# Amateur Radio Booklet

## 2023 Edition

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# License

## Contributors

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# 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* | | |

| | Band | Region 1 | Region 2 | Region 3 |
|---|---|---|---|---|
| | 20m | **14000 — 14250 ◊** | | |
| | | **14250 — 14350 ∞** | | |
| | 17m | **18068 — 18168 ◊** | | |
| | 15m | **21000 — 21450 ◊** | | |
| | 12m | **24890 — 24990 ◊** | | |
| | 10m | **28000 — 29700 ◊** | | |
| VHF (MHz) | 6m | *50 — 52* | **50 — 54** | |
| | 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* | | |

| | Band | Region 1 | Region 2 | Region 3 |
|---|---|---|---|---|
| | 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*<br><br>CW, QRSS, DM | **135.7 — 137.8 kHz** *BW 200 Hz*<br><br>All Modes | **135.7 — 137.8 kHz** *BW 500 Hz*<br><br>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*<br><br>CW | **472 — 479 kHz** *BW 500 Hz*<br><br>CW, DM | **472 — 479 kHz** *BW 500 Hz*<br><br>CW, DM |
| **475 — 479 kHz** *BW 500 Hz*<br><br>NBM | | |

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

# 160 Meters

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

Status: Primary R1, R2, R3

# 80 Meters

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

Status: Primary R1, R2, R3

# 60 Meters

| Region 1 | Region 2 | Region 3 |
|---|---|---|
| **5351.5 — 5354 kHz** <br> *BW 200 Hz* <br><br> CW, NBM | **5351.5 — 5354 kHz** <br> *BW 500 Hz* <br><br> CW, DM | **5351.5 — 5354 kHz** <br> *BW 500 Hz* <br><br> CW, NBM, DM |
| **5354 — 5366 kHz** <br> *BW 2700 Hz* <br><br> All Modes, Pref. USB | **5354 — 5366 kHz** <br> *BW 2700 Hz* <br><br> All Modes | **5354 — 5366 kHz** <br> *BW 2700 Hz* <br><br> All Modes, Pref. USB |
| **5366 — 5366.5 kHz** <br> ***BW 20 Hz*** <br><br> Weak Signal | **5366 — 5366.5 kHz** <br> ***BW 20 Hz*** <br><br> CW, DM | **5366 — 5366.5 kHz** <br> ***BW 20 Hz*** <br><br> 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*<br><br>CW<br>7030 – CW QRP CoA | **7000 — 7040 kHz** *BW 200 Hz*<br><br>CW<br>< 7025 – DX<br>7030 – CW QRP CoA | **7000 — 7030 kHz** *BW 200 Hz*<br><br>CW |
| **7040 — 7050 kHz** *BW 500 Hz*<br><br>NBM, DM | **7040 — 7050 kHz** *BW 500 Hz*<br><br>CW, DM | **7030 — 7200 kHz** *BW 2700 Hz*<br><br>CW, SSB, DM<br>7030 – QRP CoA<br>7070 – DV CoA<br>7090 – SSB QRP CoA<br>7095 – DX Phone CoA<br>7110 – EMCOM CoA<br>7165 – Image CoA |
| **7050 — 7200 kHz** *BW 2700 Hz*<br><br>All Modes<br>< 7060 – DM<br>7070 – DV CoA<br>7090 – SSB QRP CoA<br>7110 – EMCOM CoA<br>7165 – Image CoA<br>> 7175 – DX | **7050 — 7300 kHz** *BW 2700 Hz*<br><br>All Modes<br>7060 – EMCOM CoA<br>7070 – DV CoA<br>7090 – SSB QRP CoA<br>7165 – Image CoA<br>7240 – EMCOM CoA<br>7275 – EMCOM CoA<br>7285 – SSB QRP CoA<br>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**<br>*BW 200 Hz*<br><br>CW<br>10116 – CW QRP CoA | | |
| **10130 — 10150 kHz**<br>*BW 500 Hz*<br><br>NBM, DM | **10130 — 10140 kHz**<br>*BW 500 Hz*<br><br>CW, DM | **10130 — 10150 kHz**<br>*BW 500 Hz*<br><br>NBM, DM |
| | **10140 — 10150 kHz**<br>*BW 2700 Hz*<br><br>CW, DM | |

