Design and Analysis of Star Spiral with Application to Wideband Arrays with Variable Element Sizes

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(ABSTRACT)

This dissertation details the development of the star spiral antenna and demonstrates the advantages of the star spiral when used in a wideband array with variable element sizes. The wideband array with variable element sizes (WAVES) is a multi-octave array that uses different sized circular Archimedean spirals for each octave of frequency coverage. A two-octave WAVES array has been presented in the literature, but a gap in the two-octave frequency coverage exists along the principal axes. The star spiral antenna was developed to eliminate the performance gap in the WAVES array. The star spiral is a type of slow-wave spiral that also offers array-packing advantages, particularly for the WAVES array. The size reduction that can be achieved with the star spiral is comparable to that of the square spiral, but the star spiral is much more efficient in terms of its expected size reduction compared to its circumference. The far-field patterns, gain, and scan performance of the star spiral are similar to that of the circular Archimedean spiral. The use of the star spiral to eliminate the performance gap in a WAVES array of circular Archimedean spirals is detailed. Furthermore, a three-octave WAVES array of star spirals is built and measured, and the scan performance of the array is investigated via simulation.
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# Table of Contents

1. Introduction .................................................................................................................................................. 1  
   1.1. Motivation .................................................................................................................................................. 1  
   1.2. Literature review ....................................................................................................................................... 2  
      1.2.1. Wideband arrays ........................................................................................................... 2  
      1.2.2. Spiral antennas ..................................................................................................................... 5  
      1.2.3. Slow-wave spiral antennas .............................................................................. 6  
   1.3. Dissertation overview ....................................................................................................................... 7  

2. Analysis of Archimedean spiral antenna ................................................................................................. 8  
   2.1. Theory .................................................................................................................................................... 8  
   2.2. Simulation ............................................................................................................................................. 10  
   2.3. Addition of loss and resistive loading ......................................................................................... 20  
   2.4. Ground plane effects ..................................................................................................................... 25  
   2.5. Measurements ........................................................................................................................................ 31  
   2.6. Summary ............................................................................................................................................. 57  

3. Analysis of a simple WAVES array of Archimedean spiral antennas .................................................... 59  
   3.1. Theory of WAVES array geometry ........................................................................................... 59  
   3.2. Two-octave linear array ............................................................................................................... 60  
   3.3. Two-octave planar array .............................................................................................................. 67  
   3.4. Summary ............................................................................................................................................. 73  

4. Analysis and measurement of star spiral antenna ..................................................................................... 75  
   4.1. Evolution of star spiral ................................................................................................................... 75  
   4.2. Star spiral optimization with genetic algorithm ................................................................... 84  
   4.3. Analysis of optimized star spiral antenna .................................................................................. 92  
   4.4. Measurements of star spiral .................................................................................................... 101  
   4.5. Summary ............................................................................................................................................. 126  

5. Array of star spirals ....................................................................................................................................... 127  
   5.1. Infinite array of spirals ............................................................................................................... 127  
   5.2. Linear WAVES array of star spirals ......................................................................................... 133  
   5.3. 3-octave WAVES array ........................................................................................................... 138  
   5.4. Scan Performance of 3-Octave WAVES Array .................................................................... 164  
   5.5. Alternative WAVES Array Geometries .................................................................................. 169  
   5.6. Summary ............................................................................................................................................. 171  

6. Conclusions .................................................................................................................................................. 172  
   6.1. Summary ............................................................................................................................................. 172  
   6.2. Contributions ....................................................................................................................................... 174  
   6.3. Future work ........................................................................................................................................... 175  

References ..................................................................................................................................................... 176  
Vita ................................................................................................................................................................. 179
List of Multimedia Objects

Table 2.1 Parameters for Archimedean spiral with various inner radii. For all cases there are 16 segments per turn and 5 segments on the feed wire ........................................... 13

Table 4.1 Comparison of circular and slow-wave spiral performance ......................... 78
Table 4.2 Comparison of star spiral and circular spiral performance............................. 81
Table 4.3 Comparison of performance improvement in star spiral versus the square spiral .......................................................................................................................... 98
Table 4.4 Geometry parameters for spirals discussed in Chapter 4............................... 99

