MATLAB-NEC2 Planar Coil Generator/Optimizer Documentation

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1. Introduction

The purpose of this MATLAB code is to generate and optimize a planar coil structure. Currently the first version of this code is intended to maximize directive gain of the structure. NEC2 (https://www.nec2.org/) is utilized to calculate the directive gain.

Parameters:

- Driving frequency
- Starting inner radius
- End final radius
- Number of turns

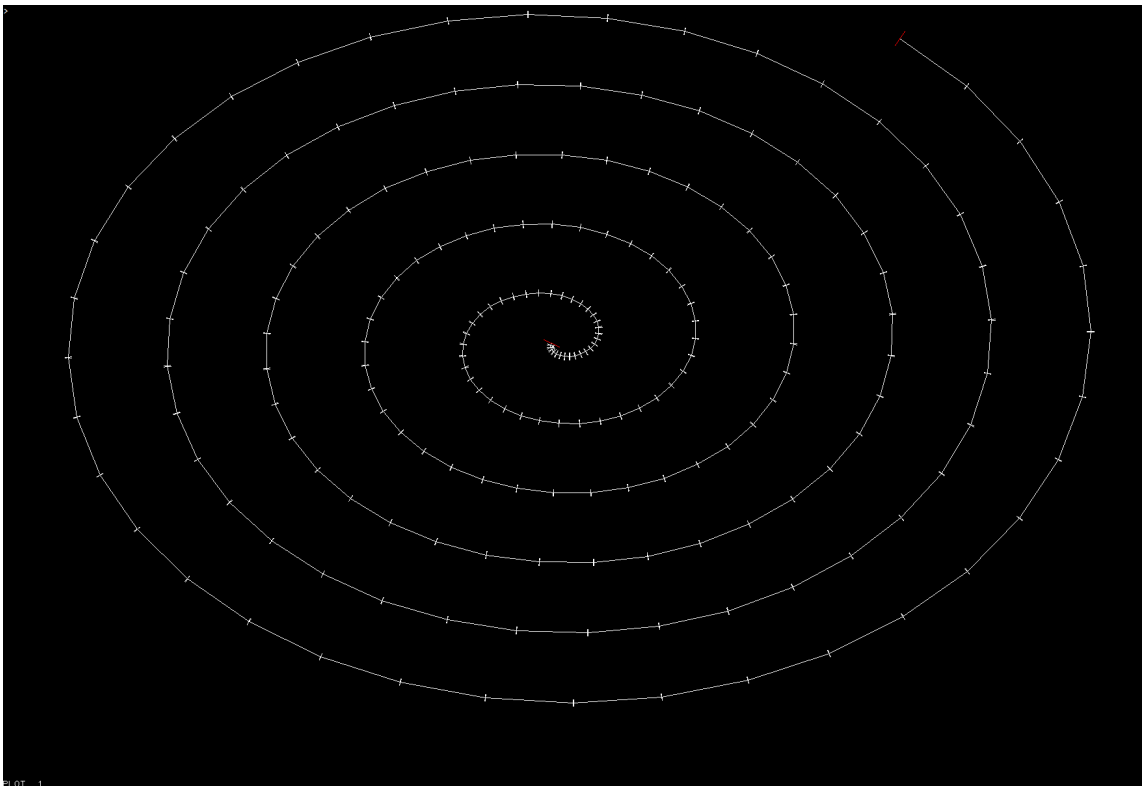

Figure 1: The generated planar coil on the x-y plane. The coil is comprised of linear segments whose edges are indicated by the short, perpendicular lines.

2. Geometry Calculations:

To generate the planar coil geometry, the following equations and relationships were used:

$$r = r_i + bs$$

$$b = \frac{r_f - r_i}{s_f}$$

$$x = rcos(s)$$
$$y = rsin(s)$$

Variable definition:

$$r = radius\ of\ the\ planar\ spiral$$
$$r_i = initial\ radius\ located\ at\ the\ start\ of\ of\ the\ spiral$$
$$r_f = final\ radius\ locatetd\ at\ thet\ end\ of\ the\ spiral$$
$$b = a\ constant\ relating\ change\ of\ radius\ and\ change\ in\ \ angle$$
$$x = the\ first\ 2D\ cartesian\ coordinate\ defined\ by\ some\ radius\ and\ angle$$
$$y = the\ second\ 2D\ cartisian\ coordiante\ defined\ by\ some\ radius\ and\ angle$$

3. Optimization Methodology

The utilized optimization algorithms, genetic algorithm and hill climb algorithm provided by MATLAB libraries, are described in the following sections.

3.1. Genetic Algorithm

I. Generate a random population of sets of parameters that describe an antenna.
II. Evaluate which sets of parameters have higher gains.
III. Create a new population by repeating the following steps until the new population is complete.
    i. Select two parent sets of parameters from a population according to which have best gain (the higher gain, the greater likelihood of being selected to be parents) to create an offspring set of parameters.
    ii. There is a probability to mutate the offspring at each parameter option.
    iii. Place the new offspring in a new population.
IV. Use the newly generated population for a further run of the algorithm.
    i. If the end condition is satisfied (max number of iterations), stop and return the best parameter solution in the current population.
    ii. Otherwise, return to step II.

3.2. Hill Climb Algorithm

I. Obtain initial values for all of the parameters within their reasonable bounds from the genetic algorithm.
II. Calculate the output of the function using the obtained parameter values.
III. Adjust a parameter in one direction.
    i. Calculate the output of the function of interest, and if the value is less than the previously obtained value, adjust go to step IV.

   ii. If the value is greater than the previously obtained value, repeat step III.
IV. Adjust a parameter in the other direction.
   i. Calculate the output of the function and if the value is less than the previously obtained value, return to the highest-value parameter setting obtained previously and go to step V.
   ii. If the value is greater repeat step IV.
V. Adjust a different parameter and continue to step V.i.
   i. If there are no more parameters to adjust and no more directions to try, you are stuck at a local extremum, end algorithm.

The step sizes adjust the further in one direction the algorithm goes. The step size will decrease to make sure the most precise value for the local extremum is obtained.

4. Output Information

The following items are outputted: inner radius, outer radius, number of turns, drive frequency, directive gain. These parameters can be used to construct a planar coil geometry by utilizing the calculations described in section 2.

5. Comments and Conclusions

The following issues have not been fully addressed:

- The program is only supported with Windows machines
- NEC2 does not support micro-scale precision
- NEC2 is not automatically on the environment path for a Windows machine. If MATLAB does not recognize the call to the NEC2DX<?> command, then follow these instructions:
  - Access the system Control Panel
  - Click the advanced system settings link
  - Click “Environment Variables”
  - Select the “Path” variable then click “Edit”.
  - Add a new path to the exact location/folder holding the NEC2 program files.
- The user is free to adjust certain variables contained within the MATLAB code (other than the described parameters) such as:
  - w_radius (RRS_PSC_NEC_GeometryGain.m): the radius of the coil wire
  - lb_ri, ub_ri, lb_rf, ub_rf, lb_n, ub_n, lb_f, ub_f (PlanarSpiralCoil_Optimizer.m): the lower and upper bounds of the parameters
  - f_mid_MHz & f_mid (PlanarSpiralCoil_Optimizer.m): the driving frequency for the ideal coil

This value is determined by the following calculation:

$$v = \frac{c}{\sqrt{\varepsilon_r}}$$
$$\lambda = \frac{v}{f}$$
$$C = \pi D$$

Let diameter, D, have a maximum value D_{max} (basic size constraint).

$$C_{max} = \pi D_{max}$$
$$C_{ideal} = \lambda$$

Set C_{ideal} as C_{max} because it is likely that the larger the coil, the greater gain is obtained. In the optimizer, greater gain is desirable.

$$\pi D_{max} = \frac{v}{f}$$
$$f = \frac{v}{\pi D_{max}}$$

Variable definition:

$$v = propagation\ velocity$$
$$\lambda = wavelength$$
$$f = driving\ frequency$$
$$C = largest\ circumference\ of\ the\ planar\ coil$$
$$D = largest\ diameter\ of\ the\ planar\ coil$$

- An error may appear while running the optimizer. This error was resolved by adjusting the scaling value of the parameters. All the parameters, except frequency, are scaled up while frequency is scaled down to a fraction of its ideal value. For example: the inner radius is scaled by 10 then the frequency is scaled by 0.1.

6. Appendix A | MATLAB Code File: PlanarSpiralCoil_Optimizer.m

```
% RRS_PlanarSpiralCoil_Geom.m
% Name: Ressa Reneth Sarreal
% Email: rsarreal3@gatech.edu
% Date: May 8, 2019
%{
Steps:
1. Geometry Generator
    i.   mathematical representation of a spiral
    ii.  segment mathematical representation
    iii. generate nec file that will contain segments precisely
2. Optimizing functions
    i. Genetic Algorithm
    ii. Hill Climb from best genetic algorithm population
%}

%{
Three different parameters that actually need to be optimized
are the inner radius, outer radius and number of turns.

Parameters:
- ri = Desired initial radius
- rf = Desired final radius
- si = Initial angle (radians)
- sf = Final angle (radians)
- n = number of turns
- f = driving frequency
- m = number of segments
%}

clear all; close all;

% please input everything in terms of meters/NEC units
% i.e. Meters, MHz, radians?
PI = 3.1415;

% f = v/(pi*Diameter)
f_mid_MHz = 10.600; % MHz
f_mid = 10.600 * 10^9; % Hz

e_r = 80; % permittivity of perilymph (approx. water)
v = 3 * 10^8 / sqrt(e_r); % speed of propagation
lambda = v / f_mid % wavelength


% Define upper and lower bounds for parameters
lb_ri = 10000*0.001*lambda/(2*PI);
ub_ri = 10000*0.01*lambda/(2*PI);
lb_rf = 10000*0.1*lambda/(2*PI);
ub_rf = 10000*2*lambda/(2*PI);
lb_n = 2;
ub_n = 6;
lb_f = 0.0001*f_mid_MHz*0.1;
ub_f = 0.0001*f_mid_MHz*1.5;
```

```
% initialize parameter vectors
num_parameters = 4; % inner radius, outer radius, #turns, frequency
lb = [lb_ri, lb_rf, lb_n, lb_f];
ub = [ub_ri, ub_rf, ub_n, ub_f];

p0=lb+(ub-lb).*rand(size(lb));% initial guess for parameters


% Perform genetic algorithm.
[p1, fval] = ga(@RRS_PSC_NEC_GeometryGain, length(lb), [], [], [], [], lb,
ub);
%p1 = [ri_1, rf_1, n_1, freq_1];
p1;
% Perform the hillclimb algorithm.
options = optimset('fmincon');
options = optimset(options, 'DiffMinChange', 1e-3);
[p2, gain_t] = fmincon(@RRS_PSC_NEC_GeometryGain, p1, [], [], [], [], lb, ub,
[], options);
p2;
```

7. Appendix B | MATLAB Code File: RRS_PSC_NEC_GeometryGain.m

```
function [gain_t]=RRS_PSC_NEC_GeometryGain(p)
%{
This program is used with optimization code.
It creates an NEC input file given the parameters for a 10 element YAGI
antenna.  Then, it runs NEC and reads in the parameters(Gain, Impedance,
etc) generated by NEC.
%}
%=========Create NEC input file=========================================
Fname_nec='PSC.in';
FID_nec=fopen(Fname_nec,'wt');

ri = p(1); % inner radius
rf = p(2); % outer radius
n = p(3); % number of turns
f = p(4); % driving frequency


PI = 3.1415; %rad
m = 200; % segments
w_radius = rf/n%0.0001; %  1um radius
si = 0; % radians
sf = 2*PI*n; % radians
b = (rf - ri)/sf; % constant

%    Geometry input for NEC
fprintf(FID_nec,strcat('CM RRS Planar Spiral Coil','\n'));
fprintf(FID_nec,strcat('CM Single Coil','\n'));
fprintf(FID_nec,strcat('CE File Generated by MATLAB','\n'));

% For every segment, generate a wire segment

ds = sf/m ; % change in angle

for i = 1:m

    if i == 1
        s_start = si; % starting angle for the segment
    else
        s_start = s_end;
    end
    s_end = si + ds*i; % end angle for the segment

    r_start = ri + b*s_start;
    r_end = ri + b*s_end;

    x_start = r_start * cos(s_start);
    x_end = r_end * cos(s_end);
    y_start = r_start * sin(s_start);
    y_end = r_end * sin(s_end);

    % Generate top side:
    fprintf(FID_nec, 'GW %3i %3i %8.4f %8.4f %8.4f %8.4f %8.4f %8.4f
%8.4f\n', i, 1, x_start, y_start, 0, x_end, y_end, 0, w_radius);
```

```
end
%    Program Control Commands for NEC
fprintf(FID_nec,strcat('GE','\n'));
fprintf(FID_nec,'EX %3i %3i %3i %3i %8.4f %8.4f\n', 0, m/2, 1, 0, 1, 0);
%Exitation Command loop 2 (tag = 8) segment 3, 1V
fprintf(FID_nec,'FR %3i %3i %3i %3i %8.4f %8.4f\n', 0, 1, 0, 0, f, 0); %set
freq to a variable (one of initial parameters)
fprintf(FID_nec,'RP %3i %3i %3i %3i %8.4f %8.4f %8.4f %8.4f\n', 0, 1, 1,
1000, 0, 0, 0, 0); %calculate gain at boresite
% For RP line, maybe have theta at 90 or 0 unsure.
fprintf(FID_nec,strcat('EN','\n'));
fclose(FID_nec);


%=======Create file to pipe to NEC ===================================
FID_input=fopen('input_CMD','wt');
fprintf(FID_input,strcat(Fname_nec,'\n'));
fprintf(FID_input,strcat('PSC.out','\n'));
fclose(FID_input);
%=======Run NEC=======================================================
!NEC2Dx500 < input_CMD >tmp;
%=======Read Data form NEC output file================================
[freq,Z,gain_t,E_theta,E_phi,n_freq_meas,run_time] = nec_read('PSC.out');

end
```

