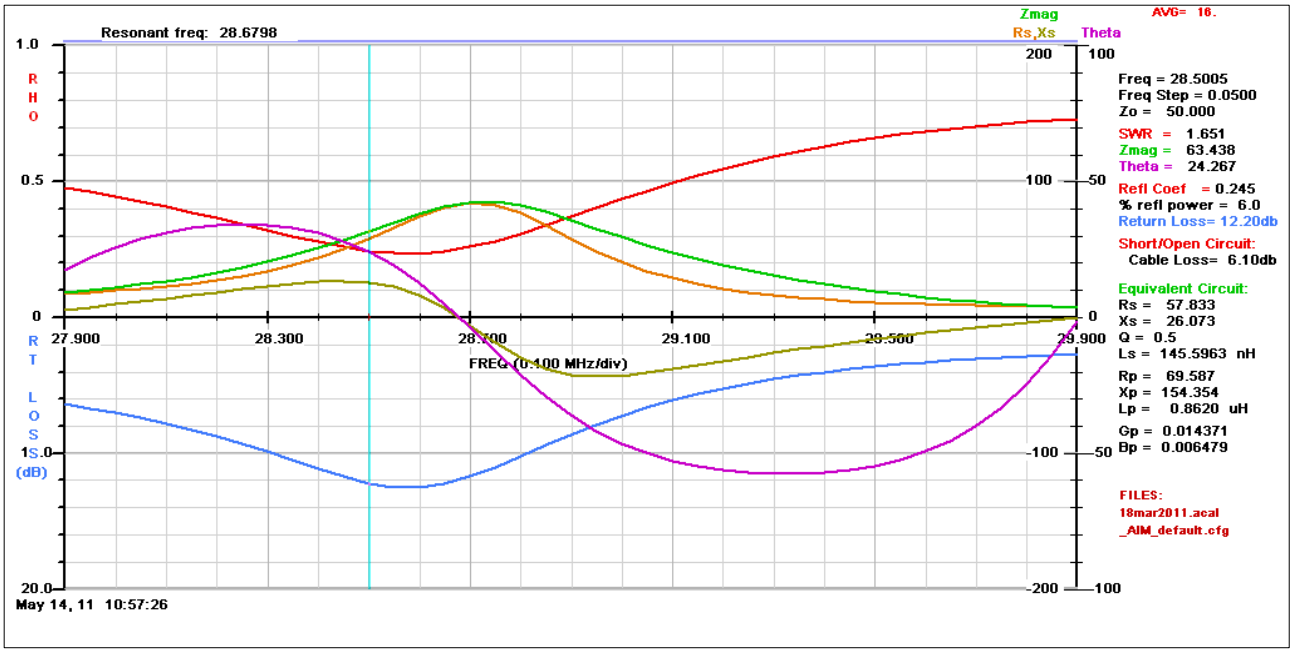
Proof reading by G3YEU

Graphics By G8ODE Apr 2008 iss 1.3

40m-10m DELTA LOOP ANTENNA - GU3WHN

AIM 4170C Antenna RF Analyser results for the GU3WHN 40m Loop

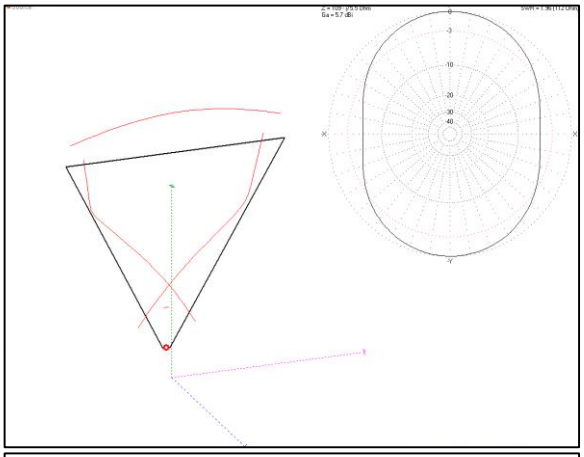


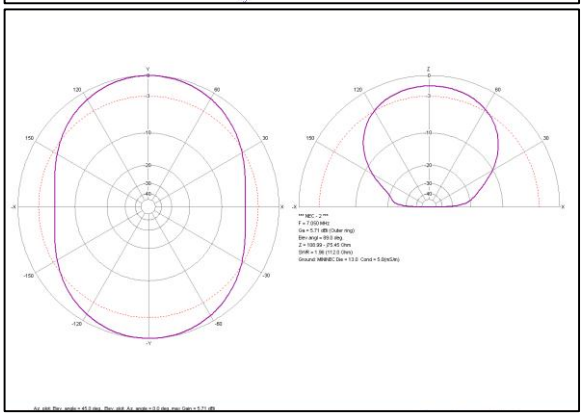


The following pages have a GAL-ANA model of the GU3WHN inverted Delta Loop. The model was created assuming that the feedpoint impedance was 112 Ω, and that the bottom of the antenna with the balun was at a height of 2m above the ground. The NEC2 engine was used together with the Sommerfeld-Norton correction for the close proximity of real ground, the characteristics of which were modelled using average ground (13mS/m) with a soil conductivity of 13.

