International Amateur Radio Union Ethics and Operating Procedures for the Radio Amateur

Fourth Edition

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IARU

International Amateur Radio Union

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Contents

Abbreviations

See Q-codes, like QRM, in Table 10-A, page 28, and operational abbreviations, like CQ, in Table 10-B, page 30.

AC	Alternating Current
AM	Amplitude Modulation
AFSK	Audio Frequency Shift Keying
AMSAT	Radio Amateur Satellite Corporation
AMTOR	Amateur Teleprinting Over Radio
APRS	Automatic Packet Reporting System
ARRL	American Radio Relay League
ARSPEX	Amateur Radio Space Exploration Working Group
ASK	Amplitude Shift Keying
ATU	Antenna Tuning Unit
CAT	Computer Aided Transceiver
CB	Citizens Band
CE	Conformité Européenne
CEPT	European Conference of Postal and Telecommunications Administrations
CISPR	Comité international spécial des perturbations radioélectriques
CITEL	Inter-American Telecommunications Commission
CPR	Cardiopulmonary Resuscitation
CW	Continuous Wave
DC	Direct Current
DQRM	Deliberate QRM
DSP	Digital Signal Processing
DX	Long distance
DXCC	DX Century Club
ECC	Electronic Communications Committee
EIRP	Effective Isotropic Radiated Power
EMC	Electromagnetic Compatibility
EME	Earth-Moon-Earth
EMI	Electromagnetic Interference
EMF	Electromagnetic Field
ERP	Effective Radiated Power
EU	European Union
FCC	Federal Communications Commission
FM	Frequency Modulation
FSK	Frequency Shift Keying
FT8	Franke–Taylor design, 8-FSK
GPS	Global Positioning System
HAREC	Harmonised Amateur Radio Examination Certificate
HF	High Frequency
IARP	International Amateur Radio Permit
IARU	International Amateur Radio Union
IARUMS	International Amateur Radio Union Monitoring Service
ICAO	International Civil Aviation Organization
ICNIRP	International Commission for Non-Ionising Radiation Protection
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ITU	International Telecommunication Union
LED	Light Emitting Diode
LEO	Low Earth Orbit
LoTW	Logbook of the World
LSB	Lower Sideband
MF	Medium Frequency
MS	Meteor Scatter
NATO	North Atlantic Treaty Organisation
NBFM	Narrow Band Frequency Modulation
NIR	Non-Ionising Radiation
OOK	On-Off Keying
OSCAR	Orbiting Satellite Carrying Amateur Radio
PDF	Portable Document Format
PEP	Peak Envelope Power
PM	Phase Modulation
POTA	Parks on the Air
PSK	Phase Shift Keying
PTT	Push to Talk
QPSK	Quadrature Phase Shift Keying
RBN	Reverse Beacon Network
RCD	Residual Current Device
RF	Radio Frequency
RS	Readability and Strength
RSGB	Radio Society of Great Britain
RST	Readability, Strength, and Tone
RTTY	Radio Teletype
SOTA	Summits on the Air
S&P	Search and Pounce
SDR	Software Defined Radio
SMS	Short Message Service
SNR	Signal-to-noise Ratio
SSB	Single Sideband
SSTV	Slow-Scan Television
SWR	Standing Wave Ratio
T/R	Technical Recommendation
UHF	Ultra High Frequency
USB	Upper Sideband
UTC	Coordinated Universal Time
VFO	Variable Frequency Oscillator
VHF	Very High Frequency
VSWR	Voltage Standing Wave Ratio
WARC	World Administrative Radio Conference
WPM	Words per Minute
WSPR	Weak Signal Propagation Reporter

Foreword

It is with great pride and a strong sense of responsibility that we present this new edition of the Ethics and Operating Procedures for the Radio Amateur – the first edition of our second century. For one hundred years, the IARU has supported the spirit of amateur radio: international friendship, technical progress, and service to the public. Today, more than ever, the way we behave on the air shows the values at the heart of our worldwide community.

This new edition is based on the well-respected work created more than fifteen years ago by two experienced radio amateurs. However, it is more than just a revision. It has been fully rewritten, clearer, more useful, and closer to the realities of amateur radio today. It is for everyone: experienced operators and newcomers alike. It gives us a shared basis for communication that is respectful, helpful, and enjoyable. In a time of fast technical change and global challenges, high standards are important. They help us protect our access to the spectrum and keep a positive image of amateur radio around the world.

Amateur radio is one of the few hobbies that crosses borders, languages, and cultures. This is a privilege, and it brings a duty to act with respect, patience, and courtesy. Our Code of Conduct reminds us that every contact is not only a technical exchange. It is also a reflection of who we are and what we share.

This unity did not happen by chance. During a century that saw wars, political conflict, and division, the IARU has survived because it has kept world politics off the air. Many times, there were reasons – sometimes strong – to bring the conflicts of the moment into our work together. Each time, we chose not to. I believe this is one of the main reasons we have lasted one hundred years.

I encourage every radio amateur to read these pages, to share them, and to follow them. Let us set a good example, not only for other operators today, but for the radio amateurs of the future.

We have just completed one hundred remarkable years. Here is to the next century of respectful and responsible communication!

Sylvain Azarian F4GKR
President of the International Amateur Radio Union Region 1

Acknowledgements

The authors would like to acknowledge the late John Devoldere ON4UN, and Mark Demeuleneere ON4WW, authors of the *IARU Ethics and Operating Procedures for the Radio Amateur, Third Edition*. Concepts discussed in this work are based closely on the previous edition, even though the fourth edition has been fully rewritten and updated to meet the present challenges facing amateur radio. This book would not have been possible without their dedication and efforts.

The IARU would like to acknowledge and thank all its member societies, and their members, for their continued support, feedback, and their assistance in preparing this edition. The IARU would also like to thank Silvano Ancelotti for the cover page image. [1]

Notes to the Reader

All call signs used in this text, including EI0HQ, 4U1UN, ZL6HQ, and OA4O, illustrate various operational aspects of amateur radio. It is neither implied that their holders have participated in any of the illustrated interactions, nor that they have approved this text. They were merely chosen to represent the three IARU regions.

When this text refers to "amateur radio" in general, it should be taken as a collective reference to both the Amateur Service and the Amateur Satellite Service, as outlined by the ITU Radio Regulations Article 25.

All chapter, section, and figure cross-references, the links to the tables of abbreviations and contents shown in the top-right of every page, and the external links, can be clicked on using a compatible PDF reader. Although all the external links have been validated at the time of writing, the authors would like to apologise if they become broken.

Legal Note

This document does not have any legal standing per-se. It aims to summarise key International Telecommunications Union (ITU) regulations that are related to amateur radio and amateur satellite service. It also covers good on-air practices that have been common at the time of publication. It highlights some behaviours and activities which do not comply, or which even contradict those regulations and practices. To understand the legal impact of such non-compliance, please refer to the national regulations of the country in which you operate. Although most of the regulations have been transcribed by many countries into their national laws, there are significant differences.

Regardless of the legal context, it is hoped that you will consider following the recommendations presented in this document to help make amateur radio better for everyone. The authors would like to thank you for your consideration.

1 Front cover image is copyright by Silvano Ancelotti © 2025. Used under the terms of cc by 4.0 licence, creativecommons.org/licenses/by/4.0

Part A: Ethics, Regulations, and Code of Conduct

1 Ethics and Code of Conduct

The basic ethics for amateur radio are no different to those in every other aspect of life: treat people the way you would like to be treated. Recognise that other radio amateurs may have different views to yours. Be friendly, tolerant, and polite. Enjoy, and let others enjoy radio.

1.1 Basic Principles of the Code of Conduct

These are the basic principles on how to conduct ourselves in amateur radio.

- Friendship. Radio amateurs all share the airwaves, and we are never alone in that space. We should be friendly, considerate, and respectful to other radio amateurs.
- Tolerance. Radio amateurs do not necessarily share each other's opinions, and they may not consider your opinions to be the best ones for them. It is helpful to remain tolerant and understanding of people and their differing opinions. We can help to bridge our differences by being respectful in our communications.
- Politeness. Be polite, courteous, and gentle when on the air. Do not use rude language or abusive words. Remember that others are listening to you – not just the person that you are in contact with. Remain in control of your language and tone, and do not lose your good temper.
- Understanding. Be understanding of those who may not be as expert as you are in a subject. If you hear something that you know to be wrong, and if you wish to do something about it, act in a friendly, positive manner. Offer helpful, constructive criticism if necessary, aiming to politely explain the issue. Avoid causing negative feelings by using strong or impolite language.
- Progress. Operating practice and radio technology are evolving. By continually experimenting and learning, by improving our skills and our stations, and by openly sharing what we do, we strengthen the foundation of radio knowledge for those who will succeed us, thus helping amateur radio to meet the challenges of the future.
- Diversity, equality, and inclusion. The global nature of amateur radio community enables us to benefit from each other's diverse experiences. For amateur radio to thrive and to grow, we need to include and treat each other equally. Welcome and be respectful of everyone on the air, even if you have different sex, age, ethnicity and national origin, abilities and disabilities, religion, sexual orientation, gender identity and expression, financial means, education, or political persuasion.
- Social responsibility. Your skills as a radio amateur can help your community in many ways, especially in times of need. You could provide emergency communications when there is a natural disaster or another significant emergency. You can also serve your community by sharing your knowledge and passion for radio, and by helping others to develop new skills or interests that enrich their social lives.

2 Risk of Conflict

THE RADIO SPECTRUM, including amateur radio satellites, and signal repeaters, is a space shared by all radio amateurs not only with each other, but also with other users, including public broadcast, government, military, and commercial services. Millions of radio amateurs use shared radio bands in harmony and with respect for others while following their own interests and goals. Occasionally, a few may come into conflict.

For example, you may suddenly hear someone making a general call (CQ), or talking to someone else, on the same frequency that you have been using. How is that possible if you were the only one using this frequency? Indeed, the other station may also be thinking that you have just intruded on their frequency. Are they being rude?

There is usually another, more likely explanation. The propagation conditions change all the time. The chances are that the stations that previously could not hear each other suddenly can. Perhaps there were no bad intentions on either side. Most likely the ionospheric conditions have changed, and radio propagation brought them within the receiving range of each other.

2.1 How to Avoid Conflict

Many conflicts are caused by a lack of awareness of operational guidance. For example, many operators want to make long distance (DX) contacts with faraway locations around the world, especially with places where amateur radio activity is rare. Making such contacts would be impossible were it not for the temporary and complex activities known as DXpeditions. Not causing conflict whilst hoping for such a rare DX contact requires more than patience and a friendly attitude. It is also necessary to become familiar with specific operating techniques in addition to those used daily, such as how to operate in split mode, explained in Chapter 15.

Resolving a conflict is harder than avoiding it in the first place. Many conflicts could be avoided if operators were familiar with both basic and more specialised operational procedures. It is hoped that the *IARU Ethics and Operating Procedures for the Radio Amateur* can help to solve this growing problem by summarising good operating procedures and the guidance learned from the established amateur radio practice. Some of it was honed by professional radio operators and much has been sourced from the International Telecommunication Union (ITU) and International Amateur Radio Union (IARU) recommendations. Keep learning and stay informed about the inevitable future changes to those procedures, because the technology and the needs of radio amateurs will continue to evolve.

3 Purposes of Amateur Radio

The ITU Radio Regulations Article 1.56 defines the amateur service as "a radiocommunication service for the purposes of:

- self-training
- intercommunication
- technical investigations

... carried out by amateurs, that is, by duly authorised persons interested in radio technique solely with a personal aim and without pecuniary interest." It means that you cannot make money from amateur radio communications. Article 1.57 defines the amateur satellite service as "a radiocommunication service using space stations on earth satellites for the same purposes as those of the amateur service." [2]

3.1 Role of Amateur Radio in Emergency Communications

Amateur radio may be the last communication method available to some communities in a natural disaster or another emergency. Amateur radio equipment and skills have often proven to be very helpful at times of a communications emergency. You can play an important role under those circumstances if you understand what is permitted, what is expected, and what is required from you at those highly stressful times. You must continue to obey the regulations, and under no circumstances should you interfere and confuse existing emergency operations.

The ITU Radio Regulations permit amateur radio stations to transmit international communications on behalf of third parties only in case of emergencies or disaster relief. National administrations have the final say about this provision in their jurisdictions. However, the ITU recommends that administrations should encourage the development of amateur service and amateur-satellite service networks capable of providing radiocommunications in the event of natural disasters or other emergencies. [3]

If you are interested, join and receive further training from a recognised emergency communications organisation in your country to learn how to provide reliable, efficient, and effective emergency communications. Do not become a problem because of a lack of training. However, if you own equipment, such as repeaters or gateways, you can offer it without having to directly participate in emergency communications.

The IARU coordinates the work of amateur radio emergency network organisations.[4] Guides, including the *IARU Emergency Telecommunications Guide,* are available in several languages. [5] Your national radio society can also provide locally relevant guidance.

2 www.itu.int/pub/R-REG-RR (Edition of 2020)
3 www.itu.int/rec/R-REC-M.1042-4-202602-I
4 www.iaru-r1.org/about-us/committees-and-working-groups/emcomm
5 R1: iaru-r1.org/about-us/committees-and-working-groups/emcomm/emergency-operating-procedures
R2: iaru-r2.org/en/on-the-air/emergency-communications
R3: iaru-r3.org/on-the-air/emergency-communications

3.1.1 Emergency Communications Essentials

While emergency communications may happen anywhere on the bands, the IARU Band Plans specify ranges of frequencies, known as emergency centres of activity, where national and international emergency communications should be focused. However, some countries use different frequencies – check your local band plans.

! If you hear the words *mayday, emergency, welfare-traffic,* SOS, or QUF – stop transmitting and listen. Monitor the frequency and write down everything that you can hear. Gather the following information:

- WHEN – date, time, frequency
- WHERE – place of the emergency
- WHAT – what happened, what is to be done
- HOW – how can it be helped
- WHO – who can help

Never transmit unless you are sure you can help. Do not leave the frequency until you are sure you cannot help anymore, preferably not until someone from a recognised emergency services agency is helping. If the station in emergency is not being answered, or they cannot hear you when you call back, you should pass the information and requests to emergency services, including the police, ambulance or fire services, coastguard, or a Red Cross/Red Crescent organisation. Call your national emergency telephone number, unless you have been trained otherwise. [6]

Follow the instructions that the station in the emergency is giving to you. The frequency is always controlled by that station, or by a station appointed by them if they are better placed to control the traffic and to keep the frequency clear.

There is rarely a need for the emergency traffic to be passed around the world. Once the message has reached a location with reliable telephone communications, it should be delivered to and left to be handled by the authorities at that location.

! Do not pass on rumours or requests for assistance that do not come from appropriate sources in the disaster area.
- Assistance must be managed by the emergency coordinators in the area, who set the priorities and make decisions about scarce resources, including ports and airports.
- Duplicate requests can cause confusion and waste time and resources.

Amateur radio can play an important communication role in an emergency, however, you should leave advice and the planning of aid to the authorised persons and institutions.

6 Such as 112, 999, 911, etc. Make sure you know your national emergency telephone number.

4 Regulations and Authority

Operating in the amateur service requires a licence, a permit, or another authorisation, with only a few exceptions to this rule. For the purpose of this document all such authorisations are referred to as a licence.

Comply with the laws and the regulations of the country in which you are operating, and any conditions that your licence may impose. Different types of organisations are responsible for administering amateur radio in each jurisdiction. This text refers to them as regulators. You need to know who they are, and the regulations and guidelines that you must follow in your country. Different rules can apply when operating abroad, see Chapter 18 Away from Home.

! Regulations change often. You are required to know and to obey all the changes, too.

All countries represented by the IARU have rules that are based on the ITU Radio Regulations. Operating practices described in this guide are based on them, including the universal requirement to identify all radio transmissions, the content of contacts, and the purposes of amateur radio service. Some regulators explicitly recommend following the IARU operating practice guidelines, including the band plans.

4.1 Authority and Self-discipline in Amateur Radio

Many of the regulators do not have a deep interest in how radio amateurs behave on the air, if they operate according to the laws and their guidelines. The amateur radio community has always relied on an element of self-regulation and self-discipline. An example of self-regulation is the consensual, iterative development of the IARU Band Plans. An example of self-discipline is the broad support of those band plans.

The amateur radio community does not have its own policing service. Only the authorities can deal with breaches of the law. Nevertheless, self-discipline, based on ethics and the codes of conduct, has worked well for over a century.

Any radio amateur attempting to play the role of the police on the air is more likely to cause further anguish than to resolve the issue at hand. Avoid commenting on others' mistakes and their perceived transgressions directly on the air. If you feel strongly about an issue, consider communicating with the other person by other means, such as email, whilst remaining respectful and tolerant. Contact your national radio society for further advice, especially if witnessing considerable interference. See also Section 5.5.1 How to Deal with Spectrum Interference.

Above all, do not lose your temper and always comply with the regulations. For example, transmitting without clearly identifying yourself using your full call sign, even if attempting to offer some advice, is against ITU regulations, and remains illegal in many countries. [7]

7 ITU Radio Regulations (2020) Article 25.9. Appendix 14, rev WRC-07 (how to identify).

5 Non-Interference and Electromagnetic Compatibility

INTERFERENCE issues that can affect both an amateur radio station and devices in the surrounding area are discussed in this chapter. Equipment that is known to comply with electromagnetic compatibility (EMC) standards is less likely to suffer from those issues. Look for relevant certifications or quality marks.

5.1 Electromagnetic Compatibility (EMC)

EMC is the ability of electronic devices and systems to function properly in their electromagnetic environment, without causing interference and without being affected by it. It ensures that different electronic equipment can coexist and operate in the same space without disrupting each other's performance.

When devices generate electromagnetic emissions, they can interfere with nearby equipment. This is known as electromagnetic interference (EMI). EMC aims to control and reduce those emissions, so that they do not cause problems, whilst also ensuring that devices are robust enough to resist interference from external sources.

Good EMC practice is crucial because the world is increasingly saturated with electronics. Everything from household appliances to complex communications systems emits and absorbs some level of electromagnetic energy. If designers do not follow good EMC practices, devices could malfunction, communication signals could be lost, and interference could result in degraded performance or even in a complete failure of important equipment.

5.2 Electromagnetic Compatibility Standards

International organisations have established EMC standards. Products must comply with those standards before they can be sold or used in many countries. These regulations are in place to protect consumers, promote compatibility between systems, and prevent harmful interference in critical applications such as aviation, healthcare, and communications. The widely adopted ones include:

- Comité international spécial des perturbations radioélectriques (CISPR) has been setting global standards for controlling EMI in consumer electronics, appliances, and industrial equipment since 1934.
- European Union manages the CE type approval. It indicates that a product complies with the EMC Directive 2014/30/EU, which governs the electromagnetic emissions and the immunity of electrical equipment, and compliance with other relevant directives.
- Federal Communications Commission (FCC) in the USA mandates EMC compliance for devices emitting radiofrequency energy.
- International Electrotechnical Commission (IEC) 61000 standards address EMC testing and measurement methods, globally.

Amateur radio licences issued in many countries permit the licensee to build their own radio equipment, including transmitters. Unless that equipment is intended for sale to the public, amateurs are usually exempt from having to certify its regulatory compliance. Nevertheless, amateurs must still comply with the EMC and other regulations.

- Make sure to know the EMC rules applicable to your country and region before you construct your own radio equipment.
- Understand that you are responsible for EMC compliance even if purchasing equipment, especially if it does not come with approval marks or certifications.[8]

5.3 Handling EMC Issues

Amateur radio operators often use highly sensitive receivers capable of picking up faint signals from thousands of kilometres away. Any unwanted signals or noise within our frequency bands can interfere with the reception.

There are many good, non-interfering solar panel optimisers and inverters, electric motors, electric fences on farms, switched mode power supplies, broadband extenders, LED drivers, and streetlamps. Unfortunately, quite often, devices from this list are poorly designed or interconnected, and particularly prone to causing harmful EMI.

The first step when dealing with an EMC issue is to rule out whether our station is the source of the problem, because much EMI can originate from our own equipment or the nearest home environment.

To check, power your transceiver with a battery and turn off electricity supply to your house, if it is possible and safe to do so. If the interference disappears, then the culprit is within your own home. Inspect every power supply, LED light, and appliance, until you identify the one causing the issue.

