NEC Model of WA6SVT Omni-Gain Vertical Collinear for VHF and UHF

Introduction

Mike Collis (WA6SVT) originally described this antenna in the August 1990 issue of "73" Amateur Radio Magazine, the article is reproduced at http://www.repeater-builder.com/antenna/wa6svt.html . This type of antenna is not new, it was described by Wheeler in 1954.

Collis makes the claim:

> *This rugged antenna, an omnidirectional collinear, is capable of surviving harsh environments. It's a good choice for repeater installations and can be top, or side mounted to the tower. You can obtain approximately 3 - 10 dB of gain over a dipole, depending on the number of elements you use.*

The antenna has become very popular with home constructors, though Collis does not attempt to describe its principles of operation. There have been several variants that make 'improvements' to the 'design'.

Whilst there are lots of articles on this, derivative and similar antennas, there is a dearth of objective evidence that they work as claimed.

This article deals only with the base antenna, developing an NEC-4 model to explore the antenna's operation and characteristics when dimensioned using Collis's formula. Results in NEC-2 may be a little different, its accuracy on short segments / fat wires is a little poorer.

Model

Collis provides a formula for calculation of a half wave length as 5904/f" where f is in MHz. For the purpose of this model, a quarter wave is calculated as 5904/440*0.0254/2m. This length must be corrected for velocity factor as given in Table 1. A design frequency of 440MHz has been used.

Table 1:

Element	Description	Electrical length (λ)	Velocity factor
1	top quarter wave whip	0.25	1.00
2	quarter wave coax	0.25	0.66
3	half wave coax	0.50	0.66
4	half wave coax	0.50	0.66
5	quarter wave coax	0.25	1.00
6	bottom quarter wave sleeve	0.25	1.00

Table 1 lists the elements of the model from top to bottom, and for clarity, the velocity factor applicable to each one from Collis's article.

4NEC2 and NEC-4.1 were used for modelling. The model uses a single GW element for the array, and segment numbers are calculated for connection of transmission line connections and source. The model uses 4NEC2 symbolic substitution.

