Amateur Radio Booklet

2023 Edition

Noël Martin – F4JJD

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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 infinite symbol, e.g. **1800 — 1850 ∞.**

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 lozenge symbol, e.g. **7000 — 7200 ◊.**

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

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

2200 Meters

Region 1	Region 2	Region 3
135.7 — 137.8 kHz *BW 200Hz* CW, QRSS, DM	**135.7 — 137.8 kHz** *BW 200 Hz* All Modes	**135.7 — 137.8 kHz** *BW 500 Hz* 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 *BW 200 Hz* CW	**472 — 479 kHz** *BW 500 Hz* CW, DM	**472 — 479 kHz** *BW 500 Hz* CW, DM
475 — 479 kHz *BW 500 Hz* NBM		

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

160 Meters

<table>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>1810 — 1838 kHz
BW 200 Hz

CW
1836 – CW QRP</td><td>1800 — 1810 kHz
BW: 500 Hz

DM</td><td>1800 — 1830 kHz
BW: 200 Hz

CW</td></tr>
<tr><td>1838 — 1840 kHz
BW: 500 Hz

NBM</td><td>1810 — 1840 kHz
BW: 200 Hz

CW, DM
1812 – CW QRP CoA</td><td>1830 — 1840 kHz
BW: 500Hz

CW (DX), NBM
1836 – CW QRP CoA</td></tr>
<tr><td rowspan="2">1840 — 1850 kHz
BW: 2700 Hz

All Modes</td><td>1840 — 1850 kHz
BW: 2700 Hz

CW, DM, SSB (DX)</td><td rowspan="2">1840 — 2000 kHz
BW: 2700 Hz

All Modes</td></tr>
<tr><td>1850 — 2000 kHz
BW: 2700 Hz

All Modes
1910 – SSB QRP CoA</td></tr>
</table>

Status: Primary R1, R2, R3

80 Meters

<table>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>3500 — 3580 kHz
BW: 200 Hz

CW (3505 – DX CoA)
3555 – CW QRS CoA
3560 – CW QRP CoA
> 3570 – NBM</td><td>3500 — 3580 kHz
BW: 200 Hz

CW (3505 – DX CoA)
3555 – CW QRS CoA
3560 – CW QRP CoA
> 3570 – NBM</td><td>3500 — 3535 kHz
BW: 200 Hz

CW (3505 – DX CoA)</td></tr>
<tr><td>3580 — 3600 kHz
BW: 500 Hz

NBM, DM</td><td>3580 — 3600 kHz
BW: 500 Hz

CW, DM</td><td rowspan="2">3535 — 3900 kHz
BW 2700 Hz

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</td></tr>
<tr><td>3600 — 3800 kHz
BW: 2700 Hz

All Modes
3690 – SSB QRP CoA
3735 – Image CoA
3760 – EMCOM CoA
3775 – DX CoA</td><td>3600 — 4000 kHz
BW 2700 Hz

All Modes
3690 – SSB QRP CoA
3735 – Image CoA
3750 – EMCOM CoA
3775 – DX CoA
3845 – Image CoA
3885 – AM CoA
3985 – EMCOM CoA</td></tr>
</table>

Status: Primary R1, R2, R3

60 Meters

Region 1	Region 2	Region 3
5351.5 — 5354 kHz *BW 200 Hz* CW, NBM	**5351.5 — 5354 kHz** *BW 500 Hz* CW, DM	**5351.5 — 5354 kHz** *BW 500 Hz* CW, NBM, DM
5354 — 5366 kHz *BW 2700 Hz* All Modes, Pref. USB	**5354 — 5366 kHz** *BW 2700 Hz* All Modes	**5354 — 5366 kHz** *BW 2700 Hz* 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)

Warning: very small bandwidth between 5366-5366.5 kHz

40 Meters

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

<table>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td colspan="3">10100 — 10130 kHz
BW 200 Hz

