Analysis of the Off Centre Fed (OCF) dipole

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Introduction

The following article attempts to analyse the Off Centre Fed (OCF) dipole in a typical amateur radio installation covering 7, 14, 21 and 28 MHz, with particular emphasis on the losses. The analysis is carried out by using programs which are available on the internet.

The initial antenna design is done with **EZNEC**, which sets the basic antenna parameters, such as height, length, feed point, transformer ratio, transmission line and can calculate all intermediate impedances. See *AR* Jan/Feb 2011. Reference 1.

The program **TLDetails** calculates transmission line (T-Line losses) and SWR. Reference 2.

LTspice is a simulation program which can simulate the data obtained from EZNEC and calculate losses in the transformer, which is treated as ideal in EZNEC. Reference 3.

EZNEC data -- Reference 1 – Figures 4 - 8

L single wire 1.5 mm diameter, 20.9 m long, 10 m above real ground.

Xfmr 200:50 ohm impedance ratio – 421a (Figure 2), 421c (Figure. 3).

T-Line 15 m of RG-58C, VF = 0.66, Loss = 8 dB/100 m @ 30 MHz

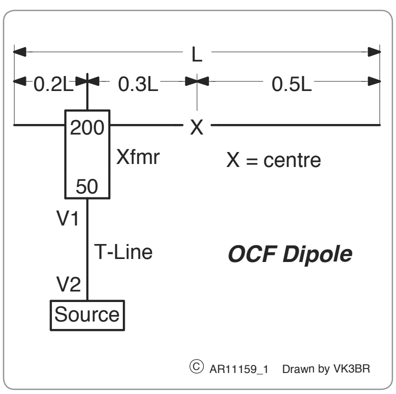

Figure 1: OCF dipole.

F (MHz)	Ant feed (0.2 L) r +/- jx	Xfmr input (V1) r +/- jx	T-Line input (V2) r +/- jx
7.1	276.3 + j139.6 (3.13 μH)	69.19 + j34.89 (782 nH)	85.70 + j15.15 (339.6 nH)
14.2	117.50 – j4.69 (2.39 nF)	29.47 – j1.17 (9.6 nF)	36.73 + j12.47 (139.8 nH)
21.2	110.3 – j22.96 (327 pF)	27.67 – j5.74 (1.3 nF)	36.82 + j15.16 (113.8 nH)
28.5	318.7 + j30.02 (167.6 nH)	79.78 + j7.51 (41.9 nH)	43.06 – j16.16 (336.4 pF)

Table 1

Table 1 shows source impedances at different points along the antenna system.

The equivalent component value for jx is shown in brackets.

Xfmr input (V1) is the impedance calculated by EZNEC with the source at V1.

Transmission Line (RG-58C) Loss – Reference 2

Power at source (V2) = 100 W

Table 2 shows power loss for T-Line = 15 m of RG-58C

F (MHz)	Power (W) @ V1	Power (W) Loss
7.1	84.6	15.4
14.2	79.0	21.0
21.2	74.0	26.0
28.5	72.4	27.6

Table 2

Table 3 shows the SWR readings at the source (V2) and at the far end (V1).

F (MHz)	SWR @ V2	SWR @ V1
7.1	1.79	1.98
14.2	1.53	1.70
21.2	1.63	1.90
28.5	1.43	1.62

Table 3

Transformer Design – Reference 3, Reference 4

Note: ECW = enamelled copper wire

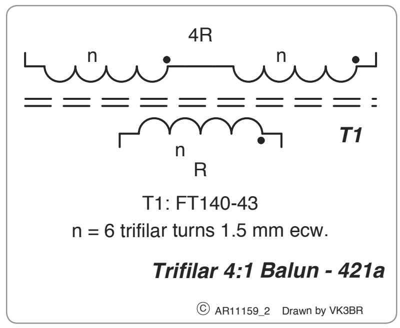

Figure 2: Xfmr 421a.

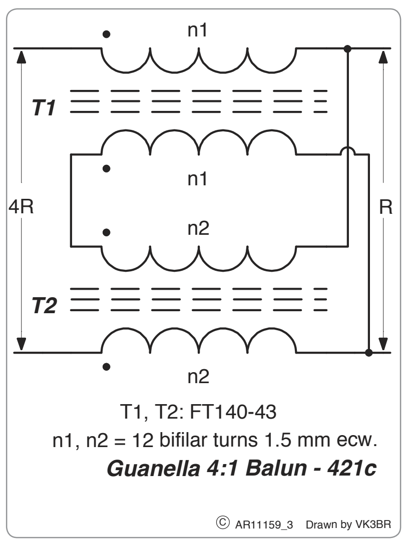

Figure 3: Xfmr 421c.

