Tutorial – RF & Microwave

Frequency Band

L band	1 to 2 GHz
S band	2 to 4 GHz
C band	4 to 8 GHz
X band	8 to 12 GHz
Ku band	12 to 18 GHz
K band	18 to 26.5 GHz
Ka band	26.5 to 40 GHz
Q band	33 to 50 GHz
U band	40 to 60 GHz
V band	50 to 75 GHz
W band	75 to 110 GHz
F band	90 to 140 GHz
D band	110 to 170 GHz

Wave guide Size and its Range

USA	Europe	START Frequency, (Ghz)	STOP Frequency (Ghz)	*TE10*	*TE20*	Inside Dimension	Inside Dimension	Inside Tol:	Wall Thickness
WR-(size)	WG-			*CUTOFF* Frequency, (GHz.)	*CUTOFF* Frequency, (GHz.)	**"a"**	**"b"**	(±)	(in)
	(size)								
2300		0.32	0.49	0.256	0.51	23	11.5	0.02	0.15
2100		0.35	0.53	0.28	0.56	21	10.5	0.02	0.125
1800		0.41	0.62	0.32	0.65	18	9	0.02	0.125
1500		0.49	0.75	0.39	0.78	15	7.5	0.015	0.125
1150		0.64	0.96	0.51	1.02	11.5	5.75	0.015	0.125
975		0.75	1.12	0.6	1.21	9.75	4.875	0.01	0.125
770		0.96	1.46	0.76	1.53	7.7	3.85	0.01	0.125
650	6	1.12	1.7	0.908	1.82	6.5	3.25	0.01	0.08
510		1.45	2.2	1.157	2.31	5.1	2.55	0.01	0.08
430	8	1.7	2.6	1.372	2.74	4.3	2.15	0.008	0.08
340	9A	2.2	3.3	1.736	3.47	3.4	1.7	0.005	0.08
284	10	2.6	3.95	2.078	4.15	2.84	1.34	0.005	0.08
229	11A	3.3	4.9	2.577	5.15	2.29	1.145	0.005	0.064
187	12	3.95	5.85	3.152	6.3	1.872	0.872	0.005	0.064
159	13	4.9	7.05	3.711	7.42	1.59	0.795	0.004	0.064
137	14	5.85	8.2	4.301	8.6	1.372	0.622	0.004	0.064
112	15	7.05	10	5.259	10.51	1.122	0.497	0.004	0.064
102		7	11	5.785	11.57	1.02	0.51	0.003	0.064
90	16	8.2	12.4	6.557	13.11	0.9	0.4	0.003	0.05
75	17	10	15	7.868	15.73	0.75	0.375	0.003	0.05
62	18	12.4	18	9.486	18.97	0.622	0.311	0.002	0.04
51	19	15	22	11.574	23.14	0.51	0.255	0.002	0.04
42	20	18	26.5	14.047	28.1	0.42	0.17	0.002	0.04
34	21	22	33	17.328	34.71	0.34	0.17	0.002	0.04
28	22	26.5	40	21.08	42.15	0.28	0.14	0.002	0.04
22	23	33	50	26.34	52.69	0.224	0.112	0.001	0.04
19	24	40	60	31.36	62.78	0.188	0.094	0.001	0.04
15	25	50	75	39.86	79.74	0.148	0.074	0.001	0.04
12	26	60	90	48.35	96.74	0.122	0.061	0.0005	0.04
10	27	75	110	59.01	118	0.1	0.05	0.0005	0.04
8	28	90	140	73.6	147.53	0.08	0.04	0.0003	0.02
7	29	110	170	90.9	181.5	0.065	0.0325	0.0002	0.02
5	30	140	220	115.7	231.42	0.051	0.0255	0.0002	0.02

- Fundamentals :
- VSWR=(ρ+1)/(ρ-1); ρ =(vswr-1)/(vswr+1)
- Return Loss : -20 log ρ
- “S “ Parameters : S11 S12 S11&S22-RL
- S21 S22. S12- Insertion Loss.
  S 21- Isolation.
- S12= S21 for Reciprocal components.

