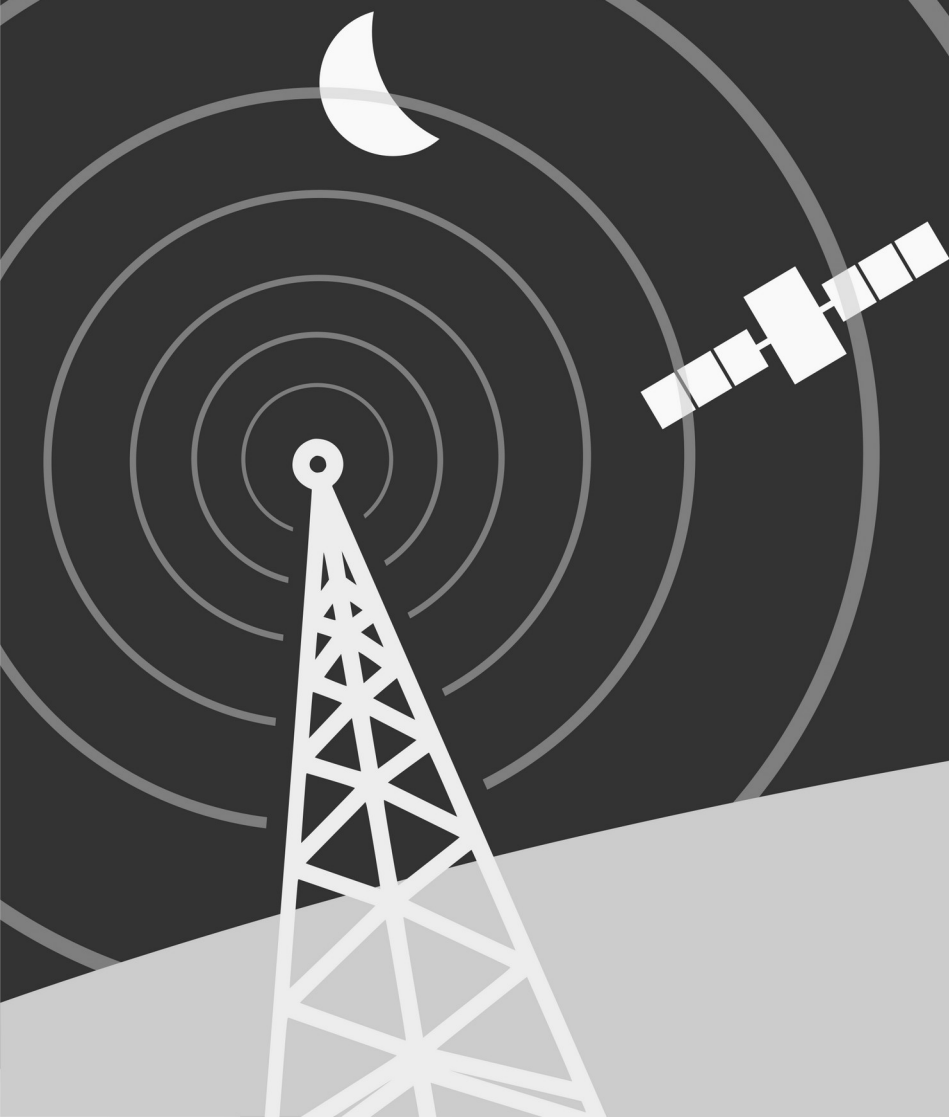


Noël Martin F4JJD



AMATEUR RADIO *BOOKLET* 2024



The Amateur Radio Booklet

Edition 2024.1

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1 Band Plans

Summary

Primary allocations are written in bold, e.g. **14000 — 14350**. If the band is **exclusive** to the amateur service the frequencies are followed by the **E** symbol, e.g. **1800 — 1850 E**.

Secondary allocations are written in italic, e.g. *135.7 — 137.8*.

If the band allows **amateur satellite (AMSAT)**, the frequencies are followed by the **S** symbol, e.g. **7000 — 7200 S**.

	Band	Region 1	Region 2	Region 3
LF (kHz)	2200m	135.7 — 137.8		
MF (kHz)	630m	472 — 479		
	160m	1810 — 1850 E	1800 — 1850 E 1850 — 2000	1800 — 2000
HF (kHz)	80m	3500 — 3800	3500 — 3750 E	3500 — 3900
	60m	5351.5 — 5366.5		
	40m	7000 — 7100 S		
		7100 — 7200 E		
		Forbidden	7200 — 7300 E	Forbidden
	30m	10100 — 10150		
	20m	14000 — 14250 S		
		14250 — 14350 E		
	17m	18068 — 18168 S		
	15m	21000 — 21450 S		
	12m	24890 — 24990 S		
	10m	28000 — 29700 S		
	6m	50 — 52	50 — 54	

	Band	Region 1	Region 2	Region 3
VHF (MHz)	2m	144 — 146 [S]		
		<i>Forbidden</i>	146 — 148 [E]	146 — 148
	1.35m	<i>Forbidden</i>	220 — 225	<i>Forbidden</i>
UHF (MHz)	70cm	430 — 440 [S]	430 — 440 [S]	
	33cm	<i>Forbidden</i>	902 — 928	<i>Forbidden</i>
	23cm	1240 — 1300		
	13cm	2300 — 2450		
SHF (GHz)	9cm	<i>Forbidden</i>	3.3 — 3.5	
	5cm	5.65 — 5.83		
		5.83 — 5.85 [S]		
		<i>Forbidden</i>	5.85 — 5.925	<i>Forbidden</i>
	3cm	10 — 10.45		
		10.45 — 10.5 [S]		
	1.2cm	24 — 24.05 [S]		
		24.05 — 24.25		
	6mm	47 — 47.2 [S]		
	4mm	76 — 77.5 [S]		
		77.5 — 78 [S]		
		78 — 81 [S]		
	2.4mm	122.25 — 123		
	2.2mm	134 — 136 [S]		
		136 — 141 [S]		
	1.2mm	241 — 248 [S]		
		248 — 250 [S]		

2200 Meters

Region 1	Region 2	Region 3
135.7 — 137.8 kHz <i>BW 200Hz</i>	135.7 — 137.8 kHz <i>BW 200 Hz</i>	135.7 — 137.8 kHz <i>BW 500 Hz</i>
CW, QRSS, DM	All Modes	CW, QRSS, DM

Max Power: 1W EIRP — Status: Secondary R1, R2, R3 (primary Fixed, Maritime Mobile, R3 Radio-navigation)

630 Meters

Region 1	Region 2	Region 3
472 — 475 kHz <i>BW 200 Hz</i>	472 — 479 kHz <i>BW 500 Hz</i>	472 — 479 kHz <i>BW 500 Hz</i>
CW		
475 — 479 kHz <i>BW 500 Hz</i>		
NBM		

Max Power: 1W EIRP — Status: Secondary R1, R2, R3 (primary Maritime Mobile)

160 Meters

Region 1	Region 2	Region 3
1810 — 1838 kHz <i>BW 200 Hz</i> CW 1836 – CW QRP	1800 — 1810 kHz <i>BW 500 Hz</i> DM	1800 — 1830 kHz <i>BW 200 Hz</i> CW
1838 — 1840 kHz <i>BW 500 Hz</i> NBM	1810 — 1840 kHz <i>BW 200 Hz</i> CW, DM 1812 – CW QRP CoA	1830 — 1840 kHz <i>BW 500Hz</i> CW (DX), NBM 1836 – CW QRP CoA
1840 — 1850 kHz <i>BW 2700 Hz</i> All Modes	1840 — 1850 kHz <i>BW 2700 Hz</i> CW, DM, SSB (DX)	1840 — 2000 kHz <i>BW 2700 Hz</i> All Modes
	1850 — 2000 kHz <i>BW 2700 Hz</i> All Modes 1910 – SSB QRP CoA	

Status: Primary R1, R2, R3

80 Meters

Region 1	Region 2	Region 3
3500 — 3580 kHz <i>BW 200 Hz</i> CW (3505 – DX CoA) 3555 – CW QRS CoA 3560 – CW QRP CoA > 3570 – NBM	3500 — 3580 kHz <i>BW 200 Hz</i> CW (3505 – DX CoA) 3555 – CW QRS CoA 3560 – CW QRP CoA > 3570 – NBM	3500 — 3535 kHz <i>BW 200 Hz</i> CW (3505 – DX CoA)
3580 — 3600 kHz <i>BW 500 Hz</i> NBM, DM	3580 — 3600 kHz <i>BW 500 Hz</i> CW, DM	3535 — 3900 kHz <i>BW 2700 Hz</i> CW, SSB, DM 3560 – QRP CoA 3600 – EMCOM CoA 3690 – DV CoA 3690 – SSB QRP CoA 3735 – Image CoA 3795 – DX SSB CoA 3845 – Image CoA
3600 — 3800 kHz <i>BW 2700 Hz</i> All Modes 3690 – SSB QRP CoA 3735 – Image CoA 3760 – EMCOM CoA 3775 – DX CoA	3600 — 4000 kHz <i>BW 2700 Hz</i> All Modes 3690 – SSB QRP CoA 3735 – Image CoA 3750 – EMCOM CoA 3775 – DX CoA 3845 – Image CoA 3885 – AM CoA 3985 – EMCOM CoA	

Status: Primary R1, R2, R3

60 Meters

Region 1	Region 2	Region 3
5351.5 — 5354 kHz <i>BW 200 Hz</i> CW, NBM	5351.5 — 5354 kHz <i>BW 500 Hz</i> CW, DM	5351.5 — 5354 kHz <i>BW 500 Hz</i> CW, NBM, DM
5354 — 5366 kHz <i>BW 2700 Hz</i> All Modes, Pref. USB	5354 — 5366 kHz <i>BW 2700 Hz</i> All Modes	5354 — 5366 kHz <i>BW 2700 Hz</i> All Modes, Pref. USB
5366 — 5366.5 kHz ▲ BW 20 Hz Weak Signal	5366 — 5366.5 kHz ▲ BW 20 Hz CW, DM	5366 — 5366.5 kHz ▲ BW 20 Hz Weak Signal

Max Power: 15W EIRP — Status: Secondary R1, R2, R3 (primary Fixed, Mobile)