Some switched mode power supplies, including so-called wall warts, are frequent sources. They tend to lack proper electromagnetic shielding and filtering components, which are essential for reducing EMI. To cut costs, manufacturers sometimes use lower-quality circuits that do not comply with EMC standards. These devices can emit high levels of RF noise that spreads across a wide range of frequencies, easily affecting sensitive radio equipment that is located nearby.

If the problem originates from the outside of your home, approach the situation carefully and methodically by gathering as much information as possible about the interference. Identify the noise's signature sound or wave form, the affected frequencies, timing when it turns on and off, and any other relevant details. This information can provide valuable clues about the source. You can compare the findings with online noise databases of common interference patterns.[9]

A portable radio receiver can be used to find where the interfering signal is at its strongest, indicating that you are nearing its source. If it turns out to be in a public area,

8 Unfortunately, it is easy to buy radio transmitters that neither comply with the EMC, nor with the safety regulations. They are available from inexpensive, poorly regulated online marketplaces.

9 See enams.de and search arrl.com

such as an arcing streetlamp, you should report the issue to your local radio regulator. They can investigate and take the necessary steps to resolve the problem.

If the issue seems to emerge from a private household, you should exercise much care and tact when approaching the property owner. Explain your concern politely. Be patient and respectful because most people would not have any understanding of amateur radio, electromagnetic waves, or EMI issues. It is unlikely that they would be even aware that they may have been causing the interference!

Keeping the conversation friendly and informative will help you to address the matter effectively. Often, the problem can be traced back to the previously mentioned inexpensive devices. Offer your assistance in identifying and replacing the faulty equipment. Because solving the issue is more important to you than to the neighbour, you may even want to pay for the replacements or fixes. Avoid feeling angry or confrontational when dealing with such delicate matters. Keeping your neighbours happy will help you enjoy amateur radio for a long time.

If it is impossible to resolve the issue in an amicable way, you may report the matter to your regulatory authority. They have the means to investigate and to take the necessary steps to address problematic interference. Unfortunately, that approach can damage the relationship with your neighbours, causing further issues.

5.4 Interference from Your Station

Every time our radios transmit, we are emitting a significant amount of RF energy. This can cause interference to nearby devices, especially those that do not have a good EMC design, especially when our station is malfunctioning.

If you receive a report about interference from your station, or if you suspect that something might be wrong, approach the situation rationally. Focus on investigating the issue logically and systematically. Gather as much information as possible, such as the date, time, and the affected equipment. Comparing the reported times of interference with your logbook can reveal a lot. If the interference occurs when you are not transmitting, it indicates that the issue lies elsewhere and not necessarily within your station.

If it looks like your station may be the cause of interference, take steps to identify the exact source. Start by swapping its components to isolate the problem. Use another transceiver, antenna, or a cable. Check your station's earthing system. Reduce your transmit power.

A close review of your radio settings is also essential, because even seemingly innocent adjustments can degrade the quality of your signal and increase interference risks. A speech processor designed to raise the modulation level of your voice that is set too high can cause an audio distortion. Similarly, an excessively high microphone gain, combined with inadequate filtering, may cause splatter, a problem where our signal spills into the neighbouring frequencies.

The rise and fall times of a Continuous Wave (CW) signal determine how quickly it reaches and drops from the strength needed to transmit a single Morse code dit (•) or dah (–). If they are too short and too fast, the signal can sound harsh and disruptive, creating key clicks and thumps that can be heard on adjacent frequencies, as shown in

Figure 5-i, and even on more distant, harmonically related bands. See Section 8.3 for recommended rise and fall times.

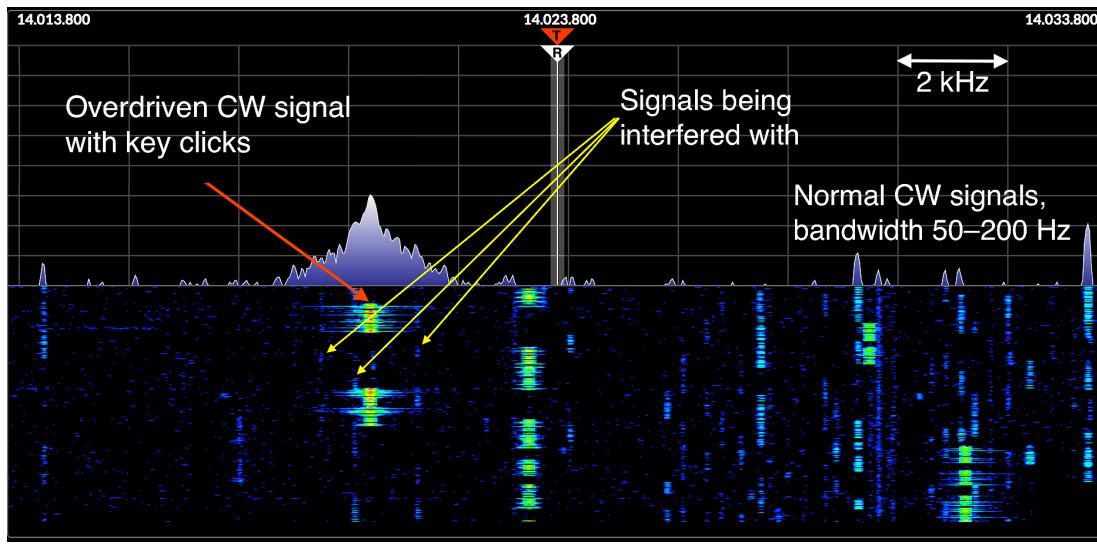

Figure 5-i: Key clicks and an overdriven CW signal causing excessive bandwidth use of over 2 kHz instead of 50–200 Hz. Bottom half: waterfall spectrogram (frequency on the horizontal, time on the vertical axis). Upper half: signal amplitude in the frequency domain, on the 20 m band. [Image by EI6LA]

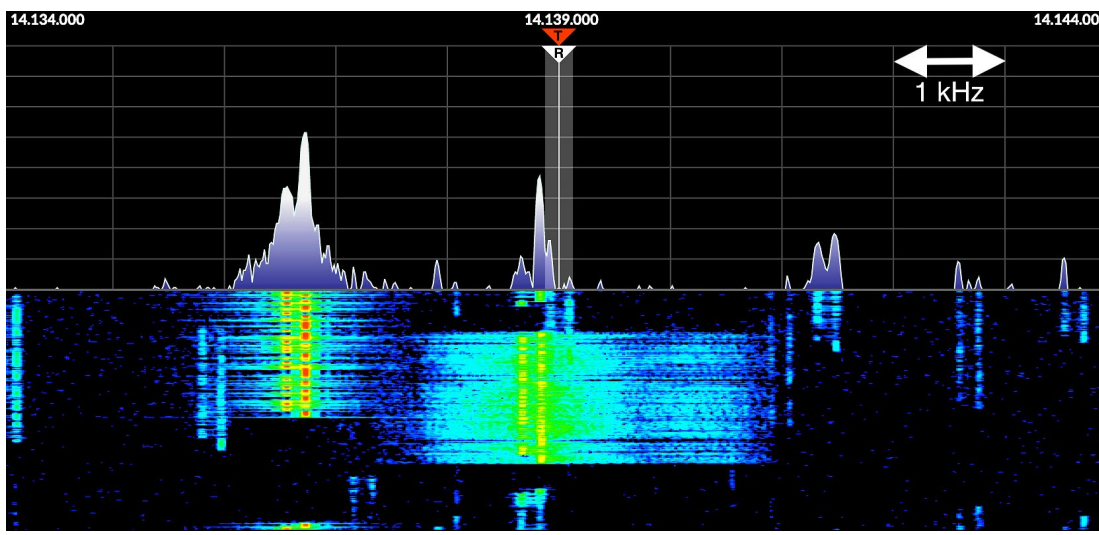

Figure 5-ii: Interference caused by two unfiltered, improperly shaped AFSK or FSK signals. The central one occupies more than 3 kHz of bandwidth. The left one occupies over 2 kHz and has key clicks extending 3 kHz. Normal signals, like the one in the centre, have the correct 300 Hz bandwidth. [Image by EI6LA]

Key clicks and splatter are harmful. They prevent others from using a large range of frequencies on this and even on other bands. This problem affects not only the CW mode of communication, but also other digital modes. [10] Techniques used for forming good digital signals, including CW, are known as pulse shaping. Figure 5-ii shows Frequency Shift Keying (FSK) splatter and key clicks perhaps caused by the lack of appropriate transmitter filtering, or by an incorrectly configured modulation technique, without appropriate pulse shaping. This problem is also often caused by an excessive audio level output from the computer when using the Audio Frequency Shift Keying (AFSK) mode, especially when amplified too much.

Harmful interference may have other causes within your station. Sometimes the issue might lie within the affected device itself, especially if it is not known to be compliant with EMC standards. A good understanding of the technologies that you are using is necessary to resolve it. Other experienced radio amateurs, and your national society, should be able to help you.

5.4.1 Overdriven Amplification

Internal amplifiers are important components in all radios. In addition, external power amplifiers can be useful in more advanced applications. However, if amplifiers are used incorrectly, they often aggravate problematic signals, causing EMI. Both internal and external amplifiers can be overdriven by an input signal whose power or modulation level exceeds the recommended limits. Overdriving can make minor distortions harmful. It also significantly increases key clicks and splatter, and can cause unintended radio transmissions on other frequencies, causing harmful EMI, even outside the amateur bands.

5.4.2 Dealing with Complaints

Maintain a calm and a cooperative attitude if you receive reports suggesting that you are the source of interference. Consider inviting the complainant to collaborate in finding a solution if you think their concern is genuine. This approach can help to resolve the issue while leaving a positive impression.

As always, having good neighbourly relations is particularly important. Your neighbours may not understand what you do. It is possible that they may think you are responsible for various issues they are experiencing, especially if they are related to radio waves. Poor TV or mobile phone reception, or inexplicable issues with the technology in their home, may get blamed on your operation. There is a lot of misinformation, and some people fear everyday radio technologies, such as mobile broadband. We can help dispel such fears by being approachable and transparent. On the other hand, if you find yourself in a more difficult situation, it is prudent to tread carefully.

10 Mode, in amateur radio, usually refers to a combination of the modulation scheme, such as amplitude modulation (AM) and the type of transmitted content, such as phone, telegraphy, or data. CW is the oldest digital mode of communication, see Chapters 13 and 14. The concept of a mode is also related to types of radio emissions, see ITU-R SM.1138-3 www.itu.int/rec/R-REC-SM.1138-3-201910-I/en

Your licence gives you the right to operate radio transmitters. It is helpful to understand what you are doing and what it could mean to people who are not interested in radio. Study the guides mentioned in Section 6.4.2 to prepare for interactions with the public.

5.5 Non-interference

The radio frequency spectrum is occupied by many services and their users. National and international regulations require that services do not interfere with each other. Such services include ambulance, aviation, fire, maritime, military, navigational aids, police, radiotelecommunications, and satellite communication, amongst others. Mobile phones and many other essential communication services also rely on their allocated radio frequency bands.

! Do not transmit on those frequencies, even in times of an emergency, unless explicitly authorised to do so.

Some of the bands have been allocated to amateur radio on a secondary basis in many parts of the world. On those bands you are not the primary user. You are not allowed to interfere with any primary user communications that may be taking place on those bands. Stop using the frequency if a non-amateur starts transmitting on it.

5.5.1 How to Deal with Spectrum Interference

Unfortunately, you will experience or witness deliberate interference (DQRM) within the amateur radio bands at some stage. Only the authorities can take action to resolve it. If it becomes serious or persistent you can assist by providing the necessary information and the evidence through the correct channels. Do not confuse deliberate interference with its more everyday EMC forms.

Identifying interference is a complex process, and its sources may be in other countries. The IARU Monitoring System (IARUMS) can help to remove the interference by following the ITU procedures and by communicating with the regulators abroad. IARUMS is interested in reports of all kinds of interference, including wilfully intrusive or potentially illegal transmissions and interference from poorly designed devices. It has a process for accepting the evidence, such as your recordings. [11] While you could report incidents directly to IARUMS, it is recommended that you first report them to your national society, who would gather the necessary information. Please contact your society's IARUMS officer, or the IARU Liaison Officer.

Nevertheless, should you encounter an individual causing you harmful interference that cannot be resolved once the interfering party has been informed, you may need to report it to the body that regulates radio communications in your country. Your national society should be able to offer further advice.

11 www.iaru-r1.org/about-us/committees-and-working-groups/iarums

6 Safety

Amateur radio is generally safe, but there are a few risks to consider for your own safety and for those who may be affected by your station. Please note that your licence does not exempt you from complying with safety regulations, including those concerning electrical safety. If in doubt, consult a qualified professional.

This section of the guide highlights the importance of safety in amateur radio, but it is not a safety guide. No responsibility or liability will be accepted by the authors or by the IARU for any event, accident, or a consequence of using it. It is your responsibility to know and to comply with any relevant safety regulations, and to apply common sense.

6.1 Electrical Safety

The human body can conduct enough current to cause serious injury or death.

! Currents of only a few tens of milliamperes through the body, particularly through the chest, can cause a fatal disturbance of the heart's rhythm.

Radio equipment may contain hazardous voltages, high available currents, and stored energy, especially in mains power supplies, high-power transmitters, amplifiers, and charged capacitors. Equipment that is safe when used normally may become dangerous if operated with protective covers removed, during maintenance, after a fault, or before capacitors have discharged.

! Maintenance involving exposed mains or high-voltage circuits should be carried out only by competent persons using appropriate procedures and equipment.

Amateur radio stations should use electrical protection appropriate to local regulations, commonly including Residual Current Devices (RCDs) or equivalent equipment. However, such devices only offer supplementary protection and do not remove all risk. A clearly marked, easily reachable station isolating switch is good practice. Make sure that other household members know how to use it.

6.1.1 Dealing with Electric Shock

If you suspect someone is experiencing an electric shock:

1. shut off the power before touching the person
2. call for help – dial your national emergency telephone line
3. commence cardiopulmonary resuscitation (CPR) if necessary [12]

12 Many countries require bystanders to offer first aid and have *Good Samaritan* or *Duty to rescue* laws that protect against liability. Check your local legislation and seek first aid training, including CPR.

6.1.2 Battery Operation

Batteries allow radio amateurs to operate almost anywhere, including during power outages. This can be valuable to the wider community, especially when operators have emergency communications training.

When using batteries:

- mount batteries securely
- fit appropriate fuses close to the battery
- a suitable isolating switch should be easily accessible in case of a difficulty
- never short-circuit a battery as this may cause fire or explosion
- carry a suitable fire extinguisher when operating from a vehicle
- switch off the engine and radio equipment when refuelling
- avoid handling leaking, swollen, damaged, or open batteries – hazardous chemicals
- take particular care with lithium-ion batteries, which can produce intense fires and toxic fumes if damaged, overheated, or incorrectly charged

6.1.3 Protective Earthing, Grounding, and Bonding

Accessible metal parts of station equipment, including Morse keys, microphones, homemade accessories, and older equipment, must not present an electric shock or RF burn hazard. Equipment that requires protective earthing, including mains-powered power supplies and other devices, must be connected to the protective earth provided by the electrical installation, in accordance with local electrical regulations.

Many transceivers, amplifiers, tuners, and accessories also have dedicated earth or ground terminals. Where the manufacturer requires their use, they must be connected as part of a safe station earthing and bonding arrangement that complies with local regulations. Where their use is optional, they should be used only where appropriate for the station design and where they do not compromise electrical safety.

Other station earthing, grounding, and bonding arrangements, including those used for antennas, RF currents, coaxial cables, or lightning protection, must also comply with local regulations and must not compromise electrical safety.

- When researching the subject of earthing, grounding, and bonding, be cautious about advice from other countries. Protective earthing differs significantly around the world.
- Equipment manuals may show station grounding, but these must be interpreted in the context of local electrical regulations and the earthing system used in the building.

Some antennas or station arrangements may require an RF earth or other bonding for good performance. [13] This is not necessarily the same as protective earthing for electrical

13 This is a complex subject. An earth or ground used for an antenna's RF performance has different requirements from protective earthing used for electrical safety. Some antennas require an RF earth for good performance, but it must never be installed in a way that compromises electrical safety. Before installing an RF earth, check whether the antenna type really needs one. In many cases, suitable chokes, baluns, or changes to the antenna system can reduce unwanted RF currents without adding a separate earth.

safety. RF burns or tingling from keys, microphones, or equipment cases may indicate unwanted RF current on station equipment. This should be corrected by reviewing the antenna, feed line, bonding, and RF-current suppression arrangements, not by adding an isolated earth connection. However, if you need an additional earth electrode (rod), bonding conductor, or station earthing point, it should be designed and installed as part of the whole electrical installation by a competent person. Do not connect station earth terminals to water or gas pipes.

Ask a qualified electrician to check the safety of any protective earthing, grounding, or bonding arrangement, especially if you have added anything to the system provided by your electricity supplier. Unauthorised or uncertified electrical work may affect your house insurance. Depending on the earthing system used in your house and locality, separate earthing systems that are not correctly bonded or installed can create lethal hazards.

6.1.4 Lightning Risk

Additional protective systems may be needed where your location is at risk of lightning storms. These systems may include lightning conductors, ground electrodes, bonding conductors, and surge protective devices, but they must be designed as part of the whole electrical installation. Antennas and towers are particularly exposed, and considerable care is needed to protect your home and family. Ask a qualified lightning expert for advice.

Even where lightning storms are uncommon, a nearby lightning strike can cause high-voltage and high-current surges on mains wiring, antenna feeders, control cables, and other conductors entering the building. In addition to correct earthing, grounding, and bonding, fit suitable surge protective devices, such as coaxial surge protectors or lightning arresters, at the point where antenna feeders enter the building. These devices must be installed outdoors, or at the building entry point, and bonded correctly to the station and building earthing system. For open wire feeders, suitable spark gap protectors may be appropriate. Although no practical amateur station protection system can save you from a direct strike, it can reduce the risk from nearby ones and from transient overvoltages.

! Disconnect antennas when not in use, preferably outside the home or at the building entry point, to reduce the risk of dangerous voltages and currents being carried inside.

6.2 Mechanical Safety

Antenna mechanical installation should follow good engineering practice. Towers, masts, brackets, rotators, and antennas should be rated for the loads they are supposed to carry, including wind and ice loads. Guy wires or ropes should be installed according to the manufacturer's instructions. Masts and antennas should be kept well clear of power lines. As a rule of thumb, keep masts at least twice their own height away from overhead power lines. Also consider the fall zone, so that failure does not endanger people or property.

- ensure that ladders are suitable for the task, stable, and secured
- use suitable fall-arrest equipment when working at height
- never work at height on your own – have someone who can see and help you

6.3 Chemical Safety

Soldering should be carried out in a well-ventilated area. Avoid inhaling the fumes and consider using lead-free solder. Wear suitable eye protection because hot solder may splatter.

Use components that comply with your national safety regulations whenever possible. Be careful when working on old circuits because their components may contain hazardous materials whose use was permitted in the past. Avoid inhaling solvents and cleaners and prevent skin contact with them.

6.4 RF Hazards

Currents and electromagnetic fields (EMFs) at radio frequencies pose additional hazards. They are easy to mitigate if you are aware of the risks.

6.4.1 RF Burns from Direct and Near Contact with RF Currents

The most immediately hazardous biological effect of exposure to RF currents is an RF burn. They are caused by physical direct or near contacts with a conductor that is energised by RF currents, such as a transmitting antenna. Even low-power transmitters, such as those referred to using the abbreviation QRP, can generate dangerous voltages in high-impedance circuits and antennas.

The RF current that is flowing into the contact point on the skin may be sufficient to cause a high temperature burn. Depending on the current and the frequency, an RF burn may be superficial, or quite deep, and it can cause damage just like a burn from a hot object. Minor RF burns can be treated like traditional burns. Seek medical help if the injury is extensive or deep.

RF burns can be caused even before you touch an energised conductor. An electrical arc can form between the skin and the conductor if the RF voltage is sufficiently high, and you are near the conductor. You can get such a burn twice: prior to a physical contact, and once again, when you touch the energised conductor.