8. Appendix C | MATLAB Code File: nec_read.m

```
function [freq,Z,gain_t,E_theta,E_phi,count,run_time] = nec_read(fname)
% This function extracts data from a NEC output file
%   count is the number of frequencies read.
%   freq is an array containing the frequencies read.
%   Z is an array containing the input impedence of the antenna.
%   gain_t is an array containing the total gain of the antenna in dB.
%   E_theta,E_phi are arrays containing the radiated field of the antenna.
%   gain_t,E_theta,E_phi are read from the first line of the pattern table.
%   Author: Waymond Scott, 10-08-2003
%fname='exp.out'
fid=fopen(fname);
count=0;
line=0;
while line~=-1
   line=  fgets(fid);
   if findstr(line,'FREQ')>0
      count=count+1;
      line;
      for m=1:2
         line=fgets(fid);
      end
      A = sscanf(line(47:58),'%f');
      freq(count)=A(1);
   end
   if findstr(line,'ANTENNA INPUT PARAMETERS')>0
      line;
      for m=1:4
         line=fgets(fid);
      end
      A = sscanf(line,'%f');
      Z(count)=A(7)+i*A(8);
   end
   if findstr(line,'RADIATION PATTERNS')>0
      line;
      for m=1:5
         line=fgets(fid);
      end
      line
      A = sscanf(line,'%f');
      gain_t(count)=A(5);
      %  line(73:length(line))
      A = sscanf(line(73:length(line)),'%f');
      E_theta(count)=A(1)*exp(i*A(2)*pi/180);
      E_phi(count)=A(3)*exp(i*A(4)*pi/180);
   end
   if findstr(line,'RUN TIME')>0
      line
      run_time = sscanf(line(12:length(line)),'%f')
   end
end
fclose(fid);
end
```

9. Appendix D | Example NEC Input File: PSC.in

```
CM RRS Planar Spiral Coil
CM Single Coil
CE File Generated by MATLAB
GW   1   1   0.0188   0.0000   0.0000   0.0297   0.0052   0.0000   0.4170
GW   2   1   0.0297   0.0052   0.0000   0.0391   0.0141   0.0000   0.4170
GW   3   1   0.0391   0.0141   0.0000   0.0460   0.0263   0.0000   0.4170
GW   4   1   0.0460   0.0263   0.0000   0.0495   0.0412   0.0000   0.4170
GW   5   1   0.0495   0.0412   0.0000   0.0491   0.0578   0.0000   0.4170
GW   6   1   0.0491   0.0578   0.0000   0.0442   0.0752   0.0000   0.4170
GW   7   1   0.0442   0.0752   0.0000   0.0345   0.0924   0.0000   0.4170
GW   8   1   0.0345   0.0924   0.0000   0.0202   0.1082   0.0000   0.4170
GW   9   1   0.0202   0.1082   0.0000   0.0013   0.1214   0.0000   0.4170
GW  10   1   0.0013   0.1214   0.0000  -0.0215   0.1311   0.0000   0.4170
GW  11   1  -0.0215   0.1311   0.0000  -0.0475   0.1362   0.0000   0.4170
GW  12   1  -0.0475   0.1362   0.0000  -0.0759   0.1359   0.0000   0.4170
GW  13   1  -0.0759   0.1359   0.0000  -0.1054   0.1297   0.0000   0.4170
GW  14   1  -0.1054   0.1297   0.0000  -0.1348   0.1170   0.0000   0.4170
GW  15   1  -0.1348   0.1170   0.0000  -0.1627   0.0979   0.0000   0.4170
GW  16   1  -0.1627   0.0979   0.0000  -0.1878   0.0725   0.0000   0.4170
GW  17   1  -0.1878   0.0725   0.0000  -0.2087   0.0412   0.0000   0.4170
GW  18   1  -0.2087   0.0412   0.0000  -0.2241   0.0049   0.0000   0.4170
GW  19   1  -0.2241   0.0049   0.0000  -0.2328  -0.0356   0.0000   0.4170
GW  20   1  -0.2328  -0.0356   0.0000  -0.2340  -0.0788   0.0000   0.4170
GW  21   1  -0.2340  -0.0788   0.0000  -0.2270  -0.1234   0.0000   0.4170
GW  22   1  -0.2270  -0.1234   0.0000  -0.2112  -0.1678   0.0000   0.4170
GW  23   1  -0.2112  -0.1678   0.0000  -0.1867  -0.2103   0.0000   0.4170
GW  24   1  -0.1867  -0.2103   0.0000  -0.1536  -0.2490   0.0000   0.4170
GW  25   1  -0.1536  -0.2490   0.0000  -0.1126  -0.2824   0.0000   0.4170
GW  26   1  -0.1126  -0.2824   0.0000  -0.0645  -0.3087   0.0000   0.4170
GW  27   1  -0.0645  -0.3087   0.0000  -0.0107  -0.3266   0.0000   0.4170
GW  28   1  -0.0107  -0.3266   0.0000   0.0474  -0.3349   0.0000   0.4170
GW  29   1   0.0474  -0.3349   0.0000   0.1080  -0.3325   0.0000   0.4170
GW  30   1   0.1080  -0.3325   0.0000   0.1690  -0.3190   0.0000   0.4170
GW  31   1   0.1690  -0.3190   0.0000   0.2285  -0.2941   0.0000   0.4170
GW  32   1   0.2285  -0.2941   0.0000   0.2843  -0.2579   0.0000   0.4170
GW  33   1   0.2843  -0.2579   0.0000   0.3341  -0.2112   0.0000   0.4170
GW  34   1   0.3341  -0.2112   0.0000   0.3761  -0.1547   0.0000   0.4170
GW  35   1   0.3761  -0.1547   0.0000   0.4083  -0.0900   0.0000   0.4170
GW  36   1   0.4083  -0.0900   0.0000   0.4291  -0.0187   0.0000   0.4170
GW  37   1   0.4291  -0.0187   0.0000   0.4372   0.0570   0.0000   0.4170
GW  38   1   0.4372   0.0570   0.0000   0.4317   0.1350   0.0000   0.4170
GW  39   1   0.4317   0.1350   0.0000   0.4121   0.2126   0.0000   0.4170
GW  40   1   0.4121   0.2126   0.0000   0.3783   0.2874   0.0000   0.4170
GW  41   1   0.3783   0.2874   0.0000   0.3309   0.3567   0.0000   0.4170
GW  42   1   0.3309   0.3567   0.0000   0.2706   0.4180   0.0000   0.4170
GW  43   1   0.2706   0.4180   0.0000   0.1989   0.4689   0.0000   0.4170
GW  44   1   0.1989   0.4689   0.0000   0.1176   0.5073   0.0000   0.4170
GW  45   1   0.1176   0.5073   0.0000   0.0290   0.5314   0.0000   0.4170
GW  46   1   0.0290   0.5314   0.0000  -0.0644   0.5397   0.0000   0.4170
GW  47   1  -0.0644   0.5397   0.0000  -0.1598   0.5315   0.0000   0.4170
GW  48   1  -0.1598   0.5315   0.0000  -0.2542   0.5061   0.0000   0.4170
GW  49   1  -0.2542   0.5061   0.0000  -0.3445   0.4639   0.0000   0.4170
GW  50   1  -0.3445   0.4639   0.0000  -0.4276   0.4054   0.0000   0.4170
GW  51   1  -0.4276   0.4054   0.0000  -0.5006   0.3319   0.0000   0.4170
GW  52   1  -0.5006   0.3319   0.0000  -0.5608   0.2451   0.0000   0.4170
GW  53   1  -0.5608   0.2451   0.0000  -0.6058   0.1474   0.0000   0.4170
```

```
GW  54   1  -0.6058   0.1474   0.0000  -0.6335   0.0415   0.0000   0.4170
GW  55   1  -0.6335   0.0415   0.0000  -0.6425  -0.0696   0.0000   0.4170
GW  56   1  -0.6425  -0.0696   0.0000  -0.6318  -0.1825   0.0000   0.4170
GW  57   1  -0.6318  -0.1825   0.0000  -0.6011  -0.2938   0.0000   0.4170
GW  58   1  -0.6011  -0.2938   0.0000  -0.5507  -0.3997   0.0000   0.4170
GW  59   1  -0.5507  -0.3997   0.0000  -0.4815  -0.4969   0.0000   0.4170
GW  60   1  -0.4815  -0.4969   0.0000  -0.3950  -0.5819   0.0000   0.4170
GW  61   1  -0.3950  -0.5819   0.0000  -0.2934  -0.6517   0.0000   0.4170
GW  62   1  -0.2934  -0.6517   0.0000  -0.1794  -0.7036   0.0000   0.4170
GW  63   1  -0.1794  -0.7036   0.0000  -0.0562  -0.7354   0.0000   0.4170
GW  64   1  -0.0562  -0.7354   0.0000   0.0725  -0.7454   0.0000   0.4170
GW  65   1   0.0725  -0.7454   0.0000   0.2030  -0.7327   0.0000   0.4170
GW  66   1   0.2030  -0.7327   0.0000   0.3313  -0.6970   0.0000   0.4170
GW  67   1   0.3313  -0.6970   0.0000   0.4531  -0.6388   0.0000   0.4170
GW  68   1   0.4531  -0.6388   0.0000   0.5646  -0.5591   0.0000   0.4170
GW  69   1   0.5646  -0.5591   0.0000   0.6619  -0.4599   0.0000   0.4170
GW  70   1   0.6619  -0.4599   0.0000   0.7417  -0.3436   0.0000   0.4170
GW  71   1   0.7417  -0.3436   0.0000   0.8008  -0.2135   0.0000   0.4170
GW  72   1   0.8008  -0.2135   0.0000   0.8370  -0.0732   0.0000   0.4170
GW  73   1   0.8370  -0.0732   0.0000   0.8485   0.0732   0.0000   0.4170
GW  74   1   0.8485   0.0732   0.0000   0.8341   0.2214   0.0000   0.4170
GW  75   1   0.8341   0.2214   0.0000   0.7938   0.3667   0.0000   0.4170
GW  76   1   0.7938   0.3667   0.0000   0.7281   0.5046   0.0000   0.4170
GW  77   1   0.7281   0.5046   0.0000   0.6383   0.6306   0.0000   0.4170
GW  78   1   0.6383   0.6306   0.0000   0.5265   0.7405   0.0000   0.4170
GW  79   1   0.5265   0.7405   0.0000   0.3959   0.8306   0.0000   0.4170
GW  80   1   0.3959   0.8306   0.0000   0.2498   0.8974   0.0000   0.4170
GW  81   1   0.2498   0.8974   0.0000   0.0924   0.9384   0.0000   0.4170
GW  82   1   0.0924   0.9384   0.0000  -0.0717   0.9516   0.0000   0.4170
GW  83   1  -0.0717   0.9516   0.0000  -0.2375   0.9360   0.0000   0.4170
GW  84   1  -0.2375   0.9360   0.0000  -0.4001   0.8915   0.0000   0.4170
GW  85   1  -0.4001   0.8915   0.0000  -0.5542   0.8186   0.0000   0.4170
GW  86   1  -0.5542   0.8186   0.0000  -0.6950   0.7189   0.0000   0.4170
GW  87   1  -0.6950   0.7189   0.0000  -0.8178   0.5950   0.0000   0.4170
GW  88   1  -0.8178   0.5950   0.0000  -0.9184   0.4501   0.0000   0.4170
GW  89   1  -0.9184   0.4501   0.0000  -0.9932   0.2881   0.0000   0.4170
GW  90   1  -0.9932   0.2881   0.0000  -1.0394   0.1138   0.0000   0.4170
GW  91   1  -1.0394   0.1138   0.0000  -1.0548  -0.0679   0.0000   0.4170
