Edition 1

RF/Microwave Reference Guide

Richardson Electronics

Engineered Solutions

www.rfpowernet.com

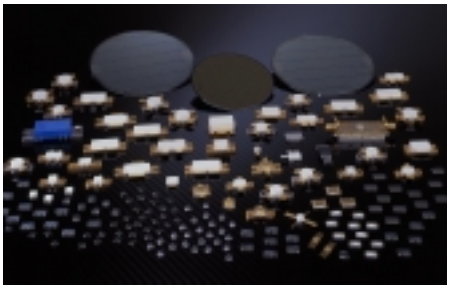
RF & Wireless Communications Group

The Richardson Electronics RF and Wireless Group serves the rapidly expanding global RF and wireless communications market and the radio and television broadcast industry. Our product and sales team of RF and wireless engineers assists our customers in designing circuits, selecting cost effective components, planning reliable and timely supply, prototype testing and assembly.

Richardson supports these growth opportunities by partnering with many of the key RF and wireless component manufacturers. One of the keys to our successful relationships with our vendors is the visibility we give them to the worldwide demand for their current products and product development. Richardson's global information system includes programs that our sales force use to forecast information that is shared with our product suppliers to assist them in predicting near and long-term demand and product life cycles. Richardson has global distribution agreements with such leading semiconductor suppliers as ANADIGICS, Ericsson, M/A-COM, Motorola and Stanford Microdevices. In addition, Richardson has partnerships with many niche RF and wireless suppliers to form the most comprehensive RF and wireless resource in the industry.

The RF /Microwave Reference Guide is a handbook for engineers who design with both active and passive components. We hope you find this guide to be a helpful and valuable reference tool that you will use regularly to design-in product needs.

Richardson Electronics represents your source for RF and wireless products, offering product solutions, technical support, current product information and a broad selection of components. Please contact your local Richardson Electronics sales offices which are listed on the back cover of this guide.



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The above application notes are available on Richardson's website: www.rfpowernet.com/appnotes.asp

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RF Semiconductors & Active Components:

ANADIGICS
CMAC
Ericsson
Filtronic
GHz Technology
KDI/Triangle
M/A-COM
Microsemi
Motorola
MTI
Pacific Monolithics
RF Gain
Semelab
Siward
Stanford
Stellex/Phoenix
ST Microelectronics
UMS
Watkins-Johnson

Interconnects, Passives & Antenna Products:

AMP
Amphenol
EZ Form
Huber & Suhner
Johanson Manufacturing
Johnson Components
KDI/Triangle
M/A-COM
Maxrad
Pacific Wireless
QMI
RF Gain
RF Power Components
Radiall
SDP Components, Inc.
Spectrum Control
Times/Polyphaser
W.L. Gore

Power Conversion Products:

Advanced Power Tech.
Bussman
Cornell-Dubilier
Draloric
Ferraz
General Electric
High Energy
Hitachi
Jennings
LEM
MTE
National Electronics
Nissei-Arcotroics
Powerex
Semtech
Spectrum Control
Unilator
United Chemi-Con
Vishay Sfernice
Wakefield Engineering
Westcode

Richardson Electronics-Value-Added Services RF Testing Labs

Richardson Electronics can provide the following services:

Testing and Sorting (Binning) of DC Parameters for Bipolar and MOSFET Devices:

- Bipolar $V_{(BR)CBO}$ $V_{(BR)CES}$ $V_{(BR)CEO}$ $V_{(BR)EBO}$ I_{CBO} I_{CES} I_{EBO} and h_{FE}
- MOSFET- $V_{(BR)DSS}$ I_{DSS} I_{GSS} $V_{GS(TH)}$ $V_{DS(ON)}$ and g_{fs}

Matched Devices:

Devices should be matched if being paralleled or used in a push-pull circuit

- h_{FE}-DC current gain (for bipolar transistors)
- g_{fs}- Forward Transconductance (for FET's)
- Gate Threshold Voltage (for FET's)
- Power Gain (Requires customer's test fixture)
- Other parameters that customer may require

Selection of Transistors to Specific Parameter Ranges:

- h_{FE}-DC current gain (for bipolar transistors)
- g_{fs}- Forward Transconductance (for FET's)
- Power Gain (Requires customer's test fixture
- Other parameters that customer may require

Selection of Low Leakage Current Devices:

- Selection of devices with low reversed biased junction current

RF Testing (Requires customer's test fixture):

- IMD-Intermodulation Distortion
- IP3- Third Order Intercept
- Power Output
- Gain
- Other parameters that customer may require

Provide hard copy of test data

Modifications:

- Branding to customer specifications
- Cutting / Milling of leads, flanges and studs
- Special lead trimming and forming
- Gold-plating of flanges and studs
- Enlarge flange holes

Custom Branding/Marking:

- Brand device with customer's part number
- Color dots or letter codes for sorting and selection
- Alphanumeric codes for date, lot, etc.

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The Greek Alphabet and Its Engineering Uses

Name	Upper Case	Lower Case	Uses
Alpha	A	α	Absorption factor, angles, angular acceleration, attenuation constant, common-base currentam plifition factor, deviation of state parameter, temperature coef ficient of resistance, ther mal-expansion coefficient, thermal diffusivity
Beta	B	β	Angles, common-emitter current-amplification factor, flux density, phase constant, wavelength costant
Gamma	Γ	γ	Electrical conductivity, Grueneisen parameter
Delta	Δ	δ	Angles, damping coefficient (decay constant), decre ment, increment, secondary-emission ratio
Epsilon	E	ε	Capacitivity, dielectric coefficient, electric field intensity, electron energy, emmissivity, permit tivity, base of natural logarithms (2.7128)
Zeta	Z	ζ	Coefficients, coordinates, impedance
Eta	H	η	Chemical potential, dielectric susceptibility (intrin sic capacitance), efficiency, hysteresis, intrinsic impedance of a medium, intrinsic standoff ratio
Theta	Θ	θ	Angle of rotation, angles, angular phase dis placement, reluctance, thermal resistance, transit angle
Iota	I	ι	Inertia
Kappa	K	κ	Coupling coefficient, susceptibility
Lambda	Λ	λ	Line density of charge, permanence, photosensi- tivity, wavelength
Mu	M	μ	Amplification factor, magnetic permeability, micron, mobility, permeability, prefix micro
Nu	N	ν	Reflectivity
Xi	Ξ	ξ	Output coefficient
Omicron	O	o	
Pi	Π	π	Peltier coefficient, ratio of circumference to diameter (3.1416)
Rho	P	ρ	Reflection coefficient, reflection factor, resistivity, volume density of electric charge
Sigma	Σ	σ	Conductivity, Stefan-Boltzmann constant, summation, surface density of charge
Tau	T	τ	Period, propagation constant,. Thomson coefficient, time constant, time-phase displacement, transmission factor
Upsilon	Y	υ	Admittance
Phi	Φ	ϕ	Angles, coefficient of performance, contact potential, magnetic flux, phase angle, phase displacement, radi- ant flux
Chi	X	χ	Angles
Psi	Ψ	ψ	Angles, dielectric flux, displacement flux, phase difference
Omega	Ω	ω	Angular frequency, angular velocity, Ohms, resistance, solid angle