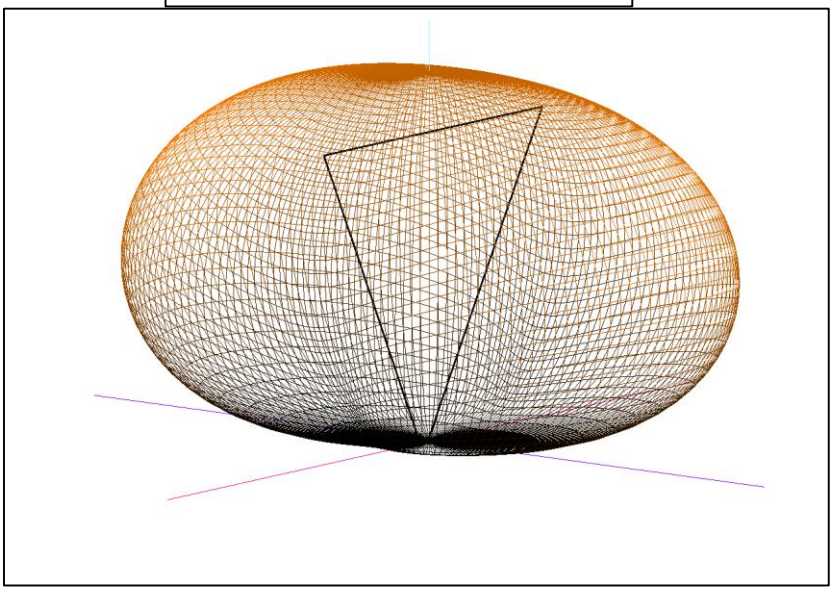
The results bear a fairly close relationship with the measured results that Mike G3WHN measured in his garden. The differences can be attributed to the simple model's inability to account for the local environment – trees and bushes and their effects in the near field of the antenna.