GW  92   1  -1.0548  -0.0679   0.0000  -1.0384  -0.2515   0.0000   0.4170
GW  93   1  -1.0384  -0.2515   0.0000  -0.9899  -0.4313   0.0000   0.4170
GW  94   1  -0.9899  -0.4313   0.0000  -0.9102  -0.6019   0.0000   0.4170
GW  95   1  -0.9102  -0.6019   0.0000  -0.8010  -0.7577   0.0000   0.4170
GW  96   1  -0.8010  -0.7577   0.0000  -0.6652  -0.8936   0.0000   0.4170
GW  97   1  -0.6652  -0.8936   0.0000  -0.5062  -1.0051   0.0000   0.4170
GW  98   1  -0.5062  -1.0051   0.0000  -0.3286  -1.0883   0.0000   0.4170
GW  99   1  -0.3286  -1.0883   0.0000  -0.1374  -1.1400   0.0000   0.4170
GW 100   1  -0.1374  -1.1400   0.0000   0.0619  -1.1580   0.0000   0.4170
GW 101   1   0.0619  -1.1580   0.0000   0.2632  -1.1411   0.0000   0.4170
GW 102   1   0.2632  -1.1411   0.0000   0.4605  -1.0891   0.0000   0.4170
GW 103   1   0.4605  -1.0891   0.0000   0.6476  -1.0030   0.0000   0.4170
GW 104   1   0.6476  -1.0030   0.0000   0.8186  -0.8846   0.0000   0.4170
GW 105   1   0.8186  -0.8846   0.0000   0.9680  -0.7371   0.0000   0.4170
GW 106   1   0.9680  -0.7371   0.0000   1.0908  -0.5644   0.0000   0.4170
GW 107   1   1.0908  -0.5644   0.0000   1.1826  -0.3712   0.0000   0.4170
GW 108   1   1.1826  -0.3712   0.0000   1.2402  -0.1632   0.0000   0.4170
GW 109   1   1.2402  -0.1632   0.0000   1.2612   0.0536   0.0000   0.4170
GW 110   1   1.2612   0.0536   0.0000   1.2442   0.2728   0.0000   0.4170
GW 111   1   1.2442   0.2728   0.0000   1.1891   0.4876   0.0000   0.4170
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GW 112   1   1.1891   0.4876   0.0000   1.0968   0.6914   0.0000   0.4170
GW 113   1   1.0968   0.6914   0.0000   0.9696   0.8779   0.0000   0.4170
GW 114   1   0.9696   0.8779   0.0000   0.8107   1.0409   0.0000   0.4170
GW 115   1   0.8107   1.0409   0.0000   0.6244   1.1752   0.0000   0.4170
GW 116   1   0.6244   1.1752   0.0000   0.4159   1.2761   0.0000   0.4170
GW 117   1   0.4159   1.2761   0.0000   0.1912   1.3400   0.0000   0.4170
GW 118   1   0.1912   1.3400   0.0000  -0.0431   1.3643   0.0000   0.4170
GW 119   1  -0.0431   1.3643   0.0000  -0.2801   1.3476   0.0000   0.4170
GW 120   1  -0.2801   1.3476   0.0000  -0.5125   1.2897   0.0000   0.4170
GW 121   1  -0.5125   1.2897   0.0000  -0.7332   1.1918   0.0000   0.4170
GW 122   1  -0.7332   1.1918   0.0000  -0.9353   1.0560   0.0000   0.4170
GW 123   1  -0.9353   1.0560   0.0000  -1.1123   0.8860   0.0000   0.4170
GW 124   1  -1.1123   0.8860   0.0000  -1.2585   0.6863   0.0000   0.4170
GW 125   1  -1.2585   0.6863   0.0000  -1.3688   0.4627   0.0000   0.4170
GW 126   1  -1.3688   0.4627   0.0000  -1.4394   0.2214   0.0000   0.4170
GW 127   1  -1.4394   0.2214   0.0000  -1.4674  -0.0304   0.0000   0.4170
GW 128   1  -1.4674  -0.0304   0.0000  -1.4514  -0.2852   0.0000   0.4170
GW 129   1  -1.4514  -0.2852   0.0000  -1.3911  -0.5353   0.0000   0.4170
GW 130   1  -1.3911  -0.5353   0.0000  -1.2877  -0.7730   0.0000   0.4170
GW 131   1  -1.2877  -0.7730   0.0000  -1.1437  -0.9910   0.0000   0.4170
GW 132   1  -1.1437  -0.9910   0.0000  -0.9629  -1.1822   0.0000   0.4170
GW 133   1  -0.9629  -1.1822   0.0000  -0.7502  -1.3405   0.0000   0.4170
GW 134   1  -0.7502  -1.3405   0.0000  -0.5115  -1.4606   0.0000   0.4170
GW 135   1  -0.5115  -1.4606   0.0000  -0.2538  -1.5382   0.0000   0.4170
GW 136   1  -0.2538  -1.5382   0.0000   0.0154  -1.5703   0.0000   0.4170
GW 137   1   0.0154  -1.5703   0.0000   0.2880  -1.5553   0.0000   0.4170
GW 138   1   0.2880  -1.5553   0.0000   0.5559  -1.4931   0.0000   0.4170
GW 139   1   0.5559  -1.4931   0.0000   0.8108  -1.3847   0.0000   0.4170
GW 140   1   0.8108  -1.3847   0.0000   1.0449  -1.2328   0.0000   0.4170
GW 141   1   1.0449  -1.2328   0.0000   1.2506  -1.0414   0.0000   0.4170
GW 142   1   1.2506  -1.0414   0.0000   1.4213  -0.8158   0.0000   0.4170
GW 143   1   1.4213  -0.8158   0.0000   1.5514  -0.5624   0.0000   0.4170
GW 144   1   1.5514  -0.5624   0.0000   1.6364  -0.2884   0.0000   0.4170
GW 145   1   1.6364  -0.2884   0.0000   1.6731  -0.0019   0.0000   0.4170
GW 146   1   1.6731  -0.0019   0.0000   1.6596   0.2886   0.0000   0.4170
GW 147   1   1.6596   0.2886   0.0000   1.5956   0.5744   0.0000   0.4170
GW 148   1   1.5956   0.5744   0.0000   1.4826   0.8466   0.0000   0.4170
GW 149   1   1.4826   0.8466   0.0000   1.3232   1.0969   0.0000   0.4170
GW 150   1   1.3232   1.0969   0.0000   1.1216   1.3173   0.0000   0.4170
GW 151   1   1.1216   1.3173   0.0000   0.8834   1.5008   0.0000   0.4170
GW 152   1   0.8834   1.5008   0.0000   0.6153   1.6414   0.0000   0.4170
GW 153   1   0.6153   1.6414   0.0000   0.3251   1.7341   0.0000   0.4170
GW 154   1   0.3251   1.7341   0.0000   0.0213   1.7756   0.0000   0.4170
GW 155   1   0.0213   1.7756   0.0000  -0.2870   1.7639   0.0000   0.4170
GW 156   1  -0.2870   1.7639   0.0000  -0.5907   1.6988   0.0000   0.4170
GW 157   1  -0.5907   1.6988   0.0000  -0.8803   1.5814   0.0000   0.4170
GW 158   1  -0.8803   1.5814   0.0000  -1.1471   1.4148   0.0000   0.4170
GW 159   1  -1.1471   1.4148   0.0000  -1.3825   1.2033   0.0000   0.4170
GW 160   1  -1.3825   1.2033   0.0000  -1.5790   0.9527   0.0000   0.4170
GW 161   1  -1.5790   0.9527   0.0000  -1.7303   0.6703   0.0000   0.4170
GW 162   1  -1.7303   0.6703   0.0000  -1.8312   0.3640   0.0000   0.4170
GW 163   1  -1.8312   0.3640   0.0000  -1.8779   0.0431   0.0000   0.4170
GW 164   1  -1.8779   0.0431   0.0000  -1.8685  -0.2832   0.0000   0.4170
GW 165   1  -1.8685  -0.2832   0.0000  -1.8025  -0.6048   0.0000   0.4170
GW 166   1  -1.8025  -0.6048   0.0000  -1.6812  -0.9120   0.0000   0.4170
GW 167   1  -1.6812  -0.9120   0.0000  -1.5077  -1.1954   0.0000   0.4170
GW 168   1  -1.5077  -1.1954   0.0000  -1.2865  -1.4460   0.0000   0.4170
GW 169   1  -1.2865  -1.4460   0.0000  -1.0239  -1.6559   0.0000   0.4170
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GW 170   1  -1.0239  -1.6559   0.0000  -0.7272  -1.8182   0.0000   0.4170
GW 171   1  -0.7272  -1.8182   0.0000  -0.4051  -1.9276   0.0000   0.4170
GW 172   1  -0.4051  -1.9276   0.0000  -0.0670  -1.9800   0.0000   0.4170
GW 173   1  -0.0670  -1.9800   0.0000   0.2770  -1.9731   0.0000   0.4170
GW 174   1   0.2770  -1.9731   0.0000   0.6167  -1.9067   0.0000   0.4170
GW 175   1   0.6167  -1.9067   0.0000   0.9416  -1.7818   0.0000   0.4170
GW 176   1   0.9416  -1.7818   0.0000   1.2418  -1.6018   0.0000   0.4170
GW 177   1   1.2418  -1.6018   0.0000   1.5078  -1.3713   0.0000   0.4170
GW 178   1   1.5078  -1.3713   0.0000   1.7314  -1.0968   0.0000   0.4170
GW 179   1   1.7314  -1.0968   0.0000   1.9051  -0.7862   0.0000   0.4170
GW 180   1   1.9051  -0.7862   0.0000   2.0233  -0.4483   0.0000   0.4170
GW 181   1   2.0233  -0.4483   0.0000   2.0817  -0.0932   0.0000   0.4170
GW 182   1   2.0817  -0.0932   0.0000   2.0779   0.2687   0.0000   0.4170
GW 183   1   2.0779   0.2687   0.0000   2.0113   0.6264   0.0000   0.4170
GW 184   1   2.0113   0.6264   0.0000   1.8833   0.9691   0.0000   0.4170
GW 185   1   1.8833   0.9691   0.0000   1.6970   1.2862   0.0000   0.4170
GW 186   1   1.6970   1.2862   0.0000   1.4576   1.5680   0.0000   0.4170
GW 187   1   1.4576   1.5680   0.0000   1.1715   1.8054   0.0000   0.4170
GW 188   1   1.1715   1.8054   0.0000   0.8471   1.9909   0.0000   0.4170
GW 189   1   0.8471   1.9909   0.0000   0.4936   2.1183   0.0000   0.4170
GW 190   1   0.4936   2.1183   0.0000   0.1216   2.1831   0.0000   0.4170
GW 191   1   0.1216   2.1831   0.0000  -0.2581   2.1827   0.0000   0.4170
GW 192   1  -0.2581   2.1827   0.0000  -0.6339   2.1164   0.0000   0.4170
GW 193   1  -0.6339   2.1164   0.0000  -0.9945   1.9856   0.0000   0.4170
GW 194   1  -0.9945   1.9856   0.0000  -1.3288   1.7935   0.0000   0.4170
GW 195   1  -1.3288   1.7935   0.0000  -1.6264   1.5453   0.0000   0.4170
GW 196   1  -1.6264   1.5453   0.0000  -1.8781   1.2480   0.0000   0.4170
GW 197   1  -1.8781   1.2480   0.0000  -2.0756   0.9100   0.0000   0.4170
GW 198   1  -2.0756   0.9100   0.0000  -2.2125   0.5411   0.0000   0.4170
GW 199   1  -2.2125   0.5411   0.0000  -2.2841   0.1522   0.0000   0.4170
GW 200   1  -2.2841   0.1522   0.0000  -2.2874  -0.2452   0.0000   0.4170
GE
EX   0 100   1   0   1.0000   0.0000
FR   0   1   0   0   0.0005   0.0000
RP   0   1   1 1000   0.0000   0.0000   0.0000   0.0000
EN
```