- Never touch antenna elements or other conductors unless you are confident that they are not energised, except for touch-safe antennas, such as the short *rubber duck* antennas used on low-power handheld transmitters.
- Ensure that no other person or animal can touch your antenna when transmitting.
- Due to the risk of an electrical arc, avoid standing close to those parts of the antenna where the voltage is high, such as the ends of a half-wave dipole, or the top of a vertical quarter-wave antenna.
- All antenna elements, including directors and reflectors, should be earthed/grounded when working on them. Even if not energised, electric potential can build up on them from other sources, such as other antennas, atmospheric static electricity, or nearby installations.

Conductors other than antennas can also carry RF currents during transmission. These currents may appear on metal equipment cases, microphones, Morse keys, computer cables, power leads, and the outside of coaxial cable shields. They are often caused by common-mode current, poor bonding, unsuitable cable routing, or insufficient RF current suppression. If these currents reach accessible metal parts, they may cause RF burns, interference, or unreliable operation. Antenna and station earthing, grounding, and bonding may help, but they are not the only solution. Unwanted RF currents should be corrected by reviewing the station layout and antenna system, including the use of suitable chokes or ferrites.

6.4.2 Non-Ionising Radiation and Electromagnetic Field (EMF) Safety

Transmitting antennas and their components, including their wires, elements, counterpoises, and radials, work by creating radiating EMFs. Radio EMFs are also known as non-ionising radiation (NIR). They are safe if the station is operated in compliance with the safety guidelines.

International organisations have been researching the safety of EMF almost since the invention of radio. National laws and regulations around the world limit the level of exposure of persons to EMF to below levels set by those organisations. Two of the most followed guidelines have been published by the International Commission for Non-Ionising Radiation Protection (ICNIRP) and by the Institute of Electrical and Electronics Engineers (IEEE). There are two key concepts: emissions and exposure.

- Emissions are produced by the antenna. They represent the signals you transmit.
- Exposure is the emissions that reach a person and are absorbed by their body.

Guidelines contain no restrictions on emissions as such. Instead, they focus on exposure to humans. All amateur operators should assess the exposure to the EMF produced by their station to ensure compliance. In some countries, it is also necessary to maintain a record of formal assessments.

Safety is important to everyone. Learn how to effectively explain the safety measures that you have implemented to your family, friends, and neighbours. See:

- RSGB: EMF-3 Communicating with Neighbours and General Public about EMF Compliance [14]
- ARRL: Helping Amateurs Interact with Neighbors Asking About Radio Transmissions [15]

14 rsgb.org/emf
15 arrl.org/rf-exposure

Part B:
Operating Procedures

7 Listening Before and After Your Licence

Have you ever dreamed of hearing radio transmissions from amateurs, public services, from all around the world, Earth's orbit, and even from the outer space? What once required expensive receivers and bulky antennas is free and only needs an Internet connection. It is easy to get a taste of amateur radio by listening this way and it will help you to gain experience even before getting your transmitting licence.

7.1 Listening Before Getting Your License

If you are curious about amateur radio, but not yet ready to invest in equipment, online radio listening services are a great way to get started. These free services allow you to listen, decode, and visualise real-time radio transmissions from receivers located around the world. They stream the radio spectrum over the Internet, enabling you to tune in and listen to amateur radio bands, shortwave broadcasts, utilities, and any other radio signals just by using a computer or a mobile device. It is enjoyable and educational. You will learn about the radio bands and their uses. You will discover different modes of communication, such as CW, which uses Morse code, phone (voice) communications using Single Sideband (SSB), and many digital modes like FT8.[16] This knowledge will help you study for and pass your licensing exam and join the amateur radio community.

Observing how licensed operators behave on the air will teach you operating procedures, etiquette, and the structure of a typical radio contact, also known as a QSO. You will become familiar with the language and the norms of the amateur radio service and learn how to structure your transmissions so that they are respectful, polite, and friendly. It will also prepare you to deal with substandard operating procedures and behaviour which, unfortunately, you may encounter, too.

Listening to transmissions from different parts of the world will help you to understand radio wave propagation conditions. You can observe how signals vary with the time of day, atmospheric conditions, and the solar activity. These factors affect radio communications in exciting and not always predictable ways.

The huge variety of signals, from casual conversations between radio amateurs to emergency communications, may awaken new interests in you. It is inspiring to hear operators from distant lands. Encountering new or unusual signals is always exciting. Here are a few examples of what you may find and listen to.

- Amateur radio operators using phone, Morse code, or digital modes, let you hear and see all the content of their communications.
- Amateur radio beacons transmit signals at predetermined power levels, timings, and frequencies. They help to understand propagation conditions. [17]
- Shortwave public broadcasts, from Africa, the Americas, Asia, Europe, Oceania, even from the polar regions. You can listen to signals from literally all over the world!

16 Franke–Taylor design 8-frequency shift keying modulation (FT8) see wsjtx.github.io/wsjtx/index.html
17 www.iaru-r1.org/on-the-air/beacon

- Time and frequency reference stations like WWV or DCF77.
- Utility text broadcasts, such as marine weather reports, using radioteletype (RTTY).
- Images sent from the International Space Station using slow scan TV (SSTV).

7.1.1 Using Online Radio Listening Services

Although there are several online radio listening services, they are all similar in operation, even if their user interfaces differ. [18] They offer slightly different features, such as the range of built-in decoders. Each service is comprised of hundreds, or more, physical receivers all around the world. Individual receivers differ in the quality of their equipment, especially their antennas. The more popular online receivers can get busy at times, and you may need to wait in a queue to control one.

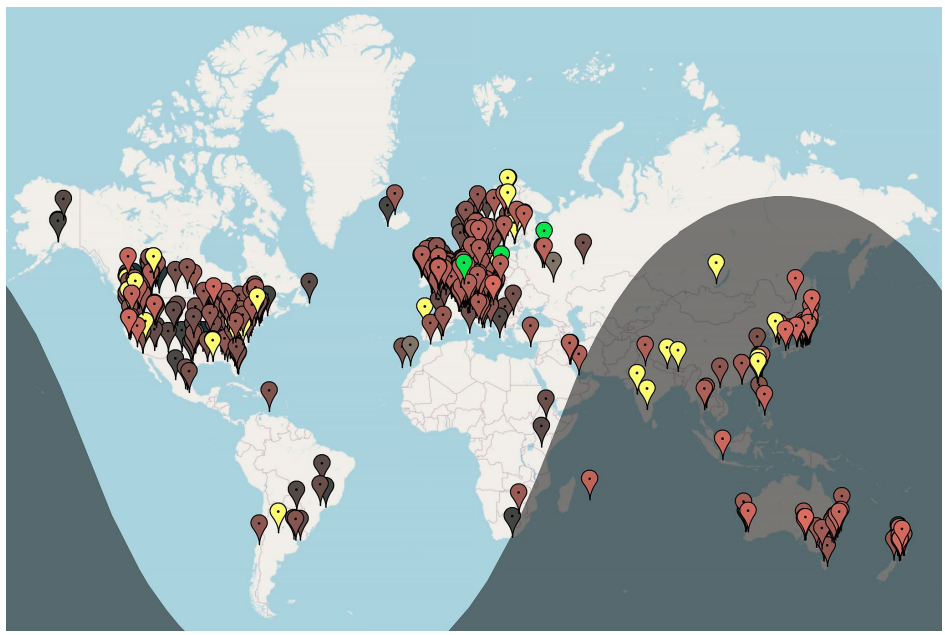

Figure 7-i: Free, online radio listening services. Map by KiwiSDR at rx.linkfanel.net. [Image by IU2DXF]

Online receivers are also referred to as online SDR receivers, because of their underlying technology, Software Defined Radio. However, there are many other uses of SDR in amateur radio. You can operate an online SDR receiver using its web interface:

1 Find a receiver. Different platforms offer searchable listings and world maps.
2 Connect to it using a web browser, by clicking on a map or a listing, or by entering its web address.

18 At the time of writing, the most popular were WebSDR, KiwiSDR, and OpenWebRx. See websdr.org, rx.linkfanel.net, and receiverbook.de.

3 Select the frequency of interest, by scrolling a live waterfall chart that shows the radio spectrum, or by entering the frequency using the keyboard.
4 Select or adjust the modulation mode and any filters.
5 Optionally, engage a decoder, for example for receiving RTTY.
6 While you are listening, you can change the volume, filter bandwidths, and make frequency adjustments.

Is this your first time? Grab a device and give it a go! Find a receiver that covers the 20 m band, which spans 14.000 – 14.350 MHz, because it is often reasonably busy, and it provides good audio from many receiver stations. [19] Once the page loads, familiarise yourself with the interface. It includes several controls, a frequency display, and a live radio spectrum graph, known as a waterfall display. It shows real-time signals, with bright lines indicating active transmissions. It even lets you zoom in and out of a range of frequencies.

Now, select the modulation scheme. For phone, choose Upper Sideband (USB) on the 20 m band. [20] If you are listening to Morse code, choose CW.

To tune to an active frequency, click on a bright line shown on the waterfall display. Fine-tuning can be achieved by using small arrows, or buttons marked + and –. If you cannot hear anything, or the signal is weak, click on a different part of the waterfall display to find a stronger signal. On the 20 m band you are likely to hear phone conversations around 14.200 MHz. CW can be found closer to the start of the band, just above 14.000 MHz. See Chapter 8 IARU and National Band Plans to learn how amateurs use the radio spectrum. Experiment with different frequencies, modes, and try different settings. Take note of interesting communications. Jot down the call signs of the operators whom you would like to look up in online databases. [21]

Online receivers can be used on any device, including smartphones. There are also apps that can decode digital transmissions, including SSTV and video-oriented modes. They can be used both with signals received online, or coming from inexpensive, handheld receivers.

If the software platform of the selected receiver supports automatic decoding of digital signals, you may want to find them. For example, the DDH47 station in Pinneberg, Germany, transmits weather bulletins for ships traveling across the North Sea on 147 kHz. [22] In addition to text messages, you can also receive radio fax images like the one shown in Figure 7-ii. There are similar stations transmitting from all continents of the world.

19 For example, University of Twente in Enschede, Netherlands using either WebSDR or KiwiSDR, or go directly to a receiver, such as hackgreensdr.org:8902 or websdr-maasbree.jouwweb.nl

20 For phone, it is common to use the upper sideband (USB) above 10 MHz, and the lower sideband (LSB) below 10 MHz. There are exceptions, such as USB on the 60 m (5 MHz) band, and many digital modes.

21 Such as hamqth.com, qrz.com, or qrzcq.com

22 KiwiSDR offers built-in digital mode decoders. You can engage the decoder and tune to this station just by clicking a tab labelled DDH47 GER, above the waterfall.

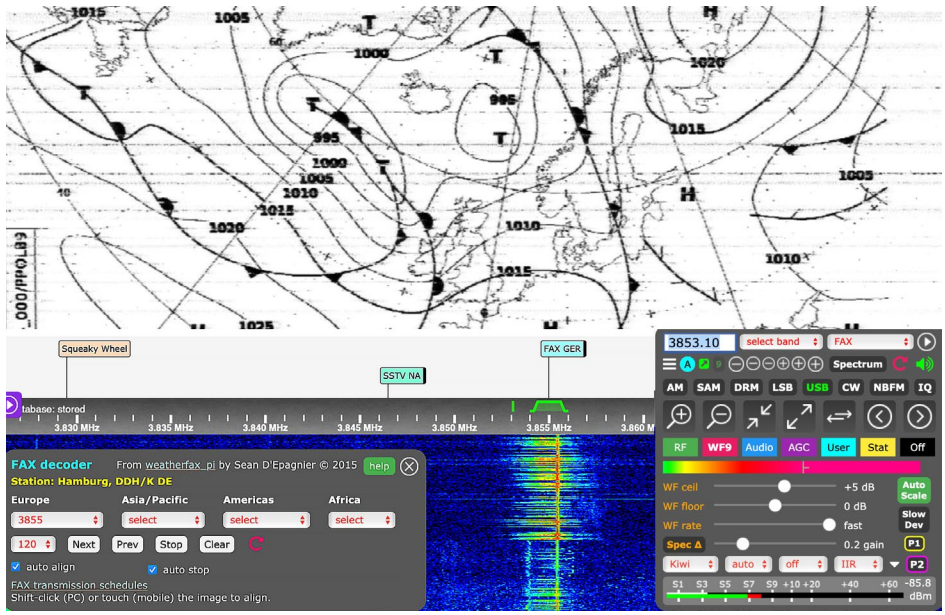

Figure 7-ii: Weather fax decoded using a free radio receiver tuned to a German station.
[Image by IU2DXF]

Propagation conditions are always changing. The best times to listen to the 20 m band are usually during the day, and in the early evening, at the geographical location of your chosen receiver. Other bands can behave differently. For example, the 80 m band is active during the late evening and night, whilst the 40 m band tends to be busy all around the clock. If you cannot find many stations on the 20 m band, which may happen when propagation conditions are not favourable, try the 40 m band, for example between 7.000–7.200 MHz. Propagation mainly depends on the time of day, and on the activity of the sun, which cycles from being quiet to active every 11 years. You can learn a lot about propagation from listening before you get your licence. There is always something to listen to!

8 IARU and National Band Plans

National regulators publish detailed radio frequency plans, coordinated by the ITU, defining the permitted uses of the entire radio spectrum.

8.1 Radio Spectrum Allocation

Large and valuable portions of the radio spectrum have been allocated to amateur radio throughout the world for over a hundred years. You must comply with the amateur radio frequency allocations as a condition of your licence. It is illegal to transmit on any frequencies outside your allocation, except for a small range of frequencies that may be exempt from licensing, such as the Citizens Band (CB) and Private Mobile Radio (PMR446), which are subject to separate national regulations.

Regulators in many countries encourage radio amateurs to follow the IARU Band Plans in addition to any applicable national band plans. These IARU Band Plans provide supplementary guidance which, when followed, promotes equitable access to allocated frequencies and supports efficient use of different communication modes by all amateurs. However, national regulations and band plans always take priority over the IARU Band Plans. You can find the IARU Band Plans at:

- IARU R1: iaru-r1.org/on-the-air/band-plans
- IARU R2: iaru-r2.org/en/on-the-air/band-plans
- IARU R3: iaru-r3.org/on-the-air/band-plans

8.2 Power Limits

You must obey the transmission power limits imposed by your national regulator as a condition of your licence. They can depend on the type of the licence, the band, and even on the range of frequencies within a band, and on the transmission mode.

You should understand the different ways in which power limits are specified. Peak Envelope Power (PEP) measured at the output of the transmitter, or at the output of an amplifier, if one is used, is a common way to express the limits. Effective Isotropic Radiated Power (EIRP) is also used, especially on the bands that may have stricter or lower limits. You must be able to control your transmit power, regardless of how the limits have been set. Further rules govern power limits away from a fixed station, for example, whilst operating portable or mobile transmitters. See Chapter 18 Away from Home.

8.3 IARU Band Plans

The three IARU regions have adopted voluntary band plans for the frequencies allocated to the amateur service by the ITU. Bands in these plans are grouped according to their overall ITU band, such as the 3–30 MHz High Frequency (HF) band, 30–300 MHz Very High Frequency (VHF), 300–3000 MHz Ultra High Frequency (UHF) and so on. In

casual amateur radio terminology, however, HF often also refers to the lower ITU bands, usually including the 300 kHz – 3 MHz Medium Frequency (MF) band.

There is much agreement between the band plans of the different regions, permitting compliant, long-distance, worldwide communications. Make sure to use your region's band plan. However, being aware of the differences in the band plans in the other regions that you wish to contact will improve your chance of success.

Band plans divide each band into smaller frequency segments, which are designated as preferred for a specific modulation type. This designation is based on bandwidth requirements and the nature of each mode to avoid interference between them. Modes that use a bandwidth of 500 Hz or less are referred to as narrowband modes.

Make sure that your chosen mode's bandwidth remains within the guidelines. For example, a well-shaped CW signal with a 6 ms rise and fall time, and not overdriven by poor amplification, requires only 50 – 200 Hz, even when transmitting at 35 words per minute (WPM). However, if only a 2 ms rise and fall time is used with overdriven amplification, it may cause harmful interference that is 3 kHz wide. A clean FT8 signal uses only 50 Hz, but when the computer audio levels are set too high, or the amplification is poor, it can use over 2 kHz of bandwidth. Such signals are no longer narrowband. They cause interference, and they are more difficult to decode. See Figure 5-i and Figure 5-ii for examples of such problematic signals. The most common bandwidths in the HF band plan are:

- 200 Hz, usually allocated exclusively to CW at the start of the band
- 200 Hz, for CW and other narrowband modes, including some digital ones like FT8
- 500 Hz, for CW and narrowband modes requiring more than 200 Hz, such as RTTY
- 2700 Hz, for all modes, including SSB, but also CW and all digital modes, usually allocated in the remainder of the band
- wider bandwidth requirements, such as the 6000 Hz required by AM, are typically accommodated in the phone segment of the band plan, with a provision to maintain sufficient signal separation from other users.

Table 8-A: IARU R1 detailed 80 m band plan (effective 01 June 2016)

	FREQUENCY SEGMENT (kHz)	MAX BANDWIDTH (Hz)	PREFERRED MODE AND USAGE	
3,5 MHz	3500 - 3510	200	CW	Priority for inter-continental operation
	3510 - 3560	200	CW	CW contest preferred 3555 kHz - CW QRS Centre of Activity
	3560 - 3570	200	CW	3560 kHz - CW QRP Centre of Activity
	3570 - 3580	200	Narrow band modes	Digimodes
	3580 - 3590	500	Narrow band modes	Digimodes
	3590 - 3600	500	Narrow band modes	Digimodes, automatically controlled data stations (unattended)
	3600 - 3620	2700	All modes (1)	Digimodes, automatically controlled data stations (unattended)
	3600 - 3650	2700	All modes (1)	SSB contest preferred 3630kHz – Digital Voice Centre of Activity
	3650 - 3700	2700	All modes	3690 kHz – SSB QRP Centre of Activity
	3700 - 3775	2700	All modes	SSB contest preferred 3735 kHz – Image Centre of Activity 3760 kHz – R1 Emergency Centre of Activity
	3775 - 3800	2700	All modes	SSB contest preferred – Priority for inter-continental operation

There are further recommendations regarding the preferred operating modes within each frequency segment. As an example, Table 8-A shows the full IARU R1 band plan for the 80 m band. The lines are colour-coded based on the bandwidth. The columns have the following meaning:

1 Band — 3,5 MHz refers to the entire 80 m band, which is also known as the 3.5 MHz band (this column uses a decimal comma). This is equivalent to 3 500 kHz.
2 Frequency Segment (kHz) — 3 500–3 510 means the range from 3 500 kHz to 3 510 kHz, equal to 3.5 MHz – 3.51 MHz. [23]
3 Max Bandwidth (Hz) — The maximum bandwidth that can be used by a single transmission.
4 Preferred Mode and Usage — This column lists the preferred modes on the left-hand side. The additional information on the right describes the preferred usage of the given frequency range. Centre of Activity refers to a frequency on which, or near which, the preferred usage should take place.

For example, the preferred range for intercontinental phone communications using Lower Sideband (LSB) would be in the 3 775 – 3 800 kHz range on the 80 m band. [24] Slow speed CW (QRS) should be used in the vicinity of 3 555 kHz.

Even though these band plans have been widely accepted, conflicts occasionally arise. A particular usage of some frequencies may be routine for some amateurs, but still obscure to others. To resolve such conflicts, the IARU updates the band plans based on the evolution of usage patterns. However, it can take a few years before the band plans are changed.

Unlike HF, the VHF and UHF band plans are more detailed and follow a channelised approach. They can vary significantly between countries. Look them up on your national radio society web site, where you should also find information about any national regulations that deviate from the IARU Band Plans.

23 1 MHz = 1 000 kHz, 1 kHz = 0.001 MHz. And so: 3 510 kHz = 3.51 MHz, 3.8 MHz = 3 800 kHz.
24 LSB is the preferred SSB mode on 80 m.

9 Content of Transmissions

Subjects discussed on the air by radio amateurs vary widely, although most conversations revolve around radio. Over time, the rules have become more relaxed in many countries, but a few good principles are still worth keeping in mind.

9.1 What to Talk About

The ITU Radio Regulations limit the content of transmissions between amateur stations of different countries to communications "incidental to the purposes of the amateur service," and to "remarks of a personal character." They do not limit the content of conversations between amateurs located in the same country. However, national regulations may impose additional rules.