▲ Very small bandwidth between 5366-5366.5 kHz

40 Meters

Region 1	Region 2	Region 3
7000 — 7040 kHz <i>BW 200 Hz</i> CW 7030 – CW QRP CoA	7000 — 7040 kHz <i>BW 200 Hz</i> CW < 7025 – DX 7030 – CW QRP CoA	7000 — 7030 kHz <i>BW 200 Hz</i> CW
7040 — 7050 kHz <i>BW 500 Hz</i> NBM, DM	7040 — 7050 kHz <i>BW 500 Hz</i> CW, DM	7030 — 7200 kHz <i>BW 2700 Hz</i> CW, SSB, DM 7030 – QRP CoA 7070 – DV CoA 7090 – SSB QRP CoA 7095 – DX Phone CoA 7110 – EMCOM CoA 7165 – Image CoA
7050 — 7200 kHz <i>BW 2700 Hz</i> All Modes < 7060 – DM 7070 – DV CoA 7090 – SSB QRP CoA 7110 – EMCOM CoA 7165 – Image CoA > 7175 – DX	7050 — 7300 kHz <i>BW 2700 Hz</i> All Modes 7060 – EMCOM CoA 7070 – DV CoA 7090 – SSB QRP CoA 7165 – Image CoA 7240 – EMCOM CoA 7275 – EMCOM CoA 7285 – SSB QRP CoA 7290 – AM CoA	

Status: Primary R1, R2, R3; and 7000-7100 kHz AMSAT R1, R2, R3

30 Meters

Region 1	Region 2	Region 3
10100 — 10130 kHz <i>BW 200 Hz</i> CW 10116 – CW QRP CoA		
10130 — 10150 kHz <i>BW 500 Hz</i> NBM, DM	10130 — 10140 kHz <i>BW 500 Hz</i> CW, DM	10130 — 10150 kHz <i>BW 500 Hz</i> NBM, DM
	10140 — 10150 kHz <i>BW 2700 Hz</i> CW, DM	

Status: Secondary R1, R2, R3 (primary Fixed)

20 Meters

Region 1	Region 2	Region 3
14000 — 14070 kHz <i>BW 200 Hz</i> CW 14055 – CW QRS CoA 14060 – CW QRP CoA		
14070 — 14099 kHz <i>BW 500 Hz</i> NBM, DM		
14099 — 14101 kHz International Beacon Project		
14101 — 14350 kHz <i>BW 2700 Hz</i> All Modes 14130 – DV CoA 14195 – DX 14230 – Image CoA 14285 – SSB QRP 14300 – Glob EMCOM	14101 — 14350 kHz <i>BW 2700 Hz</i> All Modes 14195 – DX 14230 – Image CoA 14285 – SSB QRP 14285 – AM QRG 14300 – Glob EMCOM	14101 — 14350 kHz <i>BW 2700 Hz</i> All Modes 14130 – DV CoA 14195 – DX 14230 – Image CoA 14285 – SSB QRP 14300 – Glob EMCOM

Status: Primary R1, R2, R3; and 14000-14250 kHz AMSAT R1, R2, R3

17 Meters

Region 1	Region 2	Region 3
18068 — 18095 kHz <i>BW 200 Hz</i> CW 18086 – CW QRP CoA		
18095 — 18109 kHz <i>BW 500 Hz</i> NBM, DM		18095 — 18109 kHz <i>BW 2700 Hz</i> NBM, DM
18109 — 18111 kHz International Beacon Project		
18111 — 18168 kHz <i>BW 2700 Hz</i> All Modes 18130 – SSB QRP 18150 – DV CoA 18160 – EMCOM	18111 — 18168 kHz <i>BW 2700 Hz</i> All Modes 18130 – SSB QRP 18160 – EMCOM	18111 — 18168 kHz <i>BW 2700 Hz</i> All Modes 18130 – SSB QRP 18150 – DV CoA 18160 – EMCOM

Status: Primary and AMSAT R1, R2, R3.

15 Meters

Region 1	Region 2	Region 3
21000 — 21070 kHz <i>BW 200 Hz</i> CW 21055 – CW QRS CoA 21060 – CW QRP CoA		
21070 — 21110 kHz <i>BW 500 Hz</i> NBM, DM		
21110 — 21120 kHz <i>BW 2700 Hz</i> All Modes, except SSB		21110 — 21125 kHz <i>BW 2700 Hz</i> CW, NBM, DM
21120 — 21149 kHz <i>BW 500 Hz</i> NBM	21120 — 21149 kHz <i>BW 500 Hz</i> All Modes	21125 — 21149 kHz <i>BW 2700 Hz</i> CW, NBM, DM Satellite Uplink
21149 — 21151 kHz International Beacon Project		
21151 — 21450 kHz <i>BW 2700 Hz</i> All Modes 21180 – DV CoA 21285 – SSB QRP 21340 – Image CoA <u>21360 – Glob. EMCOM</u>	21151 — 21450 kHz <i>BW 2700 Hz</i> All Modes 21285 – SSB QRP 21340 – Image CoA <u>21360 – Glob. EMCOM</u>	21151 — 21450 kHz <i>BW 2700 Hz</i> All Modes 21180 – DV CoA 21295 – DX CoA 21340 – Image CoA <u>21360 – Glob. EMCOM</u>

Status: Primary and AMSAT R1, R2, R3.

12 Meters

Region 1	Region 2	Region 3
24890 — 24915 kHz <i>BW 200 Hz</i> CW 24906 – CW QRP CoA		
24915 — 24929 kHz <i>BW 500 Hz</i> CW, NBM, DM		
24929 — 24931 kHz International Beacon Project		
24931 — 24990 kHz <i>BW 2700 Hz</i> All Modes 24950 – SSB QRP 24960 – DV CoA	24931 — 24990 kHz <i>BW 2700 Hz</i> All Modes 24950 – SSB QRP	24931 — 24990 kHz <i>BW 2700 Hz</i> All Modes 24950 – SSB QRP 24960 – DV CoA

Status: Primary and AMSAT R1, R2, R3.

10 Meters

Region 1	Region 2	Region 3
28000 — 28070 kHz <i>BW 200 Hz</i> CW 28055 – CW QRS CoA 28060 – CW QRP CoA		28000 — 28070 kHz <i>BW 200 Hz</i> CW 28055 – CW QRS
28070 — 28190 kHz <i>BW 500 Hz</i> NBM, DM	28070 — 28190 kHz <i>BW 500 Hz</i> CW, DM	28070 — 28190 kHz <i>BW 500 Hz</i> CW, NBM > 28050 – DX
28190 — 28225 kHz <i>BW 200 Hz</i> Beacons <u>28200 – International Beacon Project</u>		
28225 — 28300 kHz <i>BW 2700 Hz</i> Beacons		28225 — 28300 kHz <i>BW 6000 Hz</i> All Modes
28300 — 29000 kHz <i>BW 2700 Hz</i> All Modes 28330 – DV CoA 28360 – SSB QRP CoA 28680 – Image CoA		28300 — 29510 kHz <i>BW 6000 Hz</i> Satellite Up & Down-Links
29000 — 29510 kHz <i>BW Unrestricted</i> All Modes > 29300 – Satellite		
29510 — 29520 kHz Guard Band ▲ NO TRANSMISSION ALLOWED		

29520 — 29590 kHz <i>BW 6000 Hz</i> All Modes Repeater Input (RH1 – RH8)
29590 — 29620 kHz <i>BW 6000 Hz</i> All Modes Repeaters Simplex 29600 – FM QRG
29620 — 29700 kHz <i>BW 6000 Hz</i> All Modes Repeater Output (RH1 – RH8)

Status: Primary and AMSAT R1, R2, R3.

6 Meters

Region 1	Region 2	Region 3
50 — 50.1 MHz <i>BW 500 Hz</i> CW < 50.010 Beacons 50.050 – CoA 50.090 – DX CoA	50 — 50.1 MHz <i>BW 500 Hz</i> CW 50.010 – 50.020 Beacons	50 — 50.1 MHz <i>BW 200 Hz</i> CW 50.020 – 50.030 Beacons
50.1 — 50.4 MHz <i>BW 2700 Hz</i> CW, SSB, NBM 50.110 – DX CoA 50.305 – PSK CoA 50.315 – EME CoA		50.1 — 50.5 MHz <i>BW 2700 Hz</i> CW, SSB, NBM .110 – DX CoA
50.4 — 50.5 MHz <i>BW 1000 Hz</i> Beacons <u>50.401 – WSPR</u>	50.4 — 50.5 MHz <i>BW 2700 Hz</i> Beacons	
50.5 — 52 MHz <i>BW 12 kHz</i> <u>Unlimited BW</u> 50.5 – 50.7 50.9 – 51.2 51.4 – 52 All Modes 50.510 – SSTV 50.530 – FM Internet 50.600 – RTTY 50.630 – DV Calling <u>Repeaters</u> 50.700 – 50.900 Output 51.200 – 51.400 Input	50.5 — 50.6 MHz <i>BW 2700 Hz</i> All Modes	50.5 — 54 MHz <i>BW 25 kHz</i> All Modes
	50.6 — 51 MHz <i>BW 12 kHz</i> All Modes	
	51 — 51.1 MHz <i>BW 2700</i> CW, SSB DX Window	

Region 1	Region 2	Region 3
52 — 54 MHz <i>BW 500 kHz</i> All Modes	51.11 — 54 MHz <i>BW 12 kHz</i> FM, DV <u>Repeaters</u> 51.110 – 51.480 Input 51.620 – 51.980 Output	

Status: Primary R1, R2, R3.