10. Appendix E | Example NEC Output File: PSC.out

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                          NUMERICAL ELECTROMAGNETICS CODE (NEC-2D)

                        *******************************************


                             - - - - COMMENTS - - - -


                    RRS Planar Spiral Coil
                    Single Coil
                    File Generated by MATLAB


                            - - - STRUCTURE SPECIFICATION - - -

                                COORDINATES MUST BE INPUT IN
                                METERS OR BE SCALED TO METERS
                                BEFORE STRUCTURE INPUT IS ENDED
```

WIRE NO.	X1	Y1	Z1	X2	Y2	Z2	RADIUS	NO. OF SEG.	FIRST SEG.	LAST SEG.	TAG NO.
1	0.01880	0.00000	0.00000	0.02970	0.00520	0.00000	0.41700	1	1	1	1
2	0.02970	0.00520	0.00000	0.03910	0.01410	0.00000	0.41700	1	2	2	2
3	0.03910	0.01410	0.00000	0.04600	0.02630	0.00000	0.41700	1	3	3	3
4	0.04600	0.02630	0.00000	0.04950	0.04120	0.00000	0.41700	1	4	4	4
5	0.04950	0.04120	0.00000	0.04910	0.05780	0.00000	0.41700	1	5	5	5
6	0.04910	0.05780	0.00000	0.04420	0.07520	0.00000	0.41700	1	6	6	6
7	0.04420	0.07520	0.00000	0.03450	0.09240	0.00000	0.41700	1	7	7	7
8	0.03450	0.09240	0.00000	0.02020	0.10820	0.00000	0.41700	1	8	8	8
9	0.02020	0.10820	0.00000	0.00130	0.12140	0.00000	0.41700	1	9	9	9
10	0.00130	0.12140	0.00000	-0.02150	0.13110	0.00000	0.41700	1	10	10	10
11	-0.02150	0.13110	0.00000	-0.04750	0.13620	0.00000	0.41700	1	11	11	11
12	-0.04750	0.13620	0.00000	-0.07590	0.13590	0.00000	0.41700	1	12	12	12
13	-0.07590	0.13590	0.00000	-0.10540	0.12970	0.00000	0.41700	1	13	13	13
14	-0.10540	0.12970	0.00000	-0.13480	0.11700	0.00000	0.41700	1	14	14	14
15	-0.13480	0.11700	0.00000	-0.16270	0.09790	0.00000	0.41700	1	15	15	15
16	-0.16270	0.09790	0.00000	-0.18780	0.07250	0.00000	0.41700	1	16	16	16
17	-0.18780	0.07250	0.00000	-0.20870	0.04120	0.00000	0.41700	1	17	17	17
18	-0.20870	0.04120	0.00000	-0.22410	0.00490	0.00000	0.41700	1	18	18	18
19	-0.22410	0.00490	0.00000	-0.23280	-0.03560	0.00000	0.41700	1	19	19	19
20	-0.23280	-0.03560	0.00000	-0.23400	-0.07880	0.00000	0.41700	1	20	20	20
21	-0.23400	-0.07880	0.00000	-0.22700	-0.12340	0.00000	0.41700	1	21	21	21
22	-0.22700	-0.12340	0.00000	-0.21120	-0.16780	0.00000	0.41700	1	22	22	22
23	-0.21120	-0.16780	0.00000	-0.18670	-0.21030	0.00000	0.41700	1	23	23	23
24	-0.18670	-0.21030	0.00000	-0.15360	-0.24900	0.00000	0.41700	1	24	24	24
25	-0.15360	-0.24900	0.00000	-0.11260	-0.28240	0.00000	0.41700	1	25	25	25
26	-0.11260	-0.28240	0.00000	-0.06450	-0.30870	0.00000	0.41700	1	26	26	26
27	-0.06450	-0.30870	0.00000	-0.01070	-0.32660	0.00000	0.41700	1	27	27	27
28	-0.01070	-0.32660	0.00000	0.04740	-0.33490	0.00000	0.41700	1	28	28	28
29	0.04740	-0.33490	0.00000	0.10800	-0.33250	0.00000	0.41700	1	29	29	29
30	0.10800	-0.33250	0.00000	0.16900	-0.31900	0.00000	0.41700	1	30	30	30
31	0.16900	-0.31900	0.00000	0.22850	-0.29410	0.00000	0.41700	1	31	31	31
32	0.22850	-0.29410	0.00000	0.28430	-0.25790	0.00000	0.41700	1	32	32	32
33	0.28430	-0.25790	0.00000	0.33410	-0.21120	0.00000	0.41700	1	33	33	33
34	0.33410	-0.21120	0.00000	0.37610	-0.15470	0.00000	0.41700	1	34	34	34
35	0.37610	-0.15470	0.00000	0.40830	-0.09000	0.00000	0.41700	1	35	35	35
36	0.40830	-0.09000	0.00000	0.42910	-0.01870	0.00000	0.41700	1	36	36	36
37	0.42910	-0.01870	0.00000	0.43720	0.05700	0.00000	0.41700	1	37	37	37
38	0.43720	0.05700	0.00000	0.43170	0.13500	0.00000	0.41700	1	38	38	38
39	0.43170	0.13500	0.00000	0.41210	0.21260	0.00000	0.41700	1	39	39	39
40	0.41210	0.21260	0.00000	0.37830	0.28740	0.00000	0.41700	1	40	40	40
41	0.37830	0.28740	0.00000	0.33090	0.35670	0.00000	0.41700	1	41	41	41
42	0.33090	0.35670	0.00000	0.27060	0.41800	0.00000	0.41700	1	42	42	42
43	0.27060	0.41800	0.00000	0.19890	0.46890	0.00000	0.41700	1	43	43	43
44	0.19890	0.46890	0.00000	0.11760	0.50730	0.00000	0.41700	1	44	44	44
45	0.11760	0.50730	0.00000	0.02900	0.53140	0.00000	0.41700	1	45	45	45
46	0.02900	0.53140	0.00000	-0.06440	0.53970	0.00000	0.41700	1	46	46	46
47	-0.06440	0.53970	0.00000	-0.15980	0.53150	0.00000	0.41700	1	47	47	47
48	-0.15980	0.53150	0.00000	-0.25420	0.50610	0.00000	0.41700	1	48	48	48
49	-0.25420	0.50610	0.00000	-0.34450	0.46390	0.00000	0.41700	1	49	49	49
50	-0.34450	0.46390	0.00000	-0.42760	0.40540	0.00000	0.41700	1	50	50	50
51	-0.42760	0.40540	0.00000	-0.50060	0.33190	0.00000	0.41700	1	51	51	51
52	-0.50060	0.33190	0.00000	-0.56080	0.24510	0.00000	0.41700	1	52	52	52
53	-0.56080	0.24510	0.00000	-0.60580	0.14740	0.00000	0.41700	1	53	53	53
54	-0.60580	0.14740	0.00000	-0.63350	0.04150	0.00000	0.41700	1	54	54	54

55	-0.63350	0.04150	0.00000	-0.64250	-0.06960	0.00000	0.41700	1	55	55	55
56	-0.64250	-0.06960	0.00000	-0.63180	-0.18250	0.00000	0.41700	1	56	56	56
57	-0.63180	-0.18250	0.00000	-0.60110	-0.29380	0.00000	0.41700	1	57	57	57
58	-0.60110	-0.29380	0.00000	-0.55070	-0.39970	0.00000	0.41700	1	58	58	58
59	-0.55070	-0.39970	0.00000	-0.48150	-0.49690	0.00000	0.41700	1	59	59	59
60	-0.48150	-0.49690	0.00000	-0.39500	-0.58190	0.00000	0.41700	1	60	60	60
61	-0.39500	-0.58190	0.00000	-0.29340	-0.65170	0.00000	0.41700	1	61	61	61
62	-0.29340	-0.65170	0.00000	-0.17940	-0.70360	0.00000	0.41700	1	62	62	62
63	-0.17940	-0.70360	0.00000	-0.05620	-0.73540	0.00000	0.41700	1	63	63	63
64	-0.05620	-0.73540	0.00000	0.07250	-0.74540	0.00000	0.41700	1	64	64	64
65	0.07250	-0.74540	0.00000	0.20300	-0.73270	0.00000	0.41700	1	65	65	65
66	0.20300	-0.73270	0.00000	0.33130	-0.69700	0.00000	0.41700	1	66	66	66
67	0.33130	-0.69700	0.00000	0.45310	-0.63880	0.00000	0.41700	1	67	67	67
68	0.45310	-0.63880	0.00000	0.56460	-0.55910	0.00000	0.41700	1	68	68	68
69	0.56460	-0.55910	0.00000	0.66190	-0.45990	0.00000	0.41700	1	69	69	69
70	0.66190	-0.45990	0.00000	0.74170	-0.34360	0.00000	0.41700	1	70	70	70
71	0.74170	-0.34360	0.00000	0.80080	-0.21350	0.00000	0.41700	1	71	71	71
72	0.80080	-0.21350	0.00000	0.83700	-0.07320	0.00000	0.41700	1	72	72	72
73	0.83700	-0.07320	0.00000	0.84850	0.07320	0.00000	0.41700	1	73	73	73
74	0.84850	0.07320	0.00000	0.83410	0.22140	0.00000	0.41700	1	74	74	74
75	0.83410	0.22140	0.00000	0.79380	0.36670	0.00000	0.41700	1	75	75	75
76	0.79380	0.36670	0.00000	0.72810	0.50460	0.00000	0.41700	1	76	76	76
77	0.72810	0.50460	0.00000	0.63830	0.63060	0.00000	0.41700	1	77	77	77
78	0.63830	0.63060	0.00000	0.52650	0.74050	0.00000	0.41700	1	78	78	78
79	0.52650	0.74050	0.00000	0.39590	0.83060	0.00000	0.41700	1	79	79	79
80	0.39590	0.83060	0.00000	0.24980	0.89740	0.00000	0.41700	1	80	80	80
81	0.24980	0.89740	0.00000	0.09240	0.93840	0.00000	0.41700	1	81	81	81
82	0.09240	0.93840	0.00000	-0.07170	0.95160	0.00000	0.41700	1	82	82	82
83	-0.07170	0.95160	0.00000	-0.23750	0.93600	0.00000	0.41700	1	83	83	83
84	-0.23750	0.93600	0.00000	-0.40010	0.89150	0.00000	0.41700	1	84	84	84
85	-0.40010	0.89150	0.00000	-0.55420	0.81860	0.00000	0.41700	1	85	85	85
86	-0.55420	0.81860	0.00000	-0.69500	0.71890	0.00000	0.41700	1	86	86	86
87	-0.69500	0.71890	0.00000	-0.81780	0.59500	0.00000	0.41700	1	87	87	87
88	-0.81780	0.59500	0.00000	-0.91840	0.45010	0.00000	0.41700	1	88	88	88
89	-0.91840	0.45010	0.00000	-0.99320	0.28810	0.00000	0.41700	1	89	89	89
90	-0.99320	0.28810	0.00000	-1.03940	0.11380	0.00000	0.41700	1	90	90	90
91	-1.03940	0.11380	0.00000	-1.05480	-0.06790	0.00000	0.41700	1	91	91	91
92	-1.05480	-0.06790	0.00000	-1.03840	-0.25150	0.00000	0.41700	1	92	92	92
93	-1.03840	-0.25150	0.00000	-0.98990	-0.43130	0.00000	0.41700	1	93	93	93
94	-0.98990	-0.43130	0.00000	-0.91020	-0.60190	0.00000	0.41700	1	94	94	94
95	-0.91020	-0.60190	0.00000	-0.80100	-0.75770	0.00000	0.41700	1	95	95	95
96	-0.80100	-0.75770	0.00000	-0.66520	-0.89360	0.00000	0.41700	1	96	96	96
97	-0.66520	-0.89360	0.00000	-0.50620	-1.00510	0.00000	0.41700	1	97	97	97
98	-0.50620	-1.00510	0.00000	-0.32860	-1.08830	0.00000	0.41700	1	98	98	98
99	-0.32860	-1.08830	0.00000	-0.13740	-1.14000	0.00000	0.41700	1	99	99	99
100	-0.13740	-1.14000	0.00000	0.06190	-1.15800	0.00000	0.41700	1	100	100	100
101	0.06190	-1.15800	0.00000	0.26320	-1.14110	0.00000	0.41700	1	101	101	101
102	0.26320	-1.14110	0.00000	0.46050	-1.08910	0.00000	0.41700	1	102	102	102
103	0.46050	-1.08910	0.00000	0.64760	-1.00300	0.00000	0.41700	1	103	103	103
104	0.64760	-1.00300	0.00000	0.81860	-0.88460	0.00000	0.41700	1	104	104	104
105	0.81860	-0.88460	0.00000	0.96800	-0.73710	0.00000	0.41700	1	105	105	105
106	0.96800	-0.73710	0.00000	1.09080	-0.56440	0.00000	0.41700	1	106	106	106
107	1.09080	-0.56440	0.00000	1.18260	-0.37120	0.00000	0.41700	1	107	107	107
108	1.18260	-0.37120	0.00000	1.24020	-0.16320	0.00000	0.41700	1	108	108	108
109	1.24020	-0.16320	0.00000	1.26120	0.05360	0.00000	0.41700	1	109	109	109
110	1.26120	0.05360	0.00000	1.24420	0.27280	0.00000	0.41700	1	110	110	110
111	1.24420	0.27280	0.00000	1.18910	0.48760	0.00000	0.41700	1	111	111	111
112	1.18910	0.48760	0.00000	1.09680	0.69140	0.00000	0.41700	1	112	112	112
113	1.09680	0.69140	0.00000	0.96960	0.87790	0.00000	0.41700	1	113	113	113
114	0.96960	0.87790	0.00000	0.81070	1.04090	0.00000	0.41700	1	114	114	114
115	0.81070	1.04090	0.00000	0.62440	1.17520	0.00000	0.41700	1	115	115	115
116	0.62440	1.17520	0.00000	0.41590	1.27610	0.00000	0.41700	1	116	116	116
117	0.41590	1.27610	0.00000	0.19120	1.34000	0.00000	0.41700	1	117	117	117
118	0.19120	1.34000	0.00000	-0.04310	1.36430	0.00000	0.41700	1	118	118	118
119	-0.04310	1.36430	0.00000	-0.28010	1.34760	0.00000	0.41700	1	119	119	119
120	-0.28010	1.34760	0.00000	-0.51250	1.28970	0.00000	0.41700	1	120	120	120
121	-0.51250	1.28970	0.00000	-0.73320	1.19180	0.00000	0.41700	1	121	121	121
122	-0.73320	1.19180	0.00000	-0.93530	1.05600	0.00000	0.41700	1	122	122	122
123	-0.93530	1.05600	0.00000	-1.11230	0.88600	0.00000	0.41700	1	123	123	123
124	-1.11230	0.88600	0.00000	-1.25850	0.68630	0.00000	0.41700	1	124	124	124
125	-1.25850	0.68630	0.00000	-1.36880	0.46270	0.00000	0.41700	1	125	125	125
126	-1.36880	0.46270	0.00000	-1.43940	0.22140	0.00000	0.41700	1	126	126	126
127	-1.43940	0.22140	0.00000	-1.46740	-0.03040	0.00000	0.41700	1	127	127	127
128	-1.46740	-0.03040	0.00000	-1.45140	-0.28520	0.00000	0.41700	1	128	128	128
