Broadband Planar Antennas with Improved Radiation Patterns for Satellite Reception

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Contents

Symbols and Abbreviations

Symbols

(a,b,c)	Spherical coordinates of patch
a_n	Unknown constant
B	Transponder bandwidth
B_w	Antenna relative bandwidth
C/N	Carrier-to-noise ratio
D	Largest dimension of antenna
d_x	Spacing between antenna elements in x-direction
d_y	Spacing between antenna elements in y-direction
$\boldsymbol{E}$	Electric field
E_x	x-component of $\boldsymbol{E}$
E_y	y-component of $\boldsymbol{E}$
E_z	z-component of $\boldsymbol{E}$
$\boldsymbol{E}(z,t)$	Instantaneous electric field
$E_x(z,t)$	x-instantaneous component of $\boldsymbol{E}(z,t)$
$E_y(z,t)$	y-instantaneous component of $\boldsymbol{E}(z,t)$
E_{x0}	Maximum magnitude of $E_x(z,t)$
E_{y0}	Maximum magnitude of $E_y(z,t)$
$\boldsymbol{E}_A(\theta_0,\phi_0)$	Far-zone electric field of an array antenna in the direction (θ_0,ϕ_0)
e_A	Efficiency of an array antenna
e_a	Efficiency accounting for losses of array structure

e_o	Total efficiency
e_c	Conduction efficiency
e_d	Dielectric efficiency
e_{qp}	Efficiency accounting for losses inserted by the extension of an array from Q to P elements
e_r	Reflection efficiency
e_s	Efficiency of a single antenna element
F	Linear integral operator
f	Frequency
f_h	Upper boundary of simulated or measured frequency band
f_l	Lower boundary of simulated or measured frequency band
G	Gain
G_A	Gain of an array antenna
G_P	Gain of an array antenna composed of P antenna elements
G_Q	Gain of an array antenna composed of Q antenna elements
G_S	Gain of a single antenna element
G/T	Gain-to-noise ratio
$\overline{G/T}$	Mean value of G/T
g	Response function to excitation
g_n	Basis function
H_y	y-component of magnetic field
h	Excitation current function
h_m	Test function
I_{nm}	Excitation factor of the element (n,m)

$\|I_{nm}\|$	Amplitude of I_{nm}
$I(x)$	Current at the position x
$\boldsymbol{J}_t$	Surface current on patch
$\boldsymbol{J}_x$	x-component of $\boldsymbol{J}_t$
$\boldsymbol{J}_y$	y-component of $\boldsymbol{J}_t$
K	Boltzmann's constant
k	Wave number
k_0	Free-space wave number
L	Patch length
L_a	Atmospheric attenuation
L_d	Free-space attenuation
L_{o1}	Feeding line overlap at Port 1
L_{o2}	Feeding line overlap at Port 2
L_{p1}	Resonant length of perforated patch at Port 1
L_{p2}	Resonant length of perforated patch at Port 2
L_{s1}	Aperture resonant length at Port 1
L_{s2}	Aperture resonant length at Port 2
L_1	Patch resonant length at Port 1
L_2	Patch resonant length at Port 2
L_{10}, L_{11}, L_{12}	Transmission lines lengths of impedance matching network at Port 1
L_{20}, L_{21}, L_{22}	Transmission lines lengths of impedance matching network at Port 2
M	Number of array elements in y-direction
$\boldsymbol{M}$	Equivalent magnetic current of aperture
M_y	Magnetic polarisation current
N	Number of array elements in x-direction

N_1	Number of perforated patch strips at Port 1
N_2	Number of perforated patch strips at Port 2
P_C	Carrier power level
P_{EIRP}	Effective isotropically radiated power
P_{NA}	Antenna noise power
P_{NS}	System noise power
P_{in}	Input power
P_{in_A}	Input power of an array antenna
P_r	Radiated power
P_{r_A}	Radiated power from an array antenna
P_{r_S}	Radiated power from a single antenna element
P_z	Electric polarisation current
Q	Quality factor
q	Fraction of power entering an antenna
$R(\theta,\phi)$	Radiation pattern of single antenna element in the direction (θ,ϕ)
R	Amplitude of $R(\theta,\phi)$
$R_A(\theta,\phi)$	Radiation pattern of array antenna
R_A	Amplitude of $R_A(\theta,\phi)$
$R_{AF}(\theta,\phi)$	Array factor
R_{AF}	Amplitude of $R_{AF}(\theta,\phi)$
R_s	Radius of sphere enclosing antenna
S_{LL}	Side lobe level
S_v	Voltage standing wave ratio
S_1	Spacing between perforated patch strips at Port 1
S_2	Spacing between perforated patch strips at Port 2

S_{11}	Scattering parameter corresponding to input impedance
S_{12}	Scattering parameter corresponding to port isolation
T_A	Antenna noise temperature
T_R	Receiver noise temperature
$T(\theta,\phi)$	Temperature distribution in the direction (θ, ϕ)
t	Substrate thickness
t_0	Thickness of foil supporting patch
t_1	Thickness of patch substrate
t_2	Thickness of feeding substrate
t_3	Thickness of space foam
$\tan\delta$	Substrate loss
$\tan\delta_1$	Loss of patch substrate
$\tan\delta_2$	Loss of feeding substrate
$\tan\delta_{eff}$	Effective substrate loss
$U(\theta,\phi)$	Radiation intensity in the direction (θ, ϕ)
$U_A(\theta_0,\phi_0)$	Radiation intensity of an array antenna in the direction (θ_0,ϕ_0)
$U_S(\theta_0,\phi_0)$	Radiation intensity of a single antenna element in the direction (θ_0,ϕ_0)
$V(x)$	Voltage at the position x
W	Patch width
W_1	Width of perforated patch strips at Port 1
W_2	Width of perforated patch strips at Port 2
W_{11}, W_{12}	Transmission lines widths of impedance matching network at Port 1
W_{21}, W_{22}	Transmission lines widths of impedance matching network at Port 2

x_0	x-coordinate of aperture
$\hat{\boldsymbol{x}}$	Unit vector in the x-direction
$\hat{\boldsymbol{y}}$	Unit vector in the y-direction
Z_{in}	Input impedance
$Z_{in}(x)$	Input impedance at the position x
α_e	Electric polarisability
α_m	Magnetic polarisability
Δf	Receiver bandwidth
ΔP	Wasted power
$\Delta\phi$	Time-phase difference
$\Delta\theta_{3\text{dB}}$	Half power beamwidth
ε_0	Air dielectric constant
ε_r	Substrate dielectric constant also called relative permittivity
ε_{r1}	Substrate dielectric constant of patch
ε_{r2}	Substrate dielectric constant of feeding
ϕ_x	x-component of phase
ϕ_y	y-component of phase
Γ	Reflection coefficient
φ_{nm}	Phase of I_{nm}
η	Constant
λ_0	Free-space wavelength
λ_g	Guided wavelength
(θ, ϕ)	Direction of radiation
(θ_0, ϕ_0)	Direction of maximum radiation
θ_p	Angle of wave propagation

Abbreviations

ACM	Aperture Coupled Microstrip
CEM	Computational Electromagnetics
DBS	Direct Broadcasting Satellite
DSR	Digital Satellite Radio
DTH	Direct To Home
LNB	Low Noise Block converter
MoM	Method of Moments
MPIE	Mixed Potential Integral Equation
PTFE	Polytetrafluoroethylene
SMA	Sub-Miniatur-A
TEM	Transverse Electromagnetic
VSWR	Voltage Standing Wave Ratio