F (MHz)	Power (W) @ V1	Power (W) @ Antenna	Power (W) Loss
7.1	84.6	72.0	12.6
14.2	79.0	75.9	3.1
21.2	74.0	71.7	2.3
28.5	72.4	67.8	4.6

Table 4

F (MHz)	Power (W) @ V1	Power (W) @ Antenna	Power (W) Loss
7.1	84.6	83.2	1.4
14.2	79.0	78.8	0.2
21.2	74.0	73.9	0.1
28.5	72.4	72.1	0.3

Table 5

F (MHz)	Total Loss (W) 421a	Total Loss (W) 421c
7.1	15.4+12.6 = 28	15.4+1.4 = 16.8
14.2	21+3.1 = 24.1	21+0.2 = 21.2
21.2	26+2.3 = 28.3	26+0.1 = 26.1
28.5	27.6+ 4.6= 32.2	27.6+0.3 = 27.9

Table 6

The transformer core uses #43 ferrite material and therefore the winding inductance changes with frequency. Values were calculated for each band using the program FT_calc_1.1.xls. Figures 10 and 11 reflect the winding inductance (50 μH) for 7 MHz.

The common mode rejection can be checked with program Balun_cmr_1.1.xls.

Both programs are available on the internet – *Reference 4.*

Loss in xfmr 421a due to antenna mismatch – Reference 3 – Figure 10 – Figure 10a.

Power in column 2 of Table 4 is that available at V1 with 15 m of RG-58C.

Power in column 3 of Table 4 is that actually dissipated in the antenna.

Loss in xfmr 421c due to antenna mismatch – Reference 3 – Figure 11 – Figure 11a.

Power in column 2 of Table 5 is that available at V1 with 15 m of RG-58C.

Power in column 3 of Table 5 is that actually dissipated in the antenna.

Total OCF Power Loss – 100 W input

Table 6 adds losses from Tables 2, 4 and 5 for T-Line = 15 m RG-58C.

Conclusion

The OCF dipole is a compromise design HF antenna which allows operation on several bands without using an antenna matching unit (ATU). Using EZNEC, the design of an OCF dipole allows many variations in overall antenna length, height and feed point to achieve the desired result. To accommodate the four bands, the overall length of the antenna (20.9 m) was made longer than that for a resonant dipole (20.2 m) on 7.1 MHz. The demo version of EZNEC is restricted in the number of wire segments.

The design aims to keep the SWR at the T-Line source (V2) below 2:1 on the bands of interest. Apart from T-Line loss, most losses are due to the inevitable mismatching between the transmission line and the antenna feed point impedance via the transformer. Use of RG-213 will reduce the T-Line loss. Losses are reduced by using the Guanella 421c transformer design, which also has a better CMR, so reducing feedline radiation and receiver noise.

References

Ref 1: EZNEC: *www.eznec.com* and AR Jan/Feb 2011

Ref 2: TLDetails: *www.ac6la.com/tldetails.html*

Ref 3: LTspice: *www.linear.com/designtools/software/#LTspice*

Ref 4: FT_calc_1.1.xls, Balun_cmr_1.1.xls: *www.vkham.com.au*

Suggestions for building an OCF dipole – Figure 12 and Figure 12a.

Most amateurs have space limitations for erecting an antenna, so I suggest you first determine maximum antenna space available, particularly heights of the wire ends and any necessary bends. This is true for any antenna simulation program. In EZNEC a wire is a straight length, so the number of horizontal and vertical bends will determine how many wires are required.

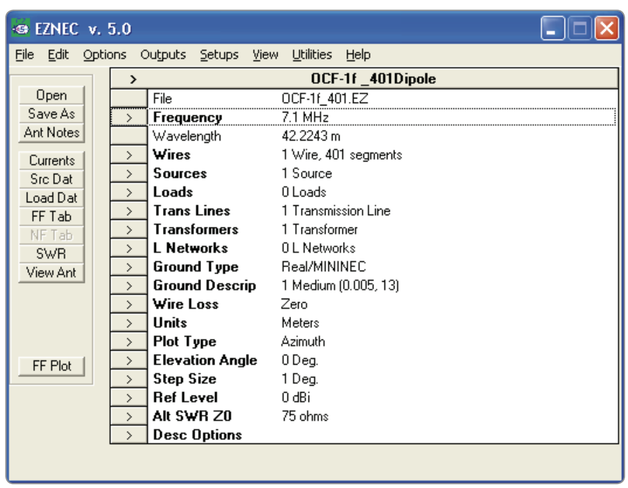

Figure 4: EZNEC main screen.