2 Meters

Region 1	Region 2	Region 3
144 — 144.025 MHz <i>BW 2700 Hz</i> All Modes ▲ Satellite Down-Links Only		
144.025 — 144.150 MHz <i>BW 500 Hz</i> CW 144.050 – Telegraphy Calling Freq 144.110 – 114.160 CW & EME	144.025 — 144.110 MHz <i>BW 500 Hz</i> CW, DM EME, Weak Signals	144.025 — 144.035 MHz <i>BW N/A</i> CW, EME, Weak Signals
144.150 — 144.400 MHz <i>BW 2700 Hz</i> SSB, CW 144.300 – SSB CoA	144.110 — 144.275 MHz <i>BW 2700 Hz</i> CW, DM, SSB Weak Signals 144.200 – QRG Calling	144.035 — 145.800 MHz <i>BW 25 kHz</i> All Modes 144.1 – DX CoA
	144.275 — 144.300 MHz <i>BW 500 Hz</i> Beacons	
	144.300 — 144.360 MHz <i>BW 2700 Hz</i> CW, SSB 144.300 – QRG Calling	
	144.360 — 144.400 MHz <i>BW 12 kHz</i> DM 144.390 – APRS CoA	

Region 1	Region 2	Region 3
144.400 — 144.500 MHz <i>BW 500 Hz</i> Beacons 144.491 – 144.493 Experimental MGM	144.400 — 144.500 MHz <i>BW 500 Hz</i> CW, DM Beacons	
144.500 — 144.794 MHz <i>BW 20 kHz</i> All Modes 144.5 – SSTV CoA 144.6 – Data CoA 144.75 – ATV	144.500 — 145.790 MHz <i>BW 12 kHz</i> FM, DV <u>Repeaters Exclusive</u> 144.600 – 144.900 145.200 – 145.500 <u>Local Options</u> 144.500 – 144.600 145.100 – 145.200	
144.794 — 145.800 MHz <i>BW 12 kHz</i> 144.800 – APRS 145.375 – DV Calling 145.500 – FM Calling <u>Repeaters Exclusive</u> 144.975 – 145.194 145.575 – 145.7935 <u>Space Communications</u> 144.975 – 145.194 145.794 – 145.800	145.790 — 145.800 MHz ▲ Guard Band	
145.800 — 146.000 MHz <i>BW 12 kHz</i> FM, DV Satellite Exclusive		
<i>Forbidden</i>	146.000 — 148.000 MHz <i>BW 12 kHz</i> FM, DV 146.520 – FM Call Freq	146.000 — 148.000 MHz <i>BW 25 kHz</i> All Modes

1.25 Meters

Region 1	Region 2	Region 3
Forbidden	220 — 222 MHz BW 12 kHz ACDS	Forbidden
	222 — 222.05 MHz BW 500 Hz CW, DM EME, Weak Signals	
	222.05 — 222.07 MHz BW 500 Hz CW, DM Beacons	
	222.07 — 222.1 MHz BW 500 Hz CW, DM, SSB Weak Signal 222.1 – SSB/CW QRG	
	222.1 — 222.15 MHz BW 2700 Hz CW, SSB Weak Signals	
	222.15 — 223.85 MHz BW 12 kHz FM, DV All Modes <u>Repeaters Exclusive</u> 222.225 – 223.380 <u>Local Options</u> 222.150 – 222.250 223.750 – 223.850	

70 Centimeters

Region 1	Region 2	Region 3
<i>Forbidden</i>	420 — 432 MHz <i>BW N/A</i>	<i>Forbidden</i>
430 — 431.975 MHz <i>BW 20 kHz</i> All Modes	ATV	430 — 431.9 MHz <i>BW 25 kHz</i> All Modes
432 — 432.1 MHz <i>BW 500 Hz</i> Telegraphy	432 — 432.1 MHz <i>BW 500 Hz</i> CW, DM EME, Weak Signals	431.9 — 432.24 MHz <i>BW 2700 Hz</i> EME, Weak Signals
432.1 — 432.4 MHz <i>BW 2700 Hz</i> Telegraphy, SSB 432.200 – SSB CoA 432.370 – Meteo Scatter	432.1 — 432.3 MHz <i>BW 2700 Hz</i> CW, SSB 432.1 – SSB/CW Call Freq	432.24 — 435 MHz <i>BW 25 kHz</i> All Modes
432.4 — 432.5 MHz <i>BW 500 Hz</i> Beacons Exclusive	432.3 — 432.4 MHz <i>BW 500 Hz</i> CW, Beacons	
432.5 — 433.575 MHz <i>BW 12 kHz</i> All Modes 432.5 – APRS 433.4 – SSTV (FM/AFSK) 433.45 – DV Calling 433.5 – FM Calling	432.4 — 433 MHz <i>BW 2700 Hz</i> CW, DM, SSB	
	433 — 433.1 MHz <i>BW 12 kHz</i> All Modes ACDS, IVG	
433.6 — 434 MHz <i>BW N/A</i> All Modes	433.1 — 435 MHz Local Option	

Region 1	Region 2	Region 3
434 — 435 MHz <i>BW 12 kHz</i> All Modes, ATV		
435 — 438 MHz <i>BW N/A</i> Satellite		
438 — 440 MHz <i>BW 25 kHz</i> All Modes	438 — 450 MHz <i>BW N/A</i> All Modes	438 — 440 MHz <i>BW 25 kHz</i> All Modes
<i>Forbidden</i>		<i>Forbidden</i>

2 Classification of Emissions

The classification of emissions is made of 3 symbols:

1. type of modulation of the main carrier;
2. nature of signal(s) modulating the main carrier;
3. type of information to be transmitted.

For instance, the Morse code is classified as **A1A**, the audio single-side band **J3E**, and radio teletype (RTTY) **F1B**.

Modulation of the main Carrier

Symbol	Definition
N	Emission of an unmodulated carrier
<i>Amplitude Modulation</i>	
A	Double-sideband
H	Single-sideband, full carrier
R	Single-sideband, reduced or variable level carrier
J	Single-sideband, suppressed carrier
B	Independent sidebands
C	Vestigial sideband
<i>Angle Modulation</i>	
F	Frequency modulation
G	Phase modulation
<i>Amplitude and Angle Modulation</i>	
D	Amplitude and Angle Modulation, simultaneously or in a pre-established sequence
<i>Emission of Pulses</i>	
P	Unmodulated pulses
K	Modulated in amplitude
L	Modulated in width/duration

Symbol	Definition
M	Modulated in position/phase
Q	Carrier modulated during the angle-period of the pulse
V	Combination of the foregoing or is produced by other means
Other	
W	Combination of 2 or more of the previous modes
X	Not covered

Nature of signals

Symbol	Definition
0	No modulating channel
1	Single channel with quantized or digital information without a sub-carrier modulation
2	Single channel with quantized or digital information with a sub-carrier modulation
3	Single channel with analogue information
7	Two or more channel with quantized or digital information
8	Two or more channel with analogue information
9	Composite (analogue and digital)
X	Not covered

Type of Information

Symbol	Definition
N	No information transmitted
A	Telegraphy, aural reception
B	Telegraphy, automatic reception
C	Facsimile
D	Data transmission, telemetry, telecommand
E	Telephony (includes sound broadcasting)
F	Television (video)
W	Combination of the above

Symbol	Definition
X	Not covered

3 Q Codes

A sample of the most used Q Codes from the ITU Rec. M.1172-0.

Every word between [brackets] should be replaced with the intention of your message.

For instance, if your callsign is **4U1UN** and another operator is asking you **QRZ**. Your reply will be:

| *You are being called by 4U1UN.*

Code	Question	Answer or Advice
QRA	What is the name of your station?	The name of my station is [callsign]
QRB	How far approximately are you from my station?	The approximate distance between our stations is [distance] kilometers.
QRE	What is your estimated time of arrival at [place]?	My estimated time of arrival at [place] is [time].
QRG	Will you tell me my exact frequency (or that of [callsign])	Your exact frequency (or that of [callsign]) is [frequency].
QRH	Does my frequency vary?	Your frequency varies.
QRI	How is the tone of my transmission?	The tone of your transmission is: 1. good 2. variable 3. bad.
QRK	What is the intelligibility of my signals (or those of [callsign])?	The intelligibility of your signals (or those of [callsign]) is: 1. bad 2. poor 3. fair 4. good 5. excellent.
QRL	Are you busy?	I am busy (or I am busy with [callsign]). Please do not interfere.

Code	Question	Answer or Advice
QRM	Is my transmission being interfered with?	Your transmission is being interfered with: 1. not interfered 2. slightly 3. moderately 4. severely 5. extremely.
QRN	Are you troubled by static?	I am troubled by static: 1. not troubled 2. slightly 3. moderately 4. severely 5. extremely.
QRO	Shall I increase transmitter power?	Increase transmitter power.
QRP	Shall I decrease transmitter power?	Decrease transmitter power.
QRQ	Shall I send faster?	Send faster ([<i>speed</i>] words per minute).
QRS	Shall I send more slowly?	Send more slowly ([<i>speed</i>] words per minute).
QRT	Shall I stop sending?	Stop sending.
QRU	Have you anything for me?	I have nothing for you.
QRV	Are you ready?	I am ready.
QRW	Shall I inform [<i>callsign</i>] that you are calling him on [<i>frequency</i>]?	Please inform [<i>callsign</i>] that I am calling him on [<i>frequency</i>].
QRX	When will you call me again?	I will call you again at [<i>time</i>] on [<i>frequency</i>].
QRZ	Who is calling me?	You are being called by [<i>callsign</i>] (on [<i>frequency</i>]).
QSA	What is the strength of my signals (or those of [<i>callsign</i>])?	The strength of your signals (or those of [<i>callsign</i>]) is: 1. scarcely perceptible 2. weak 3. fairly good 4. good 5. very good.
QSB	Are my signals fading?	Your signals are fading.

Code	Question	Answer or Advice
QSG	Shall I send [<i>number</i>] telegrams at a time?	Send [<i>number</i>] telegrams at a time.
QSL	Can you acknowledge receipt?	I am acknowledging receipt.
QSM	Shall I repeat the last telegram which I sent you (<i>or</i> some previous telegram)?	Repeat the last telegram which you sent me (<i>or</i> telegram(s) [<i>numbers</i>]).
QSN	Did you hear me (<i>or</i> [<i>callsign</i>]) on [<i>frequency</i>]?	I did hear you (<i>or</i> [<i>callsign</i>]) on [<i>frequency</i>].
QSO	Can you communicate with [<i>callsign</i>] direct (<i>or</i> by relay)?	I can communicate with [<i>callsign</i>] direct (<i>or</i> by relay through [<i>callsign</i>]).
QSP	Will you relay to [<i>callsign</i>] free of charge?	I will relay to [<i>callsign</i>] free of charge.
QSR	Shall I repeat the call on the calling frequency?	Repeat your call on the calling frequency; did not hear you (<i>or</i> have interference).
QSS	What working frequency will you use?	I will use the working frequency [<i>frequency</i>] (<i>in the high frequency bands normally only the last three figures of the frequency need be given</i>).
QSX	Will you listen to [<i>callsign</i>] on [<i>frequency</i>], or in the [<i>bands</i>] / [<i>channels</i>]?	I am listening to [<i>callsign</i>] on [<i>frequency</i>], or in the [<i>bands</i>] / [<i>channels</i>].
QSY	Shall I change to transmission on another frequency?	Change to transmission on another [<i>frequency</i>].
QTH	What is your position in latitude and longitude (<i>or according to any other indication</i>)?	My position is [<i>latitude</i>], [<i>longitude</i>] (<i>or</i> [<i>position indication</i>]).
QTJ	What is your speed?	My speed is [<i>speed</i>] kilometers per hour.
QTR	What is the correct time?	The correct time is [<i>time</i>].
QTS	Will you send your call sign for [<i>seconds</i>]?	I will send my call sign for [<i>seconds</i>].
QUA	Have you news of [<i>callsign</i>]?	Here is news of [<i>callsign</i>].
QUD	Have you received the urgency signal sent by [<i>callsign</i>]?	I have received the urgency signal sent by [<i>callsign</i>] at [<i>time</i>].

