discover... Reference Charts for RF & µWave Communications

Band Designation, Old and New

Band Designation OLD		Band Designation New	Frequency GHz	Wavelength
HF	3-30MHz	A	0.1	3m
VHF	30-300MHz		0.15	2m
			0.2	1.5m
		B 250-500MHz	0.3	100cm
UHF	300-1000MHz		0.5	60cm
		C 500-1000MHz	0.75	40cm
L	1-2GHz	D	1.0	30cm
		1-2GHz	1.5	20cm
S	2-4GHz	E 2-3GHz	2	15cm
		F 3-4GHz	3	10cm
C	4-8GHz	G 4-6GHz	4	7.5cm
		H 6-8GHz	5	6cm
X	8-12GHz	I 8-10GHz	6	5cm
J Ku	12-18GHz	J 10-20GHz	8	3.75cm
K	18-27GHz		10	3cm
Q Ka	27-40GHz	K 20-40GHz	15	2cm
	40-60GHz	L 40-60GHz	20	1.5cm
O E	60-90GHz	M 60-100GHz	30	10mm
			40	7.5mm
			50	6mm
			60	5mm
			75	4mm
			100	3mm

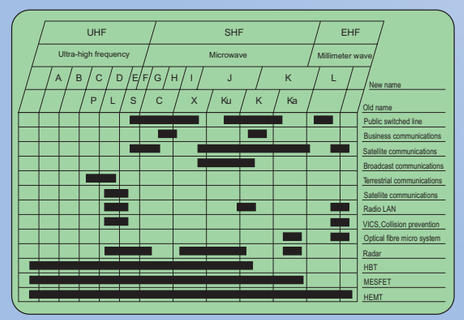
RF Measurement Conversion Tables

Conversion tables for return loss, reflection coefficient, and SWR with values for interaction of a small phasor (utility reference) expressed in dB related to the reference.

SWR	Refl. Coeff	Retn. Loss (dB)	X dB Below Ref.	Relative to Unity Reference: Ref + X (dB)	Ref - X (dB)	Ref ± X Pk to Pk Ripple
17.391	0.8913	1	1	5.5350	19.2715	24.8065
8.7242	0.7943	2	2	5.0780	13.7365	18.8145
5.8480	0.7079	3	3	4.6495	10.6907	15.3402
4.4194	0.6310	4	4	4.2489	8.6585	12.9073
3.5698	0.5623	5	5	3.8755	7.1773	11.0528
3.0095	0.5012	6	6	3.5287	6.0412	9.5699
2.6146	0.4467	7	7	3.2075	5.1405	8.3480
2.3229	0.3981	8	8	2.9108	4.4096	7.3204
2.0999	0.3548	9	9	2.6376	3.8063	6.4439
1.9250	0.3162	10	10	2.3866	3.3018	5.6884
1.7849	0.2818	11	11	2.1567	2.8756	5.0322
1.6709	0.2512	12	12	1.9465	2.5126	4.4590
1.5769	0.2239	13	13	1.7547	2.2013	3.9561
1.4985	0.1995	14	14	1.5802	1.9331	3.5133
1.4326	0.1778	15	15	1.4216	1.7007	3.1224
1.3767	0.1585	16	16	1.2778	1.4988	2.7766
1.3290	0.1413	17	17	1.1476	1.3227	2.4703
1.2880	0.1259	18	18	1.0299	1.1687	2.1986
1.2528	0.1122	19	19	0.9237	1.0337	1.9574
1.2222	0.1000	20	20	0.8279	0.9151	1.7430
1.1957	0.0891	21	21	0.7416	0.8108	1.5524
1.1726	0.0794	22	22	0.6639	0.7189	1.3828
1.1524	0.0708	23	23	0.5941	0.6378	1.2319
1.1347	0.0631	24	24	0.5314	0.5661	1.0975
1.1192	0.0562	25	25	0.4752	0.5027	0.9779