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CM Model of WA6SVT Omni-Gain Vertical Collinear for VHF and UHF
CM Mike Collis WA6SVT
CM The original version of this article appeared in the August 1990 issue of "73"
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CM Amateur Radio Magazine.
CM http://www.repeater-builder.com/antenna/wa6svt.html
CM
CM 4NEC2 Model by Owen Duffy 20130914
CM
CM The model uses a single GW element for the array, and segment numbers are
CM calculated for connection of transmission line connections and source. The
CM model uses 4NEC2 symbolic substitution.
CE
SY org=0
SY vf=0.66
SY qw=5904/440*0.0254/2 'FS quarter wave per WA6SVT
SY zo=50
SY n=10 'Segments per quarter wave
GW 1 int(n*(3+5*vf)) 0 0 org 0 0 org+(3+5*vf)*qw 0.005
GE 0
GN -1
EK
EX 0 1 int(n*(2+0*vf)) 0 1 0 0
TL 1 int(n*(2+0*vf)) 1 int(n*(2+2*vf)) -zo 2*qw 0 0 0 0
TL 1 int(n*(2+2*vf)) 1 int(n*(2+4*vf)) -zo 2*qw 0 0 0 0
TL 1 int(n*(2+4*vf)) 1 int(n*(2+5*vf)) -zo 1*qw 0 0 1e9
FR 0 41 0 0 420 1
EN
```

The 4NEC2 model source is given above.

Analysis

Fig 1:

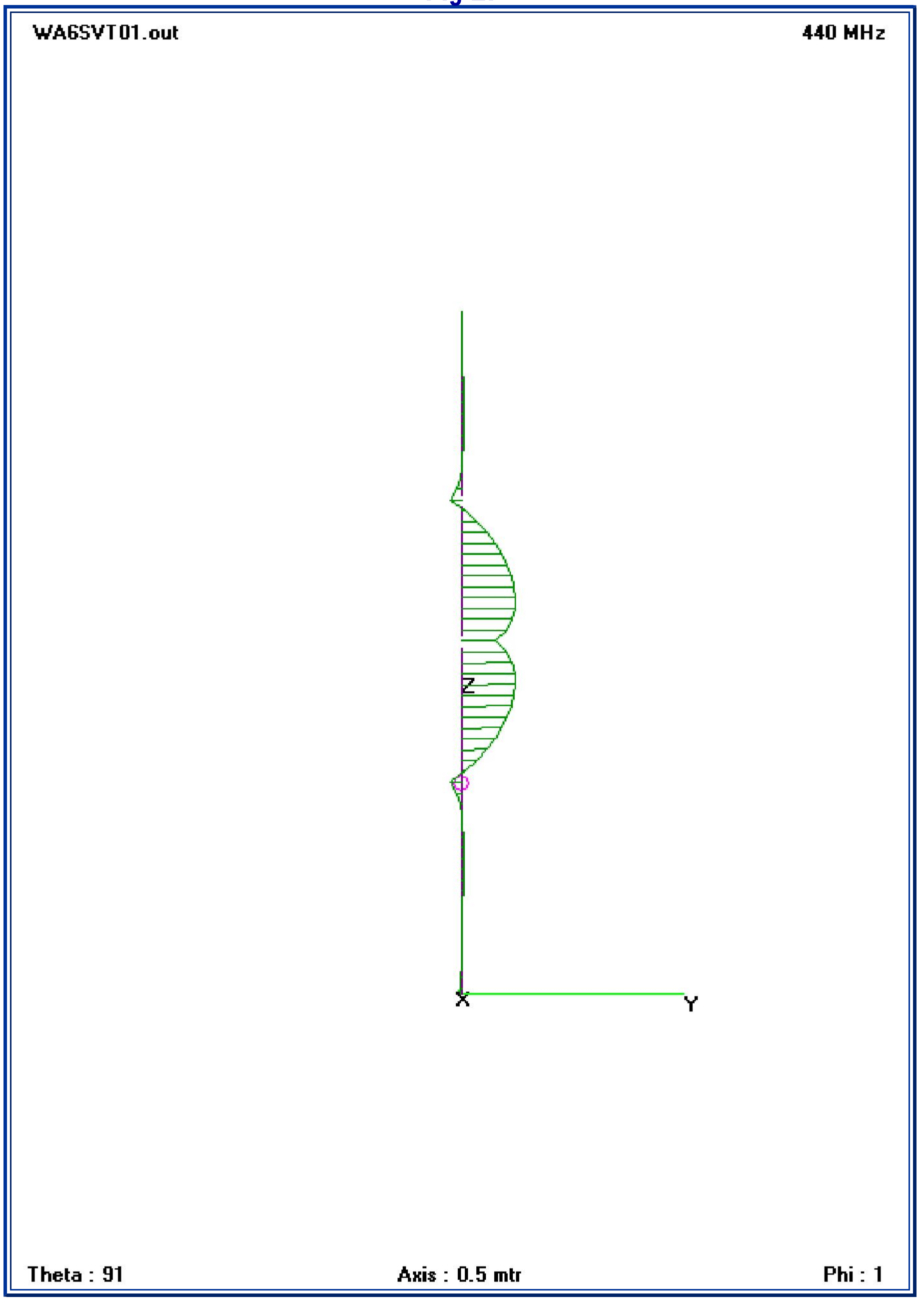

Fig 1 shows the current magnitude and phase distribution on the antenna. Current is fairly in-phase, but the current distribution is very poor resulting in half the antenna having little current and contributing little to the pattern. The antenna works about as well as a good antenna of half the size!

The challenge with any co-phased co-linear is to achieve in phase operation of most of the conductors, and effective distribution of current over the conductors.