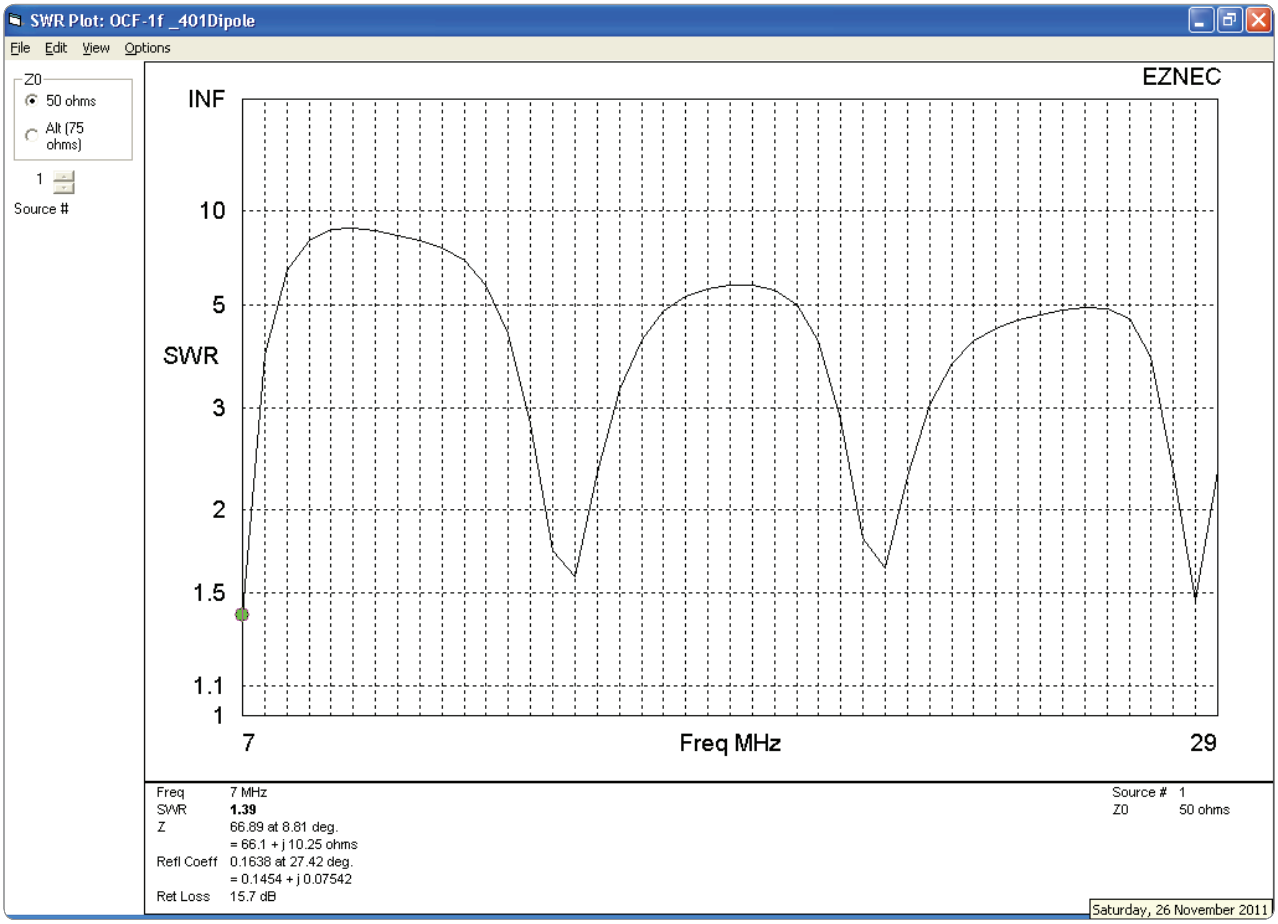

Figure 5: EZNEC – SWR 7-29 MHz.