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

# 20 Meters

| Region 1 | Region 2 | Region 3 |
|---|---|---|
| **14000 — 14070 kHz**<br>*BW 200 Hz*<br><br>CW<br>14055 – CW QRS CoA<br>14060 – CW QRP CoA | | |
| **14070 — 14099 kHz**<br>*BW 500 Hz*<br><br>NBM, DM | | |
| **14099 — 14101 kHz**<br><br>International<br>Beacon Project | | |
| **14101 — 14350 kHz**<br>*BW 2700 Hz*<br><br>All Modes<br>14130 – DV CoA<br>14195 – DX<br>14230 – Image CoA<br>14285 – SSB QRP<br>14300 – Glob EMCOM | **14101 — 14350 kHz**<br>*BW 2700 Hz*<br><br>All Modes<br>14195 – DX<br>14230 – Image CoA<br>14285 – SSB QRP<br>14285 – AM QRG<br>14300 – Glob EMCOM | **14101 — 14350 kHz**<br>*BW 2700 Hz*<br><br>All Modes<br>14130 – DV CoA<br>14195 – DX<br>14230 – Image CoA<br>14285 – SSB QRP<br>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**<br>*BW 200 Hz*<br><br>CW<br>18086 – CW QRP CoA | | |
| **18095 — 18109 kHz**<br>*BW 500 Hz*<br><br>NBM, DM | | **18095 — 18109 kHz**<br>*BW 2700 Hz*<br><br>NBM, DM |
| **18109 — 18111 kHz**<br><br>International<br>Beacon Project | | |
| **18111 — 18168 kHz**<br>*BW 2700 Hz*<br><br>All Modes<br>18130 – SSB QRP<br>18150 – DV CoA<br>18160 – EMCOM | **18111 — 18168 kHz**<br>*BW 2700 Hz*<br><br>All Modes<br>18130 – SSB QRP<br>18160 – EMCOM | **18111 — 18168 kHz**<br>*BW 2700 Hz*<br><br>All Modes<br>18130 – SSB QRP<br>18150 – DV CoA<br>18160 – EMCOM |

Status: Primary and AMSAT R1, R2, R3.

# 15 Meters

| Region 1 | Region 2 | Region 3 |
|---|---|---|
| **21000 — 21070 kHz**<br>*BW 200 Hz*<br><br>CW<br>21055 – CW QRS CoA<br>21060 – CW QRP CoA | | |
| **21070 — 21110 kHz**<br>*BW 500 Hz*<br><br>NBM, DM | | |
| **21110 — 21120 kHz**<br>*BW 2700 Hz*<br><br>All Modes, except SSB | | **21110 — 21125 kHz**<br>*BW 2700 Hz*<br><br>CW, NBM, DM |
| **21120 — 21149 kHz**<br>*BW 500 Hz*<br><br>NBM | **21120 — 21149 kHz**<br>*BW 500 Hz*<br><br>All Modes | **21125 — 21149 kHz**<br>*BW 2700 Hz*<br><br>CW, NBM, DM<br>Satellite Uplink |
| **21149 — 21151 kHz**<br><br>International<br>Beacon Project | | |

| Region 1 | Region 2 | Region 3 |
|---|---|---|
| **21151 — 21450 kHz**<br>*BW 2700 Hz*<br><br>All Modes<br>21180 – DV CoA<br>21285 – SSB QRP<br>21340 – Image CoA<br>21360 – Glob. EMCOM | **18111 — 18168 kHz**<br>*BW 2700 Hz*<br><br>All Modes<br>21285 – SSB QRP<br>21340 – Image CoA<br>21360 – Glob. EMCOM | **18111 — 18168 kHz**<br>*BW 2700 Hz*<br><br>All Modes<br>21180 – DV CoA<br>21295 – DX CoA<br>21340 – Image CoA<br>21360 – Glob. EMCOM |

Status: Primary and AMSAT R1, R2, R3.

## 12 Meters

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

Status: Primary and AMSAT R1, R2, R3.