CW
10116 – CW QRP CoA</td></tr>
<tr><td rowspan="2">10130 — 10150 kHz
BW 500 Hz

NBM, DM</td><td>10130 — 10140 kHz
BW 500 Hz

CW, DM</td><td rowspan="2">10130 — 10150 kHz
BW 500 Hz

NBM, DM</td></tr>
<tr><td>10140 — 10150 kHz
BW 2700 Hz

CW, DM</td></tr>
</table>

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

20 Meters

Region 1	Region 2	Region 3
14000 — 14070 kHz *BW 200 Hz* CW 14055 – CW QRS CoA 14060 – CW QRP CoA		
14070 — 14099 kHz *BW 500 Hz* NBM, DM		
14099 — 14101 kHz International Beacon Project		
14101 — 14350 kHz *BW 2700 Hz* All Modes 14130 – DV CoA 14195 – DX 14230 – Image CoA 14285 – SSB QRP 14300 – Glob EMCOM	**14101 — 14350 kHz** *BW 2700 Hz* All Modes 14195 – DX 14230 – Image CoA 14285 – SSB QRP 14285 – AM QRG 14300 – Glob EMCOM	**14101 — 14350 kHz** *BW 2700 Hz* 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 *BW 200 Hz* CW 18086 – CW QRP CoA		
18095 — 18109 kHz *BW 500 Hz* NBM, DM		**18095 — 18109 kHz** *BW 2700 Hz* NBM, DM
18109 — 18111 kHz International Beacon Project		
18111 — 18168 kHz *BW 2700 Hz* All Modes 18130 – SSB QRP 18150 – DV CoA 18160 – EMCOM	**18111 — 18168 kHz** *BW 2700 Hz* All Modes 18130 – SSB QRP 18160 – EMCOM	**18111 — 18168 kHz** *BW 2700 Hz* 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 *BW 200 Hz* CW 21055 – CW QRS CoA 21060 – CW QRP CoA		
21070 — 21110 kHz *BW 500 Hz* NBM, DM		
21110 — 21120 kHz *BW 2700 Hz* All Modes, except SSB		**21110 — 21125 kHz** *BW 2700 Hz* CW, NBM, DM
21120 — 21149 kHz *BW 500 Hz* NBM	**21120 — 21149 kHz** *BW 500 Hz* All Modes	**21125 — 21149 kHz** *BW 2700 Hz* CW, NBM, DM Satellite Uplink
21149 — 21151 kHz International Beacon Project		
21151 — 21450 kHz *BW 2700 Hz* All Modes 21180 – DV CoA 21285 – SSB QRP 21340 – Image CoA 21360 – Glob. EMCOM	**18111 — 18168 kHz** *BW 2700 Hz* All Modes 21285 – SSB QRP 21340 – Image CoA 21360 – Glob. EMCOM	**18111 — 18168 kHz** *BW 2700 Hz* All Modes 21180 – DV CoA 21295 – DX CoA 21340 – Image CoA 21360 – Glob. EMCOM

Status: Primary and AMSAT R1, R2, R3.

12 Meters

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

Status: Primary and AMSAT R1, R2, R3.

10 Meters

<table>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td colspan="2">28000 — 28070 kHz
BW 200 Hz

CW
28055 – CW QRS CoA
28060 – CW QRP CoA</td><td>28000 — 28070 kHz
BW 200 Hz

CW
28055 – CW QRS</td></tr>
<tr><td>28070 — 28190 kHz
BW 500 Hz

NBM, DM</td><td>28070 — 28190 kHz
BW 500 Hz

CW, DM</td><td>28070 — 28190 kHz
BW 500 Hz

CW, NBM
> 28050 – DX</td></tr>
<tr><td colspan="3">28190 — 28225 kHz
BW 200 Hz

Beacons
28200 – International Beacon Project</td></tr>
<tr><td colspan="2">28225 — 28300 kHz
BW 2700 Hz

Beacons</td><td>28225 — 28300 kHz
BW 6000 Hz

All Modes</td></tr>
<tr><td colspan="2">28300 — 29000 kHz
BW 2700 Hz

All Modes
28330 – DV CoA
28360 – SSB QRP CoA
28680 – Image CoA</td><td rowspan="2">28300 — 29510 kHz
BW 6000 Hz

Satellite
Up & Down-Links</td></tr>
<tr><td colspan="2">29000 — 29510 kHz
BW Unrestricted

All Modes
> 29300 – Satellite</td></tr>
<tr><td colspan="3">29510 — 29520 kHz

Guard Band
NO TRANSMISSION ALLOWED</td></tr>
</table>

29520 — 29590 kHz *BW 6000 Hz* All Modes Repeater Input (RH1 – RH8)
29590 — 29620 kHz *BW 6000 Hz* All Modes Repeaters Simplex 29600 – FM QRG
29590 — 29620 kHz *BW 6000 Hz* All Modes Repeater Output (RH1 – RH8)

Status: Primary and AMSAT R1, R2, R3.