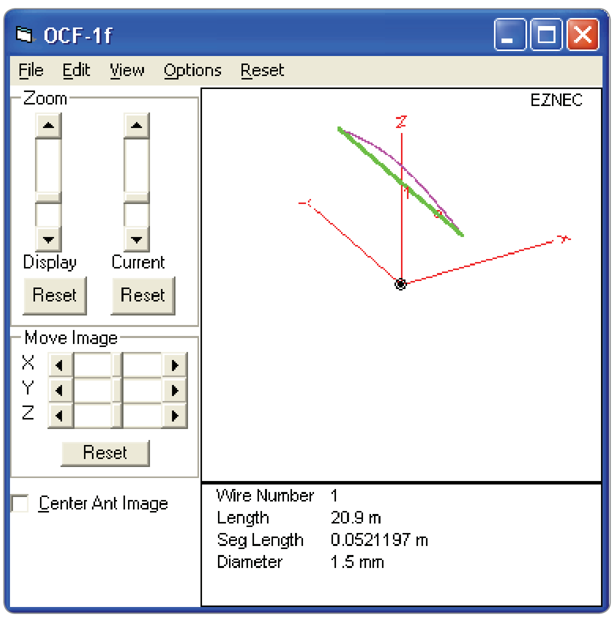

Figure 6: EZNEC antenna view.

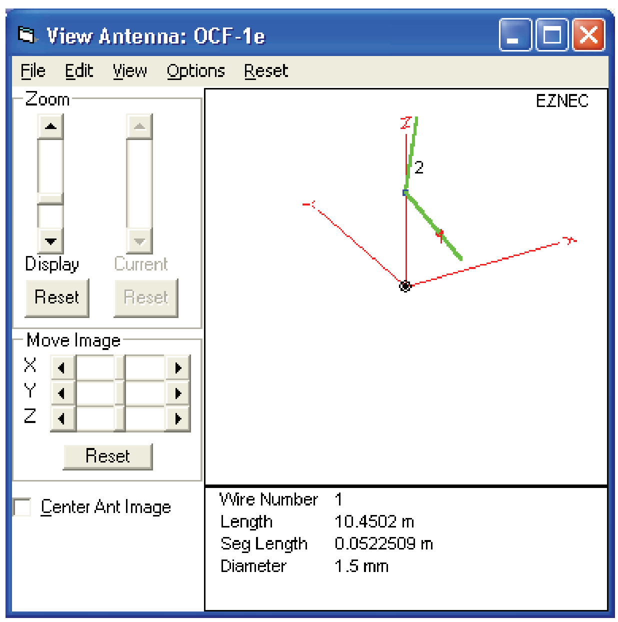

Figure 12a: EZNEC antenna view with wires at different heights.

In my example I have used a simple single wire where ends are at the same height and there are no bends, so the co-ordinates in the *Wires* table in EZNEC will be the true wire lengths.

If you have the wire ends at different heights, the actual wire lengths will not correspond to the co-ordinates entered in the *Wires* table. Figure 12 shows the corrected co-ordinates for an antenna with a bend in the middle and the ends at different heights.

Figure 12a shows the antenna and that EZNEC has correctly calculated *wire number 1* as 10.4502 m using the data in the *Wires* table of Figure 12. In this case data will be different compared with our simple example and would require all new EZNEC calculations.