In many countries, you will hear amateurs chatting about all sorts of subjects unrelated to radio, including their other hobbies, events, plans, and so on. Such topics are generally considered as remarks of a personal character.

The ITU regulations do not permit conducting business on the air, nor to use amateur radio transmissions to make money.

Broadcasting to the public, including speech or music, requires a different licence than the amateur licence. Amateur radio contacts, other than certain emergency transmissions, are always aimed at other radio amateurs. Except for test signals and initial (CQ) calls, amateur radio transmissions always address a specific participant identified by their call sign, or a group of such participants, known as a net.

Except during communication emergencies or natural disasters, passing messages on behalf of third parties is generally not permitted unless national regulations allow it, as is the case in the USA. [25]

9.2 Subjects to Avoid

As part of our long-standing etiquette some subjects should be avoided on radio:

- religion
- politics
- business – you can talk about your profession or trade, but you cannot advertise or conduct it on the air, including any selling or buying [26]
- derogatory remarks directed at any group: ethnic, racial, religious, sexual, etc.
- bathroom humour – if you would not tell a joke to a child, do not tell it on the radio

25 www.arrl.org/third-party-operating-agreements

26 Refer to local regulations if you are in doubt, but it is generally accepted that actively promoting, selling, or buying equipment or services on the amateur radio bands must be avoided.

9.3 Amateur Radio Language

Another radio amateur may refer to you or themselves as a ham. It is a colloquial term for radio amateurs. Radio amateurs address one another using their given name, or a nickname, and their call sign. Surnames, titles, and honorifics are used rarely. You may hear someone ask, *have you read any books by the late John ON4UN?* This also applies to written communications between radio amateurs.

A part of the amateur radio etiquette is to bid farewell by using "73" which stands for "best regards." You will even hear it spoken off the air, when radio amateurs meet.

Radio amateurs say that they work each other. To work means to make contacts with one another. Contacts are commonly referred to as QSOs. A longer conversation is known as a ragchew. Some amateurs prefer to ragchew, and others like to make short contacts. Others may like contesting: participating in competitions with the aim to make as many correctly logged QSOs as possible. Many like to do all those things!

Even though beginners tend to buy complete radios, some amateurs eventually homebrew: they design and build their own transmitters and receivers, and almost everyone tinkers with antenna design.

If you come from a CB background, you may notice that some familiar expressions are not commonly used in amateur radio and might not always be understood. A few terms also carry different meanings, especially in relation to propagation, station identification, radio bands, and modes.

Q-codes and other operational abbreviations, that came from Morse code, are widely used during on-air contacts, and even in casual, in-person conversations, see Chapter 10.

When spelling call signs or anything else, use the recommended phonetic spelling alphabet, see Chapter 11. Avoid non-standard spellings, which may sound amusing but are unlikely to help others understand you. Do not mix different phonetic spellings in one sentence. For example, calling *CQ from ZL6HQ, Zulu Lima Six Hotel Quebec, Zanzibar London Six Honduras Queen* would be confusing, especially if band conditions were poor. However, non-English speakers often use their national phonetic alphabets with each other. You hear them often during international radio contests.

English is the most widely used language in amateur radio, although anyone can converse in their language of choice. Because of Q-codes and abbreviations, telegraphy, including CW, allows those who speak neither English nor the language of their QSO partner to make meaningful contacts.

9.4 Listening

A good radio amateur spends plenty of time listening. Even if not everything that you hear reflects good operating practice, when you are active on the bands, set a good example. Above all, always listen, before you transmit.

10 Q-codes and Operational Abbreviations

Abbreviations are very popular in amateur radio. They make communication more efficient and less ambiguous, and they have become part of everyday radio amateur language. The most important abbreviations include a subset of the standardised Q-codes, and a few additional ones developed from common on-air operating practices.

10.1 Q-codes

Q-codes are standardised three-letter combinations that begin with the letter Q. Developed between 1909 and 1912, they were designed to facilitate commercial transmissions, speeding up the sending of Morse code messages and serving as a form of international telegraphy language. [27] They are widely used in CW and RTTY, and even on phone, assisting operators who speak different languages. There are many more than those shown below, however, some operators may not understand the less popular ones. [28]

Table 10-A: Q-codes

Q-code	As a question	As a statement or an answer
QRG	What is the (exact) frequency?	The frequency is …
QRK	What is the readability of my signals?	The readability of your signals is 1–5 [29]
QRL	Are you busy? Is the frequency busy?	I am busy The frequency is in use
QRM	Are you being interfered with?	I am being interfered with [30]
QRN	Are you bothered by atmospherics (noise of a natural origin)?	I am bothered by atmospherics
QRO	Should I increase power?	Increase your power
QRP	Should I decrease my power?	Decrease your power
QRS	Should I decrease my sending speed?	Decrease your sending speed [31]
QRT	Should I stop my transmission?	Stop your transmission

27 The first twelve codes were standardised in the 1912 International Radiotelegraph Convention Regulations. We still use some of them: QRK, QRL, QRM, and QRN. The current list is the 1995 recommendation ITU-R M.1172 which focuses on maritime radio use. itu.int/rec/R-REC-M.1172-0-199510-I/en

28 en.wikipedia.org/wiki/Morse_code_abbreviations

29 The response to QRK? recommended by the ITU uses 1=Bad, 2=Poor, 3=Fair, 4=Good, 5=Excellent. These are different from the R (RST) code shown in Section 13.4, even if the intuitive meaning is similar.

30 Optionally, you can use a scale from 1–5. 1: Not at all, 2: Slightly, 3: Moderately, 4: Strongly, 5: Very strongly.

31 To indicate your desired speed, e.g. 10 WPM (words per minute), transmit QRS 10.

Q-code	As a question	As a statement or an answer
QRU	Do you have anything for me? [32]	I have nothing for you
QRV	Are you ready?	I am ready
QRX	When will you call me back?	I will call you back at ... Also: wait, standby [33]
QRZ	Who is/was calling me? [34]	You are called by ...
QSB	Is my signal fading?	Your signal is fading
QSL	Can you confirm reception?	I confirm reception
QSO [35]	Can you make contact with ...? Can you communicate with ... directly?	I can communicate with ... (directly)
QSX	Can you listen on ...?	Listen on ...
QSY [36]	Shall I start transmitting on ...?	Start transmitting on ... frequency Also: change frequency to ...
QTH	What is your location?	My location is ...
QUF [37]	Have you received the distress signal sent by ... (name and/or call sign)?	I have received the distress signal sent by ... (name and/or call sign) at ... hours.

Some Q-codes have evolved and slightly changed in meaning over the years. Learn both the meaning listed in Table 10-A, and the additional meanings shown in Table 10-B.

10.2 Q-code as a Question or an Answer

Q-codes can be used to ask a question and to provide an answer. In telegraphy, simply add a question mark "?" after the code to make it into a question. In telephony, if it is appropriate to use a Q-code, simply speak with a questioning tone of voice. For example, in telegraphy, to ask *Is this frequency in use?* you could transmit:

- QRL?

To which you may receive a response such as:

- QRL

32 This code is sometimes used in CW as a polite way of implying that if the other operator has nothing further to discuss, then communications should end sooner rather than later.

33 If a number follows, e.g., QRX 3, it usually means *Wait for three minutes.* You can also specify a time for the subsequent call. QRX on its own is used to say *please wait a moment.*

34 See Section 13.5 How to use QRZ.

35 In addition to being a Q-code, QSO is also a common operational abbreviation for a *radio contact.*

36 See Section 13.6.1 Changing Frequency (QSY).

37 See Section 3.1.1 Emergency Communications Essentials.

QRL on its own, without a question mark, means *Yes, the frequency is in use.* You could also get a different reply, such as YES, or Y. Essentially, a Q-code without a question mark indicates a statement or an answer.

On phone, if you are making a quick contact, you may want to receive a verbal acknowledgement of some information that you have just exchanged. Using a questioning tone of voice to ask *QSL?* is a common way to do that. It means *Can you confirm reception of the information we have just exchanged?* In reply, the other operator may just say *QSL* to acknowledge that they have received and understood the exchange.

Q-codes used by radio amateurs are just like a spoken language, and they can be used for other, similar purposes depending on the context. For example, you could also use the QSL code to say *QSL via buro* which would have the meaning of *I will confirm (acknowledge) our contact by sending a card via the bureau.*

10.3 Operational Abbreviations

Like Q-codes, operational abbreviations are used in radio communications to speed up message transmission and to facilitate conversations between operators speaking different languages. The most popular ones are listed in Table 10-B.

Some of the operational abbreviations, especially when used in a conversation, have the same meaning as a Q-code from which they originate. For example, two radio amateurs may be conversing about a place, referring to it as a QTH, saying something like *Have you seen the new QTH where the awards dinner is going to be held?* Clearly, they are not using QTH as a strict Q-code to ask or confirm their location. Instead, QTH now simply means *a location*. Similarly, you may hear someone say *Nothing seemed to happen on that QRG,* meaning, on that frequency.

Table 10-B: Operational abbreviations

Abbreviation	Meaning
AGN	Again, please repeat
Being QRV	Being ready, being available
BK	Signal used to interrupt a transmission in progress
BURO	QSL card bureau
CL	Station is closing down
CQ	General call to all stations, intended to be answered by anyone
CW	Continuous Wave, synonymous with Morse code in amateur radio
DE	From – used in front of the call sign of the calling station
DX	Long distance, usually meaning on another continent
Going QRT	Leaving the station, stopping transmissions
K	Over – an invitation for the other operator to transmit
MSG	Message

Abbreviation	Meaning
OP	Operator
PSE	Please
QRG	Frequency
QRX	Just a moment, please stand by
QSL	I confirm
QSL Card	Paper card that confirms a contact
QSO	Radio contact
QTH	Location
QSY	Change of frequency
RST	Readability, signal-strength, tone-report, see Section 13.4
R	Received, but it can also imply a *yes* [38]
RX	Receiver
SKED	Scheduled call, planned and agreed ahead
SOS	Emergency – see 3.1.1 Emergency Communications Essentials
SRI	Sorry
TU, TKS, TNX	Thank you
TX	Transmitter
UR	Your

38 The phonetic spelling of R is *Romeo,* however, when you hear R on its own, as a confirmation of reception, you will hear it spoken as *Roger.* Although it is not supposed to imply *yes* or *correct,* but only a confirmation of the reception, it can be taken as a *yes* depending on the context.

11 Phonetic Alphabet

The international phonetic alphabet should be used whenever it is necessary to spell out call signs, words, and abbreviations. [39] The regulations require its use when transmitting by phone to a station in another country.

Phonetic alphabet also helps to ensure that important information can be understood even when signals are weak or distorted, or when operators speak different languages. This is particularly important in emergency situations, and helpful during radio contests. However, national regulations may permit the use of alternative national phonetic alphabets for local communication.

11.1 International Radiotelephony Spelling Alphabet

The phonetic alphabet, also known as the International Radiotelephony Spelling Alphabet, the North Atlantic Treaty Organization (NATO) phonetic alphabet, or the International Civil Aviation Organization (ICAO) phonetic alphabet, is commonly used by all radio amateurs. It is shown in the two tables on the next page. The first table shows the letters using the ITU-recommended ICAO pronunciation. Numbers, however, do not follow the ITU recommendation. [40] Instead, radio amateurs use the ICAO pronunciation for the numbers. [41] They are shown in the second table.

When speaking, emphasise the capitalised syllable. Pay attention to the recommended pronunciation of the numbers, even if it may sound unusual to native English speakers. For example:

- Spelled ZL6HQ — Zulu Lima Six Hotel Quebec
- Spoken ZL6HQ — ZOO-loo LEE-mah SIX ho-TELL keh-BECK
- Spelled 4U1UN — Four Uniform One Uniform November
- Spoken 4U1UN — FOW-er YOU-nee-form WUN YOU-nee-form no-VEM-ber
- Spelled EI90IRTS — Echo India Nine Zero India Romeo Tango Sierra
  - Spoken EI90IRTS — ECK-oh IN-dee-ah NIN-er ZE-RO IN-dee-ah ROW-me-oh TANG-go see-AIR-rah

39 Appendix 14, Rev WRC-07, ITU Radio Regulations 2020.

40 ITU Phonetic Alphabet and Figure Code pronunciation of numbers uses unusual words. They are rarely used by radio amateurs: 0=Nadazero, 1=Unaone, 2=Bissotwo, 3=Terrathree, 4=Kartefour, 5=Pantafive, 6=Soxisix, 7=Setteseven, 8=Oktoeight, 9=Novenine.

41 Annex 10 to the Convention on International Civil Aviation, 2016 Edition, Volume 2, Chapter 5, Sections 5.2.1.2 and 5.2.1.4.3. See elibrary.icao.int/product/278655

Table 11-A: International radiotelephony spelling alphabet: letters

Symbol	ITU Code word	Spoken (ITU)
A	Alfa	AL-fah
B	Bravo	BRAH-voh
C	Charlie	CHAR-lee or SHAR-lee
D	Delta	DELL-tah
E	Echo	ECK-oh
F	Foxtrot	FOKS-trot
G	Golf	GOLF
H	Hotel	ho-TELL
I	India	IN-dee-ah
J	Juliett	JEW-lee-ETT
K	Kilo	KEY-loh
L	Lima	LEE-mah
M	Mike	MIKE
N	November	no-VEM-ber
O	Oscar	OSS-cah
P	Papa	pah-PAH
Q	Quebec	keh-BECK
R	Romeo	ROW-me-oh
S	Sierra	see-AIR-rah
T	Tango	TANG-go
U	Uniform	YOU-nee-form or OO-nee-form
V	Victor	VIK-tah
W	Whiskey	WISS-key
X	X-ray	ECKS-ray
Y	Yankee	YANG-key
Z	Zulu	ZOO-loo

Table 11-B: International radiotelephony spelling alphabet: numbers

Symbol	ITU Code word	Spoken (ICAO)
0	Zero	ZE-RO
1	One	WUN
2	Two	TOO
3	Three	TREE
4	Four	FOW-er
5	Five	FIFE
6	Six	SIX
7	Seven	SEV-en
8	Eight	AIT
9	Nine	NIN-er

12 Conducting QSOs

All radio contacts follow a similar structure, with regulations – especially those concerning station identification – always in mind. This chapter focuses on the overall structure of a QSO, while the following chapters explore the specifics of the most popular amateur radio modes.

12.1 What is a QSO

A QSO is a contact by radio between two or more amateur radio stations. You can make a general call, known as a CQ, or answer someone's CQ, or call someone who has just finished another contact. In all kinds of QSOs, including phone, CW, or digital, we do not talk simultaneously. There is always one person speaking, and one, or more, listening, at a time. This is known as simplex: only one transmitting station at a time.

Many amateur radio contacts are made just to have a conversation with another person. However, many QSOs are also made to win an award or a contest. Only valid contacts count for those additional purposes. The concept of a valid QSO has been defined and agreed upon by the IARU. [42] A valid contact is one where both operators during the contact have:

1. mutually identified each other
2. received a report, and
3. received a confirmation of the successful identification and the reception of the report

It is emphasised that the responsibility always lies with the operator for the integrity of the contact.

12.2 Use your Call Sign Correctly

The short word call is sometimes used instead of the longer call sign or call letters. Even though a call sign is a unique identifier assigned to a radio station, for radio amateurs their call sign becomes part of their identity. Many are proud of it and display it prominently. It is likely that you will become known by your call sign more than by your name.

The structure of amateur station call signs is specified by the ITU. [43] In general, the first one or two characters of a call sign denote its nationality. Your regulator will assign a call sign to you when you obtain your licence. National regulations have further rules on call sign formation, including any regional identifiers, or the choice of the first characters if your country uses several different ones. You should learn the structure of the call signs which you are likely to encounter.

42 IARU R1 recommendation Sun City SC11_C4_REC12. See IARU Region 1 HF Managers Handbook, Section 2.1.1, iaru-r1.org/wp-content/uploads/2019/08/hf_managers_handbook_v9.pdf

43 Articles 19.67–19.69 in the 2020 edition cover amateur stations. Other sections of that document cover foundational concepts, such as the international series, which form the first characters of a call sign.

Do not start your transmission by identifying yourself or your correspondent by your or their given name. Do not start by saying: *Hello Mike, this is Louis.* Identify yourself with your full call sign, and not just with the end of it. It is against ITU regulations, and illegal in many countries, to identify your radio transmissions by anything other than the exact call sign that was assigned to your station. For example, identify yourself as EI0HQ, and not 0HQ, even if both parties are in the same country, Ireland (EI) in this example.

You may be required to append (suffix) or prepend (prefix) your call sign with additional symbols. For example, if you are operating from a land-based vehicle in many countries, or from a maritime vessel or an aircraft, you may need to add the /M, /MM, or /AM suffixes to your call sign. There are many other prefixes or suffixes in use worldwide.

In some countries, national regulations do not permit operators to choose some prefixes or suffixes. For example, operators in the USA or in the UK may use /QRP as a suffix. However, it is not permitted in some other countries. Know the regulations regarding call sign prefixes and suffixes, especially when operating abroad – see Section 18.4.2.

12.3 Call Sign Due Diligence

Except when dealing with some emergencies, mentioned in Section 3.1, radio amateurs are only allowed to make contacts with other radio amateurs. One way to ensure you comply with this important rule is to validate the call sign of the station you are about to contact. Knowing the general structure of call signs, and the recognised national prefixes, will go a long way. You can also perform simple lookups to check a call sign if you have some doubt. Always make sure that you work amateur radio stations that you are legitimately allowed to contact under the terms of your licence.

12.4 Frequent Identification

Always identify yourself frequently, at reasonably short intervals, and in line with the national regulations. The ITU Radio Regulations require that:

- During the course of their transmissions, amateur stations shall transmit their call sign at short intervals. [44]

Identification every 5 or 10 minutes is customary, except during contests, when it is normal to identify much more frequently, at each, or almost every QSO. Some national regulations impose specific intervals at which stations must identify themselves, especially when operating away from their home station.

! Transmitting on amateur radio bands without clearly identifying the source station constitutes a breach of regulations. It is illegal in many countries.

44 ITU Radio Regulations Article 25.9 in the 2020 and prior editions.

12.5 Before a QSO

In every QSO there is an initiating station and a replying station. [45] Before a QSO can take place, the initiating station needs to find a frequency and to ensure that it is clear. Then, they place a general call, or a call to a specific station, if a QSO has been scheduled in advance. Scheduled QSOs are known as skeds.

Unless participating in a sked, the replying station needs to find an initiating station to reply to. This can be done by listening whilst turning the radio's frequency knob. That knob is still referred to as the VFO even though many modern radios no longer use a variable frequency oscillator. It is also possible to watch a waterfall display that shows where the active signals are and to tune directly to them by using other radio controls.

Software decoders which simultaneously receive many transmissions and show their contents on a computer screen can be also used to find stations. Non-conversational digital mode software, such as used for FT8, uses this approach as the primary operating technique. It is also possible to use such decoders, also known as skimmers, with the other digital modes, including CW and RTTY.

12.5.1 Finding a station: DX Cluster vs Tuning

Tuning manually, by slowly turning a VFO whilst listening, is a very enjoyable and educational method of finding a station to reply to. It works for many modes, including CW, phone, RTTY and some other digital modes. This method, however, is ineffective for those digital modes whose signals are harder to listen to and often densely packed, sometimes even sharing the same frequency.

If you are new to amateur radio, you can learn much by using the manual tuning technique. You will discover different operating styles. It will also hone your ear to hear the quieter stations which sometimes cannot be found using other methods. Above all, manually tuning using a VFO will give you a good understanding of the structure of the band and how it is used in your region.

Instead of tuning manually, a frequency of a calling station can be obtained from other sources, including DX clusters. The term cluster refers to a network of interconnected computers, also known as nodes, that share information about initiating stations with one another. All those nodes form a global cluster. Even though you may connect to an individual node in the cluster's network, the information you receive should be identical no matter which one you have connected to. However, different nodes may use slightly different software, and the way you interact with them may allow for different functions, including filtering.