Fig 2:

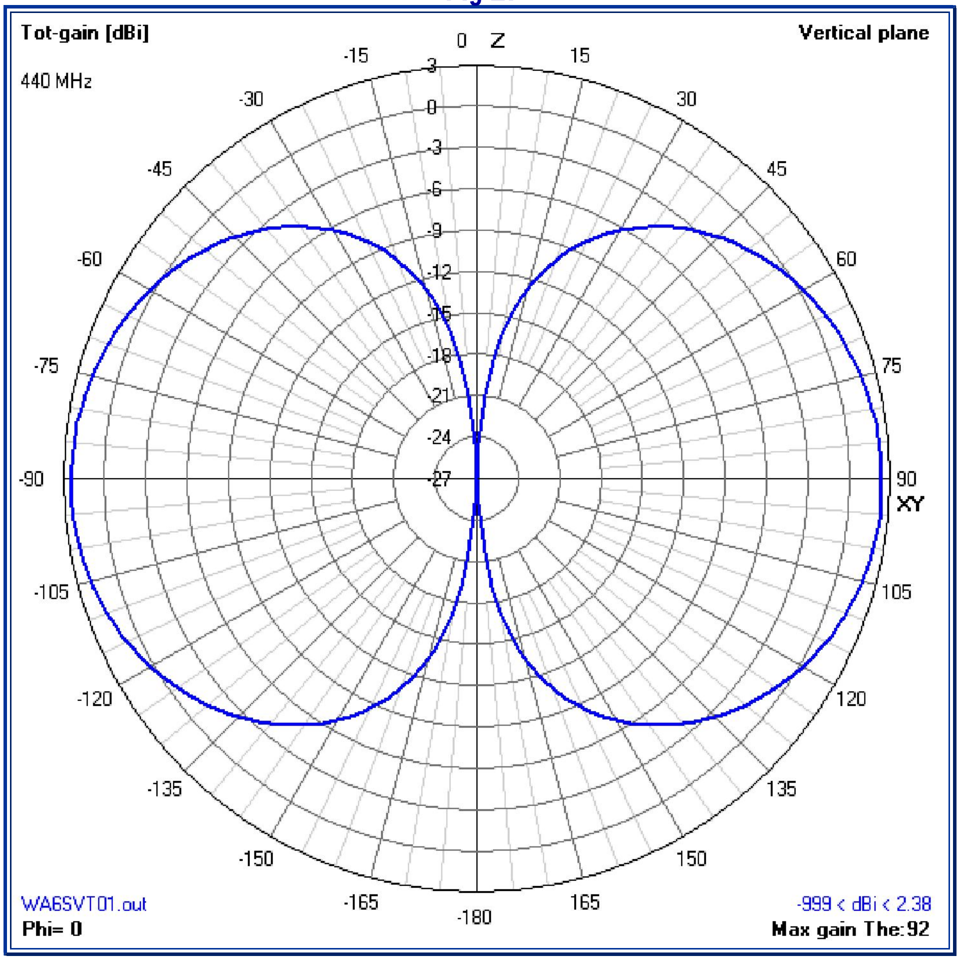

Fig 2 shows the free space pattern. It has gain of 2.4dB horizontally, an appalling pattern for an antenna promoted as suiting land mobile operations on VHF/UHF and nothing like the 5-12dBi claimed by Collis (note Collis's figures were in dBd). The poor gain is a direct result of the failure to drive effective current into the top and bottom elements.

Fig 3:

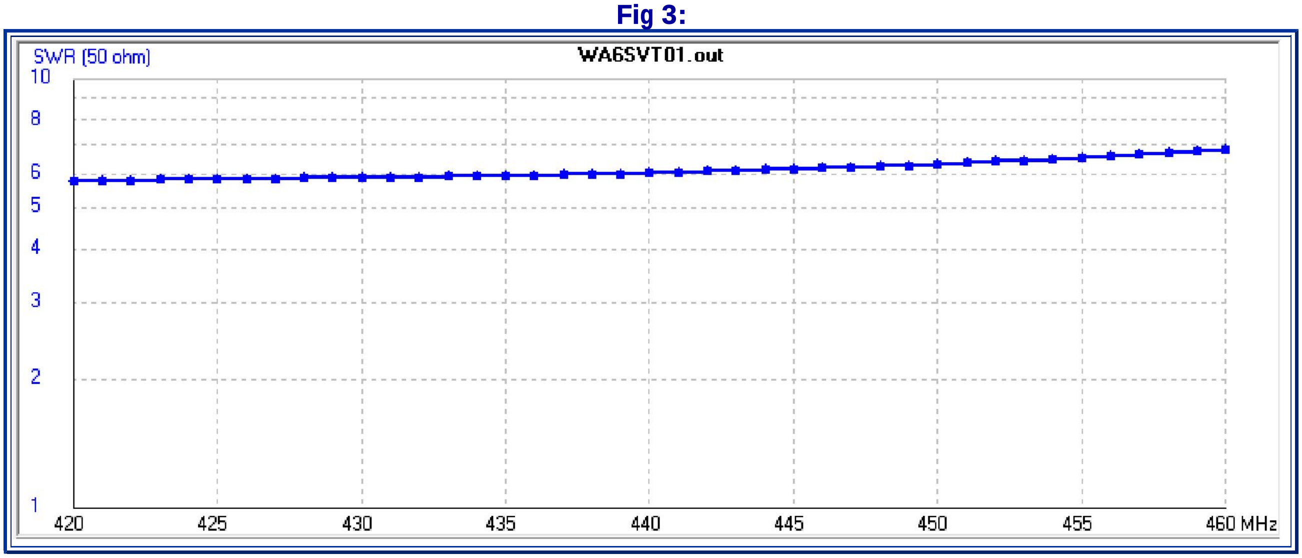

Fig 3 shows a plot of the SWR at the feed point.

Fig 4:

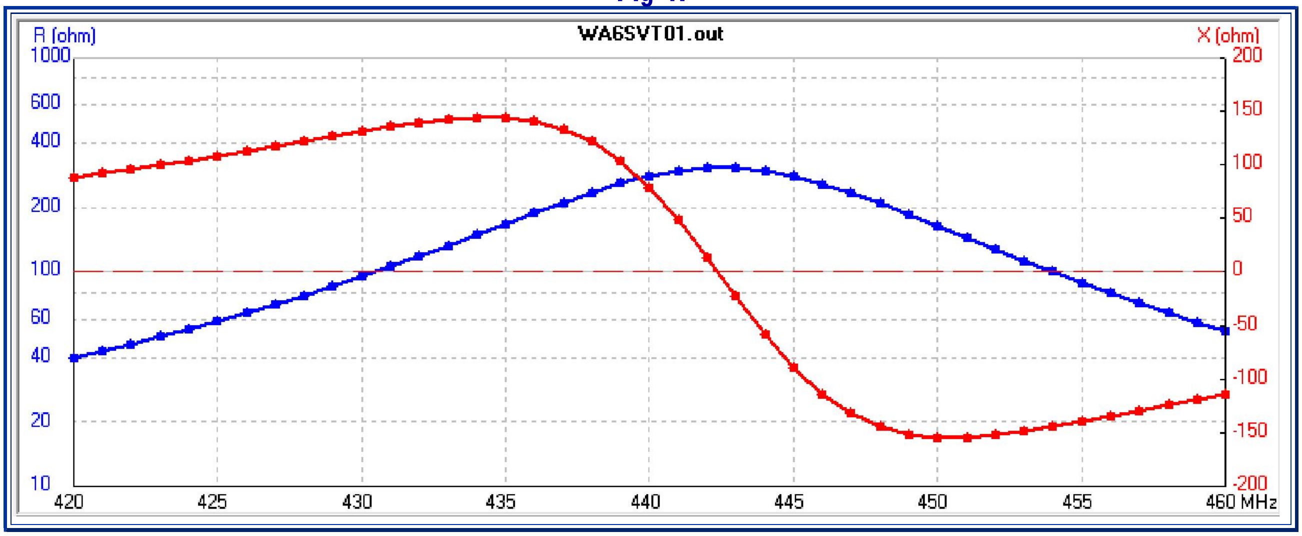

Fig 4 shows a plot of feed point R and X. Feed point impedance is 278+j79Ω at 440MHz, so some form of impedance matching is necessary. Though Collis advised to tweak some lengths to achieve a match, there is a real risk that changing element lengths further degrades the current distribution.