Code	Question	Answer or Advice
QUE	Can you speak in [<i>language</i>], with interpreter if necessary; if so, on what frequencies?	I can speak in [<i>language</i>] on [<i>frequency</i>].

4 Morse Code

A · —

B — · · ·

C — · — ·

D — · ·

E ·

F · · — ·

G — — ·

H · · · ·

I · ·

J · — — —

K — · —

L · — · ·

M — —

N — ·

O — — —

P · — — ·

Q — — · —

R · — ·

S · · ·

T —

U · · —

V · · · —

W · — —

X — · · —

Y — · — —

Z — — · ·

1 · — — — —

2 · · — — —

3 · · · — —

4 · · · · —

5 · · · · ·

6 — · · · ·

7 — — · · ·

8 — — — · ·

9 — — — — ·

0 — — — — —

Full Stop [.]	• — • — • —	Understood	• • • — •
Comma [,]	— — • • — —	Error [8 •]	• • • • • • •
Colon [:]	— — — • • •	Cross [+]	• — • — •
Question [?] ¹	• • — — • •	Transmit	— • —
Apostrophe [']	• — — — — •	Wait	• — • • •
Hyphen [-]	— • • • • —	End	• • • — • —
Slash [/]	— • • — •	Start	— • — • —
LH Bracket [(]	— • — — •	Mult. [x]	— • • • —
RH Bracket [)]	— • — — • —	At [@]	• — — • — •
Quote ["]	• — • • — •		
Equal [=]	— • • • —		

Timings

• Dit (dot)	Unit of time
— Dah (dash)	3 •
Between dits or dahs	1 •
Between letters	3 •
Between words	7 •

¹ Ask for a repetition if the message is not understood.

5 Radio Abbreviations

A sample of abbreviations, reference ITU Rec. M.1172-0.

Abbreviation or signal	Definition
AA	All after ...
AB	All before ...
ADS	Address
AR	End of transmission
AS	Waiting period
BK	Signal used to interrupt a transmission in progress
BN	All between ... and ...
BQ	A reply to an RQ (Request)
BT	Mark the separation between different parts of the same transmission
C	Yes
CFM	Confirm <i>or</i> I confirm
CL	I am closing my station
COL	Collate <i>or</i> I collate
CQ	General call to all stations
CS	Call sign; used to request a call sign
DE	<i>"From ..."</i> (used to precede the name or other identification of the calling station)
DSC	Digital selective calling
E	East (cardinal point)
ETA	Estimated time of arrival
K	Invitation to transmit
KA	Starting signal
MIN	Minute <i>or</i> Minutes
N	North (cardinal point)

Abbreviation or signal	Definition
NIL	I have nothing to send to you
NO	No (<i>negative</i>)
NW	Now
OK	We agree (<i>or</i> It is correct)
P	Prefix indicating a private radiotelegram
PBL	Preamble
PSE	Please
R	Received
RCC	Rescue coordination centre
REF	Reference to ... <i>or</i> Refer to ...
RPT	Repeat <i>or</i> I repeat
RQ	Indication of a request
S	South (cardinal point)
SAR	Search and Rescue
SIG	Signature
TFC	Traffic
TR	Used by a land station to request the position. Used also as a prefix to the reply
TU	Thank you
TXT	Text
VA	End of work
W	West (cardinal point)
WA	Word after ...
WB	Word before ...
WD	Word(s) <i>or</i> Group(s)
WX	Weather report
XQ	Prefix used to indicate the transmission of a service note
YZ	The words which follow are in plain language

6 Digital Modes

The chapter summarizes the typical calling and center-of-activity frequencies (**in MHz**) for digital modes.

The Digital Modes are not limited to the calling or to the center-of-activity frequencies, but ruled by the Band Plans.

Band	FT4	FT8	JS8
160 m		1.840	1.842
80 m	3.575	3.573	3.578
60 m		5.357	
40m	7.0475	7.074	7.078
30 m	10.140	10.136	10.130
20 m	14.080	14.074	14.078
17 m	18.104	18.100	18.104
15 m	21.140	21.074	21.078
12 m	24.919	24.915	24.922
10 m	28.180	28.074	28.078
6 m	50.318	50.313 50.323 (DX)	50.318
2 m	144.170	144.174	144.178
1.25 m		222.065	
70 cm		432.065	

Before use: verify the frequency is allowed in your region.

Band	JT65	PSK31	RTTY
2200m	0.13613		
630m			
160 m	1.838	1.838	1.840
80 m	3.570	3.580	3.590
60 m	5.357		
40m	7.076	7.040	7.040
30 m	10.138	10.141	10.140
20 m	14.076	14.070	14.080
17 m	18.102	18.103	18.100
15 m	21.076	21.070	21.080
12 m	24.917	24.920	24.925
10 m	28.076	28.070 28.120	28.080
6 m	50.276	50.305	50.600
2 m	144.120	144.138	144.600
1.25 m			
70 cm	432.065	432.088	432.600
23 cm	1296.065	1296.138	1296.600
13 cm	2301.065	2320.138	

Before use: verify the frequency is allowed in your region.

Band	WSPR	FST4/W	SSTV
2200 m	0.136	0.136	
630 m	0.4742	0.4742	
160 m	1.8366	1.839 1.8368	
80 m	3.5686		3.733
60 m	5.2872 5.3647		
40m	7.0386		7.058
30 m	10.1386		
20 m	14.0956		14.233 14.230 (Analogue)
17 m	18.1046		
15 m	21.0946		21.337
12 m	24.9246		
10 m	28.1246		
6 m	50.2937		50.510
2 m	144.489		
1.25 m			
70 cm	432.300		
23 cm	1296.500		

Before use: verify the frequency is allowed in your region.

7 Amateur Satellite

Opened bands

The table summarizes in which band the AMSAT is allowed.

However, please refer to the detailed band plans to know the exact boundaries of AMSAT traffic within each of them.

Band	Region 1	Region 2	Region 3
40m	7000 — 7100 kHz		
20m	14000 — 14250 kHz		
17m	18068 — 18168 kHz		
15m	21000 — 21450 kHz		
12m	24890 — 24990 kHz		
10m	28000 — 29700 kHz		
2m	144 — 146 MHz		
70cm	430 — 440 MHz	430 — 440 MHz	
5cm	5.83 — 5.85 GHz		
3cm	10.45 — 10.5 GHz		
1.2cm	24 — 24.05 GHz		
6mm	47 — 47.2 GHz		
4mm	76 — 77.5 GHz		
	77.5 — 78 GHz		
	78 — 81 GHz		
2.2mm	134 — 136 GHz		
	136 — 141 GHz		
1.2mm	241 — 248 GHz		
	248 — 250 GHz		

International Space Station

Mode	Uplink (MHz)	Downlink (MHz)
Voice	145.200 (R1) 144.490 (R2, R3)	145.800
	437.800	145.800
APRS (1200 baud)	145.825	145.825
	437.550	437.550
SSTV	N/A	145.800

QO-100

Mode	Uplink (MHz)	Downlink (MHz)
CW Beacon ▲ Guard Band	N/A	10489.500 — 10489.505
CW	2400.005 — 2400.040	10489.505 — 10489.540
Digimodes <i>BW 500 Hz</i>	2400.040 — 2400.080	10489.540 — 10489.580
Digimodes <i>BW 2700 Hz</i>	2400.080 — 2400.150	10489.580 — 10489.650
SSB <i>BW 2700 Hz</i>	2400.150 — 2400.245	10489.650 — 10489.745
PSK Beacon (400 bit/s) ▲ Guard Band	N/A	10489.745 — 10489.755
SSB <i>BW 2700 Hz</i>	2400.255 — 2400.350	10489.755 — 10489.850
Broadcast	2400.355	10489.855
▲ Emergency	2400.360	10489.860
Mixed Modes <i>BW 2700 Hz</i>	2400.365 — 2400.495	10489.865 — 10489.995
Experimental Beacon ▲ Guard Band	N/A	10489.995 — 10490.000

8 International Beacon Project

The International Beacon Project (IBP) coordinates HF beacons worldwide. Each beacon transmits once on each band every 3 minutes, 24 hours a day.

The message starts by the station callsign in CW at 22 words-per-minutes. Then followed by a series of dashes sent at:
100 W, 10 W, 1 W and 1 mW.

10 seconds after the end of the transmission, the beacon goes to the band higher and starts to transmit the same message again.

Beacons List

Callsign	Country	QTH	Grid
4U1UN	United Nations	New York City	FN30as
VE8AT	Canada	Inuvik, NT	CP38gh
W6WX	United States	Mt. Umunhum	CM97bd
KH6RS	Hawaii	Maui	BL10ts
ZL6B	New Zealand	Masterton	RE78tw
VK6RBP	Australia	Rolystone	OF87av
JA2IGY	Japan	Mt. Asama	PM84jk
RR9O	Russia	Novosibirsk	NO14kx
VR2B	Hong Kong	Hong Kong	OL72bg
4S7B	Sri Lanka	Colombo	MJ96wv
ZS6DN	South Africa	Pretoria	KG33xi
5Z4B	Kenya	Kariobangi	KI88ks
4X6TU	Israel	Tel Aviv	KM72jb
OH2B	Finland	Lohja	KP20eh
CS3B	Madeira	São Jorge	IM12mt
LU4AA	Argentina	Buenos Aires	GF05tj
OA4B	Peru	Lima	FH17mw

Callsign	Country	QTH	Grid
YV5B	Venezuela	Caracas	FJ69cc

Frequencies

Band	Frequency (MHz)
20m	14.100
17m	18.110
15m	21.150
13m	24.930
10m	28.200

9 Radio Waves

The radio waves are periodic waves, so a pattern is generated at a specific frequency, short-handed f . The frequency is associated to the wavelength, which represents the physical length in space of a pattern.