129	-1.45140	-0.28520	0.00000	-1.39110	-0.53530	0.00000	0.41700	1	129	129	129
130	-1.39110	-0.53530	0.00000	-1.28770	-0.77300	0.00000	0.41700	1	130	130	130
131	-1.28770	-0.77300	0.00000	-1.14370	-0.99100	0.00000	0.41700	1	131	131	131
132	-1.14370	-0.99100	0.00000	-0.96290	-1.18220	0.00000	0.41700	1	132	132	132
133	-0.96290	-1.18220	0.00000	-0.75020	-1.34050	0.00000	0.41700	1	133	133	133
134	-0.75020	-1.34050	0.00000	-0.51150	-1.46060	0.00000	0.41700	1	134	134	134
135	-0.51150	-1.46060	0.00000	-0.25380	-1.53820	0.00000	0.41700	1	135	135	135
136	-0.25380	-1.53820	0.00000	0.01540	-1.57030	0.00000	0.41700	1	136	136	136
137	0.01540	-1.57030	0.00000	0.28800	-1.55530	0.00000	0.41700	1	137	137	137
138	0.28800	-1.55530	0.00000	0.55590	-1.49310	0.00000	0.41700	1	138	138	138
139	0.55590	-1.49310	0.00000	0.81080	-1.38470	0.00000	0.41700	1	139	139	139
140	0.81080	-1.38470	0.00000	1.04490	-1.23280	0.00000	0.41700	1	140	140	140
141	1.04490	-1.23280	0.00000	1.25060	-1.04140	0.00000	0.41700	1	141	141	141
142	1.25060	-1.04140	0.00000	1.42130	-0.81580	0.00000	0.41700	1	142	142	142
143	1.42130	-0.81580	0.00000	1.55140	-0.56240	0.00000	0.41700	1	143	143	143
144	1.55140	-0.56240	0.00000	1.63640	-0.28840	0.00000	0.41700	1	144	144	144

145	1.63640	-0.28840	0.00000	1.67310	-0.00190	0.00000	0.41700	1	145	145	145
146	1.67310	-0.00190	0.00000	1.65960	0.28860	0.00000	0.41700	1	146	146	146
147	1.65960	0.28860	0.00000	1.59560	0.57440	0.00000	0.41700	1	147	147	147
148	1.59560	0.57440	0.00000	1.48260	0.84660	0.00000	0.41700	1	148	148	148
149	1.48260	0.84660	0.00000	1.32320	1.09690	0.00000	0.41700	1	149	149	149
150	1.32320	1.09690	0.00000	1.12160	1.31730	0.00000	0.41700	1	150	150	150
151	1.12160	1.31730	0.00000	0.88340	1.50080	0.00000	0.41700	1	151	151	151
152	0.88340	1.50080	0.00000	0.61530	1.64140	0.00000	0.41700	1	152	152	152
153	0.61530	1.64140	0.00000	0.32510	1.73410	0.00000	0.41700	1	153	153	153
154	0.32510	1.73410	0.00000	0.02130	1.77560	0.00000	0.41700	1	154	154	154
155	0.02130	1.77560	0.00000	-0.28700	1.76390	0.00000	0.41700	1	155	155	155
156	-0.28700	1.76390	0.00000	-0.59070	1.69880	0.00000	0.41700	1	156	156	156
157	-0.59070	1.69880	0.00000	-0.88030	1.58140	0.00000	0.41700	1	157	157	157
158	-0.88030	1.58140	0.00000	-1.14710	1.41480	0.00000	0.41700	1	158	158	158
159	-1.14710	1.41480	0.00000	-1.38250	1.20330	0.00000	0.41700	1	159	159	159
160	-1.38250	1.20330	0.00000	-1.57900	0.95270	0.00000	0.41700	1	160	160	160
161	-1.57900	0.95270	0.00000	-1.73030	0.67030	0.00000	0.41700	1	161	161	161
162	-1.73030	0.67030	0.00000	-1.83120	0.36400	0.00000	0.41700	1	162	162	162
163	-1.83120	0.36400	0.00000	-1.87790	0.04310	0.00000	0.41700	1	163	163	163
164	-1.87790	0.04310	0.00000	-1.86850	-0.28320	0.00000	0.41700	1	164	164	164
165	-1.86850	-0.28320	0.00000	-1.80250	-0.60480	0.00000	0.41700	1	165	165	165
166	-1.80250	-0.60480	0.00000	-1.68120	-0.91200	0.00000	0.41700	1	166	166	166
167	-1.68120	-0.91200	0.00000	-1.50770	-1.19540	0.00000	0.41700	1	167	167	167
168	-1.50770	-1.19540	0.00000	-1.28650	-1.44600	0.00000	0.41700	1	168	168	168
169	-1.28650	-1.44600	0.00000	-1.02390	-1.65590	0.00000	0.41700	1	169	169	169
170	-1.02390	-1.65590	0.00000	-0.72720	-1.81820	0.00000	0.41700	1	170	170	170
171	-0.72720	-1.81820	0.00000	-0.40510	-1.92760	0.00000	0.41700	1	171	171	171
172	-0.40510	-1.92760	0.00000	-0.06700	-1.98000	0.00000	0.41700	1	172	172	172
173	-0.06700	-1.98000	0.00000	0.27700	-1.97310	0.00000	0.41700	1	173	173	173
174	0.27700	-1.97310	0.00000	0.61670	-1.90670	0.00000	0.41700	1	174	174	174
175	0.61670	-1.90670	0.00000	0.94160	-1.78180	0.00000	0.41700	1	175	175	175
176	0.94160	-1.78180	0.00000	1.24180	-1.60180	0.00000	0.41700	1	176	176	176
177	1.24180	-1.60180	0.00000	1.50780	-1.37130	0.00000	0.41700	1	177	177	177
178	1.50780	-1.37130	0.00000	1.73140	-1.09680	0.00000	0.41700	1	178	178	178
179	1.73140	-1.09680	0.00000	1.90510	-0.78620	0.00000	0.41700	1	179	179	179
180	1.90510	-0.78620	0.00000	2.02330	-0.44830	0.00000	0.41700	1	180	180	180
181	2.02330	-0.44830	0.00000	2.08170	-0.09320	0.00000	0.41700	1	181	181	181
182	2.08170	-0.09320	0.00000	2.07790	0.26870	0.00000	0.41700	1	182	182	182
183	2.07790	0.26870	0.00000	2.01130	0.62640	0.00000	0.41700	1	183	183	183
184	2.01130	0.62640	0.00000	1.88330	0.96910	0.00000	0.41700	1	184	184	184
185	1.88330	0.96910	0.00000	1.69700	1.28620	0.00000	0.41700	1	185	185	185
186	1.69700	1.28620	0.00000	1.45760	1.56800	0.00000	0.41700	1	186	186	186
187	1.45760	1.56800	0.00000	1.17150	1.80540	0.00000	0.41700	1	187	187	187
188	1.17150	1.80540	0.00000	0.84710	1.99090	0.00000	0.41700	1	188	188	188
189	0.84710	1.99090	0.00000	0.49360	2.11830	0.00000	0.41700	1	189	189	189
190	0.49360	2.11830	0.00000	0.12160	2.18310	0.00000	0.41700	1	190	190	190
191	0.12160	2.18310	0.00000	-0.25810	2.18270	0.00000	0.41700	1	191	191	191
192	-0.25810	2.18270	0.00000	-0.63390	2.11640	0.00000	0.41700	1	192	192	192
193	-0.63390	2.11640	0.00000	-0.99450	1.98560	0.00000	0.41700	1	193	193	193
194	-0.99450	1.98560	0.00000	-1.32880	1.79350	0.00000	0.41700	1	194	194	194
195	-1.32880	1.79350	0.00000	-1.62640	1.54530	0.00000	0.41700	1	195	195	195
196	-1.62640	1.54530	0.00000	-1.87810	1.24800	0.00000	0.41700	1	196	196	196
197	-1.87810	1.24800	0.00000	-2.07560	0.91000	0.00000	0.41700	1	197	197	197
198	-2.07560	0.91000	0.00000	-2.21250	0.54110	0.00000	0.41700	1	198	198	198
199	-2.21250	0.54110	0.00000	-2.28410	0.15220	0.00000	0.41700	1	199	199	199
200	-2.28410	0.15220	0.00000	-2.28740	-0.24520	0.00000	0.41700	1	200	200	200

TOTAL SEGMENTS USED= 200 NO. SEG. IN A SYMMETRIC CELL= 200 SYMMETRY FLAG= 0

- MULTIPLE WIRE JUNCTIONS -

JUNCTION SEGMENTS (- FOR END 1, + FOR END 2)

NONE

- - - - SEGMENTATION DATA - - - -

COORDINATES IN METERS

I+ AND I- INDICATE THE SEGMENTS BEFORE AND AFTER I

SEG. NO.	COORDINATES OF SEG. CENTER X	Y	Z	SEG. LENGTH	ORIENTATION ANGLES ALPHA	BETA	WIRE RADIUS	CONNECTION DATA I-	I	I+	TAG NO.
1	0.02425	0.00260	0.00000	0.01208	0.00000	25.50414	0.41700	0	1	2	1
2	0.03440	0.00965	0.00000	0.01294	0.00000	43.43493	0.41700	1	2	3	2
3	0.04255	0.02020	0.00000	0.01402	0.00000	60.50864	0.41700	2	3	4	3
4	0.04775	0.03375	0.00000	0.01531	0.00000	76.78092	0.41700	3	4	5	4
5	0.04930	0.04950	0.00000	0.01660	0.00000	91.38035	0.41700	4	5	6	5
6	0.04665	0.06650	0.00000	0.01808	0.00000	105.72771	0.41700	5	6	7	6
7	0.03935	0.08380	0.00000	0.01975	0.00000	119.42098	0.41700	6	7	8	7
8	0.02735	0.10030	0.00000	0.02131	0.00000	132.14709	0.41700	7	8	9	8
9	0.01075	0.11480	0.00000	0.02305	0.00000	145.06906	0.41700	8	9	10	9
10	-0.01010	0.12625	0.00000	0.02478	0.00000	156.95323	0.41700	9	10	11	10
11	-0.03450	0.13365	0.00000	0.02650	0.00000	168.90212	0.41700	10	11	12	11
12	-0.06170	0.13605	0.00000	0.02840	0.00000	-179.39479	0.41700	11	12	13	12
13	-0.09065	0.13280	0.00000	0.03014	0.00000	-168.13092	0.41700	12	13	14	13
14	-0.12010	0.12335	0.00000	0.03203	0.00000	-156.63697	0.41700	13	14	15	14

15	-0.14875	0.10745	0.00000	0.03381	0.00000	-145.60493	0.41700	14	15	16	15
16	-0.17525	0.08520	0.00000	0.03571	0.00000	-134.65963	0.41700	15	16	17	16
17	-0.19825	0.05685	0.00000	0.03764	0.00000	-123.73229	0.41700	16	17	18	17
18	-0.21640	0.02305	0.00000	0.03943	0.00000	-112.98872	0.41700	17	18	19	18
19	-0.22845	-0.01535	0.00000	0.04142	0.00000	-102.12374	0.41700	18	19	20	19
20	-0.23340	-0.05720	0.00000	0.04322	0.00000	-91.59114	0.41700	19	20	21	20
21	-0.23050	-0.10110	0.00000	0.04515	0.00000	-81.08016	0.41700	20	21	22	21
22	-0.21910	-0.14560	0.00000	0.04713	0.00000	-70.41160	0.41700	21	22	23	22
23	-0.19895	-0.18905	0.00000	0.04906	0.00000	-60.03782	0.41700	22	23	24	23
24	-0.17015	-0.22965	0.00000	0.05092	0.00000	-49.45972	0.41700	23	24	25	24
25	-0.13310	-0.26570	0.00000	0.05288	0.00000	-39.16744	0.41700	24	25	26	25
26	-0.08855	-0.29555	0.00000	0.05482	0.00000	-28.66885	0.41700	25	26	27	26
27	-0.03760	-0.31765	0.00000	0.05670	0.00000	-18.40299	0.41700	26	27	28	27
28	0.01835	-0.33075	0.00000	0.05869	0.00000	-8.13010	0.41700	27	28	29	28
29	0.07770	-0.33370	0.00000	0.06065	0.00000	2.26795	0.41700	28	29	30	29
30	0.13850	-0.32575	0.00000	0.06248	0.00000	12.47907	0.41700	29	30	31	30
31	0.19875	-0.30655	0.00000	0.06450	0.00000	22.70870	0.41700	30	31	32	31
32	0.25640	-0.27600	0.00000	0.06651	0.00000	32.97331	0.41700	31	32	33	32
33	0.30920	-0.23455	0.00000	0.06827	0.00000	43.16004	0.41700	32	33	34	33
34	0.35510	-0.18295	0.00000	0.07040	0.00000	53.37426	0.41700	33	34	35	34
35	0.39220	-0.12235	0.00000	0.07227	0.00000	63.54131	0.41700	34	35	36	35
36	0.41870	-0.05435	0.00000	0.07427	0.00000	73.73671	0.41700	35	36	37	36
37	0.43315	0.01915	0.00000	0.07613	0.00000	83.89251	0.41700	36	37	38	37
38	0.43445	0.09600	0.00000	0.07819	0.00000	94.03341	0.41700	37	38	39	38
39	0.42190	0.17380	0.00000	0.08004	0.00000	104.17514	0.41700	38	39	40	39
40	0.39520	0.25000	0.00000	0.08208	0.00000	114.31686	0.41700	39	40	41	40
41	0.35460	0.32205	0.00000	0.08396	0.00000	124.37145	0.41700	40	41	42	41
42	0.30075	0.38735	0.00000	0.08599	0.00000	134.52883	0.41700	41	42	43	42
43	0.23475	0.44345	0.00000	0.08793	0.00000	144.62897	0.41700	42	43	44	43
44	0.15825	0.48810	0.00000	0.08991	0.00000	154.71748	0.41700	43	44	45	44
45	0.07330	0.51935	0.00000	0.09182	0.00000	164.78319	0.41700	44	45	46	45
46	-0.01770	0.53555	0.00000	0.09377	0.00000	174.92174	0.41700	45	46	47	46
47	-0.11210	0.53560	0.00000	0.09575	0.00000	-175.08728	0.41700	46	47	48	47
48	-0.20700	0.51880	0.00000	0.09776	0.00000	-164.94022	0.41700	47	48	49	48
49	-0.29935	0.48500	0.00000	0.09967	0.00000	-154.95185	0.41700	48	49	50	49
50	-0.38605	0.43465	0.00000	0.10163	0.00000	-144.85556	0.41700	49	50	51	50
51	-0.46410	0.36865	0.00000	0.10359	0.00000	-134.80445	0.41700	50	51	52	51
52	-0.53070	0.28850	0.00000	0.10563	0.00000	-124.74318	0.41700	51	52	53	52
53	-0.58330	0.19625	0.00000	0.10757	0.00000	-114.73050	0.41700	52	53	54	53
54	-0.61965	0.09445	0.00000	0.10946	0.00000	-104.65831	0.41700	53	54	55	54
55	-0.63800	-0.01405	0.00000	0.11146	0.00000	-94.63131	0.41700	54	55	56	55
56	-0.63715	-0.12605	0.00000	0.11341	0.00000	-84.58601	0.41700	55	56	57	56
57	-0.61645	-0.23815	0.00000	0.11546	0.00000	-74.57949	0.41700	56	57	58	57