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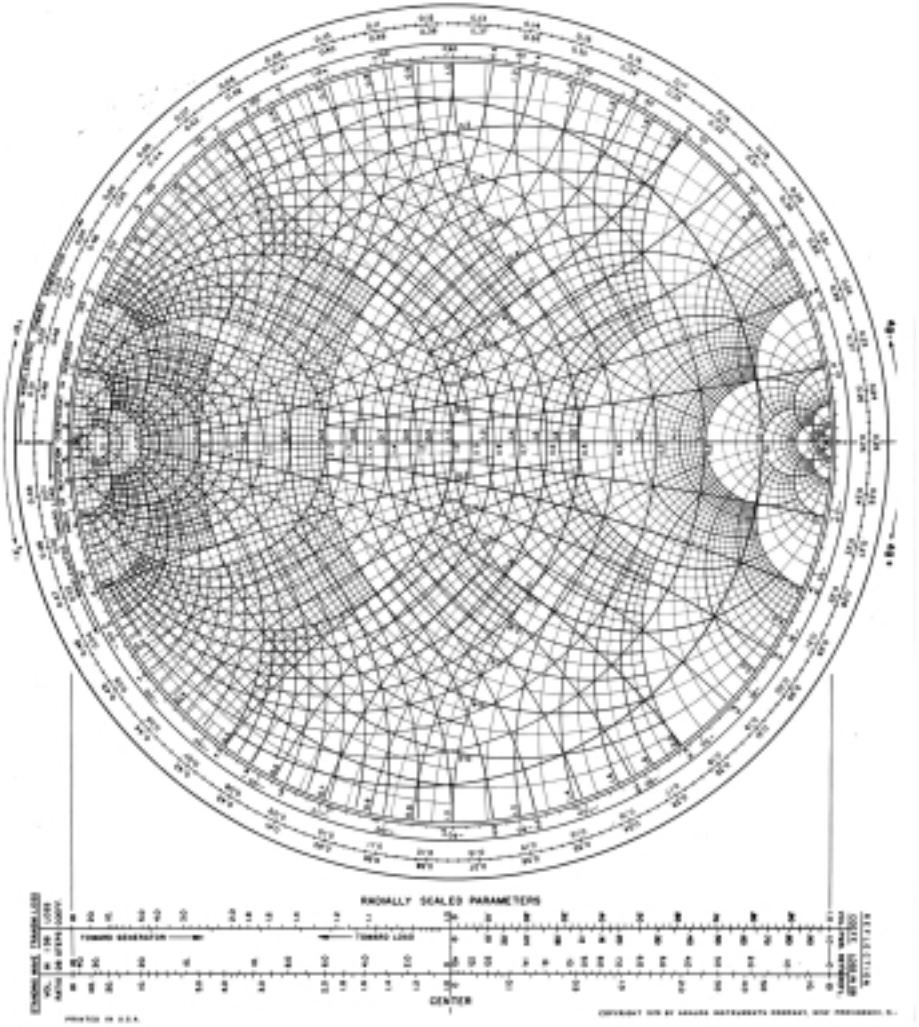
Normalized Impedance and Admittance Coordinates



Power Conversion Table

dBm	watts	dBm	watts	dBm	watts	dBm	watts	dBm	watts
30.0	1.00	38.0	6.31	46.0	39.81	54.0	251	62.0	1585
30.2	1.05	38.2	6.61	46.2	41.69	54.2	263	62.2	1660
30.4	1.10	38.4	6.92	46.4	43.65	54.4	275	62.4	1738
30.6	1.15	38.6	7.24	46.6	45.71	54.6	288	62.6	1820
30.8	1.20	38.8	7.59	46.8	47.86	54.8	302	62.8	1905
31.0	1.26	39.0	7.94	47.0	50.12	55.0	316	63.0	1995
31.2	1.32	39.2	8.32	47.2	52.48	55.2	331	63.2	2089
31.4	1.38	39.4	8.71	47.4	54.95	55.4	347	63.4	2188
31.6	1.45	39.6	9.12	47.6	57.54	55.6	363	63.6	2291
31.8	1.51	39.8	9.55	47.8	60.26	55.8	380	63.8	2399
32.0	1.58	40.0	10.00	48.0	63.10	56.0	398	64.0	2512
32.2	1.66	40.2	10.47	48.2	66.07	56.2	417	64.2	2630
32.4	1.74	40.4	10.96	48.4	69.18	56.4	437	64.4	2754
32.6	1.82	40.6	11.48	48.6	72.44	56.6	457	64.6	2884
32.8	1.91	40.8	12.02	48.8	75.86	56.8	479	64.8	3020
33.0	2.00	41.0	12.59	49.0	79.43	57.0	501	65.0	3162
33.2	2.09	41.2	13.18	49.2	83.18	57.2	525	65.2	3311
33.4	2.19	41.4	13.80	49.4	87.10	57.4	550	65.4	3467
33.6	2.29	41.6	14.45	49.6	91.20	57.6	575	65.6	3631
33.8	2.40	41.8	15.14	49.8	95.50	57.8	603	65.8	3802
34.0	2.51	42.0	15.85	50.0	100	58.0	631	66.0	3981
34.2	2.63	42.2	16.60	50.2	105	58.2	661	66.2	4169
34.4	2.75	42.4	17.38	50.4	110	58.4	692	66.4	4365
34.6	2.88	42.6	18.20	50.6	115	58.6	724	66.6	4571
34.8	3.02	42.8	19.05	50.8	120	58.8	759	66.8	4786
35.0	3.16	43.0	19.95	51.0	126	59.0	794	67.0	5012
35.2	3.31	43.2	20.89	51.2	132	59.2	832	67.2	5248
35.4	3.47	43.4	21.88	51.4	138	59.4	871	67.4	5495
35.6	3.63	43.6	22.91	51.6	145	59.6	912	67.6	5754
35.8	3.80	43.8	23.99	51.8	151	59.8	955	67.8	6026
36.0	3.98	44.0	25.12	52.0	158	60.0	1000	68.0	6310
36.2	4.17	44.2	26.30	52.2	166	60.2	1047	68.2	6607
36.4	4.37	44.4	27.54	52.4	174	60.4	1096	68.4	6918
36.6	4.57	44.6	28.84	52.6	182	60.6	1148	68.6	7244
36.8	4.79	44.8	30.20	52.8	191	60.8	1202	68.8	7586
37.0	5.01	45.0	31.62	53.0	200	61.0	1259	69.0	7943
37.2	5.25	45.2	33.11	53.2	209	61.2	1318	69.2	8318
37.4	5.50	45.4	34.67	53.4	219	61.4	1380	69.4	8710
37.6	5.75	45.6	36.31	53.6	229	61.6	1445	69.6	9120
37.8	6.03	45.8	38.02	53.8	240	61.8	1514	69.8	9550
								70.0	10000

The Effect of VSWR on Transmitted Power

VSWR	Return Loss (dB)	Trans. Loss (dB)	Volt Refl. Coeff.	Power Trans (%)	Power Refl. (%)
1.00	∞	0.000	0.00	100.0	0.0
1.01	46.1	0.000	0.00	100.0	0.0
1.02	40.1	0.000	0.01	100.0	0.0
1.03	36.6	0.001	0.01	100.0	0.0
1.04	34.2	0.002	0.02	100.0	0.0
1.05	32.3	0.003	0.02	99.9	0.1
1.06	30.4	0.004	0.03	99.9	0.1
1.07	29.4	0.005	0.03	99.9	0.1
1.08	28.3	0.006	0.04	99.9	0.1
1.09	27.3	0.008	0.04	99.8	0.2
1.10	26.4	0.010	0.05	99.8	0.2
1.11	25.7	0.012	0.05	99.7	0.3
1.12	24.9	0.014	0.06	99.7	0.3
1.13	24.3	0.016	0.06	99.6	0.4
1.14	23.7	0.019	0.07	99.6	0.4
1.15	23.1	0.021	0.07	99.5	0.5
1.16	22.6	0.024	0.07	99.5	0.5
1.17	22.1	0.027	0.08	99.4	0.6
1.18	21.7	0.030	0.08	99.3	0.7
1.19	21.2	0.033	0.09	99.2	0.8
1.20	20.8	0.036	0.09	99.2	0.8
1.21	20.4	0.039	0.10	99.1	0.9
1.22	20.1	0.043	0.10	99.0	1.0
1.23	19.7	0.046	0.10	98.9	1.1
1.24	19.4	0.050	0.11	98.9	1.1
1.25	19.1	0.054	0.11	98.8	1.2
1.26	18.8	0.058	0.12	98.7	1.3
1.27	18.5	0.062	0.12	98.6	1.4
1.28	18.2	0.066	0.12	98.5	1.5
1.29	17.9	0.070	0.13	98.4	1.6
1.30	17.7	0.075	0.13	98.3	1.7
1.32	17.2	0.083	0.14	98.1	1.9
1.34	16.8	0.093	0.15	97.9	2.1
1.36	16.3	0.102	0.15	97.7	2.3
1.38	15.9	0.112	0.16	97.5	2.5
1.40	15.6	0.122	0.17	97.2	2.8
1.42	15.2	0.133	0.17	97.0	3.0
1.44	14.9	0.144	0.18	96.7	3.3
1.46	14.6	0.155	0.19	96.5	3.5
1.48	14.3	0.166	0.19	96.3	3.7
1.50	14.0	0.177	0.20	96.0	4.0
1.52	13.7	0.189	0.21	95.7	4.3
1.54	13.4	0.201	0.21	95.5	4.5
1.56	13.2	0.213	0.22	95.2	4.8
1.58	13.0	0.225	0.22	94.9	5.1
1.60	12.7	0.238	0.23	94.7	5.3
1.62	12.5	0.250	0.24	94.4	5.6