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Program screen shots using 7.1 MHz examples –

```
                        EZNEC ver. 5.0

Frequency = 7.1 MHz

Source 1        Voltage = 309.6 V at 26.8 deg.
                Current = 1 A at 0.0 deg.
                Impedance = 276.3 + J 139.6 ohms
                Power = 276.3 watts
                SWR (50 ohm system) =  6.975  (75 ohm system) =  4.682
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Figure 7: EZNEC source at antenna feed point.

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                        EZNEC ver. 5.0

Frequency = 7.1 MHz

Source 1        Voltage = 77.49 V at 26.76 deg.
                Current = 1 A at 0.0 deg.
                Impedance = 69.19 + J 34.89 ohms
                Power = 69.19 watts
                SWR (50 ohm system) =  1.944  (75 ohm system) =  1.626
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Figure 8: EZNEC source at xfmr input (V1).

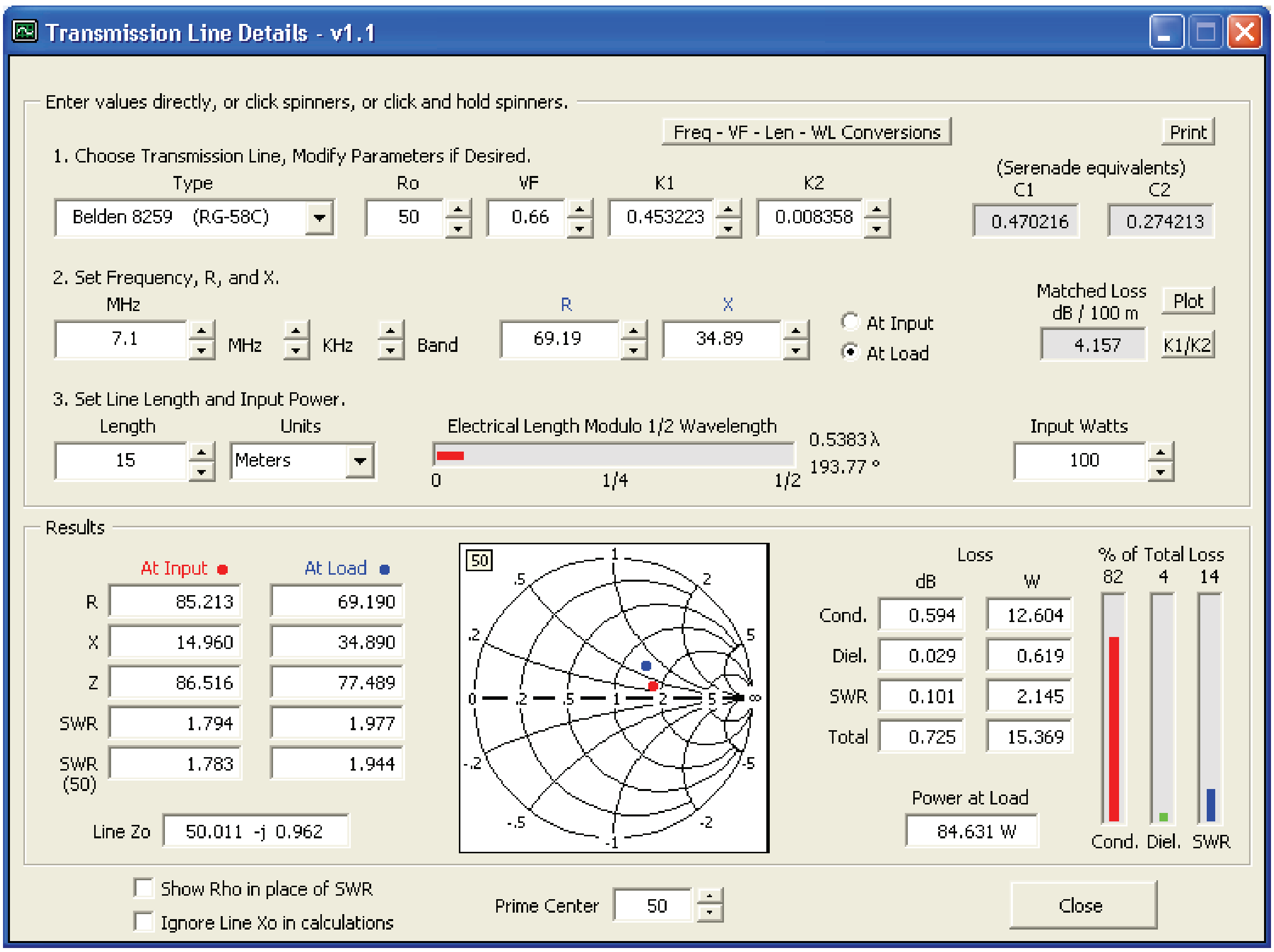


Figure 9: TLDetails T-Line SWR and loss.

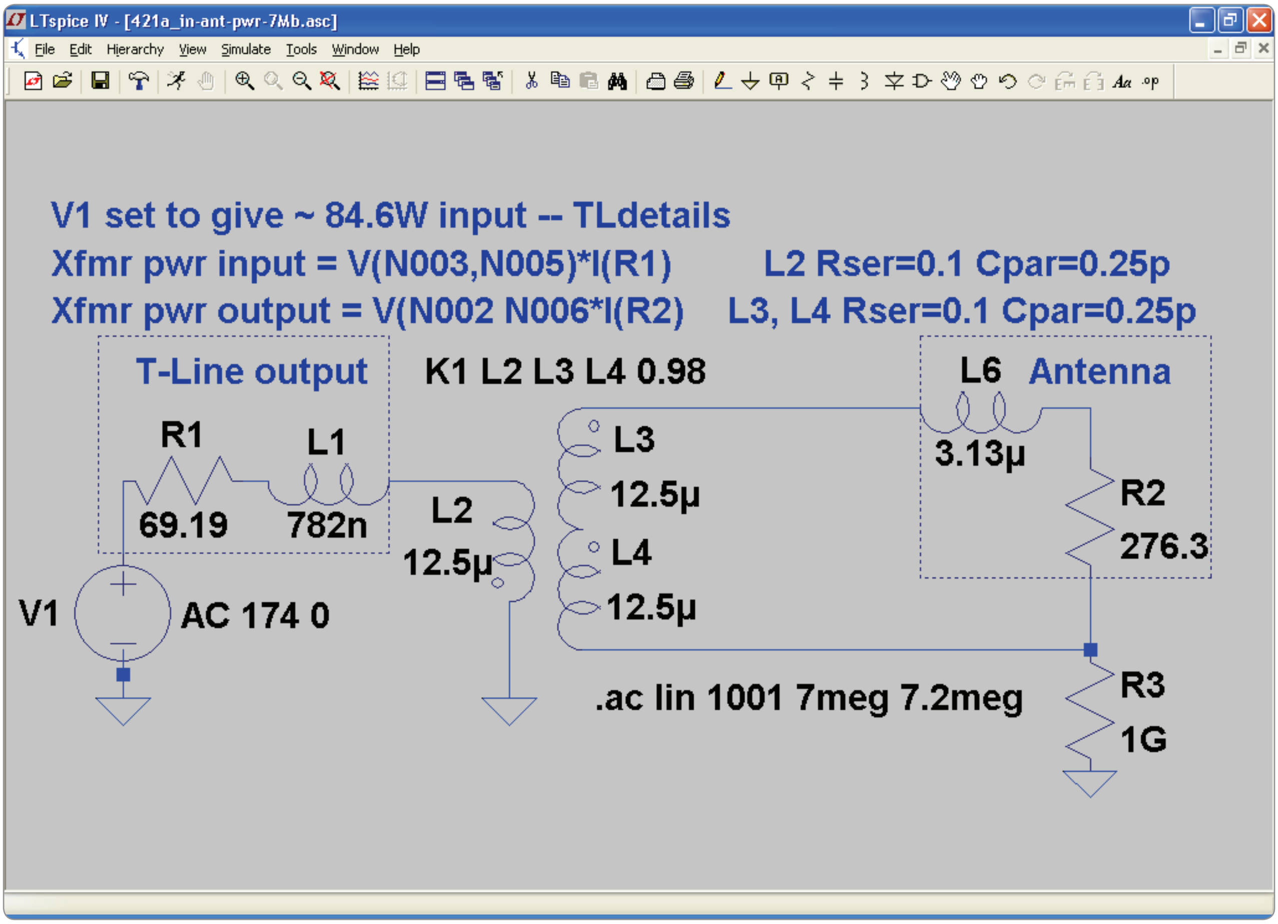


Figure 10: LTspice Xfmr 421a power transfer from T-Line (V1) to antenna.

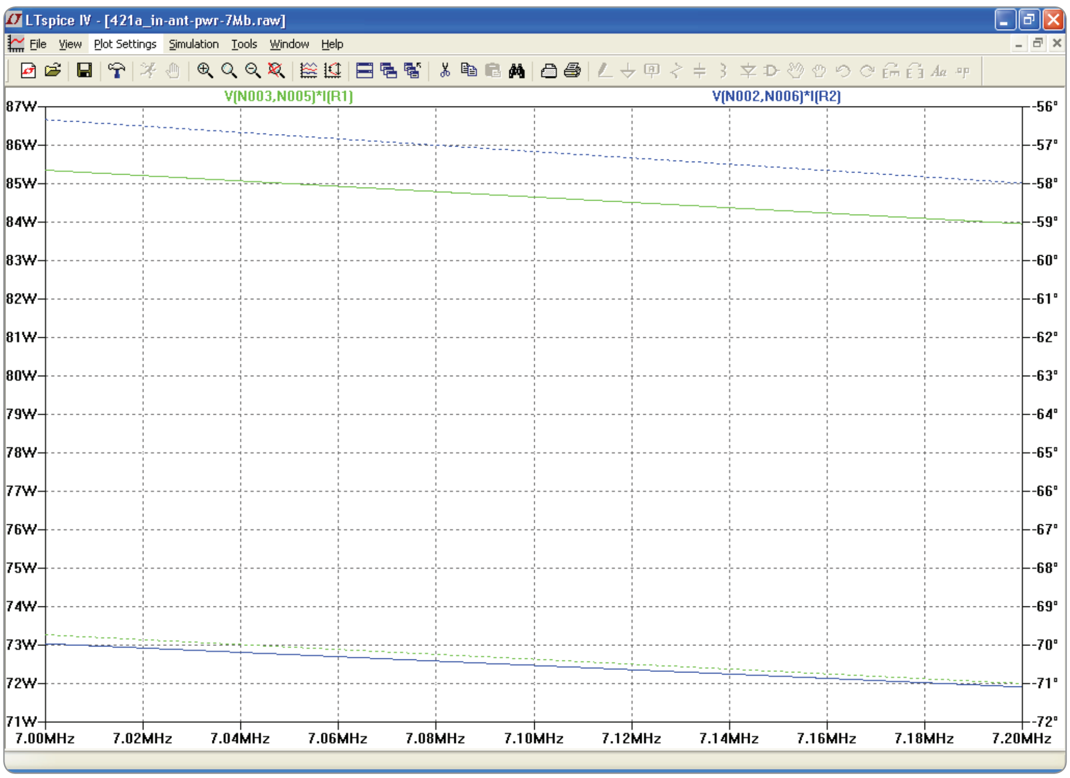


Figure 10a: LTspice plot Xfmr 421a input (V1) and output (Antenna) power.

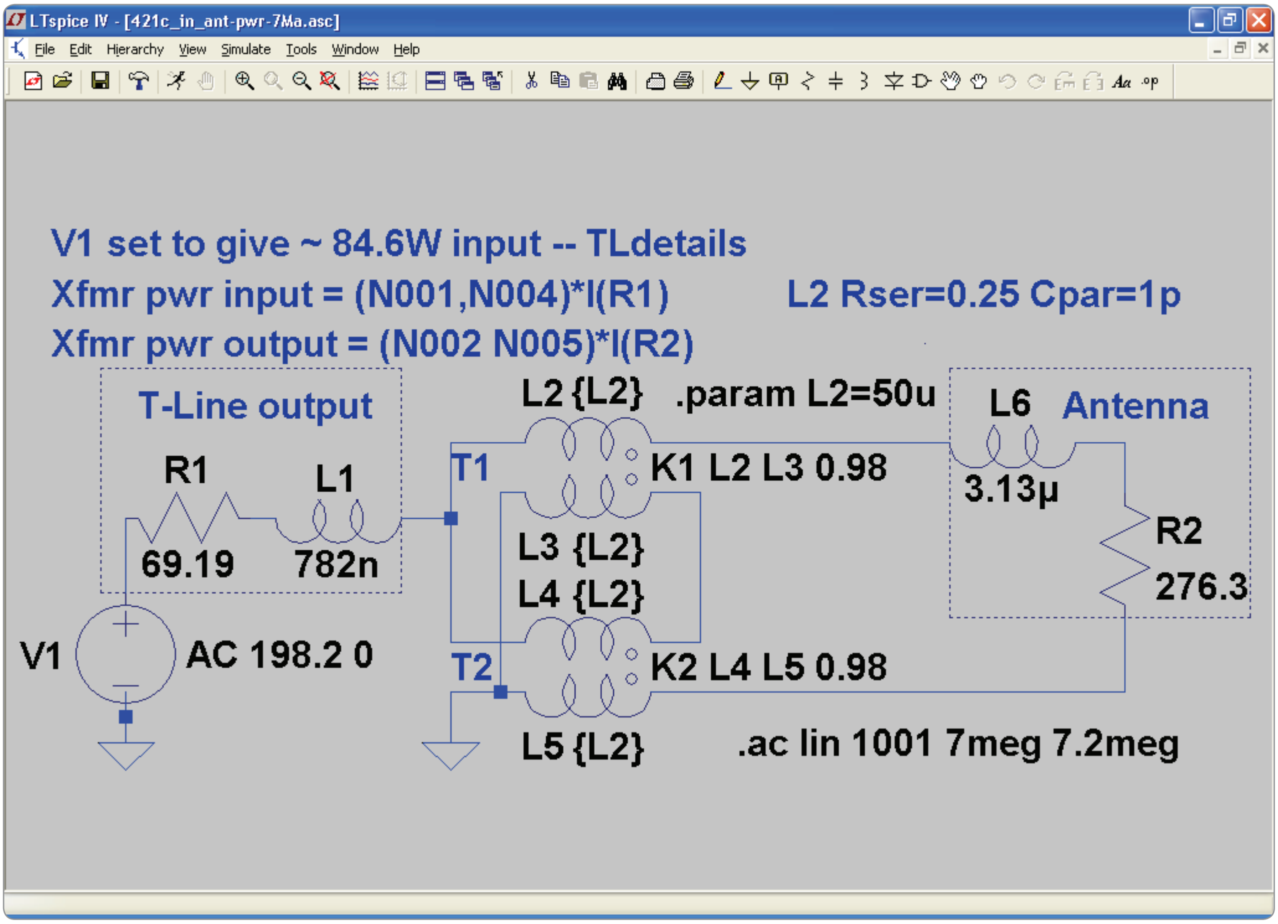