# 10 Meters

| Region 1 | Region 2 | Region 3 |
|----------|----------|----------|
| **28000 — 28070 kHz**<br>*BW 200 Hz*<br><br>CW<br>28055 – CW QRS CoA<br>28060 – CW QRP CoA | | **28000 — 28070 kHz**<br>*BW 200 Hz*<br><br>CW<br>28055 – CW QRS |
| **28070 — 28190 kHz**<br>*BW 500 Hz*<br><br>NBM, DM | **28070 — 28190 kHz**<br>*BW 500 Hz*<br><br>CW, DM | **28070 — 28190 kHz**<br>*BW 500 Hz*<br><br>CW, NBM<br>> 28050 – DX |
| **28190 — 28225 kHz**<br>*BW 200 Hz*<br><br>Beacons<br>28200 – International Beacon Project | | |
| **28225 — 28300 kHz**<br>*BW 2700 Hz*<br><br>Beacons | | **28225 — 28300 kHz**<br>*BW 6000 Hz*<br><br>All Modes |
| **28300 — 29000 kHz**<br>*BW 2700 Hz*<br><br>All Modes<br>28330 – DV CoA<br>28360 – SSB QRP CoA<br>28680 – Image CoA | | **28300 — 29510 kHz**<br>*BW 6000 Hz*<br><br>Satellite<br>Up & Down-Links |

| Region 1 | Region 2 | Region 3 |
|----------|----------|----------|
| **29000 — 29510 kHz**<br>*BW Unrestricted*<br><br>All Modes<br>> 29300 – Satellite | | |
| **29510 — 29520 kHz**<br><br>**GUARD BAND — NO TRANSMISSION ALLOWED** | | |
| **29520 — 29590 kHz**<br>*BW 6000 Hz*<br><br>All Modes<br>Repeater Input (RH1 – RH8) | | |
| **29590 — 29620 kHz**<br>*BW 6000 Hz*<br><br>All Modes<br>Repeaters Simplex<br>29600 – FM QRG | | |
| **29590 — 29620 kHz**<br>*BW 6000 Hz*<br><br>All Modes<br>Repeater Output (RH1 – RH8) | | |

Status: Primary and AMSAT R1, R2, R3.

# 6 Meters

| Region 1 | Region 2 | Region 3 |
|---|---|---|
| **50 — 50.1 MHz**<br>*BW 500 Hz*<br><br>**< .010 Beacons**<br><br>CW<br>.050 – CoA<br>.090 – DX CoA | **50 — 50.1 MHz**<br>*BW 500 Hz*<br><br>**.010 – .020 Beacons**<br><br>CW | **50 — 50.1 MHz**<br>*BW 200 Hz*<br><br>**.020 – .030 Beacons**<br><br>CW |
|  |  |  |
|  |  |  |

Status: Secondary R1, Primary R2, R3.

# 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 |

| Callsign | Country | QTH | Grid |
|----------|---------|-----|------|
| **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 |
| **YV5B** | Venezuela | Caracas | FJ69cc |

## Frequencies

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

# Digital Modes

Summary of the most used calling frequencies, if not specified the frequencies cover all IARU regions.

Usage of Digital Modes is not limited to the calling 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 | |

**DO NOT USE – WORK IN PROGRESS**

| 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 | |

**DO NOT USE – WORK IN PROGRESS**

| Band | WSPR | FST4/W | SSTV |
|---|---|---|---|
| **2200 m** | 0.136 | 0.136 | |
| **630 m** | 0.4742 | 0.4742 | |
| **160 m** | 1.8366 | 1.839<br>1.8368 | |
| **80 m** | 3.5686 | | 3.733 |
| **60 m** | 5.2872<br>5.3647 | | |
| **40m** | 7.0386 | | 7.058 |
| **30 m** | 10.1387 | | |
| **20 m** | (13.5539)<br>14.0956 | | 14.233<br>14.230<br>(Analogue) |
| **17 m** | 18.1046 | | |
| **15 m** | 21.0946 | | 21.337 |
| **12 m** | 24.9246 | | |
| **10 m** | 28.1246 | | |
| **6 m** | 50.293 | APRS | |
| **2 m** | 144.489 | 144.800 | |
| **1.25 m** | | | |
| **70 cm** | 432.300 | 432.500 | |
| **23 cm** | 1296.500 | | |