6 Meters

<table>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>50 — 50.1 MHz
BW 500 Hz

CW
< 50.010 Beacons

50.050 – CoA
50.090 – DX CoA</td><td>50 — 50.1 MHz
BW 500 Hz

CW
50.010 – 50.020 Beacons</td><td>50 — 50.1 MHz
BW 200 Hz

CW
50.020 – 50.030 Beacons</td></tr>
<tr><td colspan="2">50.1 — 50.4 MHz
BW 2700 Hz

CW, SSB, NBM
50.110 – DX CoA
50.305 – PSK CoA
50.315 – EME CoA</td><td rowspan="2">50.1 — 50.5 MHz
BW 2700 Hz

CW, SSB, NBM
.110 – DX CoA</td></tr>
<tr><td>50.4 — 50.5 MHz
BW 1000 Hz

Beacons
50.401 – WSPR</td><td>50.4 — 50.5 MHz
BW 2700 Hz

Beacons</td></tr>
<tr><td rowspan="3">50.5 — 52 MHz
BW 12 kHz

All Modes
50.510 – SSTV
50.530 – FM Internet
50.600 – RTTY
50.630 – DV Calling
51.210 – 51.590 – Repeaters

Wideband Experiments
BW unlimited

50.9 – 51.2
51.4 – 52</td><td>50.5 — 50.6 MHz
BW 2700 Hz

All Modes</td><td rowspan="3">50.5 — 54 MHz
BW 25 kHz

All Modes</td></tr>
<tr><td>50.6 — 51 MHz
BW 12 kHz

All Modes</td></tr>
<tr><td>51 — 51.11 MHz
BW 2700

CW, SSB
DX Window</td></tr>
</table>

Region 1	Region 2	Region 3
52 — 54 MHz *BW 500 kHz* All Modes	**51.11 — 54 MHz** BW 12 kHz FM, DV 51.110 – 51.980 – Repeaters	

Status: Primary R1, R2, R3.

2 Meters

<table>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td colspan="3">144 — 144.025 MHz
BW 2700 Hz

All Modes
Satellite Down-Links Only</td></tr>
<tr><td>144.025 — 144.150 MHz
BW 500 Hz

CW
144.050 – Telegraphy Calling Freq
144.350 – EME CoA</td><td>144.025 — 144.110 MHz
BW 500 Hz

CW, DM
EME, Weak Signals</td><td>144.025 — 144.035 MHz
BW N/A

CW, EME, Weak Signals</td></tr>
<tr><td rowspan="4">144.150 — 144.400 MHz
BW 2700 Hz

SSB, CW
144.300 – SSB CoA</td><td>144.110 — 144.275 MHz
BW 2700 Hz

CW, DM, SSB
Weak Signals
144.200 – QRG Calling</td><td rowspan="4">144.035 — 145.800 MHz
BW 25 kHz

All Modes
144.1 – DX CoA</td></tr>
<tr><td>144.275 — 144.300 MHz
BW 500 Hz

Beacons</td></tr>
<tr><td>144.275 — 144.360 MHz
BW 2700 Hz

CW, SSB
144.300 – QRG Calling</td></tr>
<tr><td>144.360 — 144.400 MHz
BW 12 kHz

DM
144.390 – APRS CoA</td></tr>
<tr><td>144.400 — 144.500 MHz
BW 500 Hz

Beacons
Weak Signals MGM</td><td>144.400 — 144.500 MHz
BW 500 Hz

CW, DM
Beacons</td></tr>
</table>

<table>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>144.500 — 144.794 MHz
BW 20 kHz

All Modes
144.5 – SSTV CoA
144.6 – Data CoA
144.75 – ATV</td><td rowspan="2">144.500 — 145.790 MHz
BW 12 kHz

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</td><td rowspan="2"></td></tr>
<tr><td>144.794 — 145.800 MHz
BW 12 kHz

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</td><td>145.790 — 145.800 MHz

Guard Band</td></tr>
<tr><td colspan="3">145.800 — 146.000 MHz
BW 12 kHz

FM, DV
Satellite Exclusive</td></tr>
<tr><td>Forbidden</td><td>146.000 — 148.000 MHz
BW 12 kHz

