

Contents

- Introduction XV
- Chapter 1. The Brief Elementary Basics of Antenna Arrays..... 1
 - 1.1 Some Basic Antenna Parameters Definitions 1
 - 1.1.1 Radiation Power Density 1
 - 1.1.2 Radiation Intensity 1
 - 1.1.3 Total Power Radiated 2
 - 1.1.4 Directivity 2
 - 1.1.5 Effective Area of an Antenna 3
 - 1.1.6 Radiation Pattern 4
 - 1.2 Antenna Arrays, Radiation Pattern, and Array Factor 4
 - 1.2.1 Broadside and Fire Arrays 5
 - 1.2.2 Defining Array Factor 5
 - 1.2.3 Array Pattern 8
 - 1.2.4 Effect of Array Geometry and Element Patterns 9
 - 1.2.5 Half Power Beamwidth (HPBN) (for the major lobe)..... 10
 - 1.2.6 Feeding of an Array..... 11
 - 1.2.7 Diversity Combining [2, 5, 6] 11
 - 1.2.8 Array Response Vector 11
 - 1.2.9 Spatial-Polarization Signature 12
 - 1.2.10 Grating Lobe Criteria 12
 - 1.3 Brief Review of FZP Antennas..... 13
 - 1.3.1 Why Lens Antenna? 13
 - 1.3.2 Fresnel Lens and Fresnel Zone Plate..... 14
 - 1.3.3 Classical Fresnel Zones 15
 - 1.3.4 Classical Fresnel Zone Radii..... 16
 - 1.3.5 Classical Circular Fresnel Zone Plate Lens Antenna Design 17
 - 1.3.6 Phase Correcting Fresnel Lens Antennas 18
 - 1.3.7 Grooved PCFL Antenna..... 19
 - 1.3.8 Shadow Blockage..... 20
 - 1.3.9 Mismatch Losses 21
 - 1.3.10 Reflector-Backed Fresnel Zone Plate Antenna 23
 - 1.3.11 Perforated Dielectric PCFL Antennas 28
 - 1.3.12 Printed Metallic Rings PCFL Antenna..... 30
 - 1.3.13 Subwavelength FZP 31
 - 1.3.14 Perforated Subwavelength Diffractive Lens..... 33

1.3.15 Diffractive Photonic Crystal Lens	34
1.3.16 Phase Compensation for FZP Antenna of Big Diameter	36
1.4 Reference Phase Concept	37
1.4.1 Diffracting Grating and Fresnel Zone Plate	37
1.4.2 Physics of Reference Phase	39
1.4.3 Geometrical-Optics Interpretation	41
1.4.4 Reference Phase in Diffractive Antennas	46
1.4.5 Reference Phase: Alternative Definition	49
1.5 Main Principles of Real-Time Reconfigurable Diffractive	
Antenna Design	51
1.5.1 Theory of Photoconductivity FZP	51
1.5.2 Reconfigurable Plasma FZP	56
1.5.3 Electrical and Mechanical Concepts of Reconfigurable	
Technology [83]	60
1.5.4 Mechanically Reconfigurable 1D Fresnel-Zone-Plate-Shutter	
Antenna	62
1.5.5 2-Bit Antenna-Filter-Antenna Elements	63
1.5.6 Liquid Crystal Antennas	63
References	65
Chapter 2. Lens Candidates to Antenna Array	71
2.1 Circular Fresnel Zone Plate Antennas with Varying Reference Phase	71
2.2 Square FZP	81
2.2.1 Gain of a Rectangular Aperture	82
2.2.2 Diffraction Efficiency	84
2.2.3 Improved Zoning Rule for Designing Square Fresnel Zone	
Plate Lenses	86
2.2.4 Fresnel Diffractive-Interferometric Arrays	91
2.2.5 Polygonal FZP	95
2.2.5.1 Geometrical Optimization of Polygonal Fresnel Zone	
Plates in Paraxial Approximation	95
2.2.5.2 Generalization to the Case of Arbitrary Shape of	
Aperture	98
2.2.5.3 Hexagonal FZP vs. Reference Phase	99
2.2.5.4 Comparison of Circular and Hexagonal FZP	103
2.2.5.5 "Fractal" Evolution of the Square FZP	105
2.2.5.6 Antenna Having Star-Shaped Aperture	107
2.2.5.7 Diffraction on the FZPL with Irregular Boundaries	109
2.3 Beampattern with Chiral Symmetry	111
2.3.1 Basic Principles of Zone Rotation	111
2.3.2 Square FZPs with Rotated Zones	117
2.3.3 HFZPL Antenna with Rotated Zones	120
2.3.4 FZP Antenna with Hexagonal-Cut Zones	122
2.3.5 FZPA with Rotated Alternating Hex-Cut Zones	124
2.3.6 CFZPL with Outer Ring Cut in Hexagon Shape	126
References	127

Chapter 3. FZP Lens Array	129
3.1 The Resolution Limit of FZPL With Small Values of F/D and Sub-wavelength Focus.....	129
3.1.1 Some Details According Image Quality	130
3.1.2 Main Well-Known Numerical Criteria of Point Image Evaluation	131
3.1.3 Anomaly in a High-Numerical-Aperture Diffractive Focusing Lens	133
3.1.4 Results of FZPL Investigations with Sub-wavelength Focus.....	134
3.2 Single-Zone FZPA Case.....	138
3.2.1 Focal Distance Spacing Adjustment.....	142
3.2.2 Single-Zone FZPA Compared with Superstrate Antenna	143
3.3 Small 2×2 Single-Zone HFZP Array	146
3.3.1 Microstrip Feed Networks.....	149
3.3.2 Array Characteristics.....	149
3.4 Arrays of Perforated Dielectric Fresnel Lenses	152
3.4.1 2×2 Array of Perforated FZP Lenses.....	153
3.4.2 4×4 Array of Perforated FZP Lenses.....	155
3.5 Simple Circular Zone Determination in Overlapping Case	164
3.5.1 Linear Two-Elements FZP Array.....	164
3.5.2 4×4 Array	166
References	168
Chapter 4. Some Fields of Lens Array Applications.....	171
4.1 Array of Small Lenses	171
4.2 Lens Array Based on Luneberg Lenses	173
4.3 Array of Luneberg Lenses Protrudes Outside of the Fuselage	174
4.4 Fly's-Eye Imaging Concept.....	175
4.5 Waveguide Lens Array Technology	176
4.6 Active Transmit Lens Array Antenna Concept	179
4.6.1 Hexagonal Array and Active Area for Circular Elements	180
4.7 Layered FZPL Antenna Array	182
4.8 Application of a Short-Focus FZP Array to the Hartmann-Shack Sensor	183
4.9 Exoplanet Detection Array with Unlimited Aperture	186
4.10 Applications of FZP Array with Reference Phase	188
4.10.1 Multi-path Fading in Point-to-Point Communication	188
4.10.2 Secure Communication Using Directed Phase Modulation.....	191
4.11 Suggestions for Future Work	192
4.11.1 Zones Structure with Overlapping	195
4.11.2 The Main Areas for Further Research.....	197
References	197