**DO NOT USE – WORK IN PROGRESS**

# 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.

# Q Codes

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

| Code | Question | Answer or Advice |
|------|----------|------------------|
| **QRA** | What is the name of your vessel (*or* station)? | The name of my vessel (*or* station) is … |
| **QRB** | How far approximately are you from my station? | The approximate distance between our stations is … nautical miles (*or* kilometers). |
| **QRE** | What is your estimated time of arrival at … (*or* over …) *(place)*? | My estimated time of arrival at … (*or* over …) *(place)* is … hours. |
| **QRG** | Will you tell me my exact frequency (*or* that of […])? | Your exact frequency (*or* that of ...) is ... kHz (*or* MHz). |
| **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. |

| Code | Question | Answer or Advice |
|------|----------|------------------|
| **QRK** | What is the intelligibility of my signals (*or* those of … *(name and/or call sign)*)? | The intelligibility of your signals (*or* those of … *(name and/or call sign)*) is:<br>1. bad<br>2. poor<br>3. fair<br>4. good<br>5. excellent. |
| **QRL** | Are you busy? | I am busy (*or* I am busy with … *(name and/or call sign)*). Please do not interfere. |
| **QRM** | Is my transmission being interfered with? | Your transmission is being interfered with:<br>1. nil<br>2. slightly<br>3. moderately<br>4. severely<br>5. extremely. |
| **QRN** | Are you troubled by static? | I am troubled by static:<br>1. nil<br>2. slightly<br>3. moderately<br>4. severely<br>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 (… words per minute). |

| Code | Question | Answer or Advice |
|------|----------|------------------|
| **QRS** | Shall I send more slowly? | Send more slowly (… 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 … that you are calling him on … kHz (*or* MHz)? | Please inform … that I am calling him on … kHz (*or* MHz). |
| **QRX** | When will you call me again? | I will call you again at … hours on … kHz (*or* MHz). |
| **QRZ** | Who is calling me? | You are being called by … (on … kHz(*or* MHz)). |
| **QSA** | What is the strength of my signals (*or* those of … *(name and/or call sign)*)? | The strength of your signals (*or* those of … *(name and/or call sign)*) is: 1. scarcely perceptible 2. weak 3. fairly good 4. good 5. very good. |
| **QSB** | Are my signals fading? | Your signals are fading. |
| **QSG** | Shall I send … telegrams at a time? | Send … telegrams at a time. |
| **QSL** | Can you acknowledge receipt? | I am acknowledging receipt. |

| Code | Question | Answer or Advice |
|------|----------|------------------|
| **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) number(s) …). |
| **QSN** | Did you hear me (*or* … (*name and/or call sign*)) on … kHz (*or* MHz)? | I did hear you (*or* … (*name and/or call sign*)) on … kHz (*or* MHz). |
| **QSO** | Can you communicate with … (*name and/or call sign*) direct (*or* by relay)? | I can communicate with … (*name and/or call sign*) direct (*or* by relay through …). |
| **QSP** | Will you relay to … (*name and/or call sign*) free of charge? | I will relay to … (*name and/or call sign*) 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 … kHz (*or* MHz) *(in the high frequency bands normally only the last three figures of the frequency need be given).* |
| **QSX** | Will you listen to … (*name and/or call sign(s)*) on … kHz (*or* MHz), or in the bands …/ channels …? | I am listening to … (*name and/or call sign(s)*) on … kHz (*or* MHz), or in the bands …/ channels … |