FM, DV
146.520 – FM Call Freq</td><td>146.000 — 148.000 MHz
BW 25 kHz

All Modes</td></tr>
</table>

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

<table>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>Forbidden</td><td rowspan="2">420 — 432 MHz
BW N/A

ATV</td><td>Forbidden</td></tr>
<tr><td>430 — 431.975 MHz
BW 20 kHz

All Modes</td><td>430 — 431.9 MHz
BW 25 kHz

All Modes</td></tr>
<tr><td>432 — 432.1 MHz
BW 500 Hz

Telegraphy</td><td>432 — 432.1 MHz
BW 500 Hz

CW, DM
EME, Weak Signals</td><td>431.9 — 432.24 MHz
BW 2700 Hz

EME, Weak Signals</td></tr>
<tr><td>432.1 — 432.4 MHz
BW 2700 Hz

Telegraphy, SSB
432.200 – SSB CoA
432.370 – Meteo Scatter</td><td>432.1 — 432.3 MHz
BW 2700 Hz

CW, SSB
432.1 – SSB/CW Call Freq</td><td rowspan="4">432.24 — 435 MHz
BW 25 kHz

All Modes</td></tr>
<tr><td>432.4 — 432.5 MHz
BW 500 Hz

Beacons Exclusive</td><td>432.3 — 432.4 MHz
BW 500 Hz

CW, Beacons</td></tr>
<tr><td rowspan="2">432.5 — 433.575 MHz
BW 12 kHz

All Modes
432.5 – APRS
433.4 – SSTV (FM/AFSK)
433.45 – DV Calling
433.5 – FM Calling</td><td>432.4 — 433 MHz
BW 2700 Hz

CW, DM, SSB</td></tr>
<tr><td>433 — 433.1 MHz
BW 12 kHz

All Modes
ACDS, IVG</td></tr>
<tr><td>433.6 — 434 MHz
BW N/A

All Modes</td><td>433.1 — 435 MHz

Local Option</td></tr>
</table>

<table>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>434 — 435 MHz
BW 12 kHz

All Modes, ATV</td><td></td><td></td></tr>
<tr><td colspan="3">435 — 438 MHz
BW N/A

Satellite</td></tr>
<tr><td>438 — 440 MHz
BW 25 kHz

All Modes</td><td rowspan="2">438 — 450 MHz
BW N/A

All Modes</td><td>438 — 440 MHz
BW 25 kHz

All Modes</td></tr>
<tr><td>Forbidden</td><td>Forbidden</td></tr>
</table>

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
Amplitude Modulation	
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
Angle Modulation	
F	Frequency modulation
G	Phase modulation
Amplitude and Angle Modulation	
D	Amplitude and Angle Modulation, simultaneously or in a pre-established sequence
Emission of Pulses	
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 you 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 ([*speed*] words per minute).
QRS	Shall I send more slowly?	Send more slowly ([*speed*] 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 [*callsign*] that you are calling him on [*frequency*]?	Please inform [*callsign*] that I am calling him on [frequency].
QRX	When will you call me again?	I will call you again at [*time*] on [*frequency*].
QRZ	Who is calling me?	You are being called by [*callsign*] (on [*frequency*]).
QSA	What is the strength of my signals (*or* those of [*callsign*])?	The strength of your signals (*or* those of [*callsign*]) 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 [*number*] telegrams at a time?	Send [*number*] telegrams at a time.
QSL	Can you acknowledge receipt?	I am acknowledging receipt.
QSM	Shall I repeat the last telegram which I sent you (*or* some previous telegram)?	Repeat the last telegram which you sent me (*or* telegram(s) [*numbers*]).
QSN	Did you hear me (*or* [*callsign*]) on [*frequency*]?	I did hear you (*or* [*callsign*]) on [*frequency*].
QSO	Can you communicate with [*callsign*] direct (*or* by relay)?	I can communicate with [*callsign*] direct (*or* by relay through [*callsign*]).
QSP	Will you relay to [*callsign*] free of charge?	I will relay to [*callsign*] free of charge.
QSR	Shall I repeat the call on the calling frequency?	Repeat your call on the calling frequency; did not hear you (*or* have interference).
QSS	What working frequency will you use?	I will use the working frequency [*frequency*] *(in the high frequency bands normally only the last three figures of the frequency need be given)*.
QSX	Will you listen to [*callsign*] on [*frequency*], or in the [bands] / [*channels*]?	I am listening to [*callsign*] on [*frequency*], or in the [bands] / [*channels*].
QSY	Shall I change to transmission on another frequency?	Change to transmission on another [*frequency*].
QTH	What is your position in latitude and longitude *(or according to any other indication)*?	My position is [*latitude*], [*longitude*] *(or* [*position indication*]*)*.
QTJ	What is your speed?	My speed is [*speed*] kilometers per hour.
QTR	What is the correct time?	The correct time is [*time*].
QTS	Will you send your call sign for [*seconds*]?	I will send my call sign for [*seconds]*.
QUA	Have you news of [*callsign*]?	Here is news of [*callsign*].
QUD	Have you received the urgency signal sent by [*callsign*]?	I have received the urgency signal sent by [*callsign*] at [*time*].