Effect of VSWR on Transmitted Power

VSWR	Return Loss (dB)	Trans. Loss (dB)	Volt Refl. Coeff.	Power Trans (%)	Power Refl. (%)
1.64	12.3	0.263	0.24	94.1	5.9
1.66	12.1	0.276	0.25	93.8	6.2
1.68	11.9	0.289	0.25	93.6	6.4
1.70	11.7	0.302	0.26	93.3	6.7
1.72	11.5	0.315	0.26	93.0	7.0
1.74	11.4	0.329	0.27	92.7	7.3
1.76	11.2	0.342	0.28	92.4	7.6
1.78	11.0	0.356	0.28	92.1	7.9
1.80	10.9	0.370	0.29	91.8	8.2
1.82	10.7	0.384	0.29	91.5	8.5
1.84	10.6	0.398	0.30	91.3	8.7
1.86	10.4	0.412	0.30	91.0	9.0
1.88	10.3	0.426	0.31	90.7	9.3
1.90	10.2	0.440	0.31	90.4	9.6
1.92	10.0	0.454	0.32	90.1	9.9
1.94	9.9	0.468	0.32	89.8	10.2
1.96	9.8	0.483	0.32	89.5	10.5
1.98	9.7	0.497	0.33	89.2	10.8
2.00	9.5	0.512	0.33	88.9	11.1
2.50	7.4	0.881	0.43	81.6	18.4
3.00	6.0	1.249	0.50	75.0	25.0
3.50	5.1	1.603	0.56	69.1	30.9
4.00	4.4	1.938	0.60	64.0	36.0
4.50	3.9	2.255	0.64	59.5	40.5
5.00	3.5	2.553	0.67	55.6	44.4
5.50	3.2	2.834	0.69	52.1	47.9
6.00	2.9	3.100	0.71	49.0	51.0
6.50	2.7	3.351	0.73	46.2	53.8
7.00	2.5	3.590	0.75	43.7	56.3
7.50	2.3	3.817	0.76	41.5	58.5
8.00	2.2	4.033	0.78	39.5	60.5
8.50	2.1	4.240	0.79	37.7	62.3
9.00	1.9	4.437	0.80	36.0	64.0
9.50	1.8	4.626	0.81	34.5	65.5
10.00	1.7	4.807	0.82	33.1	66.9
11.00	1.6	5.149	0.83	30.6	69.4
12.00	1.5	5.466	0.85	28.4	71.6
13.00	1.3	5.762	0.86	26.5	73.5
14.00	1.2	6.042	0.87	24.9	75.1
15.00	1.2	6.301	0.88	23.4	76.6
16.00	1.1	6.547	0.88	22.1	77.9
17.00	1.0	6.780	0.89	21.0	79.0
18.00	1.0	7.002	0.89	19.9	80.1
19.00	0.9	7.212	0.90	19.0	81.0
20.00	0.9	7.413	0.90	18.1	81.9
25.00	0.7	8.299	0.92	14.8	85.2
30.00	0.6	9.035	0.94	12.5	87.5

Wavelength and Frequency

For all forms of wave, the velocity, wavelength, and frequency are related such that the product of frequency and wavelength is equal to the velocity. For microwaves, this relationship can be expressed in the form

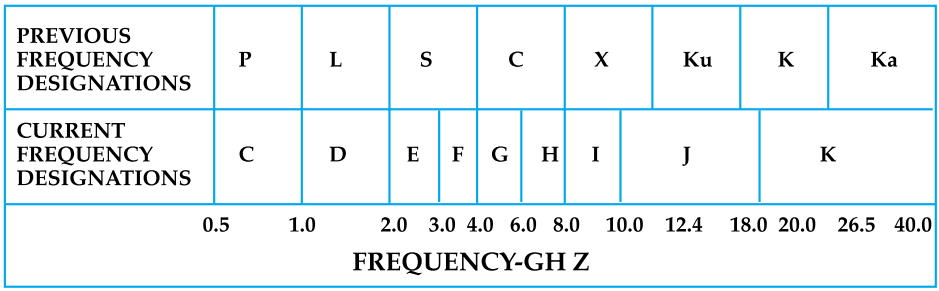
$$\lambda F \sqrt{\varepsilon} = c$$

where

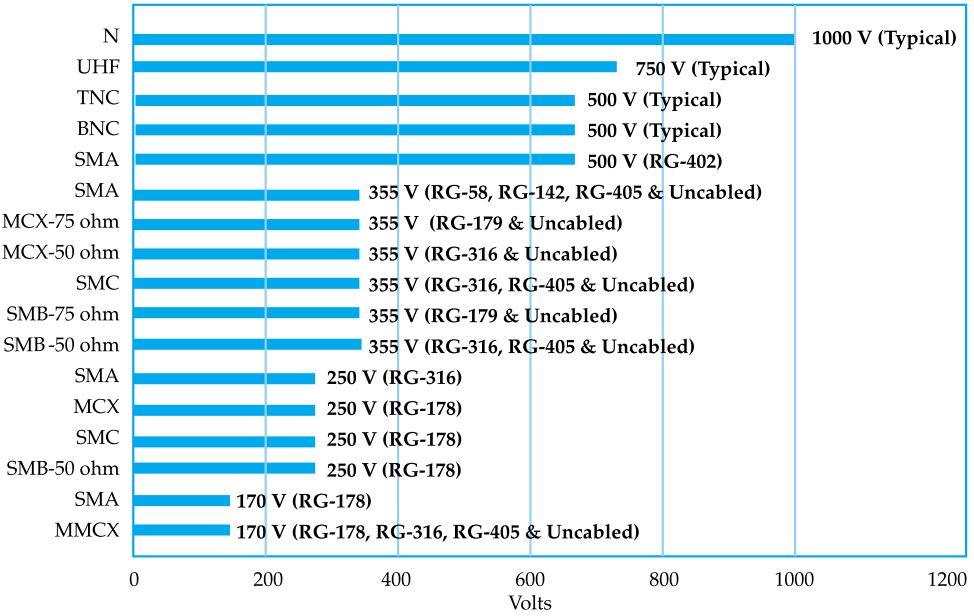
λ = wavelength in meters (m)
Φ = frequency in hertz (Hz)
ε = dielectric constant of the propagation medium
χ = velocity of light (300,000,000 m/s)

The dielectric (e) is a property of the medium in which the wave propagates. The value of e is defined as 1.000 for a perfect vacuum, and very nearly 1.0 for dry air (typically 1.006). In most practical applications, the value of e in dry air is taken to be 1.000. For mediums other than air or vacuum, however, the velocity of propagation is slower, and the value of e relative to a vacuum is higher. Teflon“, for example, can be made with dielectric constant values (e) from about 2 to 11.