| Code | Question | Answer or Advice |
|------|----------|------------------|
| **QSY** | Shall I change to transmission on another frequency? | Change to transmission on another frequency (*or* on … kHz (*or* MHz)). |
| **QTH** | What is your position in latitude and longitude *(or according to any other indication)*? | My position is … latitude, … longitude *(or according to any other indication)*. |
| **QTJ** | What is your speed? | My speed is … knots (*or* kilometers per hour *or* … statute miles per hour). |
| **QTR** | What is the correct time? | The correct time is … hours. |
| **QTS** | Will you send your call sign (*and/or* name) for … seconds? | I will send my call sign (*and/or* name) for … seconds. |
| **QUA** | Have you news of … *(name and/or call sign)*? | Here is news of … *(name and/or call sign)*. |
| **QUD** | Have you received the urgency signal sent by … *(name and/or call sign)*? | I have received the urgency signal sent by … *(name and/or call sign)* at … hours. |
| **QUE** | Can you speak in … *(language)*, with interpreter if necessary; if so, on what frequencies? | I can speak in … *(language)* on … kHz (*or* MHz). |

# Definitions

## Band Symbols

| Band number | Symbol | Frequency range (lower limit exclusive, upper limit inclusive) | Corresponding metric subdivision |
|---|---|---|---|
| 4 | VLF | 3 to 30 kHz | Myriametric waves |
| 5 | LF | 30 to 300 kHz | Kilometric waves |
| 6 | MF | 300 to 3 000 kHz | Hectometric waves |
| 7 | HF | 3 to 30 MHz | Decametric waves |
| 8 | VHF | 30 to 300 MHz | Metric waves |
| 9 | UHF | 300 to 3 000 MHz | Decimetric waves |
| 10 | SHF | 3 to 30 GHz | Centimetric waves |
| 11 | EHF | 30 to 300 GHz | Millimetric waves |
| 12 |  | 300 to 3 000 GHz | Decimillimetric waves |

## Decibels

| 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 |

Where the decibel is defined as: $dB = 10 \log_{10}\left(\frac{P_1}{P_0}\right)$ and ratio $\frac{P_1}{P_0}$.

# 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 |
| **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 |
| **X** | Not covered |

# Physics

## Constants

| Symbol | Quantity | Value |
|--------|----------|-------|
| $c$ | Speed of Light | $3.000 \cdot 10^8$ m·s$^{-1}$ |
| $\mu_0$ | 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$^{-2}$ |

## Wave Theory

| | |
|---|---|
| Period | $\tau = f^1$, with $f$ the frequency |
| Wave Length | $\lambda = c \cdot \tau$ <br> $\lambda = c \cdot f^1$ |
| Angular Frequency | $\omega = 2\pi f$ |
| Angular Wave Vector | $k = 2\pi\lambda$ |

# Electricity

| Ohm's Law | $V = R \cdot I$ |
|---|---|
| Power | $P = V \cdot I$ |
| $N$ resistors in series | $R_{total} = R_1 + \cdots + R_N$ |
| $N$ resistors in parallel | $\dfrac{1}{R_{total}} = \dfrac{1}{R_1} + \ldots + \dfrac{1}{R_N}$ |
| $N$ capacitors in series | $\dfrac{1}{C_{total}} = \dfrac{1}{C_1} + \ldots + \dfrac{1}{C_N}$ |
| $N$ capacitors in parallel | $C_{total} = C_1 + \cdots + C_N$ |
| $N$ inductances in series | $L_{total} = L_1 + \cdots + L_N$ |
| $N$ inductances in parallel | $\dfrac{1}{L_{total}} = \dfrac{1}{L_1} + \ldots + \dfrac{1}{L_N}$ |
| Inductance of a Solenoid | $L = \dfrac{\mu N^2 A}{l}$, 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: $\sum_{k=0}^{K} I_k = 0$.
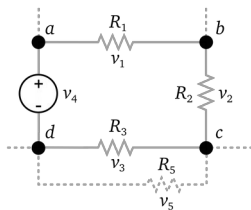
For instance on the figure[2], the law reads as: $i_1 + i_4 - i_2 - i_3 = 0$.
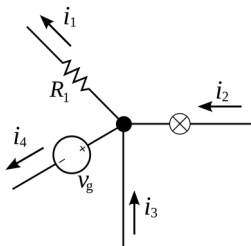
### Voltage

The directed sum of all voltage on a closed loop is equal to zero: $\sum_{k=0}^{K} V_k = 0$.
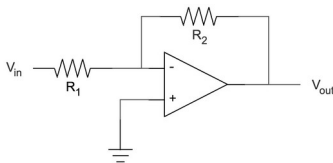
For instance on the figure[3], the law reads as: $v_1 + v_2 - v_3 - v_4 = 0$.

