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## LIST OF SYMBOLS AND ABBREVIATIONS

### Symbols

$\eta\%$	-	% of Efficiency
L	-	Antenna length
W	-	Antenna width, Watts
C	-	Capacitor
$Z_0$	-	Characteristic impedance
$f_c$	-	Cut-off frequency
$\epsilon_r$	-	Dielectric (relative) permittivity
D	-	Directivity
$\mu_{eff}$	-	Effective permeability
$\epsilon_{eff}$	-	Effective permittivity
$E$	-	Electric Field
$\epsilon$	-	Epsilon (permittivity)
$\rho$	-	Filling ratio
$\epsilon_0$	-	Free space permittivity
$\lambda_0$	-	Free space wavelength
G	-	Gain
$L_g$	-	Ground plane length
P	-	Poynting Vector
$W_g$	-	Ground plane width
$\lambda_g$	-	Guide wave length
H	-	Horizontal Polarization, Magnetic Field
L	-	Inductor
$\eta$	-	Intrinsic impedance

$\lambda$	-	Lambda (Wavelength)
$f_l$	-	Lower frequency point (in -10 dB line)
$\mu$	-	Mu (permeability)
$\Omega$	-	Ohms
$\beta$	-	Phase constant
$\varphi$	-	Phi (Azimuth Angle)
$S_{22}$	-	Reflection parameter (Port 2)
$S_{11}$	-	Reflection parameter (Port 1)
$\mu_r$	-	Relative permeability
$f_r$	-	Resonant frequency
$\xi$	-	Roll-off rate
$w_s$	-	Slot width of CPW
$c$	-	Speed of light
$L_s$	-	Strip length
$h$	-	Substrate thickness
$\theta$	-	Theta (Elevation Angle)
$S_{21}$	-	Transmission parameter (port 1 to 2)
$S_{12}$	-	Transmission parameter (port 1 to 2)
$f_u$	-	Upper frequency point (in -10 dB line)
$\mu_0$	-	Vacuum permeability
$V$	-	Volts, Vertical Polarization
$w_f$	-	Width of the center conductor of CPW
$W/h$	-	Width to height ratio

## Abbreviations

%BW	-	Percentage Bandwidth
ANN	-	Artificial Neural Networks
BPA	-	Back Propagation Algorithm

BW	-	Bandwidth
CAD	-	Computer Aided Design
CEM	-	Computational Electromagnetics
CPW	-	Coplanar Waveguide
CSRR	-	Complementary Split Ring Resonator
CST MWS	-	CST Microwave Studio (Microwave CAD software)
DNG	-	Double Negative Materials
EBG	-	Electromagnetic Band Gap
EM	-	Electromagnetic
ENG	-	Epsilon Negative (metamaterial)
FA	-	Fractal Antenna
FDTD	-	Finite Difference Time Domain Method
FE-BI	-	Finite Element method of EM field solver
FEKO	-	Microwave CAD software
FEM	-	Finite Element Method
FR4	-	Flame Retardant 4 (substrate material)
GA	-	Genetic Algorithm
GPS	-	Global Positioning System
HCFA	-	Hilbert Curve Fractal Antenna
HFSS	-	EM Simulation Software
Hiper LAN	-	Hiper Local Area Network
IA	-	Implantable Antenna
IE3D	-	EM Simulation Software
IMD	-	Implantable Medical Devices
ISM	-	Industrial Scientific and Medical
LPF	-	Low Pass Filter
MIC	-	Microwave Integrated circuit
MICS	-	Medical Implant Communications Service
MIMO	-	Multi -Input Multi -Output

MLP FF BP	-	Multi -Layer Perceptron Feed Forward Back Propagation
mm	-	Milli meter
MNG	-	Mu Negative (metamaterial)
MoL	-	Method of Lines
MoM	-	Method of Moments
MSA	-	Microstrip Antenna
MSRR	-	Multiple Split Ring Resonator
MTM	-	Metamaterial
MWCAD	-	Microwave computer aided design
NEC	-	Numerical Electromagnetic Coding
NHCFA	-	New Hilbert Curve FA
NIST	-	NIST parameter retrieval method
NNIT	-	New Non-Iterative Technique
NRI	-	Negative Refractive Index
NRW	-	Nicolson - Ross- Wier
PE	-	Perfect Electric
PFA	-	Patch Fractal Antenna
PIFA	-	Planar Inverted F-Antenna
PM	-	Perfect Magnetic
PSO	-	Particle Swam Optimization
RF-30,RF- 35, RH-5, RO TMM, RT Duroid	-	Substrate materials
RFID	-	Radio Frequency Identification
RL	-	Return loss (dB)
SAR	-	Specific Absorption Rate
SCT	-	Short Circuit Techniques

SFA	-	Square Fractal Antenna
SNG	-	Single Negative Material
SR	-	Spiral Resonators
TFA	-	Thin Fractal Antenna
UWB	-	Ultra Wide Band
VSWR	-	Voltage Standing Wave Ratio
WiFi	-	Short Range Wireless connectivity
WiMax	-	Large Range wireless connectivity
WLAN	-	Wireless local area network