58	-0.57590	-0.34675	0.00000	0.11728	0.00000	-64.54926	0.41700	57	58	59	58
59	-0.51610	-0.44830	0.00000	0.11932	0.00000	-54.55164	0.41700	58	59	60	59
60	-0.43825	-0.53940	0.00000	0.12127	0.00000	-44.49888	0.41700	59	60	61	60
61	-0.34420	-0.61680	0.00000	0.12327	0.00000	-34.48937	0.41700	60	61	62	61
62	-0.23640	-0.67765	0.00000	0.12526	0.00000	-24.47803	0.41700	61	62	63	62
63	-0.11780	-0.71950	0.00000	0.12724	0.00000	-14.47311	0.41700	62	63	64	63
64	0.00815	-0.74040	0.00000	0.12909	0.00000	-4.44296	0.41700	63	64	65	64
65	0.13775	-0.73905	0.00000	0.13112	0.00000	5.55841	0.41700	64	65	66	65
66	0.26715	-0.71485	0.00000	0.13317	0.00000	15.54944	0.41700	65	66	67	66
67	0.39220	-0.66790	0.00000	0.13499	0.00000	25.53999	0.41700	66	67	68	67
68	0.50885	-0.59895	0.00000	0.13706	0.00000	35.55712	0.41700	67	68	69	68
69	0.61325	-0.50950	0.00000	0.13895	0.00000	45.55399	0.41700	68	69	70	69
70	0.70180	-0.40175	0.00000	0.14105	0.00000	55.54378	0.41700	69	70	71	70
71	0.77125	-0.27855	0.00000	0.14289	0.00000	65.56932	0.41700	70	71	72	71
72	0.81890	-0.14335	0.00000	0.14489	0.00000	75.53218	0.41700	71	72	73	72
73	0.84275	0.00000	0.00000	0.14685	0.00000	85.50853	0.41700	72	73	74	73
74	0.84130	0.14730	0.00000	0.14890	0.00000	95.54978	0.41700	73	74	75	74
75	0.81395	0.29405	0.00000	0.15079	0.00000	105.50174	0.41700	74	75	76	75
76	0.76095	0.43565	0.00000	0.15275	0.00000	115.47463	0.41700	75	76	77	76
77	0.68320	0.56760	0.00000	0.15473	0.00000	125.47741	0.41700	76	77	78	77
78	0.58240	0.68555	0.00000	0.15677	0.00000	135.49102	0.41700	77	78	79	78
79	0.46120	0.78555	0.00000	0.15866	0.00000	145.39849	0.41700	78	79	80	79
80	0.32285	0.86400	0.00000	0.16065	0.00000	155.42912	0.41700	79	80	81	80
81	0.17110	0.91790	0.00000	0.16265	0.00000	165.39987	0.41700	80	81	82	81
82	0.01035	0.94500	0.00000	0.16463	0.00000	175.40110	0.41700	81	82	83	82
83	-0.15460	0.94380	0.00000	0.16653	0.00000	-174.62491	0.41700	82	83	84	83
84	-0.31880	0.91375	0.00000	0.16858	0.00000	-164.69421	0.41700	83	84	85	84
85	-0.47715	0.85505	0.00000	0.17047	0.00000	-154.68260	0.41700	84	85	86	85
86	-0.62460	0.76875	0.00000	0.17252	0.00000	-144.69782	0.41700	85	86	87	86
87	-0.75640	0.65695	0.00000	0.17444	0.00000	-134.74453	0.41700	86	87	88	87
88	-0.86810	0.52255	0.00000	0.17640	0.00000	-124.77116	0.41700	87	88	89	88
89	-0.95580	0.36910	0.00000	0.17843	0.00000	-114.78411	0.41700	88	89	90	89
90	-1.01630	0.20095	0.00000	0.18032	0.00000	-104.84545	0.41700	89	90	91	90
91	-1.04710	0.02295	0.00000	0.18235	0.00000	-94.84453	0.41700	90	91	92	91
92	-1.04660	-0.15970	0.00000	0.18433	0.00000	-84.89562	0.41700	91	92	93	92
93	-1.01415	-0.34140	0.00000	0.18623	0.00000	-74.90409	0.41700	92	93	94	93
94	-0.95005	-0.51660	0.00000	0.18830	0.00000	-64.95921	0.41700	93	94	95	94
95	-0.85560	-0.67980	0.00000	0.19026	0.00000	-54.97344	0.41700	94	95	96	95
96	-0.73310	-0.82565	0.00000	0.19212	0.00000	-45.02109	0.41700	95	96	97	96
97	-0.58570	-0.94935	0.00000	0.19420	0.00000	-35.04036	0.41700	96	97	98	97
98	-0.41740	-1.04670	0.00000	0.19612	0.00000	-25.10161	0.41700	97	98	99	98
99	-0.23300	-1.11415	0.00000	0.19807	0.00000	-15.13080	0.41700	98	99	100	99
100	-0.03775	-1.14900	0.00000	0.20011	0.00000	-5.16073	0.41700	99	100	101	100
101	0.16255	-1.14955	0.00000	0.20201	0.00000	4.79897	0.41700	100	101	102	101
102	0.36185	-1.11510	0.00000	0.20404	0.00000	14.76500	0.41700	101	102	103	102
103	0.55405	-1.04605	0.00000	0.20596	0.00000	24.71102	0.41700	102	103	104	103
104	0.73310	-0.94380	0.00000	0.20799	0.00000	34.69864	0.41700	103	104	105	104

105	0.89330	-0.81085	0.00000	0.20994	0.00000	44.63334	0.41700	104	105	106	105
106	1.02940	-0.65075	0.00000	0.21191	0.00000	54.58490	0.41700	105	106	107	106
107	1.13670	-0.46780	0.00000	0.21390	0.00000	64.58502	0.41700	106	107	108	107
108	1.21140	-0.26720	0.00000	0.21583	0.00000	74.52136	0.41700	107	108	109	108
109	1.25070	-0.05480	0.00000	0.21781	0.00000	84.46739	0.41700	108	109	110	109
110	1.25270	0.16320	0.00000	0.21986	0.00000	94.43468	0.41700	109	110	111	110
111	1.21665	0.38020	0.00000	0.22175	0.00000	104.38717	0.41700	110	111	112	111
112	1.14295	0.58950	0.00000	0.22373	0.00000	114.36553	0.41700	111	112	113	112
113	1.03320	0.78465	0.00000	0.22575	0.00000	124.29546	0.41700	112	113	114	113
114	0.89015	0.95940	0.00000	0.22764	0.00000	134.27027	0.41700	113	114	115	114
115	0.71755	1.10805	0.00000	0.22966	0.00000	144.21291	0.41700	114	115	116	115
116	0.52015	1.22565	0.00000	0.23163	0.00000	154.17613	0.41700	115	116	117	116
117	0.30355	1.30805	0.00000	0.23361	0.00000	164.12535	0.41700	116	117	118	117
118	0.07405	1.35215	0.00000	0.23556	0.00000	174.07884	0.41700	117	118	119	118
119	-0.16160	1.35595	0.00000	0.23759	0.00000	-175.96936	0.41700	118	119	120	119
120	-0.39630	1.31865	0.00000	0.23950	0.00000	-166.01017	0.41700	119	120	121	120
121	-0.62285	1.24075	0.00000	0.24144	0.00000	-156.07847	0.41700	120	121	122	121
122	-0.83425	1.12390	0.00000	0.24349	0.00000	-146.10109	0.41700	121	122	123	122
123	-1.02380	0.97100	0.00000	0.24542	0.00000	-136.15567	0.41700	122	123	124	123
124	-1.18540	0.78615	0.00000	0.24750	0.00000	-126.20779	0.41700	123	124	125	124
125	-1.31365	0.57450	0.00000	0.24933	0.00000	-116.25674	0.41700	124	125	126	125
126	-1.40410	0.34205	0.00000	0.25142	0.00000	-106.30852	0.41700	125	126	127	126
127	-1.45340	0.09550	0.00000	0.25335	0.00000	-96.34519	0.41700	126	127	128	127
128	-1.45940	-0.15780	0.00000	0.25530	0.00000	-86.40687	0.41700	127	128	129	128
129	-1.42125	-0.41025	0.00000	0.25727	0.00000	-76.44450	0.41700	128	129	130	129
130	-1.33940	-0.65415	0.00000	0.25922	0.00000	-66.49086	0.41700	129	130	131	130
131	-1.21570	-0.88200	0.00000	0.26127	0.00000	-56.55323	0.41700	130	131	132	131
132	-1.05330	-1.08660	0.00000	0.26315	0.00000	-46.60140	0.41700	131	132	133	132
133	-0.85655	-1.26135	0.00000	0.26514	0.00000	-36.65812	0.41700	132	133	134	133
134	-0.63085	-1.40055	0.00000	0.26721	0.00000	-26.70889	0.41700	133	134	135	134
135	-0.38265	-1.49940	0.00000	0.26913	0.00000	-16.75838	0.41700	134	135	136	135
136	-0.11920	-1.55425	0.00000	0.27111	0.00000	-6.79997	0.41700	135	136	137	136
137	0.15170	-1.56280	0.00000	0.27301	0.00000	3.14956	0.41700	136	137	138	137
138	0.42195	-1.52420	0.00000	0.27503	0.00000	13.07113	0.41700	137	138	139	138
139	0.68335	-1.43890	0.00000	0.27699	0.00000	23.03834	0.41700	138	139	140	139
140	0.92785	-1.30875	0.00000	0.27906	0.00000	32.97825	0.41700	139	140	141	140
141	1.14775	-1.13710	0.00000	0.28097	0.00000	42.93761	0.41700	140	141	142	141
142	1.33595	-0.92860	0.00000	0.28290	0.00000	52.88707	0.41700	141	142	143	142
143	1.48635	-0.68910	0.00000	0.28485	0.00000	62.82324	0.41700	142	143	144	143
144	1.59390	-0.42540	0.00000	0.28688	0.00000	72.76512	0.41700	143	144	145	144
145	1.65475	-0.14515	0.00000	0.28884	0.00000	82.70029	0.41700	144	145	146	145
146	1.66635	0.14335	0.00000	0.29081	0.00000	92.66071	0.41700	145	146	147	146
147	1.62760	0.43150	0.00000	0.29288	0.00000	102.62217	0.41700	146	147	148	147
148	1.53910	0.71050	0.00000	0.29472	0.00000	112.54509	0.41700	147	148	149	148
149	1.40290	0.97175	0.00000	0.29675	0.00000	122.49044	0.41700	148	149	150	149
150	1.22240	1.20710	0.00000	0.29870	0.00000	132.44917	0.41700	149	150	151	150
151	1.00250	1.40905	0.00000	0.30069	0.00000	142.39074	0.41700	150	151	152	151
152	0.74935	1.57110	0.00000	0.30273	0.00000	152.32608	0.41700	151	152	153	152
153	0.47020	1.68775	0.00000	0.30465	0.00000	162.28470	0.41700	152	153	154	153
154	0.17320	1.75485	0.00000	0.30662	0.00000	172.22137	0.41700	153	154	155	154
155	-0.13285	1.76975	0.00000	0.30852	0.00000	-177.82667	0.41700	154	155	156	155
156	-0.43885	1.73135	0.00000	0.31060	0.00000	-167.90138	0.41700	155	156	157	156
157	-0.73550	1.64010	0.00000	0.31249	0.00000	-157.93302	0.41700	156	157	158	157
158	-1.01370	1.49810	0.00000	0.31454	0.00000	-148.01779	0.41700	157	158	159	158
159	-1.26480	1.30905	0.00000	0.31646	0.00000	-138.06123	0.41700	158	159	160	159
160	-1.48075	1.07800	0.00000	0.31845	0.00000	-128.10064	0.41700	159	160	161	160
161	-1.65465	0.81150	0.00000	0.32038	0.00000	-118.18084	0.41700	160	161	162	161
162	-1.78075	0.51715	0.00000	0.32249	0.00000	-108.23269	0.41700	161	162	163	162
163	-1.85455	0.20355	0.00000	0.32428	0.00000	-98.28003	0.41700	162	163	164	163
164	-1.87320	-0.12005	0.00000	0.32644	0.00000	-88.34989	0.41700	163	164	165	164
165	-1.83550	-0.44400	0.00000	0.32830	0.00000	-78.40256	0.41700	164	165	166	165
166	-1.74185	-0.75840	0.00000	0.33028	0.00000	-68.45308	0.41700	165	166	167	166
167	-1.59445	-1.05370	0.00000	0.33229	0.00000	-58.52466	0.41700	166	167	168	167
168	-1.39710	-1.32070	0.00000	0.33426	0.00000	-48.56575	0.41700	167	168	169	168
169	-1.15520	-1.55095	0.00000	0.33618	0.00000	-38.63585	0.41700	168	169	170	169
170	-0.87555	-1.73705	0.00000	0.33819	0.00000	-28.67942	0.41700	169	170	171	170
171	-0.56615	-1.87290	0.00000	0.34017	0.00000	-18.75985	0.41700	170	171	172	171
172	-0.23605	-1.95380	0.00000	0.34214	0.00000	-8.80982	0.41700	171	172	173	172
173	0.10500	-1.97655	0.00000	0.34407	0.00000	1.14909	0.41700	172	173	174	173
174	0.44685	-1.93990	0.00000	0.34613	0.00000	11.05996	0.41700	173	174	175	174
175	0.77915	-1.84425	0.00000	0.34808	0.00000	21.02806	0.41700	174	175	176	175
176	1.09170	-1.69180	0.00000	0.35003	0.00000	30.94691	0.41700	175	176	177	176
177	1.37480	-1.48655	0.00000	0.35197	0.00000	40.91028	0.41700	176	177	178	177
178	1.61960	-1.23405	0.00000	0.35404	0.00000	50.83471	0.41700	177	178	179	178
179	1.81825	-0.94150	0.00000	0.35587	0.00000	60.78433	0.41700	178	179	180	179
180	1.96420	-0.61725	0.00000	0.35798	0.00000	70.71977	0.41700	179	180	181	180
181	2.05250	-0.27075	0.00000	0.35987	0.00000	80.66070	0.41700	180	181	182	181
182	2.07980	0.08775	0.00000	0.36192	0.00000	90.60159	0.41700	181	182	183	182
183	2.04460	0.44755	0.00000	0.36385	0.00000	100.54710	0.41700	182	183	184	183
184	1.94730	0.79775	0.00000	0.36582	0.00000	110.48089	0.41700	183	184	185	184
185	1.79015	1.12765	0.00000	0.36778	0.00000	120.43474	0.41700	184	185	186	185
186	1.57730	1.42710	0.00000	0.36976	0.00000	130.34919	0.41700	185	186	187	186
187	1.31455	1.68670	0.00000	0.37177	0.00000	140.31480	0.41700	186	187	188	187