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

4 Morse Code

A	•—	N	—•
B	—•••	O	———
C	—•—•	P	•——•
D	—••	Q	——•—
E	•	R	•—•
F	••—•	S	•••
G	——•	T	—
H	••••	U	••—
I	••	V	•••—
J	•———	W	•——
K	—•—	X	—••—
L	•—••	Y	—•——
M	——	Z	——••

1	•————	6	—••••
2	••———	7	——•••
3	•••——	8	———••
4	••••—	9	————•
5	•••••	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

• (Dot)	Unit of time
— (Dash)	3 dots (•)
Between — and •	1 dot (•)
Between letters	3 dots (•)
Between words	7 dots (•)

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

5 Radio Abbreviations

The complete list of abbreviations from the ITU Rec. M.1172-0.

Abbreviation or signal	Definition
AA	All after ... *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
AB	All before ... *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
ADS	Address *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
AR	End of transmission.
AS	Waiting period.
BK	Signal used to interrupt a transmission in progress.
BN	All between ... and ... *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
BQ	A reply to an RQ.
BT	Signal to mark the separation between different parts of the same transmission.
C	Yes *or* "The significance of the previous group should be read in the affirmative".
CFM	Confirm (*or* I confirm).
CL	I am closing my station.
COL	Collate (*or* I collate).
CORRECTION	Cancel my last word *or* group. The correct word *or* group follows *(used in radiotelephony, spoken as KOR-REK-SHUN)*.
CP	General call to two or more specified stations *(see Recommendation ITU-R M.1170)*.
CQ	General call to all stations.
CS	Call sign *(used to request a call sign)*.

Abbreviation or signal	Definition
DE	"From ..." *(used to precede the name or other identification of the calling station)*.
DF	Your bearing at ... hours was ... degrees, in the doubtful sector of this station, with a possible error of ... degrees.
DO	Bearing doubtful. Ask for another bearing later (*or* at ... hours).
DSC	Digital selective calling.
E	East (cardinal point).
ETA	Estimated time of arrival.
INTERCO	International Code of Signals groups follow *(used in radiotelephony, spoken as IN-TER-CO)*.
K	Invitation to transmit.
KA	Starting signal.
KTS	Nautical miles per hour *(knots)*.
MIN	Minute (*or* Minutes).
MSG	Prefix indicating a message to or from the master of a ship concerning its operation or navigation.
MSI	Maritime safety information.
N	North (cardinal point).
NBDP	Narrow-band direct-printing telegraphy.
NIL	I have nothing to send to you.
NO	No *(negative)*.
NW	Now.
NX	Notice to Mariners (*or* Notice to Mariners follows).
OK	We agree (*or* It is correct).
OL	Ocean letter.
P	Prefix indicating a private radiotelegram.
PBL	Preamble *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
PSE	Please.
R	Received.