# Operational Amplifiers

### Inverting Configuration

$$\frac{V_{out}}{V_{i}} = -\frac{R_2}{R_1}$$

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### Non-inverting Configuration

$$\frac{V_{out}}{V_i} = 1 + \frac{R_2}{R_1}$$
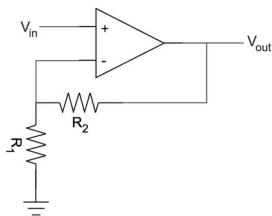


# Resistor Colors

*IEC 60062:2016 Standard*

| Color | Number | Multiplier | Tolerance |
|-------|--------|-----------|-----------|
| Pink | | $10^{-3}$ | |
| Silver | | $10^{-2}$ | ±10 % |
| Gold | | $10^{-1}$ | ±5 % |
| 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 |

# 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.[4]*

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) |

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[4]  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.

| Range | Country or Organization |
|-------|-------------------------|
| 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) |
| 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 |

| Range | Country or Organization |
|-------|-------------------------|
| 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 |

| Range | Country or Organization |
|-------|-------------------------|
| 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 |

| Range | Country or Organization |
|---|---|
| 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 |

| Range | Country or Organization |
|---|---|
| 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[5] |
| E5A – E5Z | New Zealand – Cook Islands |
| E6A – E6Z | New Zealand – Niue |
| E7A – E7Z | Bosnia and Herzegovina |
| EAA – EHZ | Spain |

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

| Range | Country or Organization |
|-------|------------------------|
| 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) |

| Range | Country or Organization |
|---|---|
| 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 |

| Range | Country or Organization |
|-------|-------------------------|
| 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 |

| Range | Country or Organization |
|---|---|
| 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 |

| Range | Country or Organization |
|-------|------------------------|
| 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) |

| Range | Country or Organization |
|---|---|
| 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 |

| Range | Country or Organization |
|---|---|
| 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) |

| Range | Country or Organization |
|-------|-------------------------|
| 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) |

# International System of Units

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 | $J \cdot s^{-1}$<br>$kg \cdot m^2 \cdot s^{-3}$ |
| C | Coulomb | Electric Charge | $s \cdot A$ |
| V | Volt | Electric Potential, Voltage | $W \cdot A^{-1}$<br>$J \cdot C^{-1}$<br>$kg \cdot m^2 \cdot s^{-3} \cdot A^{-1}$ |
| F | Farad | Capacitance | $C \cdot V^{-1}$<br>$kg^{-1} \cdot m^{-2} \cdot s^4 \cdot A^2$ |
| Ω | Ohm | Resistance | $V \cdot A^{-1}$<br>$kg \cdot m^2 \cdot s^{-3} \cdot A^{-2}$ |
| S | Siemens | Electrical Conductance | $\Omega^{-1}$ |
| Wb | Weber | Magnetic Flux | $V \cdot s$<br>$kg \cdot m^2 \cdot s^{-2} \cdot A^{-1}$ |
| T | Tesla | Magnetic Flux Density | $Wb \cdot m^{-2}$<br>$kg \cdot s^{-2} \cdot A^{-1}$ |
| H | Henry | Inductance | $Wb \cdot A^{-1}$<br>$kg \cdot m^2 \cdot s^{-2} \cdot A^{-2}$ |

# 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 |
| **Data** | |
| 1 B (byte) | 8 b (bits) |
| 1 kB | 1000 B |
| 1 kiB | 1024 B |
| **Angle** | |
| 30 deg | $\pi/6$ rad |
| 45 deg | $\pi/4$ rad |
| 60 deg | $\pi/3$ rad |
| 90 deg | $\pi/2$ rad |
| 180 deg | $\pi$ rad |
| 360 deg | $2\pi$ rad |