Figure 2.1 Geometry of Archimedean spiral antenna ..................................................... 9
Figure 2.2 Geometry of Archimedean spirals with various values of the inner radius ................................................................................................................................. 12
Figure 2.3 Simulated input impedance versus frequency for various values of the inner radius. The solid lines represent the real part of the input impedance and the dashed lines represent the imaginary part of the input impedance. ................................................................. 13
Figure 2.4 Simulated input impedance versus frequency for various values of wire radius. The solid lines represent the real part of the input impedance and the dashed lines represent the imaginary part of the input impedance. ................................................................. 14
Figure 2.5 Simulated VSWR versus frequency ................................................................ 15
Figure 2.6 Simulated radiation pattern plots versus theta for $\phi = 0^\circ$. ....................... 16
Figure 2.7 Simulated maximum gain versus frequency for $\phi = 0^\circ$. ......................... 16
Figure 2.8 Simulated boresight axial ratio versus frequency for $\phi = 0^\circ$. ................... 17
Figure 2.9 Simulated axial ratio versus theta for various frequencies, $\phi = 0^\circ$. ......... 18
Figure 2.10 Performance test for Archimedean spiral with various numbers of segments per turn and segments on the feed wire ....................................................... 19
Figure 2.11 Convergence plot of input resistance versus number of segments per turn. ......................................................................................................................... 20
Figure 2.12 VSWR versus frequency for different number of loads. The loads are added to the outer segments of each arm of the spiral. Each load is 188 ohms. 21

Figure 2.13 Maximum gain versus frequency for different number of loads. The loads are added to the outer segments of each arm of the spiral. Each load is 188 ohms. 22

Figure 2.14 Axial ratio versus frequency for different number of loads. The loads are added to the outer segments of each arm of the spiral. Each load is 188 ohms. 22

Figure 2.15 VSWR versus frequency for different conductivities. The conductivity is added to the last half turn of each arm of the spiral. 23

Figure 2.16 Maximum gain versus frequency for different conductivities. The conductivity is added to the last half turn of each arm of the spiral. 24

Figure 2.17 Axial ratio versus frequency for different conductivities. The conductivity is added to the last half turn of each arm of the spiral. 24

Figure 2.18 VSWR versus frequency for different levels of ground plane loss. 26

Figure 2.19 Axial Ratio versus frequency for different levels of ground plane loss. 26

Figure 2.20 Radiation pattern plots versus theta for different levels of ground plane loss. $\phi = 0^\circ$, $f = 4000$ MHz. 27

Figure 2.21 Geometry of spiral antenna with conical ground plane. 28

Figure 2.22 Comparison of VSWR versus frequency for different types of ground planes. 29

Figure 2.23 Comparison of gain versus frequency for different types of ground planes. 29

Figure 2.24 Radiation pattern plots versus theta for various frequencies covering three octaves of frequency bandwidth. $\phi = 0^\circ$. 30

Figure 2.25 Radiation pattern plots versus theta for frequencies at the minimum gain points. $\phi = 0^\circ$. 30

Figure 2.26 Comparison of axial ratio versus frequency for different types of ground planes. 31

Figure 2.27 Comparison of measured input impedance versus frequency to simulated results for three different strip widths. 33
Figure 2.28 Measured spirals with different strip widths of Fig. 2.27 .................. 33

Figure 2.29 Comparison of measured VSWR versus frequency to simulated results for three different strip widths. ............................................................. 34

Figure 2.30 Circular spiral measured for pattern, gain, and axial ratio validation. ... 35

Figure 2.31 Measured hybrid insertion loss and impedance mismatch. ................... 36

Figure 2.32 Measured hybrid insertion loss and impedance mismatch. ................... 36

Figure 2.33 Comparison of measured and simulated axial ratio of circular spiral. ... 37

Figure 2.34 Measured radiation patterns of spiral in Fig 2.30. Theta cuts. Black line is simulated result. ................................................................. 38-47

Figure 2.35 Measured axial ratio of spiral in Fig 2.30. Theta cuts. Black line is simulated result. ................................................................. 48-57

Figure 3.1 Basic Geometry of WAVES Array ......................................................... 59