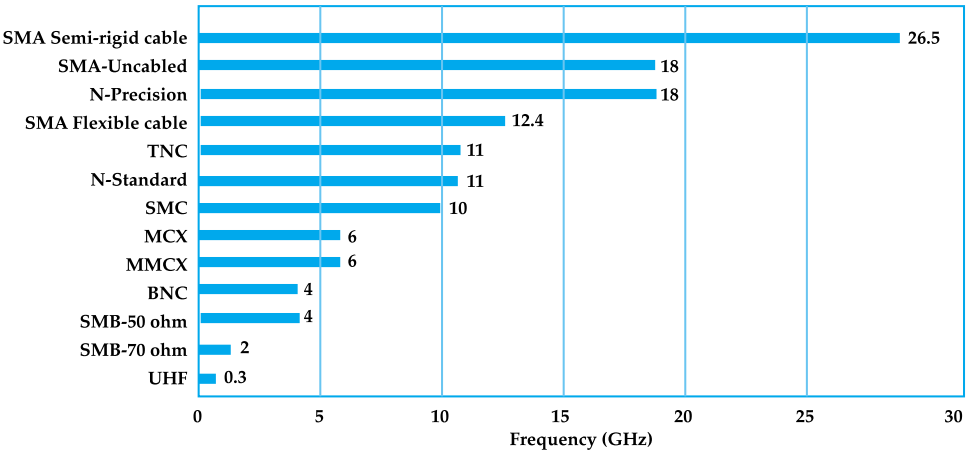
FREQUENCY BAND DESIGNATIONS



Maximum Rated Working Voltage



Maximum Rated Operating Frequency



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Normalized Dissipated Power in "T" and π Attenuator Elements

Attenuation	Power Dissipation (watts)		
(dB)	R_1	R_2	R_3
0.25	.014	.014	.028
0.50	.029	.026	.054
0.75	.043	.037	.079
1.00	.058	.046	.103
1.25	.072	.054	.124
1.50	.086	.061	.145
1.75	.100	.068	.164
2.00	.115	.073	.182
2.25	.129	.076	.199
2.50	.143	.081	.214
2.75	.157	.083	.229
3.00	.171	.086	.242
3.25	.185	.088	.254
3.50	.199	.088	.266
3.75	.213	.089	.276
4.00	.226	.091	.285
4.25	.240	.090	.294
4.50	.253	.090	.302
4.75	.267	.089	.309
5.00	.280	.089	.315
5.25	.293	.087	.321
5.50	.306	.087	.325
5.75	.319	.085	.330
6.00	.332	.084	.333
7.00	.382	.076	.342
8.00	.431	.068	.342
9.00	.476	.060	.338
10.00	.519	.052	.329
12.00	.598	.038	.301
14.00	.667	.027	.266
16.00	.726	.018	.230
18.00	.776	.013	.195
20.00	.818	.008	.164
30.00	.939	.001	.059

Frequency vs. Wavelength

Frequency	Wavelength
1 MHz	300 meters (m)
10 MHz	30 m
100 MHz	3 m
300 MHz	1 m --- 100 centimeters (cm)
1 GHz	30 cm
10 GHz	3 cm
100 GHz	3 millimeters (mm)
300 GHz	1 mm --- 10-3 m
3 x 1014	1 micron --- 10-6 m

Metric Prefixes

Metric Prefix	Multiplying Factor	Symbol
tera	10^{12}	T
giga	10^{9}	G
mega	10^{6}	M
kilo	10^{3}	K
hecto	10^{2}	h
deka	10	da
deci	10^{-1}	d
centi	10^{-2}	c
milli	10^{-3}	m
micro	10^{-6}	m
nano	10^{-9}	n
pico	10^{-12}	p
femto	10^{-15}	f
atto	10^{-18}	a

Conversion factors

1	inch	=	2.54 cm
1	inch	=	25.4 mm
1	foot	=	0.305 m
1	mile	=	1.61 km
1	nautical mile	=	6080 ft
1	statute mile	=	5280 ft
1	mil	=	2.54 x 10-5 m
1	kg	=	2.2 lb
1	neper	=	8.686 dB
1	gauss	=	10,000 teslas

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Units

Quantity	Unit	Symbol
Capacitance	farad	F
Electric charge	coulomb	Q
Conductance	mhos (siemans)	Ω
Conductivity	mhos / meter	Ω / m
Current	ampere	A
Energy	joule (watt-sec)	J
Field	volts / meter	E
Flux linkage	weber (volt-second)	ψ
Frequency	hertz	Hz
Inductance	Henry	H
Length	meter	m
Mass	gram	g
Power	watt	W
Resistance	ohm	Ω
Time	second	s
Velocity	meter / second	m / s
Electric potential	volt	V

Physical constants

Constant	Value	Symbol
Boltzmann's constant	1.38×10^{-23} J / K	K
Electric charge (e-)	1.6×10^{-19} C	q
Electron (volt)	1.6×10^{-19} J	eV
Electron (mass)	9.12×10^{-31}kg	m
Permeability of free space	4p x 10^{-7} H / m	Yo
Permittivity of free space	8.85×10^{-12} F / m	∈o
Planck's constant	6.626×10^{-34} J û s	h
Velocity of electromagnetic waves	3 x 108 m / s	c
Pi (π)	3.1416	π

Key Equations:

1. $c = \lambda F \sqrt{\epsilon}$

2. $\lambda = \frac{c}{F\sqrt{\epsilon}}$

3. $F = \frac{c}{\lambda\sqrt{\epsilon}}$

4. $T = \frac{1}{F}$

5. $\delta = \sqrt{\frac{1}{2\pi F \sigma \mu}}$

Microwave Transmission Lines:

6. Impedance inversion in a quarter-wavelength shorted stub: $\frac{Z}{Z_o} = \frac{Z_o}{Z_L}$

7. Characteristic impedance for a quarter-wavelength Q section: $Z_o = \sqrt{ZZ_L}$

8. VSWR:
   From incident voltage (Vi) and reflected voltage (Vr): $VSWR = \frac{V_i + V_r}{V_i - V_r}$

9. Length of a transmission line as a function of reflection transit time: $L_{meters} = \frac{c\upsilon T_d}{2}$

10. Impedance looking in to a transmission line:
    (a) ZL is not equal to Zo in a random-length lossy line: $Z = Z_o \frac{Z_L + Z_o \tan(\gamma l)}{Z_o + Z_L \tan(\gamma l)}$

    (b) Half-wavelength lossy lines: $Z_o = \frac{276}{\sqrt{\varepsilon}} \log \frac{2S}{d}$

11. Characteristic impedance of transmission lines:
    (a) Parallel line:
    $Z_o = \frac{276}{\sqrt{\varepsilon}} \log \frac{2S}{d}$

    (b) Coaxial line:
    $Z_o = \frac{138}{\sqrt{\varepsilon}} \log \frac{D}{d}$

    (c) Stripline:
    $Z_o = \frac{377}{\sqrt{\varepsilon}} \frac{T}{W}$

12. Transmission line impedance as a function of voltage and current: $Z_L = \frac{V_{inc} + V_{ref}}{I_{inc} + I_{ref}}$

13. Characteristic impedance of a lossy line: $\sqrt{\frac{R + j\omega L}{G + j\omega C}}$

14. Dielectric constant as a function of velocity: $\varepsilon = \frac{1}{v^2}$

15. Cutoff wavelength: $\lambda_c = \frac{2}{\sqrt{(m/a)^2 (n/b)^2}}$

16. Propagation constant as a function of frequency: $\beta = \omega\sqrt{\varepsilon\mu}\ \sqrt{1 - \left(\frac{F_c}{F}\right)^2}$

Waveguides:

17. Group velocity in a waveguide: $V_g = c \sin a$

18. Relationship between frequency and free-space wavelength: $c = F\lambda_o$

19. Wavelength in a waveguide: $\lambda = \frac{V_p \lambda_o}{c}$

20. Cutoff wavelength: $\lambda = 2a$

21. Cutoff frequency: $F_c = \frac{C}{2a}$

22. Complex impedance: $Z = R \pm jX$

23. Normalized impedance: $Z = \frac{R \pm jX}{Z_o}$

24. Power reflection coefficient: $P_{pwr} = P^2$

25. VSWR as a function of reflection coefficient: $VSWR = \frac{1+P}{1-P}$

26. Return loss as a function of VSWR: $Loss_{ret} = 10\log(P_{pwr})$

27. General mode equation for resonant cavity: $F_r = \frac{c}{2(\mu\varepsilon)}\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2 = \left(\frac{P}{d}\right)^2}$

28. Mode equation for air dielectric: $F_r = \frac{c}{2}\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2 = \left(\frac{P}{d}\right)^2}$

29. Quality factor Q of a resonant circuit: $Q_0 = \frac{2\pi\ U_s}{U_d}$

Microwave Antennas:

30. Shape factor: $SF = \frac{F2 - F1}{F_H - F_L}$

31. Q of a filter: $Q = \frac{F_c}{BW_{3dB}}$

32. Cutoff frequency of a waveguide feeding dish antenna: $f_{cutoff} = \frac{175{,}698}{d_{mm}}$

33. Gain of a parabolic dish antenna: $G = \frac{k(\pi D)^2}{\lambda^2}$

34. Focal length of parabolic dish antenna: $f = \frac{D^2}{16d}$

35. Antenna directivity as a function of power densities: $D = \frac{P_{\max}}{P_{av}}$

36. Directivity gain of an antenna: $G_d = \frac{4\pi P_a}{P_r}$

37. Power gain of an antenna: $G_p = \frac{4\pi P_a}{P_n}$

38. Relationship between directivity gain and power gain: $G_p = \frac{P_r G_d}{P_n}$

39. Gain of a horn radiator: $G = \frac{10A}{\lambda^2}$

40. Alternate notations for impedance in ac circuits: $Z = \sqrt{R^2 + (X_L - Xc^2)}$

41. Efficiency factor of an antenna comparing resistances: $k = \frac{R_r}{R_r + R_o}$

Microwave Transistors:

42. Power-frequency limit: $\frac{\sqrt{P_{\max} X_{co}}}{2\pi(l/\upsilon)} = \frac{E_{\max} V_s}{2\pi}$

43. Maximum gain: $G_{\max} = \sqrt{\frac{F_t}{F}} \frac{Z_o}{Z_{in}}$

Discrete Microwave Amplifiers:

44. Gain of a parametric amplifier: $G = f_i / f_s$

45. Noise in a parametric amplifier: $F_{noise} = \frac{R_a}{R1} + \frac{f_s}{f_i}$

46. Manley-Rowe relationship for parametric amplifiers: $\sum_{m,n} \frac{mP_{m,n}}{mf_p + nf_s} = 0$

47. Noise figure as a function of noise factor: $NF = 10 \log F_n$

48. Noise temperature as a function of noise factor: $T_e = (F_n - 1)T_0$

49. Noise temperature as a function of noise figure: $T_e = \left[anti \log\left(\frac{NF}{10}\right) - 1 \right] KT_0$

50. Total noise in a system: $P_{n(total)} = GKB(T_o + T_e)$

51. Noise factor of amplifiers in cascade: $F_n = F_1 + \frac{F_2 - 1}{G1} + \frac{F_3 - 1}{G1G2} + \text{K} + \frac{F_n - 1}{G1G2\,\text{K}\,G_{n-1}}$

52. Characteristic impedance required of a quarter-wave Q-section transformer:

$$Z_o = \sqrt{R_i \times R_o}$$

Hybrid and Monolithic Microwave Integrated Circuit Amplifiers:

53. Noise power: $P_n = KTB$

54. Noise factor as a function of SNR: $F_n = \frac{SNR_{in}}{SNR_{out}}$

55. Noise factor as a function of output noise power: $F_n = \frac{P_{no}}{KT_0BG}$

56. Component values in the LC version of the Wilkinson power divider:

$$R = 2Z_o$$

$$L = \frac{70.7}{2\pi F_o}$$

$$C = \frac{1}{2\pi 70.7 F_o}$$

57. Physical length of a quarter-wavelength coaxial cable section: $L = \frac{2952V}{F}$

58. Impedance required of a quarter-wavelength Q matching section: $Z'_o = \sqrt{Z_L Z_O}$

59. Characteristic impedance of a stripline section: $Z_o = 377\frac{h}{w\sqrt{\varepsilon}}$

60. Input/output impedance of MIC internal amplifier: $R_o = \sqrt{R_f \times R_e}$

61. Gain in MIC internal amplifier: $G_{dB} = 20 \log\left[\frac{R_f - R_e}{R_o = R_e}\right]$

62. Gain in a cascade amplifier: $G = G1 \times G2 \times G3 \times \mathrm{K} \times Gn$

63. Mismatch loss due to SWR in a single-stage amplifier: $ML = -10 \log\left[1 - \left(\frac{SWR-1}{SWR+1}\right)^2\right]$

64. Noise figure of a cascade amplifier: $NF_{total} = NF1 + \frac{NF2-1}{G1} + \frac{NF3-1}{G1G2} + \mathrm{K} + \frac{NFn-1}{G1G2Gn}$

Microwave Diodes:

65. Tunnel diode frequencies - self-resonant frequency: $F_s = \frac{1}{2\pi}\sqrt{\frac{1}{L_s C_j} - \frac{1}{(RC_j)^2}}$

Microwave Diode Generators:

66. Electron transit time in a Gunn diode: $T_t = \frac{L}{V_\delta}$

67. Operating frequency in the Gunn or transit-time mode: $F_o = \frac{V_{dom}}{L_{eff}}$

68. Criterion for LSA oscillation: $-G \geq G_o$

69. Output power from a Gunn diode: $P_o = n(MV_{th}L)(N_o eVA)$

Transmitters:

70. Output frequency of a multiplier: $F2 = N \times F1$

71. Friis's transmission equation: $\frac{P_r}{P_t} = \frac{G_t G_r \lambda^2}{(4\pi d)^2}$

72. Friis's equation in decibel form: $10 \log \frac{P_r}{P_t} = G_{t(dB)} + G_{r(dB)} + 10 \log\left(\frac{\lambda}{4\pi d}\right)^2$

73. Spreading loss in satellite communications: $L = 33\,dB + [20 \log (d_{km})] + [20 \log (F_{MHZ})]$

74. Total noise in system: $T_{total} = T_{eq(rcvr)} + T_{eq(ant)}$

ACI: Adjacent channel interference
ADPCMA: Adaptive Differential Pulse Code Modulation
ADSL: Asymmetrical Digital Subscriber Line. A method to increase transmission speed in a copper cable. ADSL facilitates the division of capacity into a channel with higher speed to the subscriber, typically for video transmission and a channel with significantly lower speed in the other direction
AFC: Automatic Frequency Control
AGC: Automatic Gain Control. Used to protect a device from optical overload while maintaining bandwidth and sensitivity performance
AGC Threshold: The level of input current at which the AGC circuit becomes active
AGC Time Constant: The amount of time it takes to achieve the required AGC level; also, the amount of time it takes to recover from AGC
AGL: Above Ground Level
AM: Amplitude Modulation
Amplifier: One or more stages of transistors with matching and bias circuits
AMPS: Advanced Mobile Phone System. The original American standard specification for analog systems. Used primarily in North America, Latin America, Australia and parts of Russia and Asia
Analog Quantities: or representations that are variable over a continuous range such as output of an amplitude-modulated, single-sideband transmitter. The amplitude as such a signal fluctuates over a continuous range from zero to the maximum, or peak, output
Analog: (data transmission) Pertaining to data in the form of continuously variable physical quantities
Analog Device: A device that operates with variables represented by continuously measured quantities such as voltages, resistance's, rotations and pressures
Analog Signal: A signal that is solely dependent upon magnitude to express the information content
Analog-To-Digital Converter: A device that converts a signal whose input is information in the analog form and whose output is the same information in digital form
ANSI: American National Standards Institute
Antenna: A device for receiving or transmitting electromagnetic energy
Antenna Power Gain: The ratio of the effected radiated power to the RF actual poweapplied to the feed point. Usually expressed in decibels
APS: Antenna Positioning System
AR: Activity Radio
ASF: Application Service Positioning. A technology that facilitates downloading of software of the Internet instead of purchasing the program over the counter - against a fixed fee
ASIC: Application Specific Integrated Circuit
ASSP: Application Specific Standard Product
ATM: Asynchronous Transfer Mode. A technology for broadband transmission of voice, data and video transmission of telecom signals in large amounts. In addition to highcapacity signal transmission, ATM provides considerable flexibility, since the individual subscriber is able to adapt the capacity of a switched connection to current requirements
ATSC: Advanced Television Systems Committee