Period	$\tau = f^{-1}$, with f the frequency
Wave Length	$\lambda = c \cdot \tau$ $\lambda = c \cdot f^{-1}$ $\lambda(\text{m}) \approx \frac{299}{f(\text{MHz})}$
Angular Frequency (or pulsation)	$\omega = 2\pi f$
Angular Wave Vector	$k = 2\pi\lambda$

Band Definitions

Symbol	Frequency range (lower limit exclusive, upper limit inclusive)	Corresponding metric subdivision
VLF	3 to 30 kHz	Myriametric waves
LF	30 to 300 kHz	Kilometric waves
MF	300 to 3 000 kHz	Hectometric waves
HF	3 to 30 MHz	Decametric waves
VHF	30 to 300 MHz	Metric waves
UHF	300 to 3 000 MHz	Decimetric waves
SHF	3 to 30 GHz	Centimetric waves
EHF	30 to 300 GHz	Millimetric waves
	300 to 3 000 GHz	Decimillimetric waves

Propagation

Ionosphere Regions

The ionosphere is the ionized region of the atmosphere is between 50 km to 2000 km of altitude. The Sun ultra-violets and X-rays ionize the atmosphere gas. The density of electrons per unit of volume (cube-meter) measures the intensity of the ionization. The collision between electrons and neutral particles, acts as a radiowave absorber. The maximum of collision has been measured between 50-90 km.

This region is split into multiple layers, with specific properties in terms of propagation. The following table summarizes each layer and its properties, only for the sake of information the lower atmosphere layers are detailed in *italic*.

Alt. (km)	Day	Night	Properties
0 — 20	<i>Troposphere</i>		
20 — 50	<i>Stratosphere</i>		
50 — 90	D	D	Absorbs: MF, HF Reflects: VLF, LF Peak electrons density at noon (10^8 to 10^9 electrons/m ³), increased during summer, very small density the night.
90 — 130	E	E	Reflects: HF Peak electron density near noon and in summer (10^{11} electrons/m ³). Unstable band for reflection, namely the <i>Sporadic Es</i> .
130 — 200	F1	F	Reflects: HF Highly sensitive to solar processes as the E band. The region distinction is not maintained at night (a single F region).

Alt. (km)	Day	Night	Properties
200 — 500	F2		Reflects: HF, sparsely VHF Greatest density of electrons, and the only layer, where density of electrons persists at night. The F and F2 are the most reliable layers for reflections.

Bands

Band	Range	Propagation
VLF	0 – 30 kHz	Waveguide, Ground-wave
LF	30 – 300 kHz	Waveguide, Sky wave, Ground-wave
MF	300 – 300 kHz	Sky-wave, Ground-wave
HF	3 – 30 MHz	Sky-wave < 12 MHz, favored the night 12 – 19 MHz, all day band > 19 MHz, favored the day
VHF	30 – 300 MHz	Line-of-sight Sporadically reflected by the F or E layers

Solar and Earth Activity

The sun activity can affect the propagation on HF, here a sample of the most common indices.

Symbols	Name	Details
R SN SSN	Wolf Number <i>Sunspot Number</i> <i>Smoothed Sunspot Number</i>	Relative measurement of the number of sunspots. <i>Between 0 and 250.</i> It indicates the activity of the Sun, the higher when the Sun cycle (11 years) is at its maximum. R > 100, the D layer may be thicker on daytime, this reduces significantly the propagation from 160- to 60-meters bands (also affects 40 and 30 meters). The bigger the higher optimal frequency.

Symbols	Name	Details
F SFI	Solar Flux Index	<p>Measures the solar flux at 2.8GHz (10.7 cm). <i>Usually between 0 and 300.</i></p> <p>It indicates how the F layer is ionized, this is good for DX.</p> <p>The bigger the higher optimal frequency. <i>The high F might favor long-distance communications.</i></p>
K	K-index 3-Hours Geomagnetic Variability	<p>Magnetosphere variations (horizontal variations of the earth's magnetic field). <i>Between 0 and 9.</i></p> <p>The lower the better.</p> <p>< 3, normal > 5, stormy conditions</p>
A	A-index Daily Geomagnetic Variability	<p>Magnetosphere variations, averaged on a day. <i>Between 0 and 400.</i></p> <p>The lower the better.</p> <p>< 15, normal > 40, active storm > 50, major storm</p>

Solar and Geomagnetic Storms

- A few minutes to a few hours after the **solar flare**, one notices HF noise (because of the solar X-Rays). This causes QSB, and in the worst case short radio blackouts.
- A few hours after the **solar flare**, the solar flux (F) increases.
- From a few hours to a couple of days after the **solar flare**, the HF band is quiet. The lower and the maximum usable frequencies opens. *Favored window for HF radio.*
- A couple of days after the **solar flare**, the solar wind reaches the Earth. The K-index suddenly increases, the geomagnetic storm starts for a few days. One enters in a **radio blackout**.

10 Antennas

Summary

Kind	Length	Z (Ω)	Gain (dBi)
Ground Plane	$\lambda/4$	36	2.19
Half-Wave Dipole	$\lambda/2$	73.1	2.15
Folded Dipole	$\lambda/2$	292	2.15
Yagi	Depends on the number of elements	The more elements the lower	The more elements the bigger

Arrays

A set of multiple connected antenna achieves an higher gain.

Theoretically, the gain follows $10 \log_{10}(n)$ with n the number of antennas.

n	2	3	4	5	6	7	8
+ Δ dBi	3	4.77	6	6.99	7.78	8.45	9

Standing Wave Ratio

The SWR measures the impedance matching between the loads (transmitter, lines, antennas...). When two loads match the SWR ratio is at 1:1. Between two loads, the SWR is defined as:

$$\text{SWR} = \frac{Z_{\max}}{Z_{\min}},$$

with Z_{\max} and Z_{\min} respectively the higher and the lower impedance of the loads.

If the value of the SWR is bigger than 1:1, a fraction of the transmitted power is reflected back to the transmitter, this can be considered as a loss. The ratio of power reads as:

$$\text{SWR} = \frac{1 + \sqrt{P_r/P_f}}{1 - \sqrt{P_r/P_f}},$$

with P_r and P_f respectively the reflected and the forwarded power. Thus, the ratio of P_r/P_f reads:

$$\frac{P_r}{P_f} = \left(\frac{SWR - 1}{SWR + 1} \right)^2 .$$

One may find below the table of losses with respect to the SWR and an application for 10W signal.

SWR	Loss	Radiated	10W
1	0,00 %	100,00 %	10,00
1.1	0,23 %	99,77 %	9,98
1.2	0,83 %	99,17 %	9,92
1.3	1,70 %	98,30 %	9,83
1.4	2,78 %	97,22 %	9,72
1.5	4,00 %	96,00 %	9,60
1.6	5,33 %	94,67 %	9,47
1.7	6,72 %	93,28 %	9,33
1.8	8,16 %	91,84 %	9,18
1.9	9,63 %	90,37 %	9,04
2	11,11 %	88,89 %	8,89
2.5	18,37 %	81,63 %	8,16
3	25,00 %	75,00 %	7,50
4	36,00 %	64,00 %	6,40
5	44,44 %	55,56 %	5,56
10	66,94 %	33,06 %	3,31

11 Electricity

Component	Resistor	Capacitor	Coil
Property	Resistance R	Capacity C	Inductance L
Unit	Ohm (Ω)	Farads (F)	Henry (H)
Impedance	$Z = R$	$Z = -\frac{j}{\omega C}$	$Z = j\omega L$
Series	$R_{tot} = R_1 + \dots + R_N$	$\frac{1}{C_{tot}} = \frac{1}{C_1} + \dots + \frac{1}{C_N}$	$L_{tot} = L_1 + \dots + L_N$
Parallel	$\frac{1}{R_{tot}} = \frac{1}{R_1} + \dots + \frac{1}{R_N}$	$C_{tot} = C_1 + \dots + C_N$	$\frac{1}{L_{tot}} = \frac{1}{L_1} + \dots + \frac{1}{L_N}$

Ohm's Law	$V = R \cdot I$, with V the tension, R the resistance, and I the current.
Power	$P = V \cdot I$
Inductance of a solenoid	$L = \frac{\mu N^2 A}{l}$, with N the number of turns, A the cross-section of the solenoid, and l the length

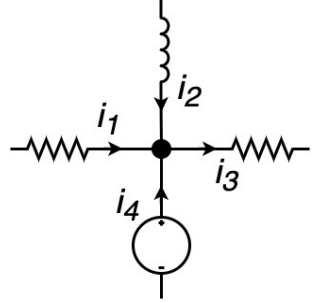
Kirchhoff's Law

Currents

On a circuit node, the algebraic sum of all currents (positive for incoming and negative for exiting) is equal to zero: $\sum_{k=0}^K I_k = 0$.

For instance on the figure, the law reads as:

$$i_1 + i_2 - i_3 + i_4 = 0.$$

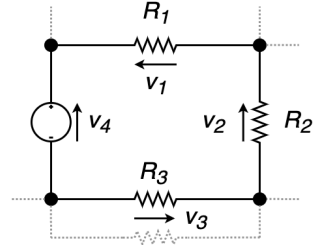


Voltage

The directed sum of all voltage on a closed loop is equal to zero: $\sum_{k=0}^K V_k = 0$.

For instance on the figure, the law reads as:

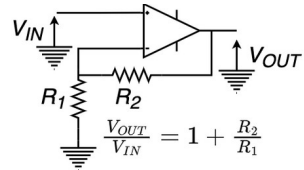
$$-v_1 - v_2 - v_3 + v_4 = 0.$$



Operational Amplifiers

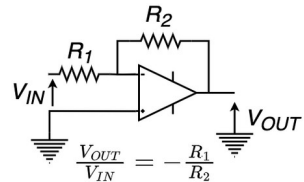
Non-inverting

In a non-inverting amplifier, the output voltage changes in the same direction to the input voltage. The operational amplifier works in a linear mode.



Inverting

In an inverting amplifier, the output voltage changes in the opposite direction to the input voltage. The operational amplifier works in a non-linear mode. It is in a comparator configuration.



Filters & RLC

The resonance frequency F_0 , and the cutoff frequency F_C , are equal to:

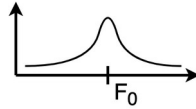
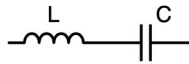
$$F_C = F_0 = \frac{1}{2\pi\sqrt{LC}}.$$

The LC circuits are not perfect, because of the hidden resistors (the wires, in the inductance...), so one speaks about RLC circuits. The value of the resistor may affect the selectivity of the filters. The quality of a LC circuit is expressed by the Q factor:

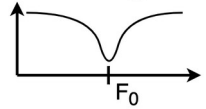
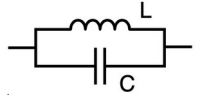
$Q = \frac{F_0}{BW}$, with the resonance frequency F_0 and the bandwidth BW .

Thus, the higher Q, the more selective is the filter.