- *dB : Ratio.*
- *Voltage : 20log (V2/V1). V2 > V1. V2< V1 then it is (- Negative).*
- *Power : 10 log (P2/P1).*
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- dbm; Unit of Power ; 0 dbm – 1.0mw.
- 30dbm- 1.0 x 10*3 = 1000 mw= 1.0 Watt.
- 60dbm – 1.0 x 10*6 = 1000 watts= 1.0KW.
- 90dbm – 1.0 x 10*9 = 1000 KW = 1.0MW.
- -20dbm – 1.0 X 10*(-2)= 0.01 mw
- Transmission Lines:
- Coaxial : Mode –TE011 – Passes all Frequencies- Cables. Attenuation αal Frequency.
- Waveguides : Low Pass Filters. Cutoff Frequency : Passes all F's below the Cutoff.
- Mode –TE10.
- Different Waveguides for Different Frequencies
- X-Band WR-90 ; Ku Band –WR75/WR 62.
- Ka Band : WR-28. C-Band –WR137.

- Components:
- Directional Couplers ; Isolators ; Circulators ; Pads ; Switches; Loads ; Terminations ;Filters ; Water Loads Bends ; W/G to Coax Adapters ; ARC Detectors ; Combiners/ Splitters ;Horns:Phas Shifters:Switches.
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- ACTIVE : SSPA, LNA, MPA, DPS,
- RADARS: GND / AIRBORNE /NAVAL.
- All Bands for different Applications:
- Surveillance: L and S Band.
- Tracking : C ; X ; Ku and Ka Bands.
- SAR : X and Ku Bands.
- Main Sub-Blocks:
- Transmitters ; Antennas : Pedestals ; Stabilized Platforms;
- Receivers : Displays.
- Transmitters : Non-Coherent – MAGNETRON Based Coherent : TWT and Klystron Based.
- Antennas : Various types – Parabolic – Many Types.

- Receivers : Pulse Compression ; Coherent ; COR etc.
- Displays : MFD ; AMLCD.
- Electronic Warfare:
- ESM ; ECM ; ECCM.
- ESM : COMINT /DF : 20 to 3000MHZ.
- RWR's (2.0 to 18.0GHZ)
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- *ECM : Communication Jammers : 20 to 3000MHZ*
- *Radar Jammers.(High Power).*
- *2.0 – 6.0GHZ -100/200 watts CW Jammers.*
- *6.0 – 18.0 GHZ – 100/200 watts CW Jammers.*
- *2.0 to 6.0 GHZ – 1.5KW Pulse Jammers.*
- *6.0 to 18.0GHZ- 1.5 KW Pulse Jammers.*
- *ECCM : RADAR Area.*

- *MILCOM :*
- *2 to 30 MHZ ; 30 to 225 MHZ and 225 to 512 MHZ- Tactical S/W Radios : HH / MANPACK / VEHICLE.FH /ECCM compatible; 50 watts CW –S/W Programmable.*
- *SATCOM: C ; KU and Ka Band.*
- *EARTH STATION : TWTA's , Antennas; Pedestals; Microwave Components, LNA's*
- *1+ 1 Redundant Systems.*
- *PAYLOADS : EPC/TWTA, SSPA ; Antennas ;Filters; LNA's ; Space Grade Components.*
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- *Phased Array Antenna Systems:*
- *T/R Modules ; Digital Phase Shifters, LNA's ; Combiners;*
- *No Moving Parts ; Fast Beam steering in EL and AZ.*
- *Futuristic Radars and EW.*
- *Antennas:*
- *HF ; VHF; UHF ; ARRAYS ; D/F ; Parabolic ; EAS ;*
- *Many Types based on Applications.*

- *Security Systems*
- *Surveillance and Security Systems.*
- *UAV's : Class based on Weight ; Payloads ; Mission Duration*
- *MINI : Surveillance.*
- *Medium : Tracking and EW @ Low Power.*
- *Aerostat Balloons:*
- *Surveillance and Security.*
- *Perimeter Vigilance : Day and Night.*

- SIMULATORS :
- RES : GND, Airborne ; Ship- RADAR
- ECM TARGET Simulators : ECM / ECCM
- THREAT Simulators ; Missile and seeker Test Bed / RWR
- SATELLITE Simulators : Testing of EARTH Station W/O Satellite Positioning; Useful for CAL and Installation.

- MILITARY SPECIFICATIONS:
- MIL-STD-883B : Semiconductor Screening.
- MIL-STD-704D : I/P Power Specifications to any Systems.
- MIL-STD-810F : Environmental Specifications.
- MIL-STD-461E- EMI/EMC: Conducted, Radiated ; RS and CS.
- ESS Screening : Each Item supplied against the Order to be Qualified.