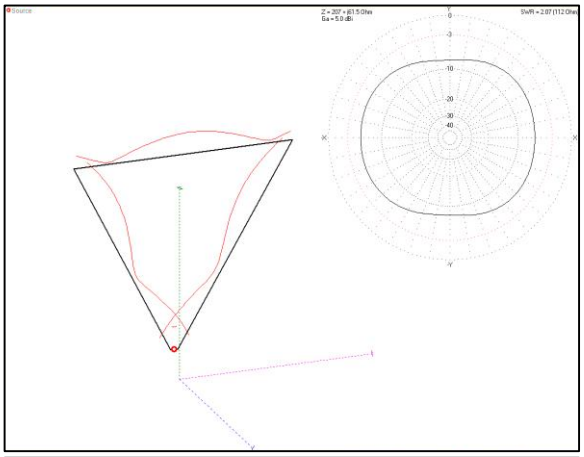
40m-10m DELTA LOOP ANTENNA - GU3WHN

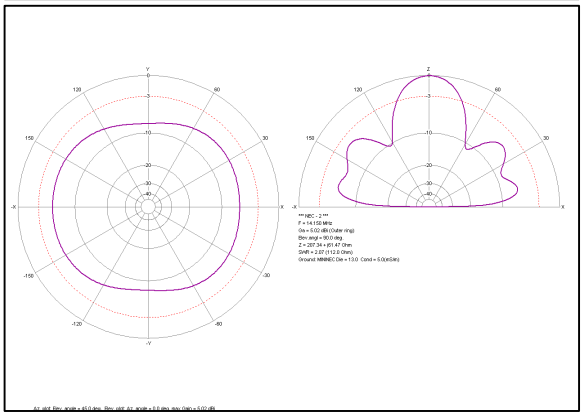




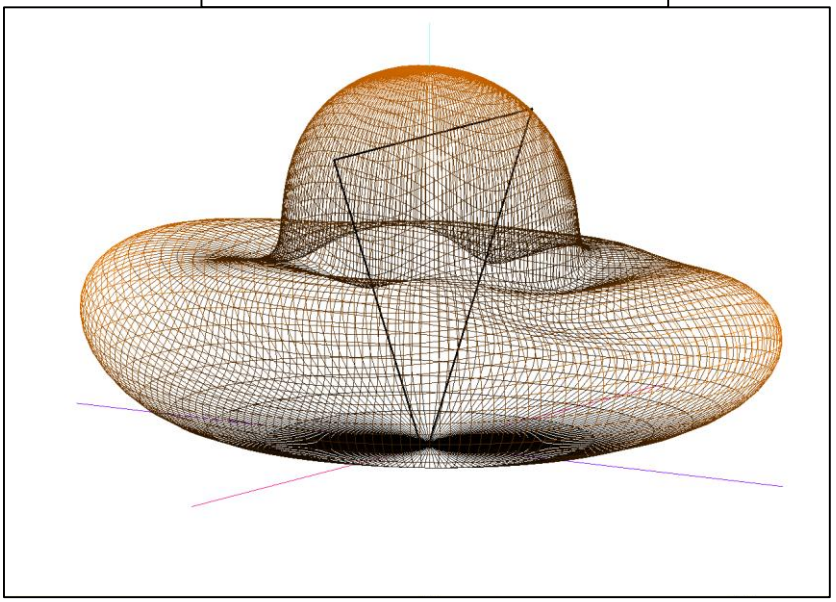
*** NEC - 2 ***
F = 7.050 MHz
Ga = 5.71 dBi (Outer ring)
Elev.angl = 89.0 deg.
Z = 108.99 - j75.45 Ohm
SWR = 1.96 (112.0 Ohm)
Ground: MININEC Die = 13.0 Cond = 5.0(mS/m)



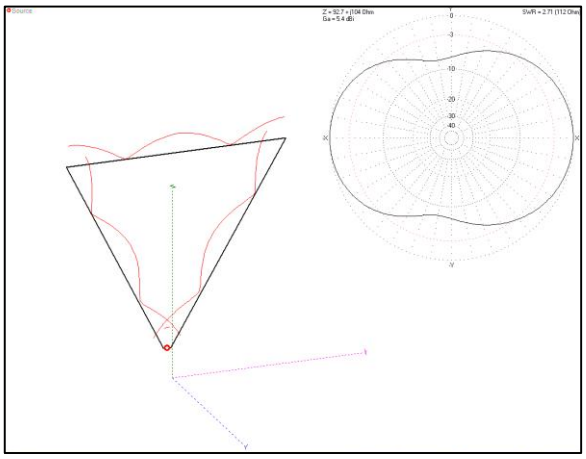


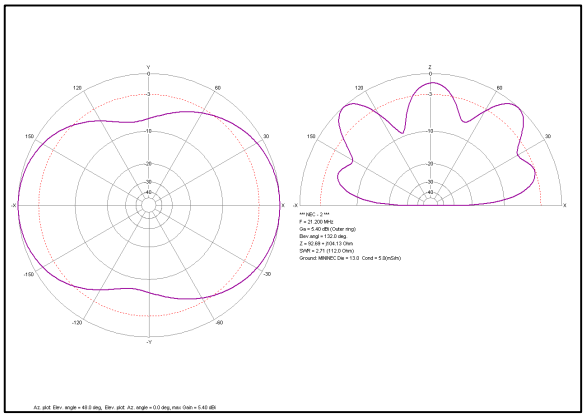


*** NEC - 2 ***
F = 14.150 MHz
Ga = 5.02 dBi (Outer ring)
Elev.angl = 90.0 deg.
Z = 207.34 + j61.47 Ohm
SWR = 2.07 (112.0 Ohm)
Ground: MININEC Die = 13.0 Cond = 5.0(mS/m)