SWR	Refl. Coeff	Retn. Loss (dB)	X dB Below Ref.	Relative to Unity Reference: Ref + X (dB)	Ref - X (dB)	Ref ± X Pk to Pk Ripple
1.1055	0.0501	26	26	0.4248	0.4466	0.8714
1.0935	0.0447	27	27	0.3796	0.3969	0.7765
1.0829	0.0398	28	28	0.3391	0.3529	0.6919
1.0736	0.0355	29	29	0.3028	0.3138	0.6166
1.0653	0.0316	30	30	0.2704	0.2791	0.5495
1.0580	0.0282	31	31	0.2414	0.2483	0.4897
1.0515	0.0251	32	32	0.2155	0.2210	0.4365
1.0458	0.0224	33	33	0.1923	0.1967	0.3890
1.0407	0.0200	34	34	0.1716	0.1751	0.3467
1.0362	0.0178	35	35	0.1531	0.1558	0.3090
1.0322	0.0158	36	36	0.1366	0.1388	0.2753
1.0287	0.0141	37	37	0.1218	0.1236	0.2454
1.0255	0.0126	38	38	0.1087	0.1100	0.2187
1.0227	0.0112	39	39	0.0969	0.0980	0.1949
1.0202	0.0100	40	40	0.0864	0.0873	0.1737
1.0180	0.0089	41	41	0.0771	0.0778	0.1548
1.0160	0.0079	42	42	0.0687	0.0683	0.1380
1.0143	0.0071	43	43	0.0613	0.0617	0.1230
1.0127	0.0063	44	44	0.0546	0.0550	0.1096
1.0113	0.0056	45	45	0.0487	0.0490	0.0977
1.0101	0.0050	46	46	0.0434	0.0436	0.0871
1.0090	0.0045	47	47	0.0387	0.0389	0.0776
1.0080	0.0040	48	48	0.0345	0.0346	0.0692
1.0071	0.0035	49	49	0.0308	0.0309	0.0616
1.0063	0.0032	50	50	0.0274	0.0275	0.0549
1.0057	0.0028	51	51	0.0244	0.0245	0.0490
1.0050	0.0025	52	52	0.0218	0.0218	0.0436
1.0045	0.0022	53	53	0.0194	0.0195	0.0389
1.0040	0.0020	54	54	0.0173	0.0173	0.0347
1.0036	0.0018	55	55	0.0154	0.0155	0.0309
1.0032	0.0016	56	56	0.0138	0.0138	0.027
1.0028	0.0014	57	57	0.0123	0.0123	0.0245
1.0025	0.0013	58	58	0.0109	0.0109	0.0219
1.0022	0.0011	59	59	0.0097	0.0098	0.0195
1.0020	0.0010	60	60	0.0087	0.0087	0.0174

RF Spectrum Bands



RF Connector Comparison Table

CONNECTOR TYPES

DETAILS	PRECISION N	TYPE N	GPC-7	SMA	3.5mm	K CONN	2.4mm	V CONN	W CONN
FREQUENCY LIMIT (GHz)	20	18	18	18	26.5	40	50	67	110
MATING TYPE	MALE/ FEMALE	MALE/ FEMALE	SEXLESS	SM/F	M/F	M/F	M/F	M/F	M/F
TYPE MATES WITH	N/PRECISION N	N ONLY	SELF	3.5 & K	SMA & K	SMA & 3.5	V	2.4	W
INCH DIMENSIONS									
OUTER CONDUCTOR		0.2756	0.2756	0.166	0.1378	0.1151	0.0945	0.0728	
CENTRE CONDUCTOR		0.1197	0.1197	0.05	0.0598	0.05	0.041	0.0316	
DIELECTRIC		AIR	AIR	TEFLON	AIR	AIR	AIR	AIR	AIR
MALE PIN		0.065	N/A	0.036		0.036	0.02	0.02	
FEMALE THREAD		5/8/24		1/4/36	1/4/36	1/4/36	METRIC	METRIC	METRIC
GLASS BEAD PIN SIZE		N/A	N/A	N/A	N/A	0.012	N/A	0.009	N/A
METRIC mm DIM'S									
OUTER CONDUCTOR		7	7	4.2	3.5	2.92	2.4	1.85	1
CENTRE CONDUCTOR		3.04	3.04	1.27	1.52	1.27	1.042	0.8036	
MALE PIN								0.25	0.25
FEMALE THREAD		INCHES	INCHES	INCHES	INCHES	INCHES	M7-.75	M7-.75	M4-.7
GLASS BEAD PIN SIZE						0.3		0.23	

