

Contents

CHAPTER 1 Electromagnetic theory and its application to waveguides	1
1.1	Units and notation
1.2	Maxwell's equations
1.2.1	The field equations
1.2.2	The Hertzian vector $\mathbf{\Pi}$
1.3	Solutions of the wave equation
1.3.1	The del operator ∇
1.3.2	Curvilinear coordinate equations
1.3.3	Scalar solutions of the wave equation
1.3.4	Vector solutions of the wave equation
1.3.5	Decoupled vector wave equations
1.4	Parallel plate and rectangular guide equivalences
1.4.1	E-field parallel to plate surfaces
1.4.2	H-field parallel to plate surfaces
CHAPTER 2 Propagation in straight waveguides	23
2.1	Lossless rectangular waveguide
2.1.1	Dominant mode propagation
2.1.2	Transverse electric (TE) modes
2.1.3	Transverse magnetic (TM) modes
2.1.4	Longitudinal section (LS) modes
2.2	Rectangular waveguide with lossy walls
2.2.1	Calculation based on the lossless mode structure
2.2.2	Calculation based on surface impedance
2.3	Power flow and losses in straight waveguide
2.3.1	TM losses
2.3.2	TM power flow
2.3.3	TE power flow

- 2.4 Lossless circular cylindrical guide
 - 2.4.1 Transverse electric modes
 - 2.4.2 Transverse magnetic modes
- 2.5 Circular cylindrical waveguide with non-zero surface impedance walls
 - 2.5.1 Transverse magnetic modes
 - 2.5.2 Transverse electric modes

CHAPTER 3 Propagation in corrugated and loaded waveguide

39

- 3.1 Some properties of loading materials
 - 3.1.1 Particle-loaded media: general observations
 - 3.1.2 Matrix loaded with spherical particles
 - 3.1.3 Magnetised ferrites
 - 3.2 Propagation in loaded waveguides
 - 3.2.1 Strip-loaded rectangular waveguide
 - 3.2.2 Slab-loaded rectangular waveguide (hybrid mode)
 - 3.2.3 Rectangular guide filled with transversely magnetised ferrite
 - 3.2.4 Rectangular waveguide partially filled with transversely magnetised ferrite
 - 3.2.5 Circular waveguide with longitudinally magnetised ferrite rod, or dielectric rod
 - 3.2.6 Shielded microstrip line
 - 3.3 Propagation in corrugated and highly anisotropic waveguides
 - 3.3.1 Transverse and axial anisotropy
 - 3.3.2 Propagation in helically anisotropic circular waveguide
 - 3.3.3 Corrugated circular waveguide
- Appendix: A relation between phenomenological damping expressions for microwave magnetic properties of ferrites

CHAPTER 4 Propagation in curved, twisted or tapered waveguides

91

- 4.1 Curved rectangular waveguide
 - 4.1.1 The circular E-plane bend
 - 4.1.2 The circular H-plane bend
- 4.2 Twisted rectangular waveguide
 - 4.2.1 Twisted coordinate system
 - 4.2.2 Dominant mode in twisted rectangular waveguide
- 4.3 Coordinate system for curved waveguides
 - 4.3.1 Curvature relations and the Serret-Frenet frame
 - 4.3.2 Derived coordinate systems

- 4.4 Curved circular waveguide
 - 4.4.1 The wave equation in curved coordinates
 - 4.4.2 The circular electric mode in curved guide
 - 4.4.3 The TM_{11} mode in curved guide
- 4.5 Tapered waveguides
 - 4.5.1 General discussion
 - 4.5.2 Differential scattering coefficients
 - 4.5.3 The coupled differential equations for the wave amplitudes

CHAPTER 5 Cylindrical rods, posts and probes in rectangular waveguide

119

- 5.1 The inductive post
 - 5.1.1 First-order (singlet) theory
 - 5.1.2 The dielectric rod
 - 5.1.3 Inductive post triplets
 - 5.1.4 Second-order (doublet) theory
- 5.2 The resonant post
 - 5.2.1 Variational formulation
 - 5.2.2 Transformation formulas
 - 5.2.3 Post near guide wall
 - 5.2.4 Post near guide centre
- 5.3 The capacitive post
 - 5.3.1 Multiplet theory
 - 5.3.2 Tilted capacitive post
- 5.4 Post between parallel plates
 - 5.4.1 Solution of the wave equation
 - 5.4.2 Approximations for the input admittance
- 5.5 Waveguide probes
 - 5.5.1 The terminated probe
 - 5.5.2 The probe current
 - 5.5.3 The post inductance