Abbreviation or signal	Definition
RCC	Rescue coordination centre.
REF	Reference to … (*or* Refer to …).
RPT	Repeat (*or* I repeat) (*or* Repeat …).
RQ	Indication of a request.
S	South (cardinal point).
SAR	Search and Rescue.
SIG	Signature *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
SLT	Radiomaritime Letter.
SVC	Prefix indicating a service telegram.
SYS	Refer to your service telegram.
TFC	Traffic.
TR	Used by a land station to request the position and next port of call of a mobile station; used also as a prefix to the reply.
TU	Thank you.
TXT	Text *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
VA	End of work.
W	West (cardinal point).
WA	Word after … *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
WB	Word before … *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition)*.
WD	Word(s) *or* Group(s).
WX	Weather report (*or* Weather report follows).
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
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	10.1387		
20 m	(13.5539) 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	50.293		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 ◊**		
20m	**14000 — 14250 ◊**		
17m	**18068 — 18168 ◊**		
15m	**21000 — 21450 ◊**		
12m	**24890 — 24990 ◊**		
10m	**28000 — 29700 ◊**		
2m	**144 — 146 ◊**		
70cm	**430 — 440 ◊**	*430 — 440 ◊*	
5cm	*5.83 — 5.85 ◊*		
3cm	*10.45 — 10.5 ◊*		
1.2cm	**24 — 24.05 ◊**		
6mm	**47 — 47.2 ◊**		
4mm	*76 — 77.5 ◊*		
	77.5 — 78 ◊		
	78 — 81 ◊		
2.2mm	**134 — 136 ◊**		
	136 — 141 ◊		
1.2mm	*241 — 248 ◊*		
	248 — 250 ◊		

Internation Space Station

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

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	$\lambda = c \cdot \tau$ $\lambda = c \cdot f^{-1}$
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

> *Partially based on the publication:* Ionosphere and its Effects on Radiowave Propagation*, ITU, 1998*.

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	*Troposphere*		
20 — 50	*Stratosphere*		
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 *Sporadic Es*.
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

10 Electricity

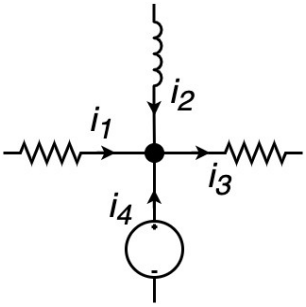
Component	Resistor	Capacitor	Coil
Property	Resistance R	Capacity C	Inductance L
Unit	Ohm (Ω)	Farads (F)	Henry (H)
Impedance	$Z = R$	$Z = -\frac{j}{\omega C}$	$Z = j\omega L$
Series	$R_{tot} = R_1 + \cdots + R_N$	$\frac{1}{C_{tot}} = \frac{1}{C_1} + \cdots + \frac{1}{C_N}$	$L_{tot} = L_1 + \cdots + L_N$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

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

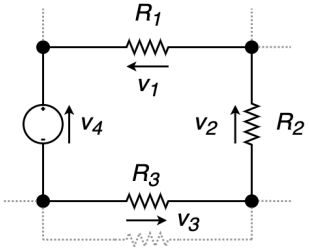
On a circuit node, the algebraic sum of all currents (positive for incoming and negative for exiting) is equal to zero: $\sum_{k=0}^{K} I_k = 0$.



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: $\sum_{k=0}^{K} V_k = 0$.

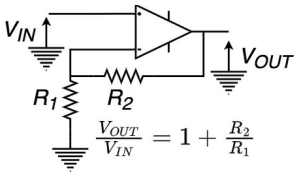


For instance on the figure, the law reads as: $-v_1 - v_2 - v_3 + v_4 = 0$.

Operational Amplifiers

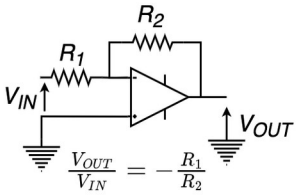
Non-inverting

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

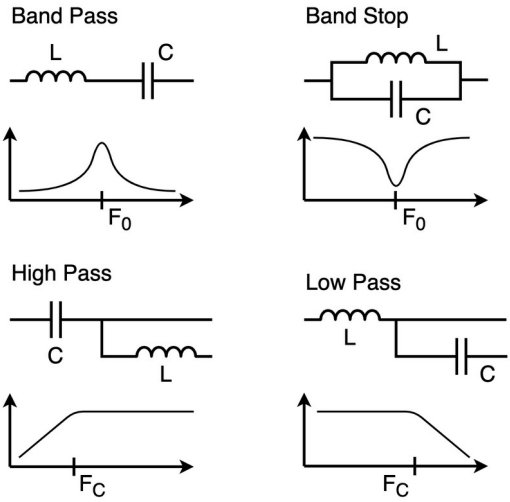
In an inverting amplifier, the output voltage changes in the opposite direction to the input voltage. The operational amplifier works in a non-linear mode. It is in a comparator configuration.



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.