Figure 11: LTspice Xfmr 421c power transfer from T-Line (V1) to antenna.

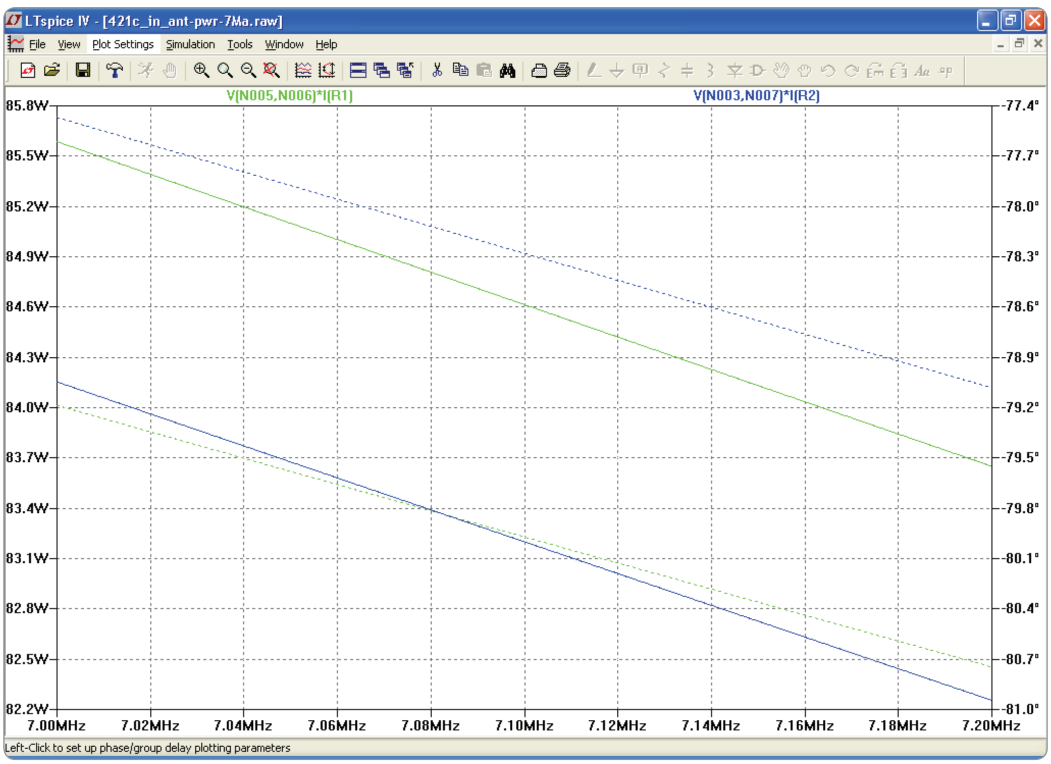
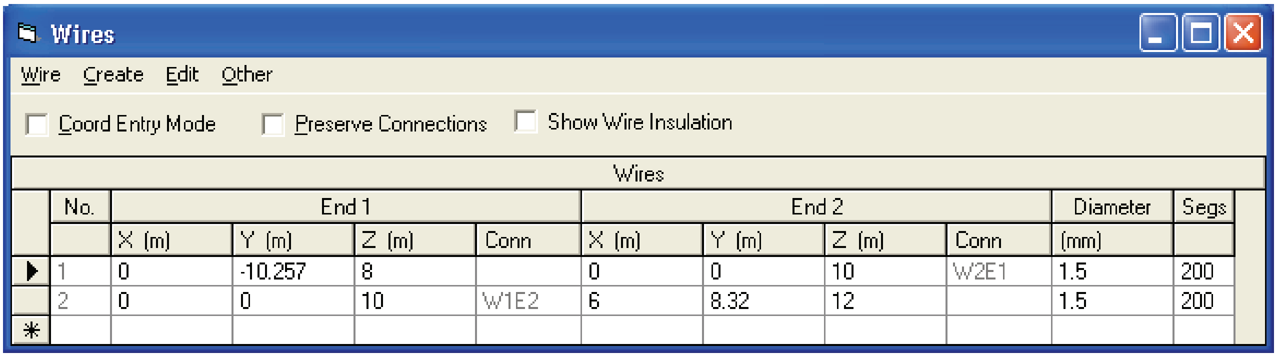


Figure 11a: LTspice plot Xfmr 421c input (V1) and output (Antenna) power.



Wires										
No.	End 1				End 2				Diameter	Segs
	X (m)	Y (m)	Z (m)	Conn	X (m)	Y (m)	Z (m)	Conn	(mm)	
1	0	-10.257	8		0	0	10	W2E1	1.5	200
2	0	0	10	W1E2	6	8.32	12		1.5	200
*										

Figure 12: EZNEC wires table with ends at different heights.