Nodes in a cluster obtain their information about stations from two sources. The first source are manual spots, which are notifications manually supplied by other amateurs who wish to share the call sign and the frequency of a station calling CQ that they have heard. The second source of cluster information are skimmers, including the Reverse Beacon Network (RBN). Skimmers are automated receivers that are constantly listening

45 The initiating station is also sometimes referred to as the *calling* station. This can be confusing, because the phrase *to call* is also used to mean *to reply* when referring to the replying station.

to the bands and report all the heard initiating stations to a cluster node. Those automatically supplied skimmer spots do not include phone (SSB) calling stations because, at the time of writing, skimmers can only decode call signs of digital modes, including CW, RTTY, PSK31/PSK63, FT8/FT4, etc. Stations calling CQ on phone can be found from manually contributed spots at present. However, skimmers are likely to improve.

- If you use a cluster to find a station to reply to, make sure to confirm that their call sign matches the one you got from the cluster. Clusters often report an incorrect or a partial call sign, leading to situations that can be disappointing, even if occasionally amusing.

There are other ways to find stations, including online and radio chat rooms, social media, and web sites. They are of particular importance when working rare or experimental modes, or more challenging bands, including some uses of VHF, UHF, and microwaves, for example for making Earth-Moon-Earth contacts. While helpful for casual contacts, these methods may be explicitly disallowed when participating in contests or awards. Make sure to study the rules.

12.5.1.1 *Submitting Cluster Spots*

Cluster spots are supposed to inform others about interesting stations that you have worked or heard, maybe a rare DX station. A cluster spot contains the other station's call sign, frequency, mode, and any other information that may be helpful to work the station, for example, if the station is using split operation.

If the station has been spotted several times recently, do not spot it again. Save the cluster for a more interesting station. Do not use clusters to announce who you have worked, nor to thank the other station – you would have done that during the contact.

If you submit spots during a contest, do not just spot your friends. Avoid organised spotting aimed at promoting a group, because radio contests are supposed to focus on radio skills, rather than on cheerleading using clusters or social media. Do not spot yourself, even by using a different call sign, except in contests which allow self-spotting. You or your friends may be disqualified.

12.5.2 Selecting a Clear Frequency

If you would like to make a general call, that is, a CQ, or a call to a specific station that you have in mind, but which has not started transmitting yet, you become the initiating station. You will be the first to transmit, and you have the important responsibility to select an appropriate frequency for your chosen mode and to ensure non-interference. Follow these steps before you make that first call:

1. Check which segment of the band is preferred for the intended use. Refer to the IARU and any national band plans – keep them near your radio. Your licence conditions may place additional restrictions on the frequencies that you are allowed to use.
2. Before calling on a frequency, listen carefully to make sure it is clear. If you are using a digital mode such as FT8, use the waterfall or a software spectrum scope to select a

frequency, or a frequency offset, that appears sufficiently clear, even if the mode supports simultaneous transmissions by more than one station on the same frequency. Avoid selecting frequencies too close to another nearby transmission. If you are using a traditional mode, it is also a good idea to glance at the waterfall to check whether a signal was present shortly before you started listening.

3 If you can just hear speech-like sounds or the rhythm of speech from a signal on a nearby frequency, consider moving a little up or down the band. On phone, never select an LSB frequency that is so low, or a USB that is so high, that it would cause your transmission to fall outside the allocated band. SSB requires 2.7 kHz bandwidth below (LSB) or above (USB) the frequency shown on your transmitter's frequency display.

4 If your equipment requires you to transmit a carrier to engage the antenna tuning unit (ATU) to find an impedance match, do it now. Be as brief as possible, because there is a chance you may cause interference to others even though the frequency appears to be clear. You may also tune the ATU on a nearby frequency, perhaps in a portion of the band allocated to a different mode which you know is less likely to be in use. If you do that, make sure to listen carefully on that frequency before you tune. Tuning, especially if lasting more than a second, can be very disruptive to others.

5 If the frequency still appears clear, ask:

5.1 On phone: *Is this frequency in use from EI0HQ?* Some operators ask *is this frequency clear?* but that may be confusing. A frequency clear to one station may not be to another. It is better to ask *is this frequency in use?*

5.2 In CW, RTTY, and other conversational digital modes, transmit: QRL? DE EI0HQ

5.3 Although you are supposed to identify all transmissions, you will hear stations only transmit QRL? or even just a question mark "?" on their own in CW. The reason is not to interfere with a transmission in progress that you may not be hearing. QRL? is less likely to interfere than QRL? DE EI0HQ. It is expected that you identify yourself after a QRL? if the frequency was clear when you began your QSO. On the other hand, if you decided not to transmit, even if clear, you should still identify yourself. For example: QRL? (pause – frequency is clear) DE EI0HQ. Arguably, you could also briefly identify yourself if the frequency was in use, albeit causing some unwanted interference. You could transmit: QRL? (pause – frequency is in use) SRI DE EI0HQ. SRI means sorry. However, regulations imply that you should not cause interference. In this case you must decide between causing some interference or failing to identify.

6 If no one has indicated that the frequency is in use, ask again, listen, and wait.

7 If no one is indicating that the frequency is in use, go ahead and make your call.

You may be wondering that if you have already listened for a while on an apparently clear frequency, why do you have to ask if the frequency is in use. The reason for that is that one station, who is part of a QSO, may be in a location that you cannot hear. That station could be transmitting on this frequency to someone who is listening. You cannot hear the transmitting station, and they probably will not hear you, because there is no propagation path between you. However, the other station that they are in a QSO with, who is listening, may be in your propagation path. If you were to transmit, they would no longer be able to hear their partner. If you ask if the frequency is in use, their

correspondent may hear you and confirm. If you start transmitting without asking, you are likely to cause man-made interference (QRM) to one of the stations.

If you are in a phone QSO and hear someone asking whether the frequency is in use, or you hear QRL? or just a question mark "?" in CW, you should reply:

- On phone: *Yes*
- Or more fully: *Yes, this frequency is in use*
- In CW, any of: QRL, Y, or YES

Note how QRL on its own, without a question mark, means *This frequency is in use*.

Many operators use both a waterfall display, and listening, to find a clear frequency. If you wanted to be even more assured of it, you may look up cluster spots, sorted by frequency, to see if there are stations using it in other parts of the world, whom you cannot hear, but which could interfere with the stations that you want to reach. For example, a European operator may want to be heard on the east of North America. Knowing from the cluster that the otherwise clear frequency is occupied by a station on the American west would help to select another frequency. It is more likely that the European would be heard by a potential American east coast station when there is no interference from the west coast station that they cannot hear in Europe, but which shows up on the cluster.

12.6 Format of a QSO

Once the QSO has started, it consists of a series of overs. An over can be a short or a longer sentence, or a few sentences, spoken or transmitted by only one operator at a time. An over usually ends with the person saying *over* to indicate to the listening operator that it is their turn to transmit. In CW, an over is usually ended by sending letters K or KN, which are explained in Chapter 13. In other modes, especially digital, there are other conventions for indicating the end of an over or of the entire QSO.

When your correspondent switches over to you, it is a good habit to wait a moment before starting your transmission, to see if someone else may be trying to join you.

Should transmissions be short or long? Preferably short, because it is easier for your correspondent to comment on something that you said.

12.6.1 Order of Call Signs

Call sign of the station you speak to comes first, followed by your own call sign. For example, if you are EI0HQ, and you talk to 4U1UN, the correct order of call signs is:

- on phone: *4U1UN from EI0HQ*
- or even shorter: *4U1UN EI0HQ*
- or, in CW or RTTY: 4U1UN DE EI0HQ
- or, in FT8: 4U1UN EI0HQ IO63 [46]

46 IO63 is the Maidenhead grid square of the QTH of EI0HQ. See also the next footnote and Section 14.3.2.

12.6.2 General Structure of a QSO

Transmission mode type usually determines if the QSO is conversational or non-conversational. A conversational QSO has a free-flowing structure, letting operators talk about anything at any time, for example:

1 Initial, general CQ call, or a call to a specific station
2 Reply to the initial call consisting of the minimum necessary information, usually including the call sign of the calling station, and always including the replying station's call sign
3 Exchange of signal reports and basic information, first by the initiating station, then by the replying station
4 Further overs to cover any other subjects of interest
5 Closure, usually consisting of pleasantries, thank you, 73, usually first by the initiating station, then by the replying station
6 Subsequent CQ call by the initiating station, unless closing down or tail-ended by another replying station

Tail-ending happens when another station has been listening to a QSO and decides to call either the initiating station or the replying station when the contact is ending. Tail ending is a common practice especially during casual QSOs. If tail-ending is addressed at the replying station, it is customary for the replying station to suggest moving to another frequency, see QSY in Section 13.6.1. There are also conventions and signalling techniques that stations can use to indicate if others are welcome to tail-end, or even to join a QSO that is already in progress. They are discussed in the following two chapters.

Non-conversational QSOs are common with time-synced digital modes, see Section 14.2. They are much shorter, and quite economical with the information being exchanged, keeping the QSO to a minimum, somewhat like a contest QSO. For example:

1 Initial general CQ call, usually including geographic information such as the Maidenhead Locator System grid square [47]
2 Reply including geographic information
3 Signal report by the initiating station
4 Signal report by the replying station, including an acknowledgement of the received call sign and signal report, and optionally their closure, thank you, 73, etc.
5 Closure by the initiating station consisting of a` thank you, 73, etc.
6 Optionally, closure by the replying station, unless implied otherwise
7 Subsequent CQ call by the initiating station

Some of those overs can be combined to make an even shorter QSO consisting of only five overs, including the first CQ call. See examples in the next two chapters.

47 Maidenhead Locator System, Maidenhead grid locator, grids, or simply squares, is a geocoding mechanism used by radio amateurs to describe geographical locations. wikipedia.org/wiki/Maidenhead_Locator_System

13 Phone and CW QSOs

Phone and CW QSOs are conversational in nature. Because they share many similarities, this chapter introduces them together. There are other digital conversational modes which follow CW QSO conventions. They are introduced in the next chapter.

Listening, especially while you are studying for your licence, is an excellent way to learn how to conduct QSOs. Joining an amateur radio club can build on that experience by providing friendly advice from seasoned operators who would be happy to help you make your first QSOs.

13.1 Phone and CW

Phone and CW have been popular for a long time. They are enjoyable because operators make a personal connection with each other. You hear their voice, and you feel the emotion of the other person. The ability to connect with people from diverse cultures from all around the world can be very rewarding. This social aspect of our global community is often the reason why people decide to become radio amateurs. Operators form lasting friendships through regular communication and shared interests. Talking is the most natural way of making new friends, even if it takes a little courage at first.

When conversing using a Morse key, you can feel the confidence of an experienced operator, or the nervousness of a novice, or the hesitation of a friend who is pausing to consider your question. CW can feel even more personal than phone for some amateurs because of the concentration it requires. It is as if you were hanging on every word and each letter that your friend is sending to you. Their sending rhythm, if they use a manual key, is very personal. It is known as the operator's fist. Many can recognise each other just from their fist, even before they have heard the call sign. Being the oldest mode of radio communication, CW has a rich and a fascinating history, traditions, abbreviations, and many interesting operating techniques.

Unless you already know it, consider learning CW. It will reward you with reliable, long-distance, personal, and hugely enjoyable experiences for the rest of your life. There are several international clubs that teach CW. [48] Your national radio society can help you find a local one. You can also self-study online. [49]

13.2 Making Initial Calls

When selecting a frequency follow the advice from Section 12.5 Before a QSO. Consider if using one of the known centres of activity might be appropriate. For example, a CW novice may want to use a centre of activity dedicated to slower operation (QRS). Find them in the IARU and national band plans.

48 CW Academy (CWA), part of CW Operators Club (CWOPS), offers free courses, cwops.org/cw-academy
49 For example, see Learn CW Online lcwo.net and Morse Code Ninja morsecode.ninja/learn

13.2.1 Format of Phone and CW CQ Calls

On phone, to make a CQ call inviting any station to reply, use one of these:

- *CQ CQ CQ from EI0HQ EI0HQ EI0HQ standing by*
- *CQ CQ CQ this is EI0HQ EI0HQ EI0HQ standing by* [50]

The phrase *standing by* is used to invite others to reply. Even though you may hear some people say *over* at this point in the QSO, *standing by* usually makes more sense. *Over* can imply that you are already talking to someone to whom you want to *over to,* but there is no other station involved yet.

Repeating your call sign two or three times helps faraway stations decipher it. It is also useful for detecting errors when the propagation conditions are poor. However, brevity is also important to the listening stations and repeating it more than three times is rarely necessary. It is better to be brief, then to pause and listen for long enough to hear even a quiet reply, and to make the whole CQ call again if no one came back.

In CW, transmit:

- CQ CQ CQ DE EI0HQ EI0HQ EI0HQ K

The final symbol, K, is known as an invitation to transmit. Although you will hear different variants of the CQ call on the air, this format is recommended by the IARU and the ITU. [51]

Some stations precede the K with a prosign <AR> meaning end of message, or the operational abbreviation PSE, meaning please. Prosigns, or procedural signs, are used extensively in CW. They are written as letters between angle brackets <AR> or by using the barred notation with the letters having a line above them, like $\overline{\text{AR}}$. [52] This indicates that the letters A and R should be sent together without the usual space of one dit between them. You will learn several CW prosigns when you study Morse code. [53] Some of them are also used in other digital modes.

The optional use of PSE is courteous but not required. In general, avoiding unnecessary extras increases predictability and improves accuracy, especially for the less experienced operators. If you use the optional prosign <AR>, make sure to follow it by K. Ending the CQ call with <AR> alone is not sufficient. A CW CQ call that uses that optional prosign could have this form:

- CQ CQ CQ DE EI0HQ EI0HQ EI0HQ <AR> K

50 For brevity, the *from* form is used in the rest of this document, however, the *this is* form is equally popular.

51 The structure of CW calls presented in this guide follows the common practice and is based on the recommendation ITU-R M.1677-1 (2009) in addition to the *IARU Ethics and Operating Procedures 3rd Edition,* including the subsequent IARU R1 Recommendation VA14_C3_REC_21.

52 This document's typography uses the angle bracket notation for prosigns, instead of the barred notation, for accessibility reasons.

53 en.wikipedia.org/wiki/Prosigns_for_Morse_code

13.2.2 CQ Calls to Specific Geographic Areas

If you are only interested in hearing from stations on another continent, or stations from specific countries, you can ask for that in your CQ call. There are other ways to specify who you would like to hear from, which follow the same general format. For example, to ask only for stations from Japan to respond, whose representative national prefix is JA, you would call on phone: [54]

- *CQ Japan CQ Japan CQ Japan from EI0HQ EI0HQ EI0HQ standing by*

or, in CW:

- CQ JA CQ JA CQ JA DE EI0HQ EI0HQ EI0HQ K

13.2.3 CQ DX

To work only those stations that are located faraway, make a CQ DX call. On phone, you could use one of those:

- *CQ DX CQ DX CQ DX from EI0HQ EI0HQ EI0HQ standing by*
- *CQ DX CQ DX CQ DX outside Europe this is EI0HQ EI0HQ EI0HQ standing by*

or, in CW:

- CQ DX CQ DX CQ DX DE EI0HQ EI0HQ EI0HQ K

If a station replies who is not DX for you, be obliging and polite. Perhaps they have not heard DX in your call, or maybe you are a new country to them. Make a quick QSO with that station, then call DX again. On the other hand, if you hear CQ DX, do not reply unless you are DX to that station. On HF this means another continent, or a rare country or entity. On VHF and UHF, it usually means an unusually long distance for the band and conditions, often several hundred kilometres or more. When choosing frequencies for calling CQ DX you can use sections of the band plan that are recommended for intercontinental operations. By not carrying local traffic, they should be quieter and more conducive for long-distance signals, which are often weak at the receiving side.

13.2.4 Calling Specific Stations

A SKED is a scheduled contact which, presumably, you have arranged in advance. Because it is not a general call to any station, but to a specific one, do not call CQ. For example, to call 4U1UN on phone, use one of these formats:

54 Japan, like other countries, has many call sign prefixes, including JA, JB, JC... One of them is used to denote the entire country. It is usually the historically first, or the most popular one, like JA for Japan. See rsgb.org/main/operating/licensing-novs-visitors/international-prefixes

- *4U1UN 4U1UN 4U1UN from EI0HQ EI0HQ EI0HQ standing by*
- *4U1UN 4U1UN 4U1UN from EI0HQ EI0HQ EI0HQ calling on sked and listening for you*

In CW, you could transmit one of these:

- 4U1UN 4U1UN 4U1UN DE EI0HQ EI0HQ EI0HQ KN
- 4U1UN 4U1UN 4U1UN SKED DE EI0HQ EI0HQ EI0HQ KN

The KN, or a <KN> at the end indicates that you do not want any other stations to call you, except 4U1UN. KN can be written both without the angle brackets, or with them, as a <KN>. This is because KN can be sent as two letters, K and N, with the normal space of one dit between the letters. This is unlike prosigns, such as <AR>. However, Morse code, like other languages, is evolving. Many operators treat KN as a <KN> prosign. A similar situation arises regarding the Morse abbreviation BK (break in conversation) which can also be heard as a <BK>.[55] If you do not mind other stations interrupting or joining you, use K on its own. Because it is rare for stations to join or interrupt a QSO in progress, many operators use K instead of KN.

13.3 Replying to Initial Calls

Replying to initial calls is easy. The call sign of the station you are contacting always goes first. It should be always transmitted, except when unnecessary, for example during a contest. However, you should always identify yourself, especially at this stage of a QSO. If you are ZL6HQ, to reply on phone to a call by EI0HQ, choose one of these:

- *EI0HQ from ZL6HQ over*
- *EI0HQ this is ZL6HQ over*
- *This is ZL6HQ over*
- *ZL6HQ over*
- *ZL6HQ*

In CW, you could answer with one of the following:

- EI0HQ DE ZL6HQ KN
- DE ZL6HQ KN
- ZL6HQ KN
- ZL6HQ

55 This use of KN and <BK> originates in amateur radio. BK has been standardised as an abbreviation consisting of two letters, but not as the prosign <BK>. KN has not been standardised at all by regulators, unlike many prosigns and abbreviations that have been used by professional radio operators for over a century. For those still in maritime use, including BK and K, but not KN, see ITU-R M.1172 (1995) at www.itu.int/rec/R-REC-M.1172-0-199510-I/en. This guide aims to recommend the long-term standardised usage where possible, and, in the absence of an agreement, the common forms heard on the amateur radio bands.

You should decide which one to use depending on the context. The longer forms, which include both call signs, are generally preferred and they are often used in casual chats, while the shorter forms work for contest-style QSOs.

It is generally unnecessary to repeat your own call sign multiple times when replying, because the initiating station should repeat your call sign if they heard it correctly. If you have been misheard, you will have a chance to correct your call sign soon. If they have not heard you clearly, they may ask you to clarify by repeating the part they heard, or by asking QRZ?, or by sending a question mark "?" on its own. In this context, these mean *who called me* or *please repeat.* QRZ is explained in more detail in Section 13.5.

Note the correct use of *over* on phone and K or KN in CW. At this point in the QSO the initiating station would acknowledge your reply by addressing you with your call sign, unless they have not heard you or if they have already begun working another station.

The initiating station may also acknowledge you in other ways, for example, by thanking you for the call, by giving you your signal report, or by sharing other information such as their name or QTH. For example, on phone, you may hear:

- *ZL6HQ from EI0HQ thank you for your call. Your signal report is 59 … over*

Or in CW, it might go along the lines of:

- ZL6HQ DE EI0HQ TKS FER UR CALL <BT> RST 599 … KN

The prosign <BT> is used as a separator, like a comma in a sentence. You can normally tell that the other station is talking to you because they used your call sign when acknowledging you, especially during the first few of overs.

What if the initiating station does not copy your call sign correctly, especially if the conditions are poor? Now is a good opportunity to fix this problem, as otherwise they may log your call sign incorrectly. Correcting it on phone is easy. On your next QSO say something along the lines of:

- *EI0HQ my call sign is ZL6HQ ZL6HQ ZL6HQ over*

In CW, simply repeat your call sign twice or three times. The other station should understand that they made a mistake. For example:

- EI0HQ DE ZL6HQ ZL6HQ ZL6HQ KN

The QSO can continue in many ways from now on. Much depends on the context and the style of both operators. It is common to exchange short descriptions of your station, perhaps the make and model of your rig and the antenna. If you are still new, especially to CW, keep this portion of the QSO short. The other operator may also be a novice, and likely grateful for an exchange that is not too demanding. If the two of you have another QSO in the future, perhaps even a sked, you will have a chance to cover more detail.