Resistor Colors

IEC 60062:2016 Standard

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

11 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

[3] In accordance with Resolution 99 Rev. Dubai, 2018

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

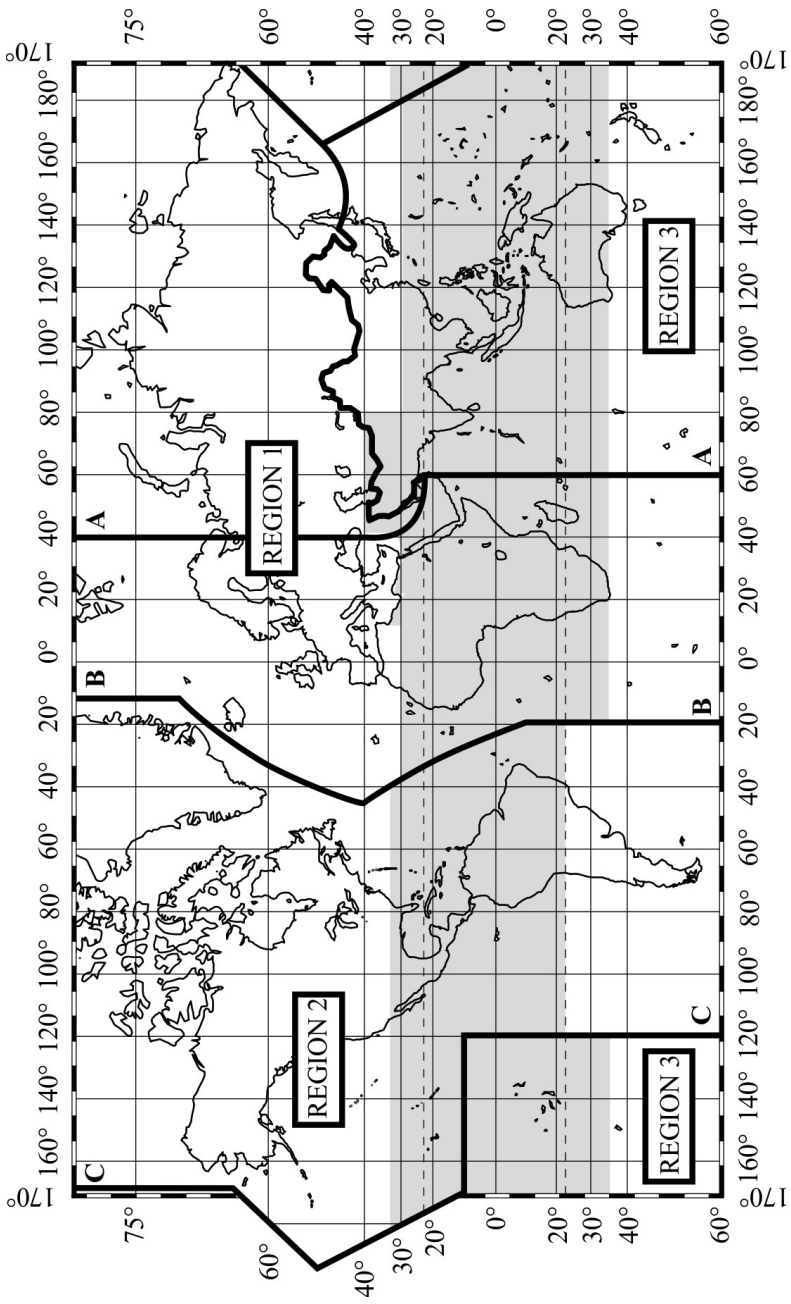
OKA – OLZ	Czech Republic
OMA – OMZ	Slovak Republic
ONA – OTZ	Belgium
OUA – OZZ	Denmark
P	
P2A – P2Z	Papua New Guinea
P3A – P3Z	Cyprus (Republic of)
P4A – P4Z	Netherlands (Kingdom of the) - Aruba
P5A – P9Z	Democratic People's Republic of Korea
PAA – PIZ	Netherlands (Kingdom of the)
PJA – PJZ	Netherlands (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)