Figure 3.2 Geometry for two octave linear WAVES array ..................................... 60

Figure 3.3 Larger and smaller element power pattern for spirals shown in Fig. 3.2 and the corresponding theoretical pattern, $g(\theta) = \cos^{0.669}(\theta)$. .................................................................. 62

Figure 3.4 Simulated VSWR for 3-element linear WAVES array of Fig 3.2 .......... 64

Figure 3.5 Radiation patterns for 3-element linear WAVES array of Fig. 3.2 ....... 65

Figure 3.6 Gain curves for the 3-element linear WAVES array of Fig 3.2 .......... 66

Figure 3.7 Geometry of 8-element planar WAVES array of Fig 3.7 ................. 67

Figure 3.8 VSWR for 8-element planar WAVES array of Fig 3.7 ..................... 68

Figure 3.9 Radiation patterns for 8-element planar WAVES array. The smaller elements are switched on at 2000 MHz. .......................................................... 70

Figure 3.10 Radiation patterns for 8-element planar WAVES array of Fig. 3.7, $\phi = 45^\circ$ .................................................................................. 72
Figure 3.11 Gain of 8-element planar WAVES array of Fig 3.7, $\phi = 45^\circ$ ................. 73

Figure 4.1 Complementary circular Archimedean spiral. ................................................. 76
Figure 4.2 Slow-wave spiral with zigzag profile................................................................. 77

Figure 4.3 Slow-wave spiral with star shaped profile. ....................................................... 77

Figure 4.4 Comparison of VSWR for circular, zigzag, and pointed star spirals .......... 79

Figure 4.5 Comparison of gain for circular, zigzag, and pointed star spirals .............. 79

Figure 4.6 Comparison of axial ratio for circular, zigzag, and pointed star spirals. .... 80

Figure 4.7 First iteration star spiral antenna element. ..................................................... 82

Figure 4.8 Star spiral with circular center. ........................................................................ 82

Figure 4.9 Comparison of VSWR for two star spiral antennas and circular spiral. .... 83

Figure 4.10 Comparison of gain for two star spiral antennas and circular spiral. ....... 83

Figure 4.11 Comparison of axial ratio for two star spiral antennas and circular spiral. .................................................................................................................................. 84

Figure 4.12 Result of first genetic algorithm optimization............................................. 86

Figure 4.13 VSWR comparison for circular spiral and result of first genetic algorithm optimization........................................................................................................................ 86

Figure 4.14 Result of second genetic algorithm optimization. ..................................... 88

Figure 4.15 VSWR comparison for circular spiral and result of second genetic algorithm optimization........................................................................................................................ 89

Figure 4.16 Result of final genetic algorithm optimization. ........................................... 91

Figure 4.17 VSWR comparison for circular spiral and result of final genetic algorithm optimization........................................................................................................................ 92

Figure 4.18 Star spiral with $taper = 260$ ........................................................................ 93
Figure 4.19 VSWR comparison for result of final genetic algorithm optimization and final star spiral to be used throughout this thesis. ............................................................. 93

Figure 4.20 Star spiral with taper = 227 ................................................................. 95

Figure 4.21 VSWR comparison of three different star spirals with the circular spiral. ................................................................................................................................. 95

Figure 4.22 Current magnitude comparison of three different star spirals with the circular spiral at various frequencies. ........................................................................................ 96-97

Figure 4.23 Square spiral for comparison to star spiral. ......................................... 99

Figure 4.24 VSWR comparison of star spiral with a square and circular spiral .... 100

Figure 4.25 Boresight gain comparison of star spiral with a square and circular spiral. .............................................................................................................................. 100

Figure 4.26 Axial ratio comparison of star spiral with a square and circular spiral. .. 101

Figure 4.27 Measured star spiral antenna. .............................................................. 102

Figure 4.28 Comparison of the measured input impedance of the star spiral of Fig. 4.27 with the circular spiral of Fig. 2.30 and simulated data. ................................................ 103

Figure 4.29 Comparison of the measured VSWR of star spiral of Fig. 4.27 with circular spiral of Fig. 2.30, square spiral of Fig. 4.23, and simulated data. The measured data is referenced to 150Ω ........................................................................................................... 103