13.4 RST Reports

Every normal QSO includes an exchange of signal reports. Some communication modes, such as FT8, report automatically measured signal-to-noise ratios (SNR), see Section 14.2.2. Phone and CW, on the other hand, use traditional RST codes. The RST or RS code is used to report on the quality of the received radio signal. RST consists of three numbers, while RS uses only two.

When listening to CW, you can hear some of the numbers (figures) being sent as letters, rather than as numbers. This is because some letters are quicker to transmit than the corresponding numbers. For example, 9 can be sent as letter N, and so the frequently used RST code 599 becomes 5NN. This convention is known as *cut numbers* and is common during CW contests. [56]

- R – READABILITY. This is an assessment of how easy it is to correctly copy, i.e., to understand the information being transmitted. It is common for readability to be less than perfect even if signals are very strong, or the other way round.
- S – SIGNAL STRENGTH. It indicates how powerful the received signal is at the receiving location. Nowadays, it is rare to use the values from the table below, unless your receiver has no S-meter. Instead, it is common to report the value shown on the meter. [57] If the S-meter indicates a signal stronger than 9, you should report the value that the meter shows in dB. For example, assuming that R is 5 and the S-meter shows +10 dB above 9, you could use a phrase such as *59 plus 10* or *10 over 59*. However, many S-meters only provide a true readout when the receiver's attenuators and preamplifiers are either switched off, or set to a specific value, and when the RF gain control is at its maximum. Consider briefly changing those settings before you give your report of the signal's strength. As a recipient of a report, bear in mind that the received S value represents a combination of factors, including propagation and the receiving station's equipment, including antennas.
- T – TONE. Used in CW. It describes the quality of the CW modulation. While this part of the RST code is still in use, its relevance has diminished because modern transmitters produce signals with a good tonal quality. Since it is almost always perfect, you would expect to always receive or send a T value of 9. Assuming that you are using modern equipment, rather than historical or homebrew, if you receive anything less than T9 it indicates a problem that needs to be addressed. Similarly, in the unlikely case of you hearing anything but a perfect tone, you should send a code other than 9. Unfortunately, there is no universal scheme to report other CW signal problems, which are common nowadays, such as key clicks and splatter. If you experience them, it may be a good idea to contact the other station, perhaps by means other than radio, and to politely let them know. A third digit is also reported in some other digital modes than CW, but with a different meaning.

56 1, 9, and 0 are the most popular CW cut numbers, but there are more: 1 A, 2 U, 3 V, 5 E, 7 G, 8 D, 9 N, 0 T. Numbers 4 and 6 are not abbreviated. However, cut numbers are never used to transmit a call sign.

57 There are discrepancies between the calibration and readouts of S-meters. A commonly used S-meter should show a reading of 9 when receiving a signal of 50 µV (microvolts) on HF, and 5 µV on VHF/UHF, assuming a 50 Ω system. Some receivers permit changes to the scales and calibrations.

Table 13-A: R values in RST

R value	Readability
R1	Unreadable
R2	Barely readable, occasional words distinguishable
R3	Readable with considerable difficulty
R4	Readable with practically no difficulty
R5	Perfectly readable

Table 13-B: S values in RST

S value	Strength
S1	Faint signal, barely perceptible
S2	Very weak
S3	Weak
S4	Fair
S5	Fairly good
S6	Good
S7	Moderately strong
S8	Strong
S9	Very strong signals

Table 13-C: T values in RST

T value	Tone
T1	Extremely rough hissing note
T2	Very rough AC note, no trace of musicality
T3	Rough AC tone, rectified but not filtered
T4	Rough note, some trace of filtering
T5	Filtered rectified AC but strongly ripple-modulated
T6	Filtered tone, definite trace of ripple modulation
T7	Near pure tone, trace of ripple modulation
T8	Near perfect tone, slight trace of modulation
T9	Perfect tone, no trace of ripple or modulation of any kind

Sending realistic reports is helpful, and you should do that in every QSO. However, there are two common exceptions to this recommendation: many radio contests, or when working a particularly busy station, such as a rare DXpedition.

Some contests do not require RST reports at all. Although a signal report is generally required for a valid QSO, other information may be exchanged instead. A QSO that is valid under contest rules is generally also considered valid for other purposes. In many other contests, including the biggest worldwide contests organised by the IARU, 59 or 599 are almost always sent, no matter the signal quality! The signal may be weak and hard to copy, yet the perfect code is still sent. This is explained in Section 16.5.

If a DX station in a remote part of the world gets so busy that there are dozens of stations trying to call it simultaneously, a so-called pileup happens, see Chapter 15. To expedite each QSO in a pileup, only the bare minimum of information is exchanged, almost nothing is repeated, and 59 or 599 is frequently given regardless of the actual signal quality, even if it is poor. Below are a few examples of day-to-day RST reports:

- On phone: 59 = perfectly readable, very strong signals
- On phone: 59+15 = perfectly readable, very strong, S-meter shows 15 dB above 9
- On phone: 44 = readable with practically no difficulty, fair signals
- In CW: 599 = perfectly readable, very strong signals, perfect tone
- In CW: 489 = readable, strong signals, perfect tone
- In CW: 339 = readable with considerable difficulty, weak signals, perfect tone

13.5 How to use QRZ

QRZ? means *Who is calling me?* It should only be used when you heard someone calling you, but you were not able to copy the call sign of the caller. Importantly, QRZ? is not a replacement for CQ. If you did not hear anybody calling you, QRZ would be an incorrect way of inviting callers. Instead, call CQ as it has been explained in Section 13.2. For example, if after calling CQ EI0HQ no stations have replied, do not call EI0HQ QRZ. Instead, continue calling CQ EI0HQ. Using QRZ in this situation would be confusing for other stations who may be listening and preparing to reply to you.

Similarly, QRZ? cannot be used at the end of a CQ call. When you call CQ, you have not yet been called by anyone. It would be confusing to ask who has called you, since no one has replied yet. That means, do not transmit CQ EI0HQ QRZ.

On the other hand, in a busy pileup, perhaps during a contest or a DXpedition, you may hear QRZ? after a QSO has ended. This can make some sense if other stations happen to be calling at that moment in time. Otherwise, it is better to call CQ after ending a QSO, including during contests.

13.6 Mid-QSO Problems

Many QSOs experience problems, often due to changes in propagation. For example, fading may force you to miss or misunderstand what was said. Use your common sense to ask for repeats and offer corrections on phone. Although there are sophisticated ways to ask for repeats in CW, which some operators use, sending one or two question marks "?" usually means that you require a repeat of what was transmitted.

13.6.1 Changing Frequency (QSY)

There are many situations when changing the frequency is useful. For example, the replying station may want to have a QSO on another frequency when it has been tail-ended, see Section 12.6.2. Changing the frequency is also a good way to deal with interference that you may hear from another operator (QRM) while you are listening during your QSO. If you experience such interference, do not assume any ill will. They probably

cannot hear the station that you are currently listening to. Let them know, politely. On phone, say:

- *This frequency is in use. This is EI0HQ, thank you.*

In CW, you may send:

- QRL QRL TU DE EI0HQ

Sometimes, this does not work. The interfering station may not hear you, even though you can hear them, because propagation can work in one direction only. Perhaps it would be better to conclude this QSO and plan another one. Alternatively, you may want to move to another frequency (QSY). Use the VFO and your waterfall display to check if a nearby frequency is clear, perhaps 1–5 kHz up or down. Ask the station that you are in contact with to wait a little. On phone, say something like:

- *ZL6HQ from EI0HQ please wait (or please QRX)*

In CW, you could transmit:

- ZL6HQ DE EI0HQ QRX <AR>

In this context, the QRX code means *please wait, standby.* Because that last transmission is not ended with a KN, some operators add the optional prosign <AR> meaning that this is the end of that message, without asking your counterpart to transmit anything. You just want them to wait a little. Now that you have some time, check that the other frequency is clear by following the steps listed in Section 12.5.2. If it is clear, ask your fellow amateur to move to it by specifying the frequency. On phone:

- *ZL6HQ from EI0HQ please QSY to 7150 kHz 7150 kHz over*

In CW you could send:

- ZL6HQ DE EI0HQ PSE QSY 7020 QSY 7020 KN

Instead of specifying the frequency, especially if the band is not very busy, it is common to ask the other station to simply move up or down a few kHz. On phone:

- *ZL6HQ from EI0HQ please QSY DOWN 5 DOWN 5 over*

In CW you could send:

- ZL6HQ DE EI0HQ QSY DOWN 1 DOWN 1 KN

The QSO may now resume on the new frequency.

13.6.2 QSO Too Fast to Copy

If you cannot copy the other station, even though they have repeated, you could ask them to slow down and repeat once again. On phone:

- *ZL6HQ from EI0HQ please slow down and repeat over*

In CW you would send:

- ZL6HQ DE EI0HQ QRS AGN KN

The QRS code means *decrease your sending speed.* AGN stands for *again* and it also means *please repeat.* It is used in CW and in some other conversational digital modes. Optionally, you could provide a number to indicate the CW speed that you are comfortable with in WPM, for example, QRS 15. However, a good operator should listen and match your sending speed without having to be asked to slow down. [58] For that reason, do not send faster than you wish to receive.

13.6.3 Fading (QSB)

Fading propagation is a frequent reason why contacts become difficult or impossible to continue. You can explain this by saying on phone:

- *ZL6HQ from EI0HQ heavy QSB QSB please repeat over*

In CW you could send:

- ZL6HQ DE EI0HQ QSB QSB AGN KN
- ZL6HQ DE EI0HQ QSB QSB ? KN

QSB means that reception is affected by fading signals. Sending a question mark "?" on its own, instead of AGN, is another common way to ask for a repeat in CW.

13.7 Concluding a QSO

If you are not sure how to politely suggest an end to a QSO, you could ask if the other station has anything else to share with you. While you would use your language skills on phone to pose that delicate question, in CW there is a convenient code:

- ZL6HQ DE EI0HQ QRU? KN

58 Although this good practice applies to normal QSOs, including ragchewing, contesters and DXpeditions may not want to slow down when they are trying to maintain a consistently fast QSO rate and rhythm.

QRU? means *do you have anything for me?* It politely suggests that you would prefer to end the QSO unless there are important matters left to discuss. [59] There are other useful customs and traditions that you will quickly pick up whilst on the air.

It is customary to exchange some pleasantries at the end of a QSO, saying thank you, hoping to meet, or see, the other person again, or to tell them how much you have enjoyed the QSO. Almost all amateur radio QSOs end with 73. Even non-conversational digital QSOs often include a 73.

73 stands for *best regards,* but some operators say, on phone, *best 73,* or *best 73s.* Although this may not sound grammatically correct to some, it is a second nature to many amateurs, expressing their friendliness. On phone, you could say:

- *73 John and see you soon from EI0HQ, now clear, and standing by for any stations*

In CW, you could transmit:

- 73 JOHN CUL DE EI0HQ <SK> E E

CUL is one of many CW pleasantries. It means *see you later.* <SK> indicates the end of a QSO. The two somewhat spaced-apart dits, or Morse letters E, are a customary way of saying something like *bye bye* or waving a hand to your friend. You might hear a single, friendly dit back, in exchange. There are many other ways to conclude a QSO.

When the QSO ends, another station that has been listening may want to tail-end. To do so, it calls before the initiating station transmits their next CQ call. If no one tail-ends, the initiating station can simply call CQ again.

If you do not have the time for another QSO, or if you need a break, you should state that in the closing of the current QSO. On phone, you could say:

- *73 John and see you soon from EI0HQ, and closing down the station*

In CW, you could transmit:

- 73 JOHN CUL DE EI0HQ <SK> CL E E

The CL abbreviation means *station closing down.* This way you have ended both the QSO and your current on-air session. Sometimes a station does not hear your CL and may still contact you for a QSO. Consider offering them a quick one. When it ends, you may want to transmit CL a couple of times to make your intentions clearer, or use the Q-code QRT, which means *stop transmissions.*

59 One might also use QSB as an excuse to end a QSO that has become somewhat tiresome. You need to be the judge of the appropriateness of that slight mischief.

13.8 Example Phone and CW QSOs

There is no single right or wrong way to structure a QSO. The two examples below are suited for a beginner. They are not intended to be a template or a standard.

The initiating station's overs are marked with a solid • bullet while the replying station is marked with a hollow ◦ one.

13.8.1 Phone QSO

- *Is this frequency in use?*
- *Is this frequency in use? This is EI0HQ*
- *CQ CQ CQ from EI0HQ EI0HQ EI0HQ standing by*
- *EI0HQ from 4U1UN over*
- *4U1UN from EI0HQ thank you for your call. Your signal report is 59 plus 10. My name is Megan, Mike Echo Golf Alpha November. QTH Cork. How copy? 4U1UN from EI0HQ over*
- *EI0HQ from 4U1UN good evening, Megan. I copy you well, 57, 57. My name is Bill, Bravo India Lima Lima, QTH New York New York. I use a homebrew 25 W rig into a dipole 10 metre high. Please QSL via bureau or LOTW. Many thanks for the nice QSO Megan. 73 and see you soon. EI0HQ from 4U1UN over*
- *4U1UN from EI0HQ Thank you, Bill, fully copied. I also have a homebrew rig, but only 5 W into a short vertical. Will QSL via LOTW. Many thanks, 73 and see you soon, Bill. From EI0HQ now clear, and standing by for any stations*

13.8.2 CW QSO

- QRL?
- QRL? DE EI0HQ
- CQ CQ CQ DE EI0HQ EI0HQ EI0HQ K
- EI0HQ DE 4U1UN KN
- 4U1UN DE EI0HQ TU FER CALL <BT>
  RST 599 <BT>
  NAME MEGAN MEGAN QTH CORK CORK <BT>
  HW CPY? 4U1UN DE EI0HQ KN
- EI0HQ DE 4U1UN GE MEGAN GUD CPY <BT>
  RST 579 <BT>
  NAME BILL BILL QTH NEW YORK NEW YORK <BT>
  RIG HOMEBREW 25 W INTO DIPOLE 10 M <BT>
  QSL BURO OR LOTW <BT>
  TU FER NICE QSO CUL MEGAN ES 73 EI0HQ DE 4U1UN KN
- 4U1UN DE EI0HQ R GE BILL <BT>
  RIG ALSO HOMEBREW 5 W INTO SHORT VERT <BT>
  WILL LOTW <BT>
  MNI TNX ES CUL BILL 73 DE EI0HQ <SK> E E
- E

Instead of using <BT> you could also pause for a little longer, or transmit a comma, to indicate the slight change of the subject. Although these different types of pauses are optional, they help less experienced CW operators follow the conversation.

The CW example shows a structure that could also apply to other conversational digital modes, such as RTTY. It also shows a few CW abbreviations that have not been included in Table 10-A and Table 10-B. There are many more! [60]

CUL	See you later
ES	And
FER	For
GE	Good evening
GUD	Good
HW CPY?	How do you copy?
MNI	Many

60 See morsecode.ninja/reference and en.wikipedia.org/wiki/Morse_code_abbreviations

14 Digital Mode QSOs

Digital modes of radio communication existed long before computers. Morse code radiotelegraphy began at the end of the 19th century using spark gap transmitters, which were later replaced by more efficient Continuous Wave, or CW, transmitters. RTTY, often regarded as the second oldest widely used radio digital mode after Morse radiotelegraphy, was introduced in 1922. Many other digital modes gained and lost popularity during the 20th century. FT8, introduced in 2017, and other similar modes have made brief, structured, non-conversational QSOs very popular.

Digital modes use encoding techniques to prepare text, images, and data, including digitised voice, for radio modulation. They transmit it over radio frequencies by using one of the three main digital modulation schemes: amplitude-shift keying (ASK), frequency-shift keying (FSK), and phase-shift keying (PSK).

Modern digital modes use power and bandwidth efficiently while having good resistance to noise and interference. They are suitable for many applications, including keyboard-to-keyboard chat, file exchange, telemetry, predefined message exchange, and email-like communications that are particularly useful in emergency situations.

Conversational digital mode QSOs, like those using RTTY, are like a CW QSO. Non-conversational time-synchronised modes, like FT8, are different. In a CW or SSB QSO, operators typically converse by exchanging free-form messages to share signal reports, weather conditions, operator locations, and personal remarks. In contrast, QSOs that use non-conversational digital modes focus primarily on predefined messages, rarely containing anything more than call signs, QTH, and signal reports. Communication is more structured and concise, and software automates message exchange using standardised protocols, reducing the need for manual intervention.

Some radio transmitters feature a dedicated input that accepts keying waveforms containing encoded data for certain digital modes. These transmitters can directly modulate the keyed data to produce an RF signal without a need for any intermediate audio output. For example, a transmitter with an FSK input can directly modulate RTTY, much like CW. This approach eliminates the need for a software modem, resulting in a simpler setup. [61] By relying on your transmitter's built-in digital modulator, you also benefit from its pulse-shaping technology, which can help to avoid problems such as splatter and key clicks. See section 5.4 Interference from Your Station.

Alternatively, modem software can use an internal or external computer sound card to convert data into an audio frequency signal. In ITU radio emission designators, this audio signal is referred to as a subcarrier. [62] The audio subcarrier is then fed to the transmitter's SSB modulator to produce RF signals. This technique is used by many non-conversational,

61 In the ITU emission designators F1B, F stands for *frequency modulation,* 1 means *one channel containing digital information without a subcarrier,* B *telegraphy for machine reception.* These modulation schemes are usually labelled on the radio as FSK, RTTY, or PSK, in contrast to the SSB mode which is used to modulate modem software's audio subcarrier output.

62 For example, J2B emission designator is used for many digital modes. J stands for *single sideband with suppressed carrier* (SSB), 2 means *one channel containing digital information using a subcarrier,* and B stands for *telegraphy for machine reception.* J2D can also be used to indicate data instead of telegraphy.

time-synced modes. It can also be used for transmitting other data modes and it is often used for their reception, even if transmission is digitally modulated by the transmitter.

If using modem software, prioritise audio cleanliness, because it impacts digital signal quality. Modern radios offer a dedicated variant of the SSB modulator that has been designed for the audio subcarriers used by digital modes. [63] Refer to your radio's manual for the proper settings and procedures when using it. Carefully adjust the audio signal's levels to prevent overloading the final amplification stage of your radio, to avoid splatter, key clicks, and distortion.

Whichever of the two techniques you use for the transmission, direct modulation or modems producing the audio subcarrier, ensure the highest quality of your RF signal. It will help you to make successful and efficient QSOs without causing harmful interference.

14.1 Conversational Modes (RTTY, PSK, ...)

Conversational modes such as RTTY, AMTOR, PSK31, or QPSK31 enable keyboard conversations over the radio waves. Real-time chatting is possible, because transmission speeds can match the operators' typing skills.

RTTY is popular, especially during contests, and for the reception of utility reports, such as weather forecasts. Some amateurs use older, analogue, mechanical teleprinters. However, both RTTY, and other conversational modes, such as PSK31, benefit from computer technology even if your transceiver has built-in support for RTTY. Software applications support several conversational digital modes, integrating features such as automatic frequency control, real-time decoding, and other conveniences. [64] Software can also increase the reliability of those modes by using algorithms that can decode signals even in the presence of significant interference and poor conditions. Some of the conversational digital modes, like AMTOR and QPSK31, also use their own error correction techniques to further improve communication reliability.

14.1.1 Structure of Conversational Digital QSOs

A conversational digital QSO follows the general structure of a CW QSO, which has been explained in Chapter 13. It is common to use the same Q-codes and operational abbreviations. There are, however, some differences between CW and those modes.

Digital modes can be relatively fast, more than 50 WPM in RTTY. Operators tend to use longer phrases and fewer abbreviations than in CW. A conversational mode QSO is like a Short Message Service (SMS) text chat using a phone. You can use punctuation and even rudimentary text emojis such as :)

Software can be configured to transmit predefined, frequently used messages. You can automate them by using macros, which automatically replace part of a text with a call sign, a name, etc. Some amateurs prepare a message with a longer description of their station and interests, which can be a little longer than one would expect in CW. However,

63 Sometimes labelled as USB-D and LSB-D, or as DATA or DIGI. It is an SSB modulator and demodulator whose receive and transmit filters, and other settings, have been optimised for the audio subcarrier.