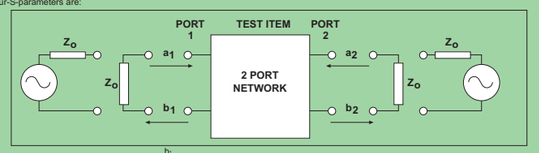
IMPORTANT TERMS

PIN DEPTH	The axial distance between the Reference Plane (typically Outer Conductor), and the Centre Conductor
SPARK PLUG	A Screw-In Connector
FLANGE MOUNT	A Screw-On Connector
BACK SIDE	The Interface between the connector and the internal circuit:Location of most connector problems
GLASS BEAD	Used to create a Hermetic package.A large source of Connector mismatch.

S-Parameters

In microwave circuit design S-parameters are very useful for the full characterisation of any 2 port Network. In contrast to z,y and h-parameters, which require broadband short circuited and open circuited connections at the TEST ITEM for the measurement, S-parameters are determined with input and output terminated with the resistive characteristic impedance of test systems (generally 50 ohms in a coaxial line system).
Parasitic oscillations in active devices are minimised when these devices are terminated in resistive loads. S-parameters are complex, having a magnitude and a phase relationship, and are measured in terms of incident and reflected voltages using a VECTOR VOLTMETER or VECTOR NETWORK ANALYSER (VNA).

The four-S-parameters are:



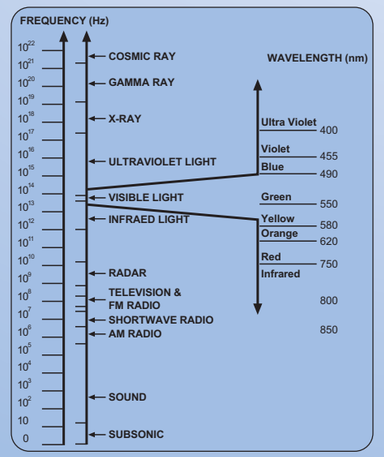
INPUT-REFLECTION COEFFICIENT $S_{11} = \frac{b_1}{a_1}$
Looking into port 1 when port 2 is perfectly matched.

FORWARD - TRANSMISSION COEFFICIENT $S_{21} = \frac{b_2}{a_1}$
Voltage transmission coefficient from port 1 to port 2 when port 2 is perfectly matched.

REVERSE-TRANSMISSION COEFFICIENT $S_{12} = \frac{b_1}{a_2}$
Voltage transmission coefficient from port 2 to port 1 when-port 1 is perfectly matched.

OUTPUT-REFLECTION COEFFICIENT $S_{22} = \frac{b_2}{a_2}$
Looking into port 2 when port 1 is perfectly matched.