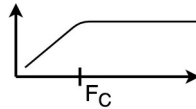
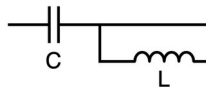
Band Pass



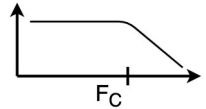
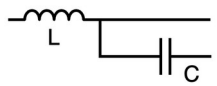
Band Stop



High Pass



Low Pass



Resistor Colors

| IEC 60062:2016 Standard

Color	Number	Multiplier	Tolerance
Black	0	10^0	N/A
Brown	1	10^1	$\pm 1 \%$
Red	2	10^2	$\pm 2 \%$
Orange	3	10^3	$\pm 0.05 \%$
Yellow	4	10^4	$\pm 0.02 \%$
Green	5	10^5	$\pm 0.5 \%$
Blue	6	10^6	$\pm 0.25 \%$
Violet	7	10^7	$\pm 0.1 \%$
Gray	8	10^8	$\pm 0.01 \%$
White	9	10^9	N/A
Silver		10^{-2}	$\pm 10 \%$
Gold		10^{-1}	$\pm 5 \%$

12 ITU Prefixes Allocation

With respect to the Appendix 42 of the RR:

The first two characters of a call sign shall be two letters or a letter followed by a digit or a digit followed by a letter. The first two characters or in certain cases the first character of a call sign constitute the nationality identification.²

For instance, **Monaco** has the range **3AA – 3AZ**, so the country is identified with **3A**. If the allocation is wider, as **Spain** with **EAA – EHZ**, the country can be identified with **EA, EB, ..., EH**.

Range	Country or Organization
2—3	
2AA – 2ZZ	United Kingdom of Great Britain and Northern Ireland
3AA – 3AZ	Monaco (Principality of)
3BA – 3BZ	Mauritius (Republic of)
3CA – 3CZ	Equatorial Guinea (Republic of)
3DA – 3DM	Eswatini (Kingdom of)
3DN – 3DZ	Fiji (Republic of)
3EA – 3FZ	Panama (Republic of)
3GA – 3UZ	Chile
3VA – 3VZ	Tunisia
3WA – 3WZ	Viet Nam (Socialist Republic of)
3XA – 3XZ	Guinea (Republic of)
3YA – 3YZ	Norway
3ZA – 3ZZ	Poland (Republic of)
4	
4AA – 4CZ	Mexico
4DA – 4IZ	Philippines (Republic of the)
4JA – 4KZ	Azerbaijan (Republic of)

² For call sign series beginning with B, F, G, I, K, M, N, R, W and 2, only the first character is required for nationality identification. In the cases of half series (i.e. when the first two characters are allocated to more than one Member State), the first three characters are required for nationality identification.

4LA – 4LZ	Georgia
4MA – 4MZ	Venezuela (Bolivarian Republic of)
4OA – 4OZ	Montenegro
4PA – 4SZ	Sri Lanka (Democratic Socialist Republic of)
4TA – 4TZ	Peru
4UA – 4UZ	United Nations
4VA – 4VZ	Haiti (Republic of)
4WA – 4WZ	Timor-Leste (Democratic Republic of)
4XA – 4XZ	Israel (State of)
4YA – 4YZ	International Civil Aviation Organization
4ZA – 4ZZ	Israel (State of)
5	
5AA – 5AZ	Libya (State of)
5BA – 5BZ	Cyprus (Republic of)
5CA – 5GZ	Morocco (Kingdom of)
5HA – 5IZ	Tanzania (United Republic of)
5JA – 5KZ	Colombia (Republic of)
5LA – 5MZ	Liberia (Republic of)
5NA – 5NZ	Nigeria (Federal Republic of)
5PA – 5QZ	Denmark
5RA – 5SZ	Madagascar (Republic of)
5TA – 5TZ	Mauritania (Islamic Republic of)
5UA – 5UZ	Niger (Republic of the)
5VA – 5VZ	Togolese Republic
5WA – 5WZ	Samoa (Independent State of)
5XA – 5XZ	Uganda (Republic of)
5YA – 5ZZ	Kenya (Republic of)
6	
6AA – 6BZ	Egypt (Arab Republic of)
6CA – 6CZ	Syrian Arab Republic
6DA – 6JZ	Mexico
6KA – 6NZ	Korea (Republic of)
6OA – 6OZ	Somalia (Federal Republic of)

6PA – 6SZ	Pakistan (Islamic Republic of)
6TA – 6UZ	Sudan (Republic of the)
6VA – 6WZ	Senegal (Republic of)
6XA – 6XZ	Madagascar (Republic of)
6YA – 6YZ	Jamaica
6ZA – 6ZZ	Liberia (Republic of)
7	
7AA – 7IZ	Indonesia (Republic of)
7JA – 7NZ	Japan
7OA – 7OZ	Yemen (Republic of)
7PA – 7PZ	Lesotho (Kingdom of)
7QA – 7QZ	Malawi
7RA – 7RZ	Algeria (People's Democratic Republic of)
7SA – 7SZ	Sweden
7TA – 7YZ	Algeria (People's Democratic Republic of)
7ZA – 7ZZ	Saudi Arabia (Kingdom of)
8	
8AA – 8IZ	Indonesia (Republic of)
8JA – 8NZ	Japan
8OA – 8OZ	Botswana (Republic of)
8PA – 8PZ	Barbados
8QA – 8QZ	Maldives (Republic of)
8RA – 8RZ	Guyana
8SA – 8SZ	Sweden
8TA – 8YZ	India (Republic of)
8ZA – 8ZZ	Saudi Arabia (Kingdom of)
9	
9AA – 9AZ	Croatia (Republic of)
9BA – 9DZ	Iran (Islamic Republic of)
9EA – 9FZ	Ethiopia (Federal Democratic Republic of)
9GA – 9GZ	Ghana
9HA – 9HZ	Malta
9IA – 9JZ	Zambia (Republic of)

9KA – 9KZ	Kuwait (State of)
9LA – 9LZ	Sierra Leone
9MA – 9MZ	Malaysia
9NA – 9NZ	Nepal (Federal Democratic Republic of)
9OA – 9TZ	Democratic Republic of the Congo
9UA – 9UZ	Burundi (Republic of)
9VA – 9VZ	Singapore (Republic of)
9WA – 9WZ	Malaysia
9XA – 9XZ	Rwanda (Republic of)
9YA – 9ZZ	Trinidad and Tobago
A	
A2A – A2Z	Botswana (Republic of)
A3A – A3Z	Tonga (Kingdom of)
A4A – A4Z	Oman (Sultanate of)
A5A – A5Z	Bhutan (Kingdom of)
A6A – A6Z	United Arab Emirates
A7A – A7Z	Qatar (State of)
A8A – A8Z	Liberia (Republic of)
A9A – A9Z	Bahrain (Kingdom of)
AAA – ALZ	United States of America
AMA – AOZ	Spain
APA – ASZ	Pakistan (Islamic Republic of)
ATA – AWZ	India (Republic of)
AXA – AXZ	Australia
AYA – AZZ	Argentine Republic
B — C	
BAA – BZZ	China (People's Republic of)
C2A – C2Z	Nauru (Republic of)
C3A – C3Z	Andorra (Principality of)
C4A – C4Z	Cyprus (Republic of)
C5A – C5Z	Gambia (Republic of the)
C6A – C6Z	Bahamas (Commonwealth of the)
C7A – C7Z	World Meteorological Organization

C8A – C9Z	Mozambique (Republic of)
CAA – CEZ	Chile
CFA – CKZ	Canada
CLA – CMZ	Cuba
CNA – CNZ	Morocco (Kingdom of)
COA – COZ	Cuba
CPA – CPZ	Bolivia (Plurinational State of)
CQA – CUZ	Portugal
CVA – CXZ	Uruguay (Eastern Republic of)
CYA – CZZ	Canada
D	
D2A – D3Z	Angola (Republic of)
D4A – D4Z	Cabo Verde (Republic of)
D5A – D5Z	Liberia (Republic of)
D6A – D6Z	Comoros (Union of the)
D7A – D9Z	Korea (Republic of)
DAA – DRZ	Germany (Federal Republic of)
DSA – DTZ	Korea (Republic of)
DUA – DZZ	Philippines (Republic of the)
E	
E2A – E2Z	Thailand
E3A – E3Z	Eritrea
E4A – E4Z	State of Palestine ³
E5A – E5Z	New Zealand – Cook Islands
E6A – E6Z	New Zealand – Niue
E7A – E7Z	Bosnia and Herzegovina
EAA – EHZ	Spain
EIA – EJZ	Ireland
EKA – EKZ	Armenia (Republic of)
ELA – ELZ	Liberia (Republic of)
EMA – EOZ	Ukraine
EPA – EQZ	Iran (Islamic Republic of)

ERA – ERZ	Moldova (Republic of)
ESA – ESZ	Estonia (Republic of)
ETA – ETZ	Ethiopia (Federal Democratic Republic of)
EUA – EWZ	Belarus (Republic of)
EXA – EXZ	Kyrgyz Republic
EYA – EYZ	Tajikistan (Republic of)
EZA – EZZ	Turkmenistan
F — G	
FAA – FZZ	France
GAA – GZZ	United Kingdom of Great Britain and Northern Ireland
H	
H2A – H2Z	Cyprus (Republic of)
H3A – H3Z	Panama (Republic of)
H4A – H4Z	Solomon Islands
H6A – H7Z	Nicaragua
H8A – H9Z	Panama (Republic of)
HAA – HAZ	Hungary
HBA – HBZ	Switzerland (Confederation of)
HCA – HDZ	Ecuador
HEA – HEZ	Switzerland (Confederation of)
HFA – HFZ	Poland (Republic of)
HGA – HGZ	Hungary
HHA – HHZ	Haiti (Republic of)
HIA – HIZ	Dominican Republic
HJA – HKZ	Colombia (Republic of)
HLA – HLZ	Korea (Republic of)
HMA – HMZ	Democratic People's Republic of Korea
HNA – HNZ	Iraq (Republic of)
HOA – HPZ	Panama (Republic of)
HQA – HRZ	Honduras (Republic of)
HSA – HSZ	Thailand
HTA – HTZ	Nicaragua
HUA – HUZ	El Salvador (Republic of)