CHAPTER 6 Diaphragms in rectangular waveguide

167

- 6.1 Schwinger's transformation applied to quasi-static solutions
 - 6.1.1 General comments
 - 6.1.2 The inductive diaphragm
 - 6.1.3 The inductive strip
 - 6.1.4 The capacitive diaphragm
 - 6.1.5 The capacitive strip
 - 6.1.6 Evaluation of integrals

- 6.2 The singular integral equation method
 - 6.2.1 The capacitive strip
 - 6.2.2 Singular integral equations
 - 6.2.3 Diaphragm and strip
 - 6.2.4 Symmetrical double inductive strip
- 6.3 Quasi-dynamic method of solution of the singular integral equation
 - 6.3.1 The quasi-dynamic method
 - 6.3.2 Application to the symmetrical capacitive diaphragm
 - 6.3.3 Evaluation of various integrals
- 6.4 The Wiener–Hopf technique
 - 6.4.1 The unsymmetrical inductive diaphragm
 - 6.4.2 Solution by the Wiener–Hopf method
 - 6.4.3 Factorisation of $s(u)$

CHAPTER 7 Multiple diaphragms and gratings 228

- 7.1 The extension of the singular integral equation to multiple intervals
 - 7.1.1 General comments
 - 7.1.2 The integral equation with gaps
- 7.2 The extension of Carleman's equation to multiple intervals
 - 7.2.1 Notation and some auxiliary relations
 - 7.2.2 Carleman's equation with gaps
- 7.3 The double unsymmetrical inductive aperture in rectangular waveguide
 - 7.3.1 Integral equation for the diaphragm
 - 7.3.2 Evaluation of the integrals
 - 7.3.3 Determination of the constants
 - 7.3.4 The diaphragm susceptance

CHAPTER 8 Waveguide junctions – change of shape 249

- 8.1 Singular integral equation method applied to steps in rectangular waveguide
 - 8.1.1 Three-term extension of Carleman's equation
 - 8.1.2 Application to the H-plane step
 - 8.1.3 Application to the E-plane step
 - 8.1.4 Diaphragm-junction interaction
- 8.2 Conformal transformation applied to waveguide steps
 - 8.2.1 E-plane step equations
 - 8.2.2 Conformal transformation quasi-static solution
 - 8.2.3 Higher-order solution

- 8.3 Relation between the singular integral equation and the conformal transformation methods
 - 8.3.1 General comments
 - 8.3.2 The E-plane step conformal formulation
 - 8.3.3 Inversion via contour integration
 - 8.3.4 Waveguide step conformal solution
 - 8.3.5 Properties of the integral solution
- 8.4 Bifurcated waveguide
 - 8.4.1 Singular integral equation solution
 - 8.4.2 Diaphragm-junction interaction
 - 8.4.3 Wiener–Hopf solution
 - 8.4.4 The in-line T-junction
- 8.5 E-plane T-junction in rectangular waveguide
 - 8.5.1 Mode expansion formulation
 - 8.5.2 Singular integral formulation
 - 8.5.3 Variational solution
 - 8.5.4 Equivalent circuit representation
 - 8.5.5 Element values

CHAPTER 9 Waveguide junctions – change of media **302**

- 9.1 Transversely magnetised ferrite
 - 9.1.1 The junction field equation
 - 9.1.2 Solution using Carleman’s equation
 - 9.1.3 Diaphragm-junction interaction
 - 9.1.4 The surface-wave anomaly
 - 9.1.5 The surface-wave solution
 - 9.1.6 General comments on the solution
- 9.2 Junction with inhomogeneous waveguide
 - 9.2.1 General comments
 - 9.2.2 Formulation in terms of waveguide modes
 - 9.2.3 Electric field formulation
 - 9.2.4 Magnetic field formulation
 - 9.2.5 Variational formulation
 - 9.2.6 The eigenvalues for dielectric step loading
 - 9.2.7 Discussion of the form of solution
 - 9.2.8 Second-order approximation

Appendix: Radiation from curved structures **336**

- A.1. The radiation condition in local coordinate systems
- A.2. Curved dielectric slab
- A.3. The curved dielectric rod or optical fibre

Index **343**