Attenuation: The decrease in amplitude of a signal between any two points in a circuit. Usually expressed in decibels. Attenuation is the opposite of amplification
AWGN: Additive White Gaussian Noise
AXE: An open architecture, Ericsson's communications platform. A system for computer-controlled digital exchanges chat constitute the nodes in large public telecommunications networks. The basis for Ericsson's wireline and mobile systems
Background Noise: In an amplifier or other device that draws current, there is always some noise output in addition to the desired signal
BAN: Broadband Access Network
Bandwidth: The amount of frequency space occupied by a signal, and required for effective transfer of the information to be carried by that signal
Baud Rate: The measure of the speed of transmission of a digital code
BER: Bit Error Rate
Bias: A potential difference which is applied deliberately between two points for the purpose of controlling a circuit
Bipolar: (< 4 GHz) Advantages: Proven technology, Low $/Watt, High Power/Chip area & package ratio, Low ESD Active Semiconductor formed by two P-N junctions whose function is amplification of an electric current. (Emitter, Base, Collector)
Bit: A binary digit. The binary systems of numbers is often called base 2. The decimal system is base 10
Bit Rate: The rate of a binary-coded transmission which is the number of bits per second
Bluetooth: A radio technology built around a new chip that makes it possible to transmit signals over short distance between telephones, computers and other devices without the use of wires
Broadband Modulation: The transfer of information by a radio signal requires a certain minimum amount of spectrum space. This minimum depends on the rate at which this information is conveyed. Sometimes called wideband modulation
BiCMOS: Bipolar Complementary Metal Oxide Semiconductor
BPSK: Binary Phase Shift Keying
BTA : Basic Trading Area
Cable Communications: Any system of transferring information by wire
Cable Television: A supplement to conventional television. Signals are transmitted by cable and sometimes heterodyned, or converted to lower frequencies for more efficient transmission
CAP: Carrier Amplitude Phase Modulation
CATV: Community Antenna Television (cable television)
Carrier: An alternating-current wave of constant frequency, phase and amplitude. By varying the frequency, phase or amplitude of a carrier wave, information is transmitted
C-Band: (4-8 GHz)
CDMA: Code Division Multiple Access. A technology for digital transmission of radio signals between, for example, a mobile telephone and a radio base station. In CDMA, a frequency is divided into a number of codes
CDPD: Cellular Digital Packet Data
Cellular: A wireless phone system that uses a grid of 'cells', each including transmitters, receivers, and antennas. Most of the world's cellular systems started with analog technology, although most operators are now migrating to digital to ease capacity restraints and offer new services

CEMA: Consumer Electronics Manufacturers Association
CEPT: Conference Europeenne des Postes et Telecommunications
Channel: A particular band of frequencies to be occupied by one signal, or one 2-way conversation in a given mode
Class of Operation: A: Very linear, low distortion, low power for voice, AM, digital modulation schemes AB: Less linear, distortion, very high power C: Nonlinear, distortion, very high power
CMOS: Complementary Metal Oxide Semiconductor
CMRS: Commercial Mobile Radio Service
C/N: Carrier-to-Noise Ratio
Converter: Any device that converts frequency, voltage or current from one value to another
Corona: The minimum voltage requirement at which the breakdown of air gaps between conductors will not occur. Corona develops primarily in low air pressure situations, such as conditions which would be seen in high altitude aircraft. Corona is important since it will create noise and distort the transmitted signal if it occurs.
CRC: Cycle redundancy check
CTB: Composite Triple Beat
CT2: Cordless Telephone, 2nd Generation (digital)
Current (Amps): Flow of electric charge (electrons)
CW: Continuous Wave
DAMPS: Digital Advanced Mobile Phone System. Earlier designation of American standard for digital mobile telephony used primarily in North America, Latin America, Australia and parts of Russia and Asia. Now known as TDMA.
DAVIC: Digital Audio Visual Council
DBM: Decibel reference to 1 miliwatt; 0 dBm equals one miliwatt
dBa: Adjusted decibels
DBS: Direct Broadcast Satellite
DCA: Dynamic channel assignment
DC-To-AC Converter: A circuit that changes the voltages of a direct current power supply to alternating current supply
DC Transmission: When electric power is sent from one point to another as a direct current
DCS 1800: Variant of GSM at 1.8 GHz, used in Europe
DCS 1900: Variant of GSM at 1.9 GHz, for PCS applications
Decibel (dB): A unit of measuring relative levels of current, voltage or power
DECT: Digital European Cordless Telephone
Demodulation: The extraction of the modulation or information from a radio-frequency current
Detector: The photodiode in optical receivers
Digital: A method of processing information through the use of electronic or optical pulses that represent the binary digits 0 and 1. Wireless digital technology enables clear sound, encrypted transmissions, and value-added text and data services. It is also more resistant to cloning fraud
Discrete Components: An electronic component such as a resistor capacitor inductor, or transistor that has been manufactured before its installation in the circuit

Dish Antenna: A high-gain antenna that is used for the transmission and reception of ultra-high-frequency and microwave signals
DLC: Data Link Control (layer)
DME: Distance Measuring Equipment
DMOS: Diffused Metal Oxide Semiconductor
DMT: Discrete Multi-tone Modulation
Down Conversion: The heterodyning of an input signal with the output of local oscillator, resulting in an intermediate frequency that is lower than the incoming signal frequency
DQPSK: Differential quadrature phase shift keying
DSBSC: Double Sideband Suppressed Carrier
DSP: Digital Signal Processor (Baseband)
DSS: Digital Satellite System
DSSS: Direct Sequence Spread Spectrum
DTH: Direct-to-Home
DTV: Digital Television
DWDM: Dense Wave Division Multiplexing
DWV: Dielectric Withstanding Voltage
EBU: European Broadcasting Union
EDGE: A technology that gives GSM and TDMA similar capacity to handle services for the third generation of mobile telephony. Developed to enable the transmission of large amounts of data at a high speed, 384 kilobits per second in mobile applications
EHF: Extremely High Frequency
EIA: Electronic Industries Association (U.S.)
EIRP: Effective Isotropic Radiated Power
EPG: Electronic Program Guide
EPOC: An operating system for mobile terminals, developed by Symbian (Ericsson joint-venture company including Matsushita, Motorola, Nokia and Psion)
ERP: Effective radiated power
ETACS: Extended Total Access Communication System
ETSI: European Telecommunications Standards Institute
EVM: Error Vector Magnitude
FCC: Federal Communications Commission (U.S.)
FCS: Fiber channel standard
F/D: Focal Distance-to-Diameter Ratio
FDD: Frequency division duplexing
FDDI: Fiber Distributed Digital Interface
FDM: Frequency Division Multiplex
FDMA: Frequency-Division Multiple Access
FEC: Forward Error Correction
FET: Field Effect Transistor
FEXT: Far-end Crosstalk
FHSS: Frequency hopping spread spectrum
Fiber Optics: Light beams transferred from one place to another by optical fiber or fibers
Filter: A passive or active frequency selective circuit designed to modify a signal or source of power

FM: Frequency Modulation
FNPRM: Further Notice of Proposed Rulemaking (from FCC)
FPLMTS: Future Public Land Mobile Telecommunication Systems
Frequency: For any periodic disturbance, the frequency is the rate at which the cycle repeats. It is generally measured in cycles per second or Hertz (Hz). Rapid oscillation frequencies are specified in kilohertz (kHz), megahertz (MHz), gigahertz (GHz) and terahertz (THz). 1 kHz=1,000 Hz, 1 MHz=1,000 KHz; 1 GHz=1,000 MHz; and 1 THz=1,000 GHz
Front End: The first radio-frequency amplifier stage in a receiver. One of the most critical components of the receiver because the sensitivity of the front end dictates the sensitivity of the entire receiver
FQPSK: Filtered quadrature phase shift keying
FSK: Frequency Shift Keying
FSS: Fixed Satellite Service
FTTC: Fiber to the curb
FTTH: Fiber to the home
GaAs FET: Gallium Arsenide Field Effect Transistor (> 2 GHz)
Gain Control: An adjustable control that changes the gain of an amplifier
GFSK: Gaussian filtered FSK
GFT: Generic Flow Control
GMSK: Gaussian minimum shift keying
GMT: Greenwich Mean Time
GPRS: General Packer Radio Service. A packer-linked technology that enables highspeed (115 kilobit per second) wireless Internet and other data communications
GPS: Global Positioning Satellite or Global Positioning System
GSM: Global System for Mobile Communication. Originally developed as a panEuropean standard for digital mobile telephony, GSM has become the world's most-widely used mobile system. It is used on the 900 MHz and 1800 MHz frequencies in Europe, Asia and Australia, and the MHz 1800 frequency in North America and Latin America
GSO: Geo-synchronous Orbit
G/T: Gain-over-Noise Temperature
GUTS: Generic UDP Transport Service
HBT: (Heterojunction Bipolar Transistor) Transistor that offers higher RF power gain per stage and does not require a negative power supply
HDSL: High bit rate digital subscriber line
HDTV: High Definition Television
HEC: Header Error Control
Heterodyne: A process of the shifting of a signal of interest down to a frequency at which it may be processed more easily to extract information
HEMT: (High Electron Mobility Transistor) A transistor that yields the lowest noise figures in single FET devices
Hertz: (Hz) A unit of frequency equal to one complete cycle per second
HFC: High-band Fiber-optic Cable; Hybrid Fiber/Coax
HP: Horizontal Polarization
High: Q A filter circuit with a great deal of selectivity