12 ITU Regions



13 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

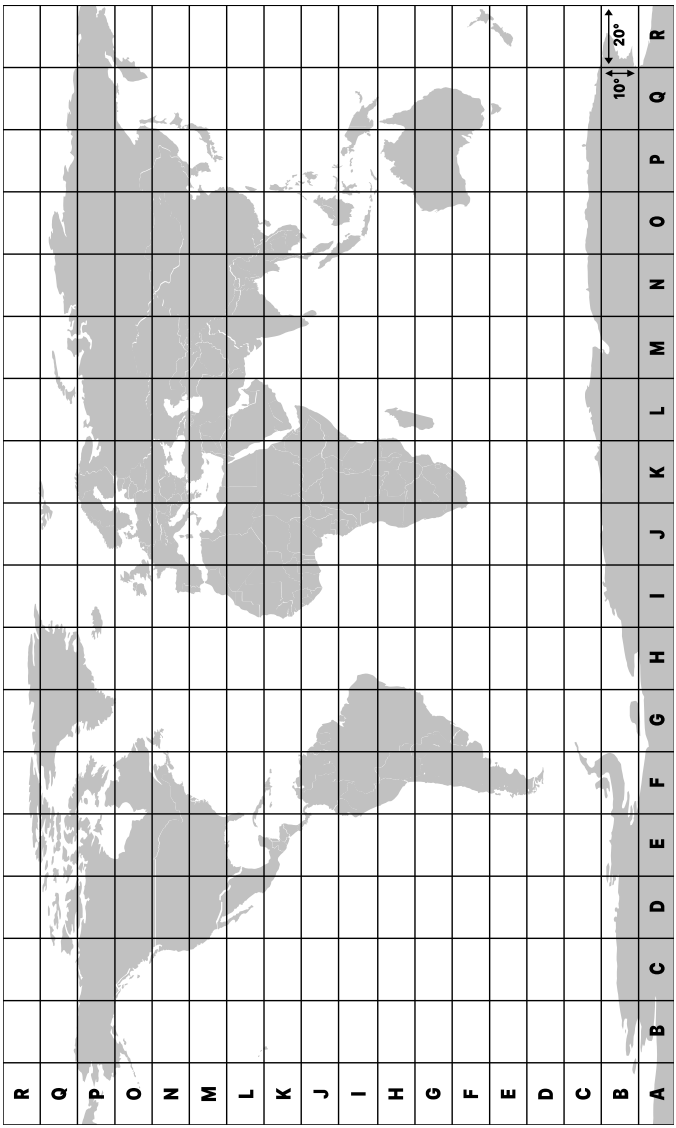
Widespread usage, occasionally replaced by country names.

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.

14 QTH Locator



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°20’
- latitude 48°50’

15 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}	*Unit*	
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	$2.99792458 \cdot 10^8$ m·s^{-1}
μ_0	Vacuum Magnetic Permeability	$1.257 \cdot 10^{-7}$ N·A^{-2}
Z_0	Characteristic Impedance of Vacuum	376.7 Ω
$\varepsilon_0 = 1/\mu_0 c^2$	Vacuum Electric Permittivity	$8.854 \cdot 10^{-12}$ F·m^{-1}
$k_e = 1/4\pi\ \varepsilon_0$	Coulomb Constant	$8.989 \cdot 10^9$ N·m^2·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

16 Mathematics

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

Algebra

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Logarithms

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

$\log_b(1) = 0$

$\log_b(b) = 1$

$\log_b(b^x) = x$

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

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

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

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

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

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

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

$\pi \approx 3.141592653590$

$e \approx 2.718281828459$

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	$\lvert z\rvert = \sqrt{a^2 + b^2}$
Argument	$\arg(z) = \begin{cases} \arctan(b/a) & \text{if } a > 0 \ , \\ \arctan(b/a) + \pi & \text{if } a > 0 \text{ and } b \geq 0 \ , \\ \arctan(b/a) - \pi & \text{if } a > 0 \text{ and } b < 0 \ , \\ \pi/2 & \text{if } a = 0 \text{ and } b > 0 \ , \\ -\pi/2 & \text{if } a = 0 \text{ and } b < 0 \ , \\ \text{undefined} & \text{if } a = 0 \text{ and } b = 0 \ . \end{cases}$
Trigonometric format	$z = \lvert z\rvert \left\{\cos\left[\arg(z)\right] + i\sin\left[\arg(z)\right]\right\}$
Exponential format	$z = \lvert z\rvert e^{i\arg(z)}$

17 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
NBM	Narrow Band Mode
Pref.	Preferred
RR	Radio Regulations
SSB	Single Side Band

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