The Electromagnetic Spectrum

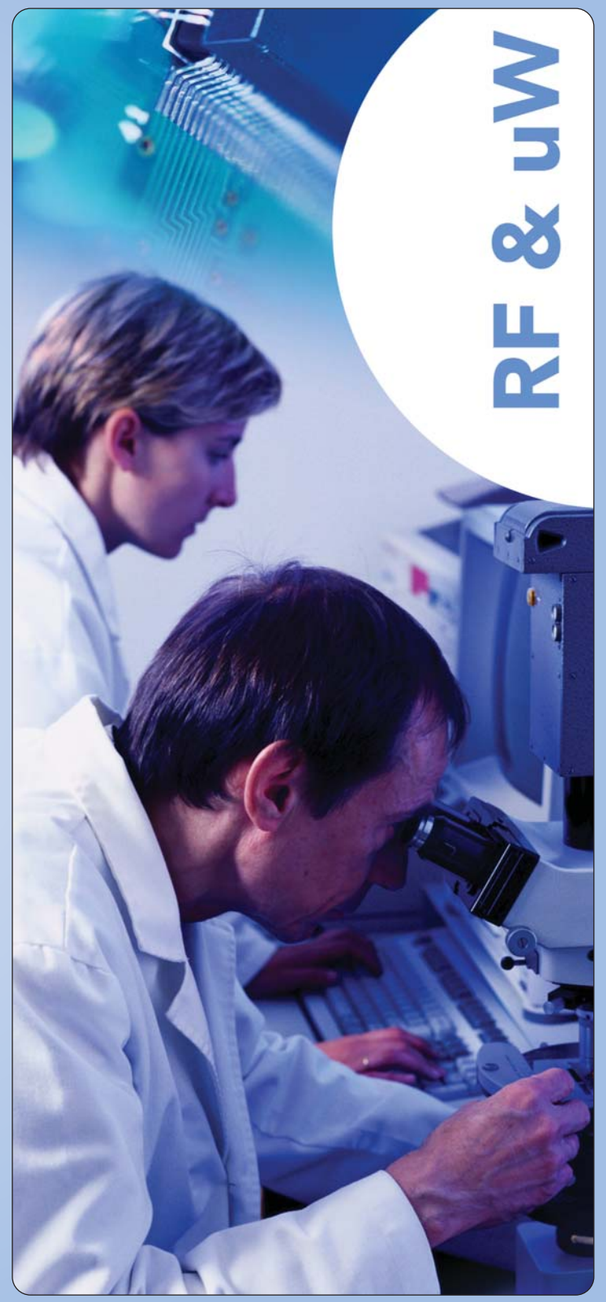


Waveguide Designation

Frequency Range (Ghz)	British WG	IEC R	EIA WR
1.14 - 1.73	6	14	650
1.72 - 2.61	8	22	430
2.60 - 3.95	10	32	284
3.30 - 4.90	11A	40	229
3.94 - 5.99	12	48	187
4.64 - 7.05	13	58	159
5.38 - 8.18	14	70	137
6.58 - 10.0	15	84	112
8.20 - 12.5	16	100	90
9.84 - 15.0	17	120	75
11.9 - 18.0	18	140	62
14.5 - 22.0	19	180	51
17.6 - 26.7	20	220	42
21.7 - 33.0	21	260	34
26.4 - 40.1	22	320	28
33.0 - 50.1	23	400	22
39.3 - 59.7	24	500	19
49.9 - 75.8	25	620	15
60.5 - 92.0	26	740	12
73.8 - 112.0	27	900	10
92.3 - 140.0	28	1200	8
114.0 - 173.0	29	1400	6
145.0 - 220.0	30	1800	5
172.0 - 261.0	31	2200	4
217.0 - 330.0	32	2600	3