64 For example, free programs such as fldigi, MMTTY, or 2Tone.

it is prudent to keep communications brief, and to let each party converse naturally, rather than to require your fellow amateur to read a lengthy prepared text.

Each of the modes comes with its own advantages and quirks that impact the structure of the QSO. For example, it may be useful to transmit the letters CQ both at the beginning and at the end of the initial call when using RTTY. Someone who is just tuning in should realise that you are calling CQ, even if they only receive part of your message, especially if it becomes garbled. See the example in Section 14.3.1.

There are many online resources to help you discover the specifics of different conversational modes. If you can, it is best to find another user of the mode you that you are interested in, to learn from their experience, and to try it out together.

14.1.2 Selecting the Frequency

Selecting the frequency for conversational digital modes is similar to how you would select a frequency for CW or phone. Many of the conversational digital modes are narrow-band modes because they require a bandwidth of less than 500 Hz. Use the IARU and national band plans to find the segment which has been dedicated to the needed bandwidth and mode. For example, in IARU R1 narrow-band digital modes are usually found in a segment just above the frequencies exclusive to CW, and just below those intended for phone and more bandwidth-hungry digital modes like SSTV. Some digital modes focus on known centres of activity, which are also listed in the IARU band plans.

You can also use band plan segments intended for all modes. These may overlap with segments that include phone (SSB) operation. All-mode segments are often used by digital modes during major contests, including international RTTY contests. Outside such events, however, using these segments for digital modes may cause or receive unintentional QRM. It Is usually better to use the dedicated digital mode segment, unless it is congested. However, some operators may not fully understand the band plan and may think that you should not be operating outside of the narrow segment that has been dedicated to digital modes. Remain friendly and use your good nature to avoid an unnecessary conflict in those situations and find another clear frequency.

Listen to ensure that a frequency is clear. Most conversational digital modes are clearly audible when you are listening using a wide enough filter. In time, you will learn to recognise the characteristic sounds of the different modes, helping you to finely tune into them by ear.

You should also familiarise yourself with the frequencies used by the less common modes, including some of the less popular time-synced, narrow-bandwidth ones. For example, it is almost impossible to hear Weak Signal Propagation Reporter (WSPR) transmissions whilst tuning, because they are very narrow, only 20 Hz, and extremely quiet. Some types of communication, including automated ones and those used for emergencies, use different modes on a handful of frequencies, but only from time to time. [65] Although you are at liberty to use any amateur radio frequency that is clear, you will avoid

65 For example, email can be exchanged using software, such as WinLink, connecting from time to time over a variety of digital modes, including AX25, PACTOR, VARA, ARDOP, and others.

conflict and annoyance by avoiding those ones. Keep an updated table of digital mode frequencies to avoid.

Unfortunately, band plans do not always provide such information because there is still a lack of an agreement on those frequencies, many of which were somewhat arbitrarily selected by their software developers without a public consultation. Until they have been updated, remain friendly and understanding.

14.2 Time-synced Modes (FT8, FT4, ...)

Time-synchronised (time-synced or time-synched) modes have proven highly effective. [66] This section focuses on FT8 because even though it is very popular, its use can be a source of many easy-to-resolve issues.

Time-synced modes use a narrow bandwidth of only 50 Hz for FT8 and 83.3 Hz for FT4. They require modem software that runs on computers, whose clocks must by accurately synchronised between the stations participating in the QSOs. The margin of clock accuracy for FT8 is ±2.5 seconds, and ±1.0 second for FT4.

These modes are also known as weak signal modes because of their ability to cope with signal weakness at the receiving end. Except for the low transmission power modes like WSPR, most are well suited to both low and high transmit power, provided they are properly configured and operated with good on-air etiquette.

14.2.1 Message Format

While conversational digital modes allow messages to have a free-flowing format, non-conversational time-synced modes rely on predefined messages, which are structured to comply with the minimum requirements of a complete QSO. [67] The decoding algorithm knows what information to expect in each message, increasing reliability.

The exchanged information comprises call signs, Maidenhead grid locators, and signal-to-noise-ratio (SNR) reports. Acknowledgements take the form of R+SNR and RRR/RR73 messages. This comprises all that is necessary for a complete and efficient non-conversational QSO. Some operators expect a final 73 message to be received before considering the QSO as being complete for logging purposes. However, every operator is at liberty to decide how to log, subject to their national regulations.

A substantial part of each transmission is used for error correction coding, ensuring that what is received can be decoded correctly. As a result, messages that have been interfered with by other transmissions, received in poor conditions, including significant QRM, QRN, and QSB, can be often successfully decoded. The operator does not control the error correction content of the messages, because it is done by the software.

66 See the latest edition of the WSJT-X User Guide wsjtx.github.io/wsjtx/index.html
67 See 12.1 What is a QSO, and QST, Oct 2017, pp. 30-36 wsjt.sourceforge.io/Work_the_World_part1.pdf

14.2.2 Signal-to-Noise Ratio (SNR) Reports

Unlike the conversational digital modes, the time-synced modes generally do not use the RST system for signal reporting. Instead, they report the actual signal-to-noise ratio (SNR), measured in decibels from the strength of the decoded signal. That SNR value is normally a negative figure. [68] The SNR is measured by the software and encoded automatically into the relevant messages in the QSO sequence. However, some contests require a conversion of the SNR to an RST signal report.

- If you receive SNR higher than −5 dB in any of the slow time-synced modes, reducing your transmit power is a good idea. [69]

14.2.3 Automatic QSO Completion (Auto Seq)

In conversational modes, the operator must start and stop the transmissions, as well as determine the sequencing of messages. In time-synced modes, the synchronisation requires the start and the stop to take place at predefined times, known as time slots, which are synchronised globally. Stations transmit on one slot, receive on the next, then transmit again, and so on. If you reply to another station, software will automatically transmit on the time slot that the calling station is listening to. [70]

Once a QSO has started, software provides automatic completion of the QSO until the acknowledgments have been received and the complete QSO is ready for logging. This is known as the Auto Seq feature. However, each QSO can be also conducted in the manual mode, where the operator decides which messages to send. Once the QSO has been completed, the software must be reengaged to start transmitting again.

Some software applications may allow continuous operation, including fully automated QSOs, without having to start them manually. This can be acceptable if the licensed operator is present and in control of the station, subject to regulations.

! Unattended operation, i.e., leaving the computer and the radio without operator control, whilst transmitting, may require a special authorisation, or it may be allowed depending on the licence held. These regulations differ world-wide.

However, fully automated contacts can be considered controversial. Some organisations, contests, and award schemes disallow them. [71]

68 The narrow signal bandwidth, such as 50 Hz, is usually referenced to the much wider 2 500 Hz noise bandwidth associated with SSB. As a result, the SNR of a successful FT8 QSO is often a negative value, such as −10 dB.

69 Slow time-synced modes include FT8, FT4, JT4, JT9, JT65, Q65 and WSPR. See WSJT-X User Guide Section "Slow Modes", available at wsjtx.github.io/wsjtx/index.html

70 You can also decide which slot to use, odd or even. This is sometimes useful when calling CQ, especially on VHF, but rarely for replying.

71 arrl.org/news/arrl-contest-and-dxcc-rules-now-prohibit-automated-contacts

14.2.4 Selecting Frequency Offsets

Each individual 50 Hz FT8 transmission occurs within a 3 kHz frequency segment. The position of that entire segment in the band has been preconfigured by the software's developers. For example, normal FT8 transmissions on the 40 m band are conducted between 7.074 – 7.077 MHz in all the IARU regions of the world.

Software decodes all the transmissions in that 3 kHz segment simultaneously, which is why you can see so many of them without having to touch the VFO. Configure your radio to use a wide enough filter, usually 2.7 – 3 kHz, in order not to restrict the ability of the software to hear all of them. [72]

If you listen to the audio whilst tuned to that global frequency, you can hear all those transmissions as many different tones. The higher the pitch, the further the transmission is from the start of the segment. When you transmit, software encodes your data into the audible tones of the audio subcarrier at a pitch that corresponds to your chosen frequency offset from the start of the overall segment.

How to select the frequency offset on which to call CQ or to reply to a call? Choose one that is as quiet as possible on the time slot on which you transmit. Rather than listening, use the waterfall spectrogram displayed by the software. You should be able to see which sliver of the frequency segment is clear enough.

Even though the modern time-synced modes are designed to decode several transmissions that may be using an identical frequency, it is better to pick one that is as free of other transmissions as possible to increase everyone's chance of success.

14.2.5 Reply on a Different Frequency than CQ (Hold Tx Freq)

You will avoid the QRM from competing callers if you answer a CQ call on a different frequency offset than the one used by the station calling CQ. This is useful if the station is popular, or if you tail-end another QSO. The calling station will see your reply, regardless of your chosen offset, especially if you are transmitting from a quieter one.

If you find a frequency that is reasonably free, and select the Hold Tx Freq option, you will continue using the same offset for your later QSOs, avoiding accidentally transmitting on the frequency of the next station to which you may want to reply.

14.2.6 FT8 DXpedition Mode (Fox/Hound)

There is a specialised FT8 DXpedition mode for the high-volume operations that can be expected during popular DXpeditions and from rare DX entities. It can sustain over 100 QSOs per hour. In this mode, the DX station is known as the fox and the calling stations are known as hounds, hence the mode is known as Fox/Hound. Check if the DXpedition is using it. If they are, set your software to the Hound mode.

Using the correct time slot is important in this mode. Double-clicking on the DXpedition's decoded message usually aligns your computer with the right time slot. If you can

72 The correct filter should be automatically applied when using SSB modes dedicated to data, such as USB-D.

read all the decoded call signs in the pileup but you cannot decode the DXpedition, this may be a sign that you have selected the wrong time slot.

14.2.6.1 *Message Format and Multi-Streaming*

The high QSO rate is achieved by a shortened QSO format and by enabling multi-streaming on the fox station. Fox will operate up to five signal streams simultaneously, at frequency offsets between 300–540 Hz. To be decoded by the fox, and to keep the fox transmit frequency free from other traffic, the hounds must call at offsets above 1 000 Hz. This is done automatically, without having to manually change the VFO. It works just like split operation in CW, RTTY, or SSB, which is explained in Section 15.2.

14.2.6.2 *Do Not Use Standard FT8 Frequencies*

A large DX pileup from the hounds calling the fox station would cause interference to the standard FT8 frequency segments which have been dedicated to day-to-day use. To avoid that, the DXpedition mode cannot operate on and within ±3 kHz of those standard FT8 frequencies. However, some software applications have enabled multi-streaming at those standard, worldwide frequencies, ignoring this restriction. Stations have been observed using multiple streams within those segments, causing harmful interference. See also Chapter 17.

! Do not use the Fox/Hound mode, or multi-streaming, on the standard, world-wide FT8 frequency segments, because it causes unnecessary conflict.

DXpedition organisers and their operators should observe the band plans when selecting their fox frequency.

14.2.6.3 *SuperFox Mode*

SuperFox mode is a feature that allows DXpeditions to transmit a digital signature. Hounds use it to verify the authenticity of the fox's call sign. If genuine, a message is displayed on the screen, hopefully deterring pirate operations.

14.3 Example Digital Mode QSOs

The following examples are not meant to be interpreted as a template or a standard, but only as guidance, especially for a beginner. The initiating station's overs are marked with a solid • bullet, while the replying station is marked with a hollow ◦ one.

14.3.1 Conversational QSO in RTTY

The following QSO is similar to the CW example in 13.8.2. It shows that it is easy to have a keyboard chat in RTTY. This example also applies to other conversational modes, like PSK31. Note how the new lines, technically comprised of line feeds and carriage returns,

make the text readable. Press Enter or Return while you type on your keyboard to break the text using new lines. Alternatively, make good use of spaces at the ends of your overs, to separate your text from the noise.

- QRL?
- QRL? DE EI0HQ
- CQ DE EI0HQ EI0HQ CQ
  - EI0HQ DE 4U1UN KN
- 4U1UN DE EI0HQ TU FOR UR CALL,
  RST 599,
  MY NAME IS MEGAN QTH CORK,
  HW CPY? 4U1UN DE EI0HQ KN
  - EI0HQ DE 4U1UN GE MEGAN FULL CPY,
    RST 579,
    MY NAME IS BILL QTH NEW YORK,
    I USE A HOMEBREW RIG 25 W INTO A DIPOLE AT 10 M,
    PSE QSL VIA BURO OR LOTW,
    TU FOR THE NICE QSO! CUL MEGAN & 73 EI0HQ DE 4U1UN KN
- 4U1UN DE EI0HQ RR GE BILL,
  MY RIG IS ALSO HOMEBREW 5 W INTO A SHORT VERTICAL,
  WILL LOTW,
  MANY TNX & CUL BILL 73 SK DE EI0HQ CQ

14.3.2 Non-Conversational QSO in FT8

In the example below, IO52 and FN20 represent the locations of the stations expressed as Maidenhead locator grid identifiers. Signal reports are SNR in decibels. Even though negative, they are good, loud enough signals. It is worth noting that this concise example complies with the definition of a valid QSO from Section 12.1.

- CQ EI0HQ IO52
  - EI0HQ 4U1UN FN20
- 4U1UN EI0HQ -06
  - EI0HQ 4U1UN R-12
- 4U1UN EI0HQ RR73

15 Pileups

Pileups occur when many radio stations attempt to respond to a single station's call. This frequently happens during contests or when a DXpedition is active. A DXpedition to a rare destination can attract dozens, or more, radio amateurs eager for a QSO, resulting in a large, energetic, and a daunting pileup. This chapter discusses pileups in general. Chapter 16 describes contests, and Chapter 17 DXpeditions.

When tackling pileups, prioritise politeness and conflict avoidance. Maintaining a courteous demeanour and respectful communication will increase your chances of making successful QSOs. It may be tempting to adopt a competitive attitude in the hope of securing more contacts, but this approach may not yield the expected results. Wait patiently for your turn to transmit and respond calmly. Do not engage in aggressive behaviour or attempt to dominate the frequency, as this will lead to friction among operators and disrupts the flow of the pileup. By approaching pileups with a mindset of cooperation, you will help to make the experience enjoyable for everyone.

A clean signal, that does not cause interference, such as key clicks or splatter, especially if using higher levels of power, will help you to succeed. Unless you have top-notch antennas and a strong signal, chances are that you will not have the loudest signal at the pileup operator's end. Timing of your transmissions is crucial. These guidelines will help you in every pileup.

- Do not call before an ongoing QSO has been completed.
- Do not rush to reply when the operator signals the end of the previous QSO with a *thank you,* or QRZ or TU in CW. This is not a race in which the winner is the first one to reply. Exercise patience and wait a couple of seconds before placing your call.
- Use your full call sign.
- Use the standard ITU/ICAO phonetic alphabet.
- Transmit your call sign only once. Repeating it will not speed things up, but it will cause more QRM.
- Do not transmit the pileup operator's call sign before yours because it is clear who you are trying to contact.
- If the operator makes a mistake when repeating your call sign, correct them by emphasising the incorrect part when you repeat it in full.
- If the operator calls out only a part of your call sign, rather than in full, they are inviting you to repeat it in its entirety, because they only heard it partially. Reply but beware that there may be many other stations that share your part. In that is the case, a very good operator will call your partial call sign after having worked those other, similar stations.
- The operator may request another repeat after having added another letter or a number to the partial call sign, hopefully making it clearer if it is yours or not.
- If the operator comes up with a call sign not resembling yours, stand by and do not transmit. They are most likely working another station. A good pileup operator will repeat the call sign they are trying to work a few times before moving to the next one.

15.1 Simplex Pileup

In a simplex pileup, both the station calling and those responding operate on the same frequency. This method is commonly used during contests and for smaller pileups, such as during a Parks on the Air (POTA) activation or when a special station is calling CQ for an award. Managing a simplex pileup can become challenging if there are too many responding stations, potentially leading to a slower QSO rate.

15.2 Split Frequency Pileup

A split frequency pileup is the preferred method for handling a large group of responding stations. The calling station transmits on one frequency, while all the responding stations transmit on another frequency, or in cases of a very large crowd, within a frequency range.

The pileup operator will typically say *up* or *listening up,* indicating that they want all stations to respond at a frequency higher than theirs. Often, during CW pileups, they will listen 1 kHz up, and during SSB pileups, 5 kHz up. If the operator asks for *5 to 10 up,* or *5 to 15 up,* it means that all stations should respond between 5 and 10 kHz, or 5 to 15 kHz, above the pileup operator's calling frequency.

During a big pileup, perhaps because of excitement, we can forget to activate the split function. Avoid this mistake, because it triggers deliberate QRM (DQRM) and other undesirable behaviours, frustration, and avoidable conflict.

A split pileup presents the challenge of determining the exact frequency on which the operator is listening at any given moment. By carefully monitoring the pileup, you can hear which station is conducting their QSO with the operator. Before making your calls, take a moment to understand the operator's rhythm. Is the operator changing their exact listening frequency after every QSO, or is there a pattern of changing after three or five QSOs? Does the operator jump from one frequency to another within the range, or do they move slowly up and down? Understanding the operator's technique will help you place your calls. You will be ready to transmit exactly where and when they are listening.

15.3 Pileup by Numbers

Some pileup operators opt to work by numbers. For instance, if the operator calls for *number one,* it indicates that they only want stations whose call sign prefix contains the digit 1 to respond. By employing this technique, the operator effectively reduces the size of the pileup to perhaps one-tenth of its actual size.

This method is used by some DXpeditions and for other purposes, including managing a call-in following an amateur radio news service bulletin. Although it is effective, it relies on the patience of the stations waiting for their turn. Avoid the urge to call prematurely and your patience will pay off.

In contests, pileups are almost never run by numbers. Instead, the rhythm, the timing of the calls, and the use of partial call sign repeats are more effective.

16 Contesting

Contesting is a radio sport. It is an enjoyable activity shared by as many as tens of thousands of radio amateurs at a time. There are hundreds of competitions every year. They take place every weekend and even on some weekdays. National radio societies and several web sites list upcoming contests. [73] The aim of a contest is to make as many contacts with other stations as possible, within a strictly defined period, and in accordance with the contest's rules. Contests reward accuracy and the ability to complete challenging QSOs. Contacts with distant stations are more valuable than the easier, local ones. Logging errors are costly. Balancing speed with accuracy under changing propagation conditions requires experience and operational fluency, a skill which takes time to develop. Improving the station always helps, or you can join a team operating from a dedicated, advanced contest station.

Many amateurs also participate for non-competitive reasons. Contests offer an excellent opportunity to make contacts with rare stations, harder to reach parts of the world, and to use less popular modes. It is also a great way to test the station's limits.

16.1 Permitted Bands

There is a broad agreement, outlined by the IARU Band Plans, that contest activity is not permitted on certain bands. In particular, the so-called WARC bands should not be used for contesting. [74] They are the 30 m, 17 m, and the 12 m bands. The 60 m band is also excluded from contests because of its secondary status in amateur service. All those excluded bands are quite narrow and unsuitable for the busy contests. They provide a welcome refuge for those amateurs who do not enjoy the hectic nature of the largest worldwide radio contests.

Contest rules also specify their permitted bands, and even segments within a band. There are further recommendations in the band plans regarding frequency segments that are preferred for use during contests.

- Study contest rules, band plans, and national restrictions, including contest-specific power limits. Be aware of significant worldwide differences.

You may hear valid contest activity on a portion of a band on which you are not allowed to transmit. For example, there is a segment of the 40 m band that can be used by radio amateurs in the United States and in Australia, but which is not allocated to amateur use in Europe and other parts of the world. Deliberately transmitting on that section of the band, in the heat of the moment, could put you in conflict with the regulations and lead to a possible disqualification from the contest.

73 www.contestcalendar.com lists many contests held throughout the year, along with their rules.
74 Narrow bands allocated to amateur radio at the 1979 World Administrative Radio Conference (WARC).