188	1.00930	1.89815	0.00000	0.37369	0.00000	150.23800	0.41700	187	188	189	188
189	0.67035	2.05460	0.00000	0.37576	0.00000	160.18104	0.41700	188	189	190	189
190	0.30760	2.15070	0.00000	0.37760	0.00000	170.11859	0.41700	189	190	191	190
191	-0.06825	2.18290	0.00000	0.37970	0.00000	-179.93964	0.41700	190	191	192	191
192	-0.44600	2.14955	0.00000	0.38160	0.00000	-169.99463	0.41700	191	192	193	192
193	-0.81420	2.05100	0.00000	0.38359	0.00000	-160.06283	0.41700	192	193	194	193
194	-1.16165	1.88955	0.00000	0.38556	0.00000	-150.11688	0.41700	193	194	195	194

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   195  -1.47760   1.66940   0.00000   0.38752    0.00000-140.17171   0.41700   194  195  196    195
   196  -1.75225   1.39665   0.00000   0.38954    0.00000-130.25191   0.41700   195  196  197    196
   197  -1.97685   1.07900   0.00000   0.39147    0.00000-120.29858   0.41700   196  197  198    197
   198  -2.14405   0.72555   0.00000   0.39348    0.00000-110.36006   0.41700   197  198  199    198
   199  -2.24830   0.34665   0.00000   0.39544    0.00000-100.43185   0.41700   198  199  200    199
   200  -2.28575  -0.04650   0.00000   0.39741    0.00000 -90.47577   0.41700   199  200    0    200



 ***** DATA CARD NO.  1   EX   0   100     1     0  1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
0.00000E+00
 ***** DATA CARD NO.  2   FR   0     1     0     0  5.00000E-04  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
0.00000E+00
 ***** DATA CARD NO.  3   RP   0     1     1  1000  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
0.00000E+00



                                  - - - - - - FREQUENCY - - - - - -

                                     FREQUENCY= 5.0000E-04 MHZ
                                     WAVELENGTH= 5.9960E+05 METERS



                        APPROXIMATE INTEGRATION EMPLOYED FOR SEGMENTS MORE THAN   1.000 WAVELENGTHS APART



                                  - - - STRUCTURE IMPEDANCE LOADING - - -

                                     THIS STRUCTURE IS NOT LOADED



                                  - - - ANTENNA ENVIRONMENT - - -

                                           FREE SPACE



                                  - - - MATRIX TIMING - - -

                               FILL=    0.063 SEC.,  FACTOR=    0.016 SEC.



                                           - - - ANTENNA INPUT PARAMETERS - - -

   TAG   SEG.    VOLTAGE (VOLTS)         CURRENT (AMPS)         IMPEDANCE (OHMS)        ADMITTANCE (MHOS)      POWER
   NO.   NO.    REAL        IMAG.       REAL        IMAG.       REAL        IMAG.       REAL        IMAG.     (WATTS)
   100   100 1.00000E+00 0.00000E+00-3.28167E-12 3.18519E-06-3.23463E-01-3.13953E+05-3.28167E-12 3.18519E-06-1.64084E-
12



                                  - - - CURRENTS AND LOCATION - - -

                                     DISTANCES IN WAVELENGTHS

  SEG.  TAG    COORD. OF SEG. CENTER     SEG.            - - - CURRENT (AMPS) - - -
  NO.   NO.      X        Y        Z      LENGTH     REAL        IMAG.       MAG.        PHASE
     1    1   0.0000   0.0000   0.0000  0.00000  -3.7965E-11 -1.9513E-06  1.9513E-06  -90.001
     2    2   0.0000   0.0000   0.0000  0.00000  -2.7044E-11 -1.5508E-06  1.5508E-06  -90.001
     3    3   0.0000   0.0000   0.0000  0.00000   1.1442E-11 -2.8119E-07  2.8119E-07  -89.998
     4    4   0.0000   0.0000   0.0000  0.00000   1.1442E-11  6.3906E-07  6.3906E-07   89.999
     5    5   0.0000   0.0000   0.0000  0.00000  -1.0401E-11  4.5160E-07  4.5160E-07   90.001
     6    6   0.0000   0.0000   0.0000  0.00000   2.8864E-11  1.0055E-06  1.0055E-06   89.998
     7    7   0.0000   0.0000   0.0000  0.00000   2.5028E-11  3.2486E-07  3.2486E-07   89.996
     8    8   0.0000   0.0000   0.0000  0.00000  -4.7456E-12 -6.8167E-07  6.8167E-07  -90.000
     9    9   0.0000   0.0000   0.0000  0.00000  -4.3946E-11 -7.0723E-07  7.0723E-07  -90.004
    10   10   0.0000   0.0000   0.0000  0.00000  -2.6524E-11 -1.2781E-07  1.2781E-07  -90.012
    11   11   0.0000   0.0000   0.0000  0.00000   1.7942E-11 -2.5776E-07  2.5776E-07  -89.996
    12   12   0.0000   0.0000   0.0000  0.00000   1.1962E-11  2.3432E-08  2.3432E-08   89.971
    13   13   0.0000   0.0000   0.0000  0.00000   2.3143E-11  7.4983E-07  7.4983E-07   89.998
    14   14   0.0000   0.0000   0.0000  0.00000  -1.3522E-11  6.3906E-09  6.3906E-09   90.121
    15   15   0.0000   0.0000   0.0000  0.00000  -2.5093E-11 -9.4794E-08  9.4794E-08  -90.015
    16   16   0.0000   0.0000   0.0000  0.00000  -6.8462E-13 -5.3042E-07  5.3042E-07  -90.000
    17   17   0.0000   0.0000   0.0000  0.00000   2.5483E-11  3.6853E-07  3.6853E-07   89.996
    18   18   0.0000   0.0000   0.0000  0.00000   1.1653E-11  3.4137E-07  3.4137E-07   89.998
    19   19   0.0000   0.0000   0.0000  0.00000  -1.6797E-11  3.3870E-07  3.3870E-07   90.003
    20   20   0.0000   0.0000   0.0000  0.00000  -3.1594E-11 -6.0285E-07  6.0285E-07  -90.003
    21   21   0.0000   0.0000   0.0000  0.00000   2.8604E-11  9.6924E-08  9.6924E-08   89.983
    22   22   0.0000   0.0000   0.0000  0.00000  -3.9005E-13  2.9157E-07  2.9157E-07   90.000
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23	23	0.0000	0.0000	0.0000	0.00000	9.5888E-12	5.9163E-07	5.9163E-07	89.999
24	24	0.0000	0.0000	0.0000	0.00000	2.2298E-11	4.7291E-07	4.7291E-07	89.997
25	25	0.0000	0.0000	0.0000	0.00000	-6.2668E-11	-1.4911E-06	1.4911E-06	-90.002
26	26	0.0000	0.0000	0.0000	0.00000	-2.6654E-12	1.0736E-06	1.0736E-06	90.000
27	27	0.0000	0.0000	0.0000	0.00000	1.2300E-10	1.3527E-06	1.3527E-06	89.995
28	28	0.0000	0.0000	0.0000	0.00000	-1.1416E-10	-1.1588E-06	1.1588E-06	-90.006
29	29	0.0000	0.0000	0.0000	0.00000	-1.8226E-11	-2.1568E-08	2.1568E-08	-90.048
30	30	0.0000	0.0000	0.0000	0.00000	9.8553E-11	1.1226E-06	1.1226E-06	89.995
31	31	0.0000	0.0000	0.0000	0.00000	-5.3177E-11	2.6068E-07	2.6068E-07	90.012
32	32	0.0000	0.0000	0.0000	0.00000	8.9062E-12	-1.0289E-06	1.0289E-06	-90.000
33	33	0.0000	0.0000	0.0000	0.00000	-2.7629E-11	1.0821E-06	1.0821E-06	90.001
34	34	0.0000	0.0000	0.0000	0.00000	4.7586E-11	2.6415E-07	2.6415E-07	89.990
35	35	0.0000	0.0000	0.0000	0.00000	-2.3598E-11	-1.5742E-06	1.5742E-06	-90.001
36	36	0.0000	0.0000	0.0000	0.00000	-5.5420E-12	2.5946E-06	2.5946E-06	90.000
37	37	0.0000	0.0000	0.0000	0.00000	1.1685E-11	-1.9513E-06	1.9513E-06	-90.000
38	38	0.0000	0.0000	0.0000	0.00000	-4.9894E-12	3.3657E-07	3.3657E-07	90.001
39	39	0.0000	0.0000	0.0000	0.00000	7.9473E-12	8.8936E-07	8.8936E-07	89.999
40	40	0.0000	0.0000	0.0000	0.00000	-2.2786E-11	-1.0023E-06	1.0023E-06	-90.001
41	41	0.0000	0.0000	0.0000	0.00000	3.9200E-11	2.3166E-07	2.3166E-07	89.990
42	42	0.0000	0.0000	0.0000	0.00000	-5.3112E-11	2.6796E-07	2.6796E-07	90.011
43	43	0.0000	0.0000	0.0000	0.00000	7.0860E-11	-2.2474E-07	2.2474E-07	-89.982
44	44	0.0000	0.0000	0.0000	0.00000	-9.4523E-11	-9.1279E-07	9.1279E-07	-90.006
45	45	0.0000	0.0000	0.0000	0.00000	1.1676E-10	1.8938E-06	1.8938E-06	89.996
46	46	0.0000	0.0000	0.0000	0.00000	-1.3041E-10	-3.0206E-06	3.0206E-06	-90.002
47	47	0.0000	0.0000	0.0000	0.00000	1.3236E-10	3.0632E-06	3.0632E-06	89.998
48	48	0.0000	0.0000	0.0000	0.00000	-1.1936E-10	-3.1101E-06	3.1101E-06	-90.002
49	49	0.0000	0.0000	0.0000	0.00000	8.4771E-11	1.9364E-06	1.9364E-06	89.997
50	50	0.0000	0.0000	0.0000	0.00000	-4.3101E-11	-1.3484E-06	1.3484E-06	-90.002
51	51	0.0000	0.0000	0.0000	0.00000	2.8929E-12	5.3255E-10	5.3256E-10	89.689
52	52	0.0000	0.0000	0.0000	0.00000	2.4216E-11	1.3979E-07	1.3979E-07	89.990
53	53	0.0000	0.0000	0.0000	0.00000	-4.2776E-11	-1.0065E-06	1.0065E-06	-90.002
54	54	0.0000	0.0000	0.0000	0.00000	5.1227E-11	5.6664E-07	5.6664E-07	89.995
55	55	0.0000	0.0000	0.0000	0.00000	-5.5192E-11	-1.1737E-06	1.1737E-06	-90.003
56	56	0.0000	0.0000	0.0000	0.00000	4.8367E-11	4.2018E-07	4.2018E-07	89.993
57	57	0.0000	0.0000	0.0000	0.00000	-3.8258E-11	-9.2344E-07	9.2344E-07	-90.002
58	58	0.0000	0.0000	0.0000	0.00000	2.6426E-11	2.1302E-08	2.1302E-08	89.929
59	59	0.0000	0.0000	0.0000	0.00000	-2.4021E-11	-7.2108E-07	7.2108E-07	-90.002
60	60	0.0000	0.0000	0.0000	0.00000	2.2997E-11	-1.1982E-07	1.1982E-07	-89.989
61	61	0.0000	0.0000	0.0000	0.00000	-2.4118E-11	-7.2134E-07	7.2134E-07	-90.002
62	62	0.0000	0.0000	0.0000	0.00000	1.9844E-11	-2.8478E-07	2.8478E-07	-89.996
63	63	0.0000	0.0000	0.0000	0.00000	-1.5667E-11	-4.8332E-07	4.8332E-07	-90.002
64	64	0.0000	0.0000	0.0000	0.00000	7.6710E-12	-8.1893E-07	8.1893E-07	-89.999
65	65	0.0000	0.0000	0.0000	0.00000	-1.2697E-12	-1.4765E-07	1.4765E-07	-90.000
66	66	0.0000	0.0000	0.0000	0.00000	-4.0214E-12	-6.4266E-07	6.4266E-07	-90.000
67	67	0.0000	0.0000	0.0000	0.00000	3.8010E-12	-1.4366E-07	1.4366E-07	-89.998
68	68	0.0000	0.0000	0.0000	0.00000	-3.2708E-12	-3.6912E-07	3.6912E-07	-90.001
69	69	0.0000	0.0000	0.0000	0.00000	1.9970E-12	-1.6286E-07	1.6286E-07	-89.999
70	70	0.0000	0.0000	0.0000	0.00000	-1.9076E-12	-1.4982E-07	1.4982E-07	-90.001
71	71	0.0000	0.0000	0.0000	0.00000	1.4820E-12	-8.3842E-08	8.3842E-08	-89.999
72	72	0.0000	0.0000	0.0000	0.00000	-1.4348E-12	-1.2049E-08	1.2049E-08	-90.007
73	73	0.0000	0.0000	0.0000	0.00000	1.3967E-14	2.3041E-08	2.3041E-08	90.000
74	74	0.0000	0.0000	0.0000	0.00000	7.5262E-14	1.3407E-07	1.3407E-07	90.000
75	75	0.0000	0.0000	0.0000	0.00000	-6.2692E-13	1.3439E-07	1.3439E-07	90.000
76	76	0.0000	0.0000	0.0000	0.00000	-5.2083E-13	2.6150E-07	2.6150E-07	90.000
77	77	0.0000	0.0000	0.0000	0.00000	8.1261E-13	2.6471E-07	2.6471E-07	90.000
78	78	0.0000	0.0000	0.0000	0.00000	-2.3759E-12	3.7316E-07	3.7316E-07	90.000
79	79	0.0000	0.0000	0.0000	0.00000	1.5226E-12	4.1187E-07	4.1187E-07	90.000
80	80	0.0000	0.0000	0.0000	0.00000	-1.9696E-12	4.9883E-07	4.9883E-07	90.000
81	81	0.0000	0.0000	0.0000	0.00000	3.5704E-13	5.3885E-07	5.3885E-07	90.000
82	82	0.0000	0.0000	0.0000	0.00000	-8.3877E-13	6.2448E-07	6.2448E-07	90.000
83	83	0.0000	0.0000	0.0000	0.00000	6.7675E-13	6.9171E-07	6.9171E-07	90.000
84	84	0.0000	0.0000	0.0000	0.00000	-1.1971E-12	7.4992E-07	7.4992E-07	90.000
85	85	0.0000	0.0000	0.0000	0.00000	1.0706E-12	8.3928E-07	8.3928E-07	90.000
86	86	0.0000	0.0000	0.0000	0.00000	-2.3677E-12	8.5792E-07	8.5792E-07	90.000