Power to Voltage Conversion

dBm	mW	Volts RMS	Volts Pk/Pk	dBV	dBuV
-40	0.0001	0.0022	0.0063	-53.01	66.99
-39	0.0001	0.0025	0.0071	-52.01	67.99
-38	0.0002	0.0028	0.0080	-51.01	68.99
-37	0.0002	0.0032	0.0089	-50.01	69.99
-36	0.0003	0.0035	0.0100	-49.01	70.99
-35	0.0003	0.0040	0.0112	-48.01	71.99
-34	0.0004	0.0045	0.0126	-47.01	72.99
-33	0.0005	0.0050	0.0142	-46.01	73.99
-32	0.0006	0.0056	0.0159	-45.01	74.99
-31	0.0008	0.0063	0.0178	-44.01	75.99
-30	0.0010	0.0071	0.0200	-43.01	76.99
-29	0.0013	0.0079	0.0224	-42.01	77.99
-28	0.0016	0.0089	0.0252	-41.01	78.99
-27	0.0020	0.0100	0.0283	-40.01	79.99
-26	0.0025	0.0112	0.0317	-39.01	80.99
-25	0.0032	0.0126	0.0356	-38.01	81.99
-24	0.0040	0.0141	0.0399	-37.01	82.99
-23	0.0050	0.0158	0.0448	-36.01	83.99
-22	0.0063	0.0178	0.0502	-35.01	84.99
-21	0.0079	0.0199	0.0564	-34.01	85.99
dBm	**mW**	**Volts RMS**	**Volts Pk/Pk**	**dBV**	**dBuV**
-20	0.010	0.022	0.063	-33.01	86.99
-19	0.013	0.025	0.071	-32.01	87.99
-18	0.016	0.028	0.080	-31.01	88.99
-17	0.020	0.032	0.089	-30.01	89.99
-16	0.025	0.035	0.100	-29.01	90.99
-15	0.032	0.040	0.112	-28.01	91.99
-14	0.040	0.045	0.126	-27.01	92.99
-13	0.050	0.050	0.142	-26.01	93.99
-12	0.063	0.056	0.159	-25.01	94.99
-11	0.079	0.063	0.178	-24.01	95.99
-10	0.100	0.071	0.200	-23.01	96.99
-9	0.126	0.079	0.224	-22.01	97.99
-8	0.159	0.089	0.252	-21.01	98.99
-7	0.200	0.100	0.283	-20.01	99.99
-6	0.251	0.112	0.317	-19.01	100.99
-5	0.316	0.126	0.356	-18.01	101.99
-4	0.398	0.141	0.399	-17.01	102.99
-3	0.501	0.158	0.448	-16.01	103.99
-2	0.631	0.178	0.502	-15.01	104.99
-1	0.794	0.199	0.564	-14.01	105.99
dBm	**mW**	**Volts RMS**	**Volts Pk/Pk**	**dBV**	**dBuV**
0	1.00	0.22	0.63	-13.01	106.99
1	1.26	0.25	0.71	-12.01	107.99
2	1.59	0.28	0.80	-11.01	108.99
3	2.00	0.32	0.89	-10.01	109.99
4	2.51	0.35	1.00	-9.01	110.99
5	3.16	0.40	1.12	-8.01	111.99
6	3.98	0.45	1.26	-7.01	112.99
7	5.01	0.50	1.42	-6.01	113.99
8	6.31	0.56	1.59	-5.01	114.99
9	7.94	0.63	1.78	-4.01	115.99
10	10.00	0.71	2.00	-3.01	116.99
11	12.59	0.79	2.24	-2.01	117.99
12	15.85	0.89	2.52	-1.01	118.99
13	19.95	1.00	2.83	-0.01	119.99
14	25.12	1.12	3.17	0.99	120.99
15	31.62	1.26	3.56	1.99	121.99
16	39.81	1.41	3.99	2.99	122.99
17	50.12	1.58	4.48	3.99	123.99
18	63.10	1.78	5.02	4.99	124.99
19	79.43	1.99	5.64	5.99	125.99
dBm	**mW**	**Volts RMS**	**Volts Pk/Pk**	**dBV**	**dBuV**
20	100	2.24	6.32	6.99	126.99
21	126	2.51	7.10	7.99	127.99
22	159	2.82	7.96	8.99	128.99
23	200	3.16	8.93	9.99	129.99
24	251	3.54	10.02	10.99	130.99
25	316	3.98	11.25	11.99	131.99
26	398	4.46	12.62	12.99	132.99
27	501	5.01	14.16	13.99	133.99
28	631	5.62	15.89	14.99	134.99
29	794	6.30	17.83	15.99	135.99
30	1000	7.07	20.00	16.99	136.99
31	1259	7.93	22.44	17.99	137.99
32	1585	8.90	25.18	18.99	138.99
33	1995	9.99	28.25	19.99	139.99
34	2512	11.21	31.70	20.99	140.99
35	3162	12.57	35.57	21.99	141.99
36	3981	14.11	39.91	22.99	142.99
37	5012	15.83	44.77	23.99	143.99
38	6310	17.76	50.24	24.99	144.99
39	7943	19.93	56.37	25.99	145.99
dBm	**W**	**Volts RMS**	**Volts Pk/Pk**	**dBV**	**dBuV**
40	10.00	22.36	63.25	26.99	146.99
41	12.59	25.09	70.96	27.99	147.99
42	15.85	28.15	79.62	28.99	148.99
43	19.95	31.59	89.34	29.99	149.99
44	25.12	35.44	100.24	30.99	150.99
45	31.62	39.76	112.47	31.99	151.99
46	39.81	44.62	126.19	32.99	152.99
47	50.12	50.06	141.59	33.99	153.99
48	63.10	56.17	158.87	34.99	154.99
49	79.43	63.02	178.25	35.99	155.99
50	100.00	70.71	200.00	36.99	156.99



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