Many writers have described variants which are claimed to be improvements.

Fig 5:

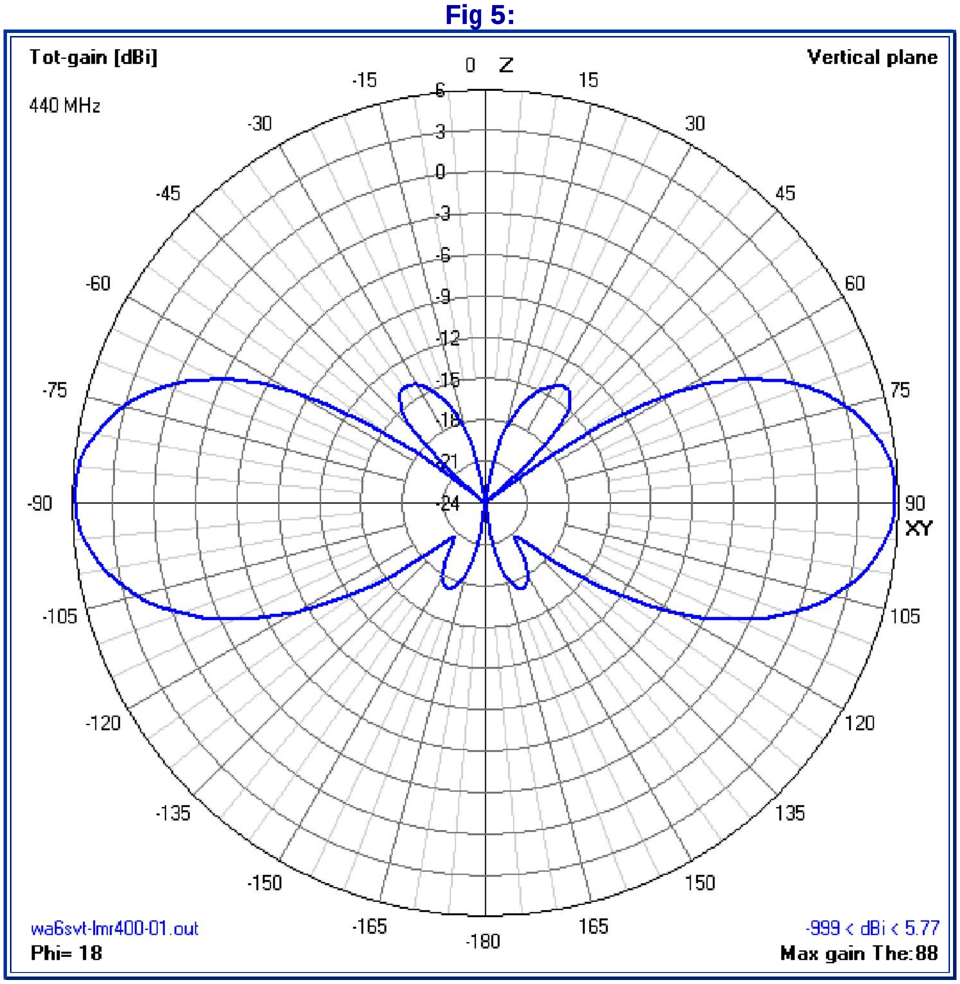

Fig 5 shows the pattern from a model using LMR400 and replacing the top quarter wave of coax with a half wave plain conductor, it has better current distribution and 3.3dB better gain than the model based Collis's original RG213. The feed point impedance is not a ready match to 50Ω cable, an efficient and effective impedance match needs to be devised.

Fig 5a:

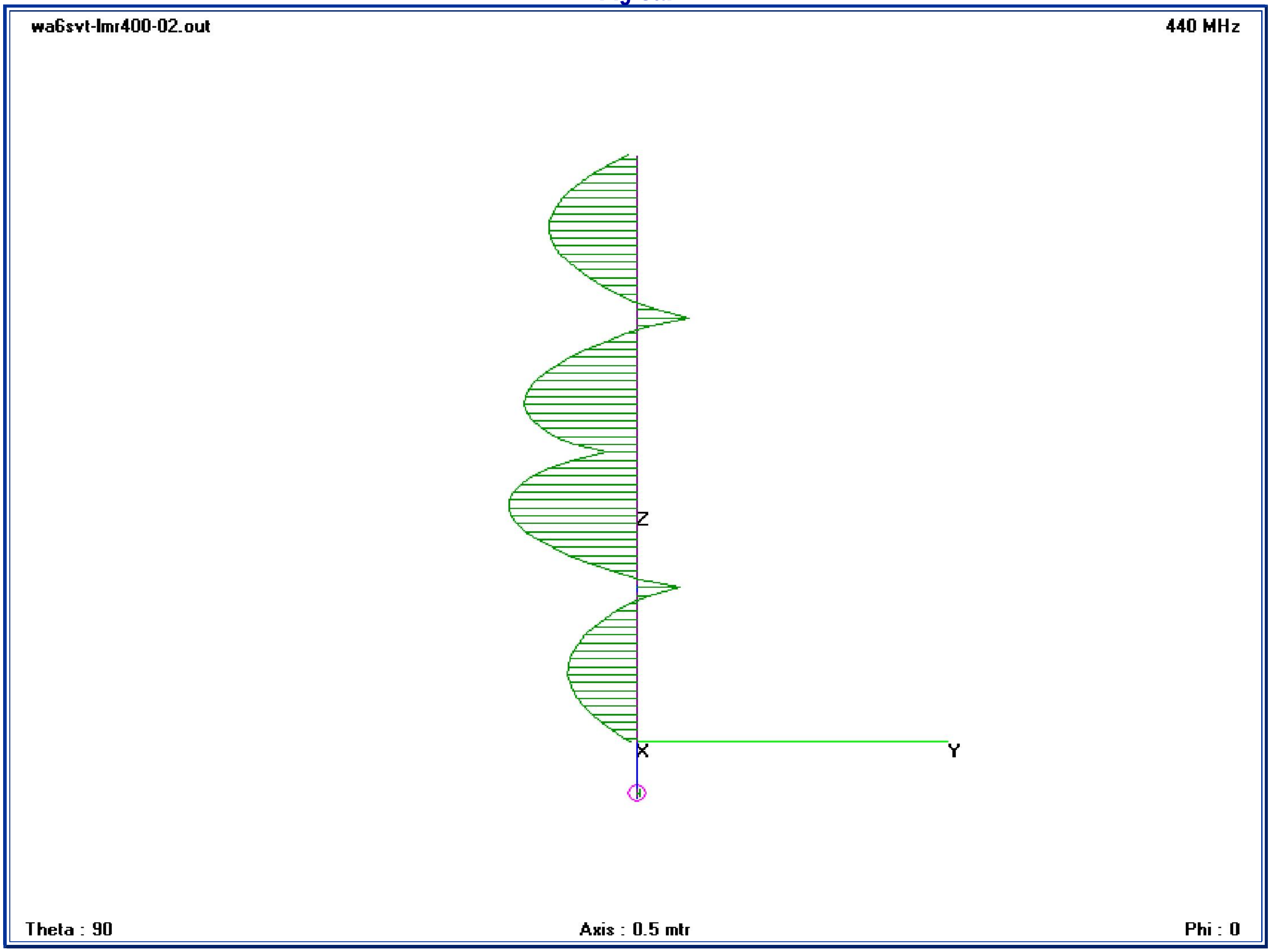

Fig 5a shows the current magnitude and phase distribution the revised model. Compare the current distribution to the WA6SVT design in Fig 1.