Figure 4.30 Comparison of the measured gain of the star spiral antenna with the circular spiral and simulated data. ............................................................................. 104

Figure 4.31 Measured impedance mismatch and hybrid loss. ............................. 105

Figure 4.32 Comparison of the measured axial ratio of the star spiral antenna with the circular spiral and simulated data. ................................................................. 105

Figure 4.33 Measured star spiral radiation patterns of Fig. 4.27. Theta cuts. Black line is the simulated result for and the gray line is the simulated result for φ = 45° .... 107-116

Figure 4.34 Measured star spiral axial ratio patterns of Fig. 4.27. Theta cuts. Black line is the simulated result for φ = 0° and the gray line is the simulated result for φ = 45° ......................................................................................................................... 117-126
Figure 5.1 Geometry of star spiral used in ASIA simulations. .............................. 128

Figure 5.2 Geometry of circular spiral used in ASIA simulations. ........................ 128

Figure 5.3 ASIA simulation of input impedance versus frequency for star spiral and circular spiral. ................................................................................................................... 129

Figure 5.4 ASIA simulation of VSWR versus frequency for star spiral and circular spiral. ................................................................................................................................ 130

Figure 5.5 ASIA simulation of input impedance versus theta scan angle for the star spiral and the circular spiral at 3000 MHz. .......................................................................................................................... 131

Figure 5.6 ASIA simulation of input impedance versus theta scan angle for the star spiral and the circular spiral at 3500 MHz. .......................................................................................................................... 131

Figure 5.7 ASIA simulation of gain loss versus theta scan angle for the star spiral and the circular spiral at 3000 MHz........................................................................................................................................... 132

Figure 5.8 ASIA simulation of gain loss versus theta scan angle for the star spiral and the circular spiral at 3500 MHz........................................................................................................................................... 132

Figure 5.9 Three-element linear WAVES array of star spirals. .............................. 133

Figure 5.10 VSWR plot of 3-element linear WAVES array of star spirals. Geometry is comparable to 3-element linear WAVES array of circular spirals from Chapter 3. ....... 134

Figure 5.11 Improved 3-element linear WAVES array of star spirals...................... 135

Figure 5.12 Equivalent 3-element linear WAVES array of circular spirals. .......... 136

Figure 5.13 Simulated VSWR plot of improved 3-element linear WAVES array of star spirals of Fig. 5.11................................................................................................................................. 137

Figure 5.14 Geometry of 3-octave WAVES array of star spirals. .......................... 138

Figure 5.15 Geometry of measured 3-octave WAVES array of star spirals........... 139-140

Figure 5.16 Measured hybrid and 8-way power divider insertion loss............... 140

Figure 5.17 Comparison of measured gain to simulated data for 7-element WAVES array. Loss includes the hybrid and 8-way power divider insertion loss and mismatch is total mismatch based on simulated element impedance................................. 142
Figure 5.18 Simulated total impedance mismatch for 7-element WAVES array. All 7 elements are active over the entire frequency band. .......................................................... 142

Figure 5.19 Comparison of measured boresight axial ratio to simulated data for 7-element WAVES array. .............................................................................................................. 144

Figure 5.20 Comparison of measured radiation patterns to simulated data for 7-element WAVES array of Fig. 5.15. Theta cuts. $\phi = 0^\circ$ ......................................................145-154

Figure 5.21 Comparison of measured axial ratio to simulated data for 7-element WAVES array of Fig. 5.15. Theta cuts. $\phi = 0^\circ$ ......................................................155-164

Figure 5.22 Comparison of gain loss versus theta scan angle at selected frequencies for the 3-octave WAVES array of star spirals. ................................................................. 165

Figure 5.23 Scanned array patterns for 3-octave WAVES array of star spirals. .166-168

Figure 5.24 Alternative 2-octave planar, circular WAVES array of star spirals. ....... 169

Figure 5.25 Alternative 3-octave planar, circular WAVES array of star spirals. ....... 170

Figure 5.26 Planar extension of 3-octave WAVES array of star spirals measured in Section 5.3....................................................................................................................... 171