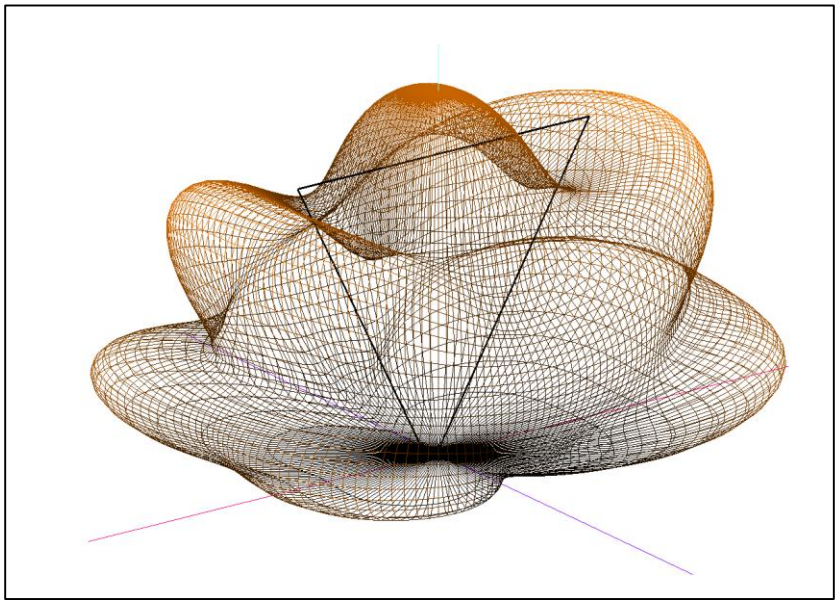


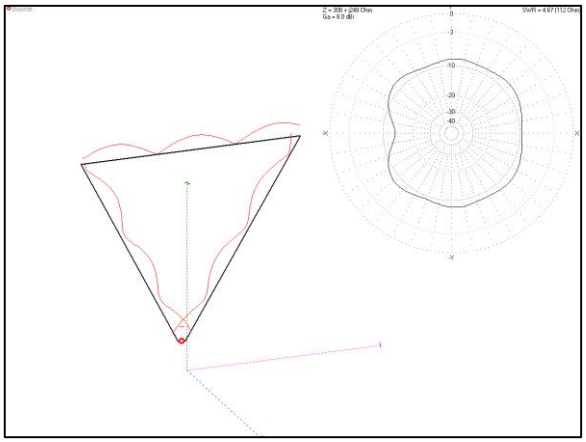
40m-10m DELTA LOOP ANTENNA - GU3WHN

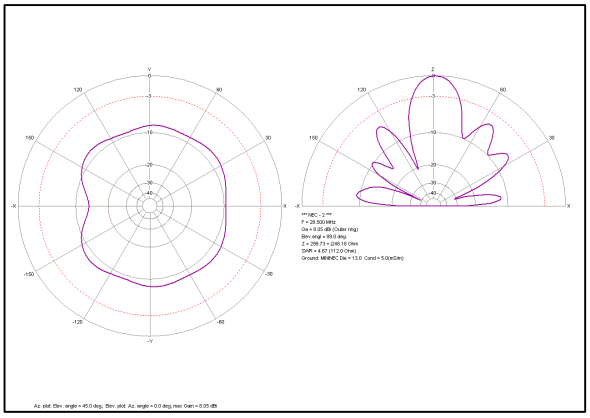




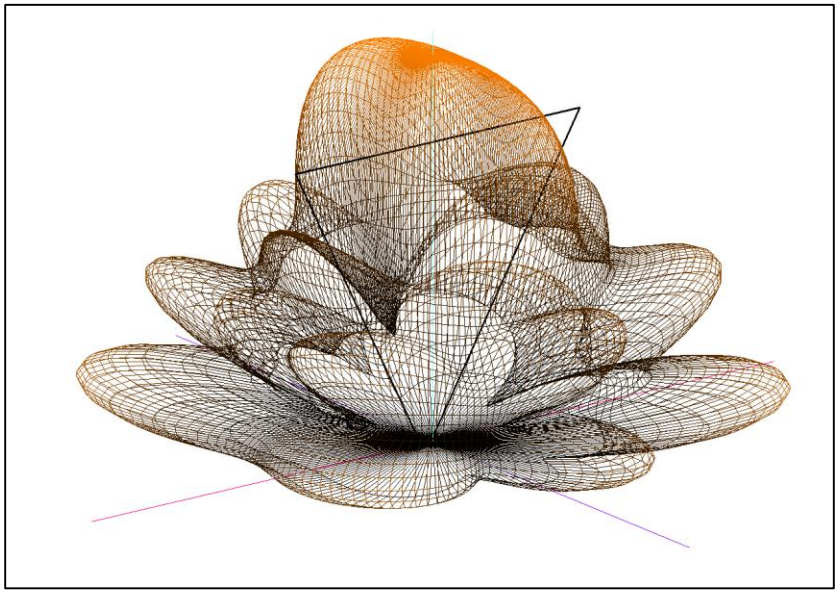
*** NEC - 2 ***
F = 21.200 MHz
Ga = 5.40 dBi (Outer ring)
Elev.angl = 132.0 deg.
Z = 92.69 + j104.13 Ohm
SWR = 2.71 (112.0 Ohm)
Ground: MININEC Die = 13.0 Cond = 5.0(mS/m)







*** NEC - 2 ***
F = 28.500 MHz
Ga = 8.05 dBi (Outer ring)
Elev.angl = 89.0 deg.
Z = 299.73 + j248.18 Ohm
SWR = 4.67 (112.0 Ohm)
Ground: MININEC Die = 13.0 Cond = 5.0(mS/m)



40m-10m DELTA LOOP ANTENNA - GU3WHN

Pictures of the inverted Delta Loop as installed in the Garden in sunny Guernsey. Note that the coax from the bottom of the balun is tied to the wooden garden structure to prevent the antenna swaying into the bushes during high winds.

Graphic by G8ODE May 2011 iss 1.0