A 4NEC2 model for this variant with matching system (shunt inductance of 20Ω reactance at 243° along LMR400 from the true feed point is at wa6svt-lmr400-01.nec.

Fig 6:

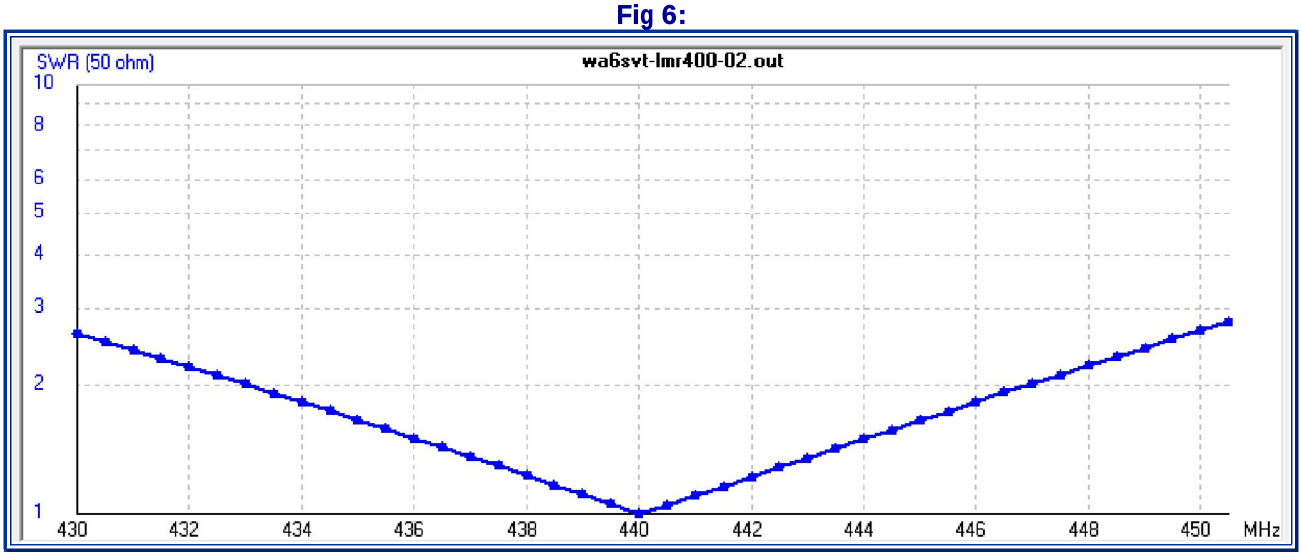

Fig 6 shows the pattern for the wa6svt-lmr400-01.nec matched configuration. Though an excellent match can be obtained, the bandwidth is very narrow, partly due to the number of resonant elements in the system, but mainly due to the narrow band nature of the 'single stub tuner' which such high VSWR on the series section.

Conclusion

The NEC model did not support the claimed performance of the antenna.

The model indicates that gain is poor, way less than claimed, and the result of poor current distribution. This fundamental problem needs to be solved to make the antenna worth its considerable length.

Readers may explore variations with the model, eg using foam coax with vf=0.85 which does work better, and a practical impedance matching arrangement.

The model also revealed that the top quarter wave stub included in the antenna does nothing material (other than providing a DC path which may be provided by the matching network anyway) and can be left out, so the top half wavelength could be constructed by simply extending the inner conductor of the half wave section below it upwards for a half wavelength avoiding making the transposing joint and shorting the top end of the stub.

Links / References

- http://www.repeater-builder.com/antenna/wa6svt.html
- WA6SVT01.nec
- wa6svt-lmr400-01.nec
- wa6svt-lmr400-02.nec

Changes

Version	Date	Description
1.01	10/09/2013	Initial.
1.02		
1.03		
1.04		
1.05		