87	87	0.0000	0.0000	0.0000	0.00000	1.9391E-12	1.0049E-06	1.0049E-06	90.000
88	88	0.0000	0.0000	0.0000	0.00000	-2.4917E-12	9.9930E-07	9.9930E-07	90.000
89	89	0.0000	0.0000	0.0000	0.00000	1.0665E-12	1.1383E-06	1.1383E-06	90.000
90	90	0.0000	0.0000	0.0000	0.00000	-1.7954E-12	1.1588E-06	1.1588E-06	90.000
91	91	0.0000	0.0000	0.0000	0.00000	3.5044E-14	1.2559E-06	1.2559E-06	90.000
92	92	0.0000	0.0000	0.0000	0.00000	-1.2555E-12	1.3330E-06	1.3330E-06	90.000
93	93	0.0000	0.0000	0.0000	0.00000	-8.8968E-13	1.3695E-06	1.3695E-06	90.000
94	94	0.0000	0.0000	0.0000	0.00000	-1.1334E-12	1.5243E-06	1.5243E-06	90.000
95	95	0.0000	0.0000	0.0000	0.00000	-6.1796E-13	1.4681E-06	1.4681E-06	90.000
96	96	0.0000	0.0000	0.0000	0.00000	-2.1092E-12	1.7610E-06	1.7610E-06	90.000
97	97	0.0000	0.0000	0.0000	0.00000	-4.3500E-13	1.4497E-06	1.4497E-06	90.000
98	98	0.0000	0.0000	0.0000	0.00000	-2.4729E-12	2.2424E-06	2.2424E-06	90.000
99	99	0.0000	0.0000	0.0000	0.00000	-6.7675E-13	1.0233E-06	1.0233E-06	90.000
100	100	0.0000	0.0000	0.0000	0.00000	-3.2817E-12	3.1852E-06	3.1852E-06	90.000
101	101	0.0000	0.0000	0.0000	0.00000	-1.5381E-12	1.0739E-06	1.0739E-06	90.000
102	102	0.0000	0.0000	0.0000	0.00000	-3.0257E-12	2.2219E-06	2.2219E-06	90.000
103	103	0.0000	0.0000	0.0000	0.00000	-1.9357E-12	1.5200E-06	1.5200E-06	90.000
104	104	0.0000	0.0000	0.0000	0.00000	-3.0275E-12	1.7873E-06	1.7873E-06	90.000
105	105	0.0000	0.0000	0.0000	0.00000	-2.7966E-12	1.5482E-06	1.5482E-06	90.000
106	106	0.0000	0.0000	0.0000	0.00000	-3.1295E-12	1.5644E-06	1.5644E-06	90.000
107	107	0.0000	0.0000	0.0000	0.00000	-3.0192E-12	1.4627E-06	1.4627E-06	90.000
108	108	0.0000	0.0000	0.0000	0.00000	-3.3403E-12	1.4060E-06	1.4060E-06	90.000
109	109	0.0000	0.0000	0.0000	0.00000	-2.4475E-12	1.3482E-06	1.3482E-06	90.000
110	110	0.0000	0.0000	0.0000	0.00000	-3.4163E-12	1.2751E-06	1.2751E-06	90.000
111	111	0.0000	0.0000	0.0000	0.00000	-2.1358E-12	1.2192E-06	1.2192E-06	90.000
112	112	0.0000	0.0000	0.0000	0.00000	-3.4577E-12	1.1374E-06	1.1374E-06	90.000

113	113	0.0000	0.0000	0.0000	0.00000	-2.2211E-12	1.0828E-06	1.0828E-06	90.000
114	114	0.0000	0.0000	0.0000	0.00000	-2.8250E-12	1.0073E-06	1.0073E-06	90.000
115	115	0.0000	0.0000	0.0000	0.00000	-2.2279E-12	9.4471E-07	9.4471E-07	90.000
116	116	0.0000	0.0000	0.0000	0.00000	-2.4447E-12	8.7186E-07	8.7186E-07	90.000
117	117	0.0000	0.0000	0.0000	0.00000	-1.9678E-12	8.1037E-07	8.1037E-07	90.000
118	118	0.0000	0.0000	0.0000	0.00000	-2.2469E-12	7.3487E-07	7.3487E-07	90.000
119	119	0.0000	0.0000	0.0000	0.00000	-2.2621E-12	6.6169E-07	6.6169E-07	90.000
120	120	0.0000	0.0000	0.0000	0.00000	-1.9799E-12	5.9489E-07	5.9489E-07	90.000
121	121	0.0000	0.0000	0.0000	0.00000	-1.9618E-12	5.1626E-07	5.1626E-07	90.000
122	122	0.0000	0.0000	0.0000	0.00000	-1.9129E-12	4.4889E-07	4.4889E-07	90.000
123	123	0.0000	0.0000	0.0000	0.00000	-1.7296E-12	3.6524E-07	3.6524E-07	90.000
124	124	0.0000	0.0000	0.0000	0.00000	-1.8718E-12	2.9376E-07	2.9376E-07	90.000
125	125	0.0000	0.0000	0.0000	0.00000	-1.6474E-12	2.1125E-07	2.1125E-07	90.000
126	126	0.0000	0.0000	0.0000	0.00000	-1.5600E-12	1.4267E-07	1.4267E-07	90.001
127	127	0.0000	0.0000	0.0000	0.00000	-1.5934E-12	5.6264E-08	5.6264E-08	90.002
128	128	0.0000	0.0000	0.0000	0.00000	-1.2374E-12	-1.8657E-08	1.8657E-08	-90.004
129	129	0.0000	0.0000	0.0000	0.00000	-1.1839E-12	-9.1871E-08	9.1871E-08	-90.001
130	130	0.0000	0.0000	0.0000	0.00000	-1.1256E-12	-1.7717E-07	1.7717E-07	-90.000
131	131	0.0000	0.0000	0.0000	0.00000	-7.1872E-13	-2.4316E-07	2.4316E-07	-90.000
132	132	0.0000	0.0000	0.0000	0.00000	-7.1408E-13	-3.3703E-07	3.3703E-07	-90.000
133	133	0.0000	0.0000	0.0000	0.00000	-2.8040E-13	-3.9208E-07	3.9208E-07	-90.000
134	134	0.0000	0.0000	0.0000	0.00000	-1.6044E-13	-5.1301E-07	5.1301E-07	-90.000
135	135	0.0000	0.0000	0.0000	0.00000	3.4258E-13	-5.1953E-07	5.1953E-07	-90.000
136	136	0.0000	0.0000	0.0000	0.00000	8.6919E-13	-7.4489E-07	7.4489E-07	-90.000
137	137	0.0000	0.0000	0.0000	0.00000	1.0238E-12	-6.3225E-07	6.3225E-07	-90.000
138	138	0.0000	0.0000	0.0000	0.00000	1.5904E-12	-5.9829E-07	5.9829E-07	-90.000
139	139	0.0000	0.0000	0.0000	0.00000	1.5804E-12	-5.9008E-07	5.9008E-07	-90.000
140	140	0.0000	0.0000	0.0000	0.00000	2.0143E-12	-5.5247E-07	5.5247E-07	-90.000
141	141	0.0000	0.0000	0.0000	0.00000	2.3208E-12	-5.3237E-07	5.3237E-07	-90.000
142	142	0.0000	0.0000	0.0000	0.00000	2.3335E-12	-5.0197E-07	5.0197E-07	-90.000
143	143	0.0000	0.0000	0.0000	0.00000	2.8185E-12	-4.8101E-07	4.8101E-07	-90.000
144	144	0.0000	0.0000	0.0000	0.00000	2.4889E-12	-4.5745E-07	4.5745E-07	-90.000
145	145	0.0000	0.0000	0.0000	0.00000	2.4548E-12	-4.4132E-07	4.4132E-07	-90.000
146	146	0.0000	0.0000	0.0000	0.00000	2.3484E-12	-4.1965E-07	4.1965E-07	-90.000
147	147	0.0000	0.0000	0.0000	0.00000	1.9896E-12	-4.0096E-07	4.0096E-07	-90.000
148	148	0.0000	0.0000	0.0000	0.00000	2.2208E-12	-3.7668E-07	3.7668E-07	-90.000
149	149	0.0000	0.0000	0.0000	0.00000	1.8185E-12	-3.5721E-07	3.5721E-07	-90.000
150	150	0.0000	0.0000	0.0000	0.00000	1.7497E-12	-3.3765E-07	3.3765E-07	-90.000
151	151	0.0000	0.0000	0.0000	0.00000	1.3143E-12	-3.2096E-07	3.2096E-07	-90.000
152	152	0.0000	0.0000	0.0000	0.00000	1.4000E-12	-2.8892E-07	2.8892E-07	-90.000
153	153	0.0000	0.0000	0.0000	0.00000	1.0670E-12	-2.7178E-07	2.7178E-07	-90.000
154	154	0.0000	0.0000	0.0000	0.00000	9.6289E-13	-2.4943E-07	2.4943E-07	-90.000
155	155	0.0000	0.0000	0.0000	0.00000	1.1347E-12	-2.1763E-07	2.1763E-07	-90.000
156	156	0.0000	0.0000	0.0000	0.00000	6.0232E-13	-2.0166E-07	2.0166E-07	-90.000
157	157	0.0000	0.0000	0.0000	0.00000	6.8251E-13	-1.6949E-07	1.6949E-07	-90.000
158	158	0.0000	0.0000	0.0000	0.00000	5.4073E-13	-1.4597E-07	1.4597E-07	-90.000
159	159	0.0000	0.0000	0.0000	0.00000	5.6473E-13	-1.1620E-07	1.1620E-07	-90.000
160	160	0.0000	0.0000	0.0000	0.00000	3.9842E-13	-8.5962E-08	8.5962E-08	-90.000
161	161	0.0000	0.0000	0.0000	0.00000	5.1786E-13	-5.8665E-08	5.8665E-08	-89.999
162	162	0.0000	0.0000	0.0000	0.00000	2.8181E-13	-3.0914E-08	3.0914E-08	-89.999
163	163	0.0000	0.0000	0.0000	0.00000	2.3903E-13	-3.2071E-09	3.2071E-09	-89.996
164	164	0.0000	0.0000	0.0000	0.00000	1.0383E-14	2.7019E-08	2.7019E-08	90.000
165	165	0.0000	0.0000	0.0000	0.00000	-1.7193E-13	5.3625E-08	5.3625E-08	90.000
166	166	0.0000	0.0000	0.0000	0.00000	-3.1137E-13	7.7303E-08	7.7303E-08	90.000
167	167	0.0000	0.0000	0.0000	0.00000	-6.2416E-13	9.1865E-08	9.1865E-08	90.000
168	168	0.0000	0.0000	0.0000	0.00000	-7.1622E-13	1.1961E-07	1.1961E-07	90.000
169	169	0.0000	0.0000	0.0000	0.00000	-9.6528E-13	1.3383E-07	1.3383E-07	90.000
170	170	0.0000	0.0000	0.0000	0.00000	-1.0581E-12	1.6160E-07	1.6160E-07	90.000
171	171	0.0000	0.0000	0.0000	0.00000	-1.2428E-12	1.7566E-07	1.7566E-07	90.000
172	172	0.0000	0.0000	0.0000	0.00000	-1.6956E-12	2.1176E-07	2.1176E-07	90.000
173	173	0.0000	0.0000	0.0000	0.00000	-1.8439E-12	2.0638E-07	2.0638E-07	90.001
174	174	0.0000	0.0000	0.0000	0.00000	-2.0234E-12	1.8949E-07	1.8949E-07	90.001
175	175	0.0000	0.0000	0.0000	0.00000	-2.3398E-12	1.8050E-07	1.8050E-07	90.001
176	176	0.0000	0.0000	0.0000	0.00000	-2.2343E-12	1.7256E-07	1.7256E-07	90.001
177	177	0.0000	0.0000	0.0000	0.00000	-2.4827E-12	1.6198E-07	1.6198E-07	90.001
178	178	0.0000	0.0000	0.0000	0.00000	-2.5368E-12	1.5527E-07	1.5527E-07	90.001
179	179	0.0000	0.0000	0.0000	0.00000	-2.6392E-12	1.4573E-07	1.4573E-07	90.001
180	180	0.0000	0.0000	0.0000	0.00000	-2.5768E-12	1.4168E-07	1.4168E-07	90.001
181	181	0.0000	0.0000	0.0000	0.00000	-2.3646E-12	1.3847E-07	1.3847E-07	90.001
182	182	0.0000	0.0000	0.0000	0.00000	-2.3238E-12	1.3314E-07	1.3314E-07	90.001
183	183	0.0000	0.0000	0.0000	0.00000	-2.1363E-12	1.2916E-07	1.2916E-07	90.001
184	184	0.0000	0.0000	0.0000	0.00000	-1.9650E-12	1.2461E-07	1.2461E-07	90.001
185	185	0.0000	0.0000	0.0000	0.00000	-1.9157E-12	1.1975E-07	1.1975E-07	90.001
186	186	0.0000	0.0000	0.0000	0.00000	-1.7039E-12	1.1643E-07	1.1643E-07	90.001
187	187	0.0000	0.0000	0.0000	0.00000	-1.3720E-12	1.1515E-07	1.1515E-07	90.001
188	188	0.0000	0.0000	0.0000	0.00000	-1.3912E-12	1.0600E-07	1.0600E-07	90.001
189	189	0.0000	0.0000	0.0000	0.00000	-1.2114E-12	1.0040E-07	1.0040E-07	90.001
190	190	0.0000	0.0000	0.0000	0.00000	-1.2141E-12	9.5789E-08	9.5789E-08	90.001
191	191	0.0000	0.0000	0.0000	0.00000	-1.0857E-12	8.8137E-08	8.8137E-08	90.001
192	192	0.0000	0.0000	0.0000	0.00000	-1.0005E-12	8.1287E-08	8.1287E-08	90.001
193	193	0.0000	0.0000	0.0000	0.00000	-8.9097E-13	7.4670E-08	7.4670E-08	90.001
194	194	0.0000	0.0000	0.0000	0.00000	-8.5039E-13	6.5807E-08	6.5807E-08	90.001
195	195	0.0000	0.0000	0.0000	0.00000	-7.9108E-13	5.7118E-08	5.7118E-08	90.001
196	196	0.0000	0.0000	0.0000	0.00000	-7.4194E-13	4.8894E-08	4.8894E-08	90.001
197	197	0.0000	0.0000	0.0000	0.00000	-6.9918E-13	3.9172E-08	3.9172E-08	90.001
198	198	0.0000	0.0000	0.0000	0.00000	-6.3666E-13	3.2077E-08	3.2077E-08	90.001
199	199	0.0000	0.0000	0.0000	0.00000	-4.4583E-13	2.2613E-08	2.2613E-08	90.001
200	200	0.0000	0.0000	0.0000	0.00000	-3.9530E-13	1.6208E-08	1.6208E-08	90.001

```
                                    - - - POWER BUDGET - - -

                                       INPUT POWER   =-1.6408E-12 WATTS
                                       RADIATED POWER=-1.6408E-12 WATTS
                                       STRUCTURE LOSS= 0.0000E+00 WATTS
                                       NETWORK LOSS  = 0.0000E+00 WATTS
                                       EFFICIENCY    = 100.00 PERCENT


                                            - - - RADIATION PATTERNS - - -

  - - ANGLES - -           - POWER GAINS -       - - - POLARIZATION - - -    - - - E(THETA) - - -    - - - E(PHI) - - -
  THETA      PHI        VERT.    HOR.     TOTAL      AXIAL     TILT   SENSE     MAGNITUDE    PHASE      MAGNITUDE    PHASE
 DEGREES   DEGREES       DB       DB       DB        RATIO     DEG.              VOLTS/M    DEGREES      VOLTS/M
DEGREES
    0.00      0.00    -999.99 -999.99 -999.99    0.00000     0.00            5.66026E-12     0.00    7.87899E-12
0.00




 ***** DATA CARD NO.  4   EN   0     0     0     0  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
0.00000E+00

 RUN TIME =     0.078
```