HIPERLAN: High Performance Radio Local Area Network (ETSI, Europe)
HIPPI: (High Performance Parallel Interface) An 800 Mb/s interface to supercomputer networks
IEC: International Standards Group
IF: (Intermediate Frequency) Desired microwave signals are first heterodyned down to an IF frequency for ease of filtering, and then further heterodyned down to another IF or baseband where the information may be recovered
IFF: Identify Friend or Foe - Used in Avionics
IMD: Intermodulation distortion - RF impairment where device non-idealities create new frequency components not in the original signal, including the common harmonic and two-tone distortion effects Impedance Resistance to alternating-current flow
Impedance: Expressed in ohms and is determined by the connector geometry and insulating material parameters. Impedance will vary with frequency. For optimum performance connector impedance must be the same as the system impedance in which the connector will be used
IMSI: International Mobile Station Identity
IMT-2000: International Mobile Telecommunications. Standard adopted by the ITU for the third generation of mobile telephony. Actually a family of Five different specifications for the radio interface in this new system generation
Inductance: The ability of a device to store energy in the form of a magnetic field
Inductor: An electronic component designed to provide a controlled amount of inductance
Insertion Loss: Dependent on the properties of the connector's insulation materials and conductors. Insertion loss is the other major factor which contributes to the total transmitted signal efficiency of the connector
Intermodulation: In a receiver, an unwanted signal sometimes interacts with the desired signal. The desired signal appears to be modulated by the undesired signal
IP: Internet Protocol. The Internet protocol defines how information travels between systems across the Internet
IP2: Second Order Intercept Point - Figure of merit for second-order (squaring) distortion of a component. Derived by artificially extrapolating a second-order response until it intercepts the fundamental input-output response
IP3: Third Order Intercept Point - Figure of merit for third-order (cubic) distortion of a component. Derived via artificially extrapolating a third-order response until it intercepts the fundamental input-output response
IPPV: Impulse pay-per-view
IR: Infrared
IRD: Integrated receiver-decoder
IS-41: Interim Standard 41 (TIA/EIA cellular network signaling standard, U.S.)
IS-54: Interim Standard 54, for analog and digital cellular radio for all of North America
IS-95: A digital mobile telephony standard based on CDMA technology
IS-136: A digital mobile telephony standard based on TDMA technology
ISDN: Integrated Service Digital Network
ISI: Intersymbol interference
ISL: Intersatellite link
ISM: Industrial Scientific & Medical (unlicensed frequency bands 915 MHz, 2.4 & 5.725 GHz)

ISP: Internet service provider. A company specializing in offering end-users access to the Internet. As a rule does not have own communications network but functions as a link between the user and the net operator
ITFS: Instructional television fixed service
ITU: International Telecommunications Union. A United Nations agency that deals with telecommunications issues
ITU-R: International Telecommunication Union-radio communication sector
IXC: Interexchange Carrier
JDC: Japan Digital Cellular, 900 to 1500 MHz
Kilohertz: (kHz) A unit of frequency equal to 1,000 hertz, or 1,000 cycles per second
LAN: Local Area Network. A small data network covering a limited area, such as within a building or group of buildings
L-Band: Radio Frequency Band of 390 to 1550 MHz
LDMOS: Laterally Diffused Metal Oxide Semiconductor-Using this structure, chips are directly attached to metal flanges to improve grounding and reduce thermal resistance. Advantages: High gain, usable efficiency, low thermal resistance and superior IMD when applied to cellular radio systems.
Laser: A device that generates coherent electromagnetic radiation in, or near, the visible part of the spectrum
LEC: Local Exchange Carrier
LEOS: Low Earth Orbit Satellite
LMDS: Local multipoint distribution service. American standard for high-speed transmission of voice and data using so-called Pmp (Point-toMultipoint) solutions. Used to provide wireless broadband traffic to small and medium-size companies or in apartment buildings
LNA: Low-noise amplifier - RF gain device designed specifically for very low imposition of additional noise power. Used to amplify very low signals without contributing significant SNR degradation
LNB: Low noise block downconverter
LO: Low Oscillator - Refers to the frequency conversion CW source used in the RF mixing process
LOS: Line of sight
MAC: Medium access control
MATV: Master antenna television
MBU: Multiple business unit
MCNS: Multimedia Cable Network Systems
MCS: Multipoint communications systems
MDS: Multipoint distribution service
MDU: Multiple dwelling unit
MESFET: Metal Semiconductor Field Effect Transistor
Microwaves: That part of the electromagnetic spectrum at which the wavelength falls between about 30 centimeters and 1 millimeter. Microwave frequencies range from 1 GHz to 300 GHz. Microwaves are very short electromagnetic radio waves but have a long wavelength than infrared energy
Microwave Oscillator: A device used to generate a microwave signal. It consists of two parts: a resonator to control the frequency of the microwave signal and an active device to generate the power

Mixer: A non-linear circuit that produces an output at the sum and difference frequencies of an applied fixed or variable oscillator called the LO, and the RF input signal of interest. (see Heterodyne)
MMDS: Multipoint Microwave Distribution System (also known as Wireless Cable)
MMIC: (Microwave Monolithic Integrated Circuit) The process by which active devices such as MESFETs and diodes, and passive devices including inductors, capacitors, resistors, and interconnects are fabricated on the same GaAs chip
MNP: Microcom Networking Protocol
Modulation: When some characteristics of an electromagnetic wave are deliberately changed or manipulated for the purpose of transmitting information (see Amplitude Modulation, Frequency Modulation and Phase Modulation)
MONET: Multiwavelength Optical Networking
MPEG: Moving Picture Experts Group of the International Standards Organization (set video compression standard)
MSA: Metropolitan Statistical Area
MSC: Mobile Switching Center
MSO: Multi-system operator
MSS: Mobile satellite services (or systems)
MTA: Major Trading Area
MTBF: Mean time between failures
MVPD: Multichannel video programming distributor
NADC: North American Digital Cellular or North American Digital Cordless
NAMPS: Narrow Band Advanced Mobile Phone Service
NEXT: Near-end crosstalk
NMT: Nordic Mobile Telephone
Noise Figure: A measure of the ability of an amplifier to increase the strength of a signal while adding the minimum possible self-generated noise. It is mathematically equal to ten times the log of the input S/N ratio to the output S/N ratio
NTSC: National Television Standards Committee (which created U.S. color TV standard)
OFS: Operational fixed service
OHM: The standard unit of resistance, reactance and impedance. A resistance of 1 ohm will conduct 1 ampere of current when a voltage of 1 volt is placed across it
Optical Overload: A condition of high input current that cause pulse width distortion at the output of the TIA
OQPSK: Offset quadrature phase shift keying
Output Power: Pout
PACA: Priority Access and Channel Assignment
PACS: (TDMA) Personal Access Communication System
PAL: Phase alternate line (European color TV standard)
Passive Component: A component that requires no external source of power for its functionality
PBX: Private Branch Exchange. An exchange system used in companies and organizations to handle internal and external calls.
PCIA: Personal Communications Industry Association
PCMCIA: Personal Computer Memory Card International Association
PCN: Personal Communications Network