HVA – HVZ	Vatican City State
HWA – HYZ	France
HZA – HZZ	Saudi Arabia (Kingdom of)
I – J	
IAA – IZZ	Italy
J2A – J2Z	Djibouti (Republic of)
J3A – J3Z	Grenada
J4A – J4Z	Greece
J5A – J5Z	Guinea-Bissau (Republic of)
J6A – J6Z	Saint Lucia
J7A – J7Z	Dominica (Commonwealth of)
J8A – J8Z	Saint Vincent and the Grenadines
JAA – JSZ	Japan
JTA – JVZ	Mongolia
JWA – JXZ	Norway
JYA – JYZ	Jordan (Hashemite Kingdom of)
JZA – JZZ	Indonesia (Republic of)
K – L	
KAA – KZZ	United States of America
L2A – L9Z	Argentine Republic
LAA – LNZ	Norway
LOA – LWZ	Argentine Republic
LXA – LXZ	Luxembourg
LYA – LYZ	Lithuania (Republic of)
LZA – LZZ	Bulgaria (Republic of)
M – N – O	
MAA – MZZ	United Kingdom of Great Britain and Northern Ireland
NAA – NZZ	United States of America
OAA – OCZ	Peru
ODA – ODZ	Lebanon
OEA – OEZ	Austria
OFA – OJZ	Finland
OKA – OLZ	Czech Republic

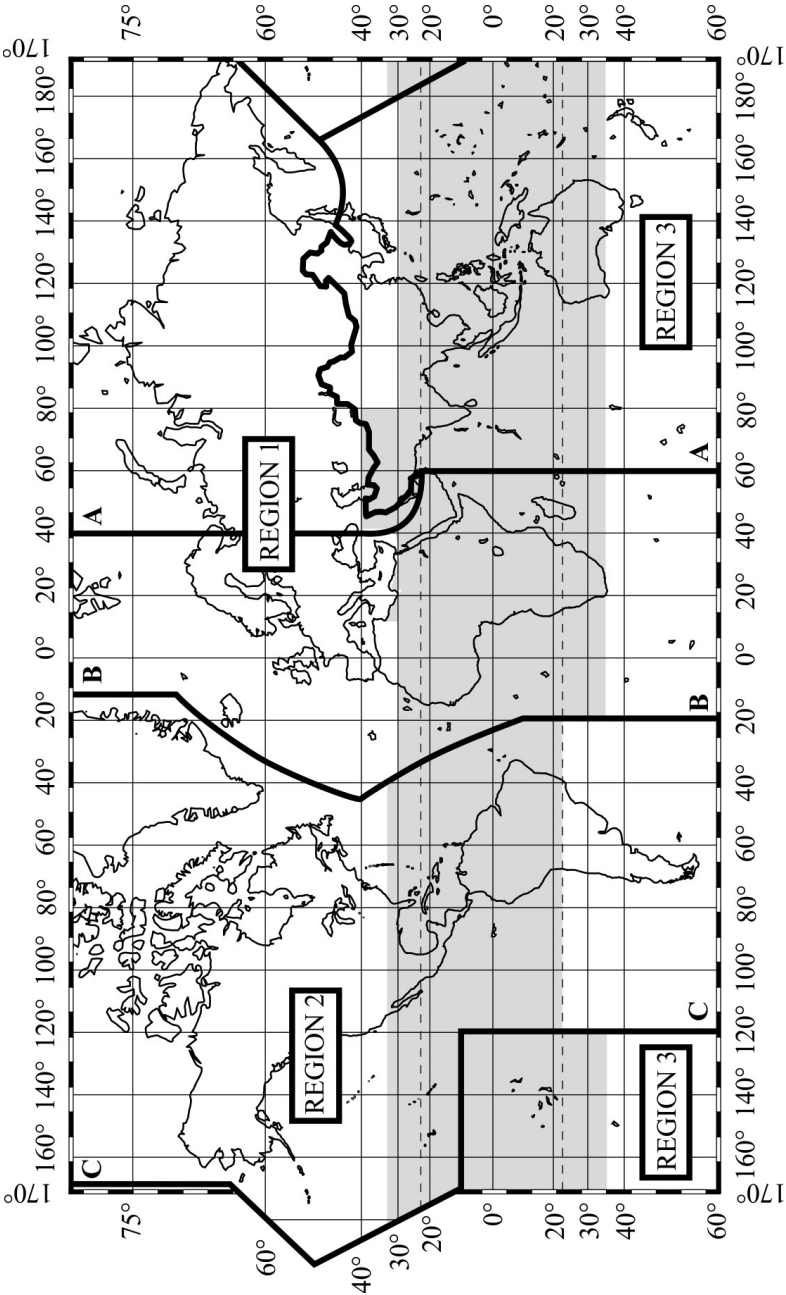
OMA – OMZ	Slovak Republic
ONA – OTZ	Belgium
OUA – OZZ	Denmark
P	
P2A – P2Z	Papua New Guinea
P3A – P3Z	Cyprus (Republic of)
P4A – P4Z	Netherlands (Kingdom of the) - Aruba
P5A – P9Z	Democratic People's Republic of Korea
PAA – PIZ	Netherlands (Kingdom of the)
PJA – PJZ	Netherlands (Kingdom of the) - Bonaire, Sint Eustatius and Saba
PJA – PJZ	Netherlands (Kingdom of the) - Curaçao
PJA – PJZ	Netherlands (Kingdom of the) - Sint Maarten (Dutch part)
PKA – POZ	Indonesia (Republic of)
PPA – PYZ	Brazil (Federative Republic of)
PZA – PZZ	Suriname (Republic of)
R – S	
RAA – RZZ	Russian Federation
S2A – S3Z	Bangladesh (People's Republic of)
S5A – S5Z	Slovenia (Republic of)
S6A – S6Z	Singapore (Republic of)
S7A – S7Z	Seychelles (Republic of)
S8A – S8Z	South Africa (Republic of)
S9A – S9Z	Sao Tome and Principe (Democratic Republic of)
SAA – SMZ	Sweden
SNA – SRZ	Poland (Republic of)
SSA – SSM	Egypt (Arab Republic of)
SSN – STZ	Sudan (Republic of the)
SUA – SUZ	Egypt (Arab Republic of)
SVA – SZZ	Greece
T	
T2A – T2Z	Tuvalu
T3A – T3Z	Kiribati (Republic of)
T4A – T4Z	Cuba

T5A – T5Z	Somalia (Federal Republic of)
T6A – T6Z	Afghanistan
T7A – T7Z	San Marino (Republic of)
T8A – T8Z	Palau (Republic of)
TAA – TCZ	Republic of Türkiye
TDA – TDZ	Guatemala (Republic of)
TEA – TEZ	Costa Rica
TFA – TFZ	Iceland
TGA – TGZ	Guatemala (Republic of)
THA – THZ	France
TIA – TIZ	Costa Rica
TJA – TJZ	Cameroon (Republic of)
TKA – TKZ	France
TLA – TLZ	Central African Republic
TMA – TMZ	France
TNA – TNZ	Congo (Republic of the)
TOA – TQZ	France
TRA – TRZ	Gabonese Republic
TSA – TSZ	Tunisia
TTA – TTZ	Chad (Republic of)
TUA – TUZ	Côte d'Ivoire (Republic of)
TVA – TXZ	France
TYA – TYZ	Benin (Republic of)
TZA – TZZ	Mali (Republic of)
U	
UAA – UIZ	Russian Federation
UJA – UMZ	Uzbekistan (Republic of)
UNA – UQZ	Kazakhstan (Republic of)
URA – UZZ	Ukraine
V	
V2A – V2Z	Antigua and Barbuda
V3A – V3Z	Belize
V4A – V4Z	Saint Kitts and Nevis (Federation of)
V5A – V5Z	Namibia (Republic of)

V6A – V6Z	Micronesia (Federated States of)
V7A – V7Z	Marshall Islands (Republic of the)
V8A – V8Z	Brunei Darussalam
VAA – VGZ	Canada
VHA – VNZ	Australia
VOA – VOZ	Canada
VPA – VQZ	United Kingdom of Great Britain and Northern Ireland
VRA – VRZ	China (People's Republic of) - Hong Kong
VSA – VSZ	United Kingdom of Great Britain and Northern Ireland
VTa – VWZ	India (Republic of)
VXA – VYZ	Canada
VZA – VZZ	Australia
W — X	
WAA – WZZ	United States of America
XAA – XIZ	Mexico
XJA – XOZ	Canada
XPA – XPZ	Denmark
XQA – XRZ	Chile
XSA – XSZ	China (People's Republic of)
XTA – XTZ	Burkina Faso
XUA – XUZ	Cambodia (Kingdom of)
XVA – XVZ	Viet Nam (Socialist Republic of)
XWA – XWZ	Lao People's Democratic Republic
XXA – XXZ	China (People's Republic of) - Macao
XYA – XZZ	Myanmar (Union of)
Y	
Y2A – Y9Z	Germany (Federal Republic of)
YAA – YAZ	Afghanistan
YBA – YHZ	Indonesia (Republic of)
YIA – YIZ	Iraq (Republic of)
YJA – YJZ	Vanuatu (Republic of)
YKA – YKZ	Syrian Arab Republic
YLA – YLZ	Latvia (Republic of)

YMA – YMZ	Republic of Türkiye
YNA – YNZ	Nicaragua
YOA – YRZ	Romania
YSA – YSZ	El Salvador (Republic of)
YTA – YUZ	Serbia (Republic of)
YVA – YYZ	Venezuela (Bolivarian Republic of)
Z	
Z2A – Z2Z	Zimbabwe (Republic of)
Z3A – Z3Z	North Macedonia (Republic of)
Z8A – Z8Z	South Sudan (Republic of)
ZAA – ZAZ	Albania (Republic of)
ZBA – ZJZ	United Kingdom of Great Britain and Northern Ireland
ZKA – ZMZ	New Zealand
ZNA – ZOZ	United Kingdom of Great Britain and Northern Ireland
ZPA – ZPZ	Paraguay (Republic of)
ZQA – ZQZ	United Kingdom of Great Britain and Northern Ireland
ZRA – ZUZ	South Africa (Republic of)
ZVA – ZZZ	Brazil (Federative Republic of)

13 ITU Regions



5-01

14 ITU Alphabet

A	Alpha	N	November
B	Bravo	O	Oscar
C	Charlie	P	Papa
D	Delta	Q	Quebec
E	Echo	R	Romeo
F	Fox-Trott	S	Sierra
G	Golf	T	Tango
H	Hotel	U	Uniform
I	India	V	Victor
J	Juliet	W	Whisky
K	Kilo	X	X-Ray
L	Lima	Y	Yankee
M	Mike	Z	Zulu

Widespread usage, occasionally replaced by country names.

1	Unaone	6	Soxisix
2	Bissotwo	7	Setteseven
3	Terrathree	8	Oktoeight
4	Kartefour	9	Novenine
5	Pantafive	0	Nadazero
•	Decimal		

Rare usage, only if transmission difficulties. Usually, the numbers are sent in english.