# Calculus

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

## Algebra

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

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

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

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

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

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

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

$\left(a^n\right)^m = a^{nm}$

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

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

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

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

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

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

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

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

$i = \sqrt{-1}$

$i^2 = -1$

# Logarithms

The function $\log_b$ denotes the $b$-basis logarithm, however the following properties apply to any basis logarithms.

$$\log(1)=0 \qquad\qquad \log_b(b)=1$$

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

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

$$\log(ab)=\log(a)+\log(b) \qquad \log\left(\frac{a}{b}\right)=\log(a)-\log(b)$$

# Trigonometry

| Angle (rad) | Sine | Cosine | Tangent |
|---|---|---|---|
| 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 | N/A |
| $2\pi/3$ | $\sqrt{3}/2$ | $-1/2$ | $-\sqrt{3}$ |
| $3\pi/4$ | $\sqrt{2}/2$ | $-\sqrt{2}/2$ | $-1$ |
| $5\pi/6$ | $1/2$ | $-\sqrt{3}/2$ | $-\sqrt{3}/3$ |
| $\pi$ | 0 | -1 | 0 |

# Remarkable Values

$e^{i\pi} = -1$                                   $e^{i\theta} = \cos(\theta) + i\sin(\theta)$

$\pi \approx 3.141593$                            $e \approx 2.718282$

$\sqrt{2} \approx 1.414214$                       $\sqrt{7} \approx 2.645751$

$\sqrt{3} \approx 1.732051$                       $\sqrt{8} \approx 2.828427$

$\sqrt{4} = 2$                                     $\sqrt{9} = 3$

$\sqrt{5} \approx 2.236068$                       $\sqrt{10} \approx 3.162278$ and $\sqrt{100} = 10$

$\sqrt{6} \approx 2.449490$                       $\sqrt{1000} \approx 31.62278$

$\log_{10}(2) \approx 0.301030$                   $\log_{10}(7) \approx 0.845100$

$\log_{10}(3) \approx 0.477121$                   $\log_{10}(8) \approx 0.903090$

$\log_{10}(4) \approx 0.602060$                   $\log_{10}(9) \approx 0.954243$

$\log_{10}(5) \approx 0.698970$                   $\log_{10}(10) = 1$

$\log_{10}(6) \approx 0.778151$                   $\log_{10}(20) \approx 1.301030$

# ITU Regions
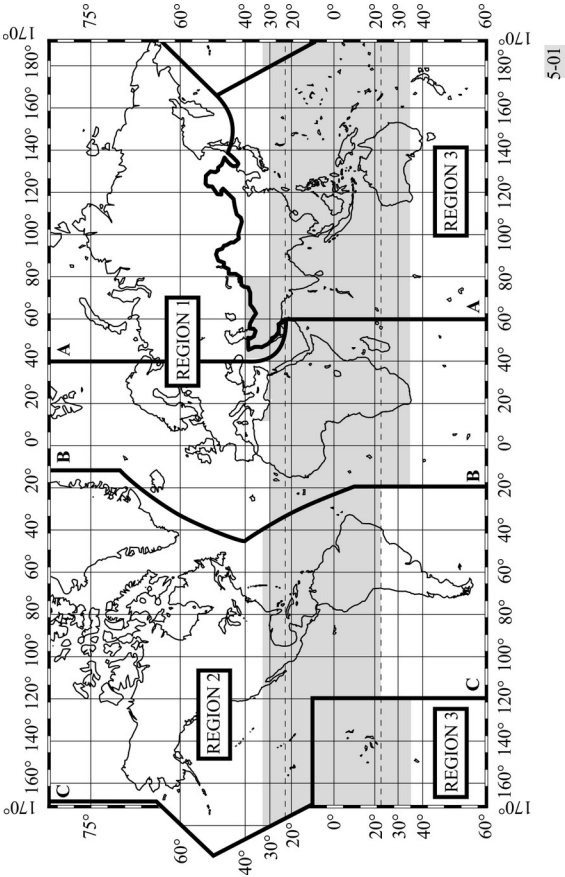
# ITU Alphabet

| | | | | |
|---|---|---|---|---|
| **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 |

| | | | | |
|---|---|---|---|---|
| **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.*

# 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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