PCS: Personal Communications Services. Collective term for American mobile telephone services in the 1900 MHz frequency band
PCS/PCN: Personal Communications System / Network
PDA: Personal Digital Assistant
PDC: Personal Digital Cellular. A Japanese standard for digital mobile telephony in the 800 MHz and 1500 MHz bands
PDU: Protocol data unit
% Efficiency: RF Pout / (RF Pin+ DC Power)
Phase A relative: quantity describing the time relationship between or among waves having identical frequency. The complete wave cycle is divided into 360 equal parts, called degrees of phase
Phase Distortion: When the output of an amplifier fluctuates in phase, even though the input does not, the circuit introduces phase distortion into the signal
Phase Modulation: (PM) When the information is impressed on a radio frequency signal by varying its phase angle
Photodiode: A semiconductor device that converts light to electrical current
PHP: Personal Handy Phone (Japan)
PHS: Personal Handy Phone System
Photoresistor: A device that exhibits a variable resistance, depending on the amount of light that strikes it
PMR: Private mobile radio
PoP: Point of presence
POTS: Plain old telephone service
Power Amplifier: An amplifier that delivers a certain amount of alternating-current power to a load. Used in audio-frequency and radio-frequency applications
Power Gain: An increase in signal power between one point and another. Used as a specification for power amplifiers
Power Transistor: A semiconductor transistor designed for power-amplifier applications at audio and radio frequencies
PPV: Pay-per-view
PRMA: Packet Reservation Multiple Access
PSD: Power spectral density
PSTN: Public Switched Telephone Network
PTI: Payload type indicator
QAM: Quadrature amplitude modulation
Q Factor: For a capacitor, inductor or tuned circuit, the Q factor, or Q, is a figure of merit. The higher the Q, the lower the loss and the more efficient the component
QPSK: Quadrature phase shift key
RLL: Radio local loop
RTMS: Radio Telephone Mobile System (Italy)
Receiver: Any circuit that intercepts a signal, processes the signal, and converts it to a form useful to a person. The signal may be in any form such as electric currents in a wire, radio waves, modulated light, or ultrasound. The receiver converts signals into audio information, video informaton, or both
Resistance: The opposition that a substance offers to the flow of electric current
Resistor: An electronic component that is deliberately designed to have a specific amount of resistance

Response Time: The length of time between the occurrence of an event and the response of an instrument or circuit to that event
RF: (Radio Frequency) An electromagnetic disturbance is a radio frequency if the wavelength falls within the range of 30 km to 1 mm. This represents a frequency range of 10 kHz to 3000 GHz. The input signal from the antenna is an RF signal
RF High Potential: RF High Potential is a minimum voltage requirement for the connector at frequencies greater than 1 MHz. This requirement insures that the connector will not exhibit excessive leakage current or dielectric failure due to high RF voltages
RFI: Radio frequency interference
RF Leakage: RF Leakage is defined as the amount of signal which radiates from the connector with respect to frequency. Sources for signal leakage can come from sits or holes in a connector body, from poorly mated connectors or through the braid in a coaxial cable.
RMA: Random multiple access
Roaming: A method that enables subscribers of one wireless operator to use their handset in another carrier's service area. Customers cannot roam on a network unless their home carrier and the visited operator have a roaming agreement and a user has compatible equipment
Router: A data switch that handles connections between different networks. A router identifies the addresses on data passing through the switch, determines which route the transmission should take and collects data in so-called packets that are then sent to their destinations
RSA: Rural Service Area
RSH: Response station hub
RX: Receiver - General abbreviation used in many situations, referring to items such as electrical data receivers, optical receivers, radio receivers and digital communication demodulators
SAW: Surface acoustic wave (filter) - Filter or oscillator technology characterized by its reliance on acoustic energy and electrical / acoustic transductors used to take advantage of impressive bandpass filter shape factors that are difficult to achieve with more traditional filter technologies
s-Band: Range of frequency between 2.0 GHz and 4.0 GHz
SCI: Scaleable coherent interface
SCPC: Single channel per carrier
SDH: Synchronous digital hierarchy
SIM: Subscriber Identity Module
SLM: Signal level meter
SMATV: Satellite master antenna television
SMR: (Specialized Mobile Radio) A communications service at 800 MHz and 900 MHz Traditionally used to provide dispatch operations over analog networks, SMR now includes digital networks offering integrated dispatch messaging and cellular communications
SMS: Short messaging service
S/N: Signal-to-noise ratio

SNR: (Signal-To-Noise Ratio) The sensitivity of a communications receiver is generally specified in terms of the audio signal-to-noise ratio that results from an input signal of a certain number of microvolts
SOHO: Small office, home office
SONET: Synchronous optical network - North American high speed baseband digital transport standard specifying incrementally increasing data stream rates for movement across digital optical links
SSPA: Solid-state power amplifier
STA: Synchronous transport module
Switch: A mechanical or electric device that is used to deliberately interrupt, or alter the path of the current through the circuit
TACS: Total Access Communication System
TDD: Time division duplexing
TDM: Time Division Multiplexing
TDMA: Time Division Multiple Access. A technology for digital transmission of radio signals between, for example, a mobile phone and a radio base station. In TDMA, the frequency band is split into a number of channels that are stacked into short time units so that several calls can share a single channel without interfering with one another. TDMA is also the name of a digital technology based on the IS -136 standard. TDMA is the current designation for what was formerly known as D-AMPS. See also IS-136 and D-AMPS
TDMA: Time division multiple access
3GPP: (Third-generation Partnership Project) A global cooperative project in which standardization bodies in Europe, Japan, South Korea and the United States as founders are coordinating WCDMA issues. See also WCDMA Threshold The minimum level at which a signal of any kind can be detected, either by the human senses or by using any electronic instrumentation
TQFP: Thin Quad Flat Pack
TI: Terrestrial interference
TIA: (Transimpedance Amplifier) A device used to convert input currents to output voltages
Transceiver: A combination of a transmitter and a receiver having a common frequency control and usually enclosed in a single package. Extensively used in two-way radio communications at all frequencies
Transducer: A device that converts one form of energy or disturbance into another. Transducers convert AC or DC into sound, radio waves or other forms
Transimpedance: The transfer function of a TIA; the output voltage divided by the input current
Transistor: A semiconductor device consisting of three or four layers used for switching or amplification at frequencies ranging from direct-current to ultra-high
TSAR: Teleservice Segmentation And Reassembly
TTC: Telecommunication Technical Committee (Japan)
TVRO: Television receive-only
TX Transmitter: - General abbreviation for items such as a digital communication modulator ICs, microwave point-to-point transmit modules, satellite downlink equipment and optical transmit components

UHF: (Ultra-High Frequency) That range of the radio spectrum band that extends from 300 MHz to 3 GHz
UMTS: Universal Mobile Telecommunications System. The name of the third-generation mobile phone standard in Europe, standardized by ETSI
U-NII: Unlicensed National Information Infrastructure spectrum at 5.8-GHz
Upconverter A device used to add a lower frequency to a microwave frequency
VCO: Voltage controlled oscillator - Frequency generation component whose output frequency can be varied by changing the voltage to a control port on the device
VDSL: Very high rate digital subscriber line
VoIP: Voice over Internet Protocol. A technology for transmitting ordinary telephone calls over the Internet using packetlinked routes. Also called IP telephony
VP: Vertical polarization
VPI: Virtual path indicator
VSELP: Vector sum excited linear prediction (speech coding)
VSAT: Very small aperture terminal
VSWR: Voltage standing wave ratio - Measure of the RF interface quality between adjacent RF circuits that require adequate impedance matching for proper transfer of electrical energy at high frequencies
VTO: Voltage tuned oscillator
WACS: Wireless Access Communications Systems
WAN: Wide Area Network
WAP: Wireless Application Protocol. A free, unlicensed protocol for wireless communications that makes it possible to create advanced telecommunications services and to access Internet pages from a mobile telephone. WAP is the de facto standard that is supported by a large number of suppliers. WCA Wireless Cable Association International
WARC: World Administrative Radio Conference
WCDMA: Wideband Code Division Multiple Access. A technology for wideband digital radio communications of Internet, multimedia, video and other capacity-demanding applications. WCDMA, developed by Ericsson and others, has been selected for the third generation of mobile telephone systems in Europe, Japan and the United States. The technology is also the principal alternative being discussed in other parts of the world, notably Asia WCS Wireless communications service
WDM: Wavelength Division Multiplexing. A new technology that uses optical signals on different wavelengths to increase the capacity of fiber optic networks in order to handle a number of services simultaneously
W-LAN: Wireless-Local Area Network. A wireless version of the LAN. Provides access to the LAN even when the user is not in the office
WLL: Wireless Local Loop
Working Voltage: Working Voltage is defined as the maximum safe operating voltage of the connector over its rated frequency range and atmospheric conditions.

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