The QTH Locator (or Maidenhead Locator System) format consists of pairs of symbols (letter or number) which encode the longitude and the latitude. Thus for every pair:

- **the first character encodes longitude,**
- **and the second character encodes latitude.**

The origin of the grid is set at the south pole:

- longitude -180° (180°W),
- latitude -90° (90°S).

The Maidenhead-grid divides the globe into multiple parts:

- Field
 - 18×18 zones of 20° longitude and 10° latitude
 - Encoded by a pair of letters from *A* to *R*
- Square
 - 10×10 zones of 2° longitude and 1° latitude
 - Encoded by a pair of numbers from *0* to *10*
- Subsquare
 - 24×24 zones of $5'$ longitude and $2.5'$ latitude
 - Encoded by a pair of letters (usually lowercase) from *a* to *x*

Example: the locator of Paris (France) City Hall is JN18eu.

- Field
 - *J* codes the longitude, the 10th letter of the alphabet or an offset of 9 (because *A* is the origin without offset), or 180° from the origin. It converts to longitude 0°E .
 - *N* codes the latitude, the 14th letter of the alphabet, or 140° from the origin. It converts to latitude 40°N .
- Square
 - *1* codes the longitude, as 2° .
 - *8* codes the latitude, as 8° .
- Subsquare
 - *e* codes the longitude, the 5th letter of the alphabet or an offset of 4 (because *a* is the origin without offset), or $20'$.
 - *u* codes the latitude, the 21st letter of the alphabet, or an offset of $20'$, or $50'$.

Consequently, the locator JN18eu, reads as:

- longitude $2^{\circ}20'$
- latitude $48^{\circ}50'$

16 Units

International System

The International System of Units, known under the abbreviation SI, is the modern form of the metric system. The system has been established and is maintained by the General Conference on Weight and Measures (CGPM).

Base Units

Symbol	Name	Quantity
s	Second	Time
m	Meter	Length
kg	Kilogram	Mass
A	Ampere	Electric Current
K	Kelvin	Temperature
mol	Mole	Amount of substance
cd	Candela	Luminous Intensity

Derived Units

A sample of the most common units for Amateur Radio

Symbol	Name	Quantity	Definitions
Hz	Hertz	Frequency	s^{-1}
W	Watt	Power	$J \cdot s^{-1}$ $kg \cdot m^2 \cdot s^{-3}$
C	Coulomb	Electric Charge	$s \cdot A$
V	Volt	Electric Potential, Voltage	$W \cdot A^{-1}$ $J \cdot C^{-1}$ $kg \cdot m^2 \cdot s^{-3} \cdot A^{-1}$
F	Farad	Capacitance	$C \cdot V^{-1}$ $kg^{-1} \cdot m^{-2} \cdot s^4 \cdot A^2$

Symbol	Name	Quantity	Definitions
Ω	Ohm	Resistance	$V \cdot A^{-1}$ $kg \cdot m^2 \cdot s^{-3} \cdot A^{-2}$
S	Siemens	Electrical Conductance	Ω^{-1}
Wb	Weber	Magnetic Flux	$V \cdot s$ $kg \cdot m^2 \cdot s^{-2} \cdot A^{-1}$
T	Tesla	Magnetic Flux Density	$Wb \cdot m^{-2}$ $kg \cdot s^{-2} \cdot A^{-1}$
H	Henry	Inductance	$Wb \cdot A^{-1}$ $kg \cdot m^2 \cdot s^{-2} \cdot A^{-2}$

Prefixes

10^n	Symbol	Name
10^{15}	P	Peta
10^{12}	T	Tera
10^9	G	Giga
10^6	M	Mega
10^3	k	Kilo
10^2	h	Hecto
10^1	da	Deca
10^0	<i>Unit</i>	
10^{-1}	d	Deci
10^{-2}	c	Centi
10^{-3}	m	Milli
10^{-6}	μ	Micro
10^{-9}	n	Nano
10^{-12}	p	Pico
10^{-15}	f	Femto

Conversions

Length	
1 inch	25.4 mm
1 feet	0.3048 m
1 yard	0.9144 m
1 mile	1.61 m
Time	
1 day	86400 s
1 hour	3600 s
1 minute	60 s
Speed	
1 mph	0.447 m/s (1.61 km/h)
1 knot	0.5144 m/s (1.852 km/h)
1 km/h	0.2778 m/s
Surface	
1 ha	10000 m ²
1 sq. feet	0.0929 m ²
1 sq. yard	0.8361 m ²
Power	
1 Wh	3600 J
1 cal	4.184 J
Mass	
1 pound	0.454 kg
1 once	0.028 kg
1 stone	6.35 kg

Pressure	
1 bar	10000 Pa
1 psi	6895 Pa
1 atmosphere	1013.25 hPa
Temperature	
0° Celsius	273.15 Kelvin °K = 273.15 + °C
0° Farhenheit	255.372 Kelvin °K = (°F – 32)·5/9 + 273.15
Data	
1 B (byte)	8 b (bits)
1 kB	1000 B 10 ³ B
1 kiB	1024 B 2 ¹⁰ B
Angle	
30 deg	π/6 rad
45 deg	π/4 rad
60 deg	π/3 rad
90 deg	π/2 rad
180 deg	π rad
360 deg	2π rad

Physics Constants

Symbol	Quantity	Value
c	Speed of Light	$2.99792458 \cdot 10^8 \text{ m} \cdot \text{s}^{-1}$
μ_0	Vacuum Magnetic Permeability	$1.257 \cdot 10^{-7} \text{ N} \cdot \text{A}^{-2}$
Z_0	Characteristic Impedance of Vacuum	$376.7 \text{ } \Omega$
$\epsilon_0 = 1/\mu_0 c^2$	Vacuum Electric Permittivity	$8.854 \cdot 10^{-12} \text{ F} \cdot \text{m}^{-1}$
$k_e = 1/4\pi \epsilon_0$	Coulomb Constant	$8.989 \cdot 10^9 \text{ N} \cdot \text{m}^2 \cdot \text{C}^{-2}$

Decibels

The decibel is defined as ten times the logarithmic $dB = 10 \log_{10} (P_1/P_2)$ between two values P_1/P_2 . Usually, in the amateur radio community we use decibels for power gains (antenna) and attenuations (feed-lines, medium, reception reports).

dB	0	1	2	3	4	5	6	7	10	16	20	30
Ratio	1	1.26	1.6	2	2.5	3.2	4	5	10	40	100	1000

17 Mathematics

A cheat-sheet of the most common rules and remarkable values.

Algebra

$$a(b + c) = ab + ac$$

$$\frac{\frac{a}{b}}{c} = \frac{a}{bc}$$

$$a\left(\frac{b}{c}\right) = \frac{ab}{c}$$

$$a^n a^m = a^{n+m}$$

$$a^0 = 1, a \neq 0$$

$$a^{-n} = \frac{1}{a^n}$$

$$\sqrt[n]{a} = a^{1/n}$$

$$\sqrt[n]{ab} = \sqrt[n]{a} \sqrt[n]{b}$$

$$(a + b)(c + d) = ac + ad + bc + bd$$

$$\frac{a}{\frac{b}{c}} = \frac{ac}{b}$$

$$\frac{a}{b} + \frac{c}{d} = \frac{ad + cb}{bd}$$

$$(a^n)^m = a^{nm}$$

$$(ab)^n = a^n b^n$$

$$a^{n-m} = \frac{a^n}{a^m}$$

$$\sqrt[m]{\sqrt[n]{a}} = \sqrt[mn]{a} = a^{1/mn}$$

$$\sqrt[n]{\frac{a}{b}} = \frac{\sqrt[n]{a}}{\sqrt[n]{b}}$$

Logarithms

The function \log_b denotes the b-basis logarithm, usually one uses a natural logarithm (denoted \ln) or a 10-basis logarithm.

$$\log_b(1) = 0$$

$$\log_b(b^x) = x$$

$$\log_b(a^r) = r \log_b(a)$$

$$\log_b(x \cdot y) = \log_b(x) + \log_b(y)$$

$$\log_b(b) = 1$$

$$b^{\log_b(x)} = x$$

$$\log_b(x/y) = \log_b(x) - \log_b(y)$$

Trigonometry

Angle (rad)	Sine (sin)	Cosine (cos)	Tangent (tan)
0	0	1	0
$\pi/6$	$1/2$	$\sqrt{3}/2$	$\sqrt{3}/3$
$\pi/4$	$\sqrt{2}/2$	$\sqrt{2}/2$	1
$\pi/3$	$\sqrt{3}/2$	$1/2$	$\sqrt{3}$
$\pi/2$	1	0	undefined
$2\pi/3$	$\sqrt{3}/2$	$-1/2$	$-\sqrt{3}$
$3\pi/4$	$\sqrt{2}/2$	$-\sqrt{2}/2$	-1
$5\pi/6$	$1/2$	$-\sqrt{3}/2$	$-\sqrt{3}/3$
π	0	-1	0

$e^{i\pi} = -1$

$\pi \approx 3.141592653590$

$e^{i\theta} = \cos \theta + i \sin \theta$

$e \approx 2.718281828459$

Complex Numbers

The imaginary number reads *i* or *j*, squared the imaginary number equals:
 $i^2 = -1$.

Number	$z = a + ib$
Real part	$\Re(z) = a$
Imaginary part	$\Im(z) = b$
Modulus	$ z = \sqrt{a^2 + b^2}$
Argument	$\arg(z) = \begin{cases} \arctan(b/a) & \text{if } a > 0 \text{ ,} \\ \arctan(b/a) + \pi & \text{if } a < 0 \text{ and } b \geq 0 \text{ ,} \\ \arctan(b/a) - \pi & \text{if } a < 0 \text{ and } b < 0 \text{ ,} \\ \pi/2 & \text{if } a = 0 \text{ and } b > 0 \text{ ,} \\ -\pi/2 & \text{if } a = 0 \text{ and } b < 0 \text{ ,} \\ \text{undefined} & \text{if } a = 0 \text{ and } b = 0 \text{ .} \end{cases}$
Trigonometric format	$z = z \{ \cos [\arg(z)] + i \sin [\arg(z)] \}$
Exponential format	$z = z e^{i \arg(z)}$

18 Document Abbreviations

Abbreviation	Description
AM	Amplitude Modulation
AMSAT	Amateur Satellite
BW	Band Width
CoA	Center of Activity
CW	Continuous Waves (Morse code)
DM	Digital Mode
DV	Digital Voice
DX	Distant contact (inter-continental)
EMCOM	Emergency Communication
Glob.	Global
ITU	International Telecommunication Union
MGM	Machine Generated Modulation
NBM	Narrow Band Mode
Pref.	Preferred
RR	Radio Regulations
SSB	Single Side Band

19 References

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