16.2 Score

The goal of a contest is to attain the highest score. Each valid contact made during contest hours scores QSO points. A contestant can also earn multiplier points (multipliers) which are awarded for various characteristics of the contacted station. Multipliers are detailed in the rules of each contest. Typically, they are granted for the first contact with a new country, call sign area, call sign prefix, CQ or ITU zone, or another geographical entity. Multipliers can be earned either once across all bands and modes, or once per band or mode, depending on the contest. The total score is usually calculated as the product of QSO points multiplied by the multiplier points:

$$Total\ Score = QSO\ Points \times Multipliers$$

To win, you need to achieve either the highest overall score, or the highest score in your selected category or overlay. Categories and overlays create an even playing field by allowing smaller and less powerful stations to compete against each other, whilst letting dedicated multi-operator stations battle it out against their kind. There is a category or an overlay for almost every situation. Study them carefully to give yourself the best chance. For example, if you have been licensed recently, you can participate in the rookie overlay, competing against other newcomers rather than more experienced old-timers.

16.3 Rules

Take time to read the contest's rules before participating. Pay attention to the start and end times. Some contests are global in scope and last a full weekend – as much as 48 hours – with thousands of participants. Others have a narrower scope, one continent or only one country, or shorter periods, even as little as 30–60 minutes.

Contest rules can include additional restrictions, such as which stations that can be contacted or what equipment that can be used. Categories and overlays introduce further rules, including the ability to use clusters for finding QSOs, as well as limits on the number of operators, bands, or on-air time.

16.4 Run or Search-and-Pounce

Contesting has two main operating methods: running and search-and-pounce.

Running happens when you find a clear frequency and start calling CQ hoping for other stations to reply to you. You may be able to run for many hours without having to change the calling frequency, and you are likely to enjoy a few pileups!

Search-and-pounce (S&P) is the opposite. You tune across the bands, looking for running stations to work. Only the biggest stations with multiple operators can afford to run throughout a long contest. Everybody else will switch to S&P from time to time. Part of the strategy is to know when to switch.

16.4.1 Running

Before you can run, you must find a clear frequency. You should follow the usual procedures mentioned in section 12.5.2 Selecting a Clear Frequency. You will be able to find a clear frequency in most contests. However, in some of the major ones, the bands can be so crowded that finding it is difficult or even impossible. It is likely that you will have to accept some interference from other contesters. You may have to make some compromises in those contests. For example, you may have to narrow your radio's receive bandwidth to limit the interference from others, and to limit your transmit bandwidth to reduce your interference to other stations. Transmitting a clean signal is always important, and of particular benefit in a crowded contest, because it makes it easier to be heard by others. Poor signals, with an excessive bandwidth, are not only harder to decode, but they also waste precious power. It is always better to concentrate signal power in no more bandwidth than the mode requires.

! You may hear stations attempting to protect their run frequency by transmitting an overly wide, overprocessed, and splattering signal. This is harmful interference, and many contests have rules against such behaviour, which can result in disqualification.

16.4.2 Search-and-Pounce (S&P)

When you S&P you look for running stations. Make sure that you have copied the station's call sign correctly. Do not blindly trust information provided by a cluster or other non-radio sources. They can show incorrect call signs, which can cost you valuable points and even deduct additional penalty points.

When the running station has completed their CQ or a QSO, transmit your call sign once. On phone, use standard phonetics. If the running stations does not respond to you or to another station, repeat your call sign once again. Patience, and some skill in timing when to transmit will be necessary if there are many other stations trying to contact this runner. It may be worthwhile to look for another running station, and to return to the pileup later. Consider if the overall number of QSOs in that contest is worth more to you than waiting for that single station.

16.5 Exchange

The rules of each contest explain the required exchange. It is the information that must be exchanged between the runner and the S&P station to score points to both.

The exchange usually consists of an RS or RST signal report, and some additional information, such as the station's ITU or CQ zone number, or a serial number that each station increments with each QSO that they make. Because the goal of the contest is to score points, it is a common practice to exchange a perfect RST report, 59 or 599, rather than a realistic one. This may seem strange at first, but it has benefits during a contest, providing something predictable and easy to copy, no matter the conditions or the accent. Exchanging any other RST reports is likely to cost you points because most contesters expect nothing other than a 59 or a 599. However, some contests do not use RST reports.

Others aim to be more challenging by using longer identifiers, or exchanges that are harder to guess. Random numbers have even been trialled to push operators' accuracy skills to the limit!

16.6 Contest QSO

Contest QSOs are the shortest ones you are likely to experience, except for working a DXpedition. A contest QSO should not convey anything other than the required exchange. All conversation is reduced to an absolute minimum that is necessary to confirm that the two stations have correctly identified each other and that they have received each other's exchanges.

It is common for the running station to call by saying *CQ contest* on phone, and by transmitting CQ TEST in CW and some digital modes. It may be shortened further, by omitting CQ, especially during a larger contest. A runner may even call by providing just their call sign, with nothing further, especially when they are calling after ending a QSO. These could be the running station's CQ calls on phone:

- *CQ contest EI0HQ*
- *EI0HQ contest*
- *EI0HQ*

In CW this usually takes one of these forms:

- CQ TEST EI0HQ
- CQ EI0HQ TEST
- EI0HQ TEST
- EI0HQ

Other digital modes have their own preferred forms. For example, in RTTY, it is useful to have CQ both at the start and at the end of the runner's call. It benefits S&P stations that only caught a part of the transmission whilst tuning:

- CQ TEST EI0HQ CQ

16.6.1 Example Phone (SSB) Contest QSO

In this example the contest exchange consists of an RS report and a serial number. The runner's next serial is 123, whilst the next serial for the S&P station happens to be 34. It is common to use dedicated contest logging programs that can generate a correct sequence of serial numbers.

The runner's overs are marked with a solid • bullet, and the S&P station is marked with a hollow ◦ one. The letters in this example use the ITU code word spelling, and the numbers (figures) have been given using the recommended ICAO spoken pronunciation, see 11.1 International Radiotelephony Spelling Alphabet.

- *CQ Contest EI0HQ Echo India Zero Hotel Quebec*
  - *Zulu Lima Six Hotel Quebec*
- *Zulu Lima Six Hotel Quebec Fife Niner Wun Too Tree*
  - *Fife Niner Tree Fower*
- *QSL Echo India Zero Hotel Quebec*

To ensure that the call signs have been copied correctly, the running station repeats the call sign of the S&P station that it has heard. If it transpires that the call sign has not been copied correctly, the S&P station will send its own call sign again, usually without providing the required exchange quite yet. This informs the running station that it needs to correct the error, before they can log the QSO. This may take a few overs.

The closing Q-code QSL is used by the running station to confirm the receipt of the exchange. You may hear other acknowledgements, such as *Thanks*. Sometimes, there is no explicit acknowledgement at all, and the running station invites the next station to reply just by transmitting the call sign. The clue that your QSO was successful lies in the context and the rhythm of the operator. If the runner has confirmed your call sign and given you their exchange without asking for repeats after hearing your exchange, it usually means you were successful. Unfortunately, sometimes it can be ambiguous, and a busy runner may not want to reconfirm a prior QSO.

The running station should always provide its call sign in every QSO, for example when ending it, like shown above. This prevents mistakes and follows regulations. In a fast-paced contest, a runner occasionally skips its call sign and acknowledges with only a QSL. However, good practice and common contest rules suggest that running stations should provide their call sign in every QSO and require it at least once in every three.

16.6.2 Example CW Contest QSO

Using the same format and rules as above, a CW contest QSO could take this form:

- CQ EI0HQ TEST
  - ZL6HQ
- ZL6HQ 599 123
  - 599 34
- TU EI0HQ

Instead of sending the somewhat long QSL, it is customary to acknowledge with a short and friendly TU in CW contests.

16.6.3 Example RTTY Contest QSO

RTTY contests are popular, busy, friendly, somewhat less stressful than SSB or CW, and make a good start for newcomers. Whilst very similar to a CW QSO, the typed nature of RTTY brings its own nuances.

For example, this could be an RTTY contest QSO:

- CQ TEST EI0HQ CQ
  - ZL6HQ
- ZL6HQ 599 123 123
  - 599 34 34
- TU EI0HQ CQ

Because standard RTTY lacks built-in error correction mechanisms, it is customary to proactively repeat important information that may become corrupted, such as serial numbers. Both stations can easily detect whether they copied correctly by noticing any discrepancy between what should have been received as two identical sequences.

Some S&P stations also send their call sign twice for that reason. When conditions are poor, this can be helpful. However, it is unnecessary if conditions are good. The runner will repeat the S&P call sign, and any errors can be corrected by sending it twice, if needed.

16.7 Contest Logging

Anyone can participate in a contest without entering it formally. To enter, it is necessary to submit the log of your contest QSOs to the contest's organisers. Most logs are sent in a special format, known as Cabrillo, and some, especially VHF contests, use EDI.[75] Both file types only contain text, but their format and layout are strict and must be followed precisely. Although they could be prepared using a plain text editor on a computer, it is more convenient to use a dedicated contest logging program.[76] Those loggers can also check that the information contained in the file complies with the requirements of the supported contests.

Contest loggers can also assist the operator during the contest. Some contest loggers can suggest and prefill the expected exchange, and they can validate the correctness of the call signs. Whilst, arguably, the use of software to assist oneself in the contest makes contesting easier, it has become common practice.

Many contest loggers can also assist in finding running stations by connecting to a cluster or to another source of real-time contest QSO information. Contests usually permit that if you enter a so-called *assisted* category. Make sure you enter the correct contest category and overlay when using logging software and check which of its features you are allowed to use.

75 wwrof.org/cabrillo and Chapter 15 of IARU R1 VHF Handbook www.iaru-r1.org/reference/handbooks

76 According to a large worldwide contest, CQ WW DX 2024, the most popular free loggers for Windows were N1MM Logger+, DxLog, QARTest, and CTESTWIN. For macOS, SkookumLogger is a free contest logger.

17 DX and DXpeditions

Long-distance contacts are known as DX. On HF this means stations on continents other than your own, or a rare country or entity. On VHF and UHF, it usually means an unusually long distance considering the band and the conditions, often several hundred kilometres or more. DX involves reaching places that are not only distant, but also less populated or with few radio amateurs. Working DX stations is enjoyable but challenging, and it requires patience. Handling pileups also calls for special skills. See Chapter 15, and consider reviewing the *DX Code of Conduct*.[77]

17.1 DX Awards

One of the most popular, long-running awards in amateur radio is the DX Century Club (DXCC). It began in 1935 and is administered by the American Radio Relay League (ARRL). At its basic level, it requires making and confirming contacts with 100 different countries, regions, or islands, collectively referred to as DXCC entities.[78] It has many additional levels. You can strive to make all the contacts on a specific mode, such as CW, or on a specific band, such as 20 m, or, indeed, to do it in every possible way.

There are other similar awards, but the DXCC is the most popular one. Logging your first DXCC entities, learning how to confirm them using paper QSL cards or the electronic Logbook of the World (LoTW), and then receiving your first DXCC award, is an exciting goal to aim for while you are learning and building your first station.[79]

17.2 DXpeditions

Groups of radio amateurs frequently travel to desirable DXCC destinations to set up a station for a period, usually a week or two. Those events are known as DXpeditions. They may go to great lengths to transport the equipment to faraway places, to obtain the necessary permits, and to staff the stations round the clock to serve as many amateurs as possible. The amateurs who operate a DXpedition tend to be very experienced. They enjoy handling large pileups, making hundreds of QSOs every hour.

Some DXpeditions may ask for voluntary donations to offset their travel costs. Because getting QSOs confirmed is an important goal for many DXCC hunters, many DXpeditions offer electronic confirmations through LoTW. Although it can be offered at no cost, sometimes a small contribution is requested for faster processing. Traditional QSL cards are also offered using the free IARU and other QSL bureaus. Alternatively, you can request a card to be sent to you by direct post for the price of a postage stamp. There are also somewhat controversial DXpeditions which require a payment of substantial amounts to confirm a QSO, without offering any free or inexpensive options. It may be questionable whether such an activity complies with the spirit of non-pecuniary amateur radio

77 rsgb.org/main/operating/dx-code-of-conduct
78 Award rules and the list of DXCC entities can be found at arrl.org/dxcc
79 www.arrl.org/quick-start

communications as required by the ITU Radio Regulations. It may be prudent to avoid requesting such QSLs and to wait for the next DXpedition that operates from that DXCC entity. Your patience will be rewarded.

17.3 DQRM Problem

When a station from a rare DXCC is on the air, making a successful contact can be difficult because of the large number of operators trying to reach it at the same time. Unfortunately, unnecessary conflict and unfriendly behaviour have been on the rise. Remain friendly, use your wise judgement and your good nature, and remember that scoring the DXCC should be an enjoyable challenge. It should not be hard work that makes you and others feel bad. Problems often start with three causes:

1 When a big DXpedition hits the airwaves, many operators are eager to make the QSO that is precious to them.
2 Operators make mistakes without knowing it. For example, they transmit in simplex rather than in split mode. Perhaps they do not listen to the DX operator. Maybe they transmit on the wrong time slot or frequency offset in FT8.
3 Regrettably, some operators then feel obliged to correct the others' mistakes, causing the DQRM. For example, as soon as somebody makes their first simplex call, they yell *up up up*, adding chaos to an already tense situation.

At this moment, the DQRM gets out of hand. Everybody is struggling to hear the DX operator, whose weak signal from the distant DXCC is drowned out by the station that made the mistake and those trying to correct it. The pileup becomes frustrated and is ready to explode. Someone decides to ignore the regulations, playing music, cursing, even using fake call signs. Mayhem ensues, and reputations suffer. No one can work the DXpedition, and everyone is fed up.

17.3.1 How to Address the DQRM Problem

It is normal to feel some stress and frustration when trying to make that long-awaited contact in a deep and energetic pileup. If you make a mistake, and you call on the DX calling frequency (simplex) you might end up on the receiving end of an insult. No one should be rude to you on the air – but you are tired, frustrated, and after all, you are only a human. You feel like pressing the push-to-talk (PTT) button to tell those impolite folks what you think about them. Many of us have experienced this. The problem of managing our frustration is psychological. Prevent those negative feelings from overpowering you and causing you to behave in ways that you would later regret.

- If you feel that the situation is becoming too much, stand by for a while. Go for a walk, read a book, watch a movie, or engage in any activity that shifts your focus away from the frustrating issue.

It may feel tough. In the back of your mind, it might seem like an admission of a defeat in a contest. You may feel that you are incapable, or not resilient enough, to handle the pileup and the DQRM. However, that is not the case, and it is not a contest. While you are taking a short break, remind yourself that even though the task may be challenging, it is supposed to bring you joy and happiness. Return to the pileup with a renewed energy and a positive expectation.

Scoring the DXCC is a hobby. We do it for the pleasure and to learn new skills. One of those skills is patience. Another one is knowing how and when to call in a big pileup. Those who score great many rare DXCC entities are not the ones who easily lose their temper. Patience, good judgement, humour, and some planning, always succeed.

If you make a mistake and find yourself on the receiving end of what feels like a storm of corrections or insults, refrain from responding. You will avoid causing the unpleasant chain reaction.

If you hear someone else making a mistake, and you are contemplating correcting it, pause and ask yourself: *is it worth it? Will my correction help, or will it add to the chaos?* Examine why you feel compelled to correct someone else's mistake. Could it be your frustration? If you have any doubt, do not correct them.

! If you are certain that correcting someone is the right thing to do, always do it in a calm, positive, and the most respectful manner. Always give your full call sign. Unidentified transmissions, no matter how short, are frustrating and illegal.

Yelling *up! up! up!* or sending it continuously on CW or RTTY is not a respectful way to correct a mistake. A better way would be:

- *ZL6HQ, this is EI0HQ, please up. Thank you.*

Nevertheless, it is almost always better to do nothing. ZL6HQ will realise their mistake and correct it all by themselves.

17.4 Operating Mode Advice

Almost all DXpeditions operate in split mode and the DQRM arises when someone transmits on their frequency. Learn how to use split on your radio, preferably without even having to look at the controls. See Section 15.2 Split Frequency Pileup.

17.4.1 CW

Some operators experience a CW pileup without having a good grasp of Morse code. While it is possible to work pileups with only basic Morse, you should aim to improve your skills. Not knowing the sounds of the essential abbreviations, like TU, EU, NA, and UP, results in frustration. The timing of your calls also becomes easier when you know how those abbreviations sound at the higher speeds of 25–40 WPM that are used by DXpeditions. Even if you enjoy slower ragchewing, take some time to learn the sounds of a few keywords and of your own call sign at faster speeds.

17.4.2 Phone

A phone pileup is prone to DQRM and illegal transmissions, like music. If you witness such behaviour, focus on the DXpedition's signal, or take a break. DXpeditions usually operate several modes. You could try another one, like CW, FT8, RTTY, or another digital mode. They can be more efficient and orderly than phone.

17.4.3 FT8 and FT4

Follow the general advice given in Section 14.2. Ensure that your signals are clean. Avoid any temptation to overdrive your audio or amplification in the hope of being louder faraway. On the contrary – you will cause harmful interference to others, and your distorted signals will be harder to decode by the distant station.

Use the DXpedition's web site to find out what software they recommend and if they use its normal mode, or the Fox/Hound mode. See Section 14.2.6.

Pirate stations masquerading as the DXpedition are illegal and a nuisance. Unlike the voice of a phone operator, or their CW fist, recognising a digital pirate can be hard. The principle of "work first, worry later" applies, however, it is helpful to use some common sense. For example, if the DX signals were weak, and they suddenly spike to 20 over 9 on the S-meter, they may be fake. To help you validate if the station is genuine, many DXpeditions use an online, real-time log. You can compare it against the call signs that you hear being worked in the pileup. The SuperFox mode can also prove the fox's identity. See Section 14.2.6.3.

17.5 When You Are the DX

One day you will find yourself on the other side of a pileup! Propagation can make your signal reach a part of the world that rarely hears you. Perhaps you activate a desirable summit or an island. Or, thanks to your excellent technique and on-air manners, many casual listeners may call you simply for the joy of meeting you.

Managing a pileup for the first time as the DX station can be both daunting and exhilarating. Clear communication and consistent operation make pileups efficient and enjoyable. Some preparation, a little strategy, and plenty of composure, also help.

- Select a clear frequency well away from other operators.
- Repeat your call sign after every QSO.
- If you are working split, inform the pileup by transmitting UP, UP 1 TO 3 (in CW), or UP 5 TO 10 (in SSB). This will let everyone know where to call you.
- When working in split, avoid asking for more bandwidth than is necessary to manage the pileup efficiently. 1 – 3 kHz would be plenty for CW, while SSB may require 5 – 10 kHz.
- If you copy a partial call sign, respond to it and put everybody else in standby: *6HQ only please.* If necessary, clarify that you are trying to work that call sign: *Please everybody stand by, 6HQ only, thank you.*
- When the station replies with the rest of their call sign, repeat it in full: *ZL6HQ, roger, you are 59,* to acknowledge that you have correctly logged them.

- If you respond using a partial call sign, stick with it for as many repeats as necessary to make the contact. Your perseverance will keep the pileup peaceful. It will also demonstrate that you are determined to keep order while treating everyone fairly.
- Do not let another caller overpower your approach. If you give up on a partial call sign too soon, the pileup will start calling out of order, ignoring your attempts.
- If the pileup is intense and less disciplined, assert yourself. You are in charge of it! Show this by working weak stations, even if louder ones are forcing their way.
- Stick to your pattern. Chaos results from an inconsistent operation. Others can learn from your operating pattern to decide when to call you. If you end each QSO with a *Thank you, 5 to 10 up,* avoid changing your phrasing. Your cadence and rhythm provide a valuable clue, especially in poor conditions on phone, and in other conversational modes.
- To keep the pileup calm, keep callers informed and happy. Let them know how you are working, especially if you are doing something unexpected. Announce when you pause or change operators and remind everyone where you are listening.

If you want a thinner pileup, you may work by numbers, see Section 15.3. Mention which number you are working after every QSO. Work the same number of stations for each digit and fully work the entire sequence. If you stop in the middle of a sequence, you will have many unhappy operators.

Calling by continent, for example, *QRZ North America only,* is not an effective way to reduce a pileup, but it helps areas with poor or temporary propagation. However, those two selective methods can also cause frustration. Many operators will be sitting idle getting anxious and may turn into your unwanted helpers.

17.5.1 DQRM When You are the DX

If your pileup is suffering from the DQRM, move the frequency a little.

- In CW try moving by 500 Hz. While sending your call sign, followed by a string of dits, slowly change your frequency so the pileup hears your change.
- On phone, move 5 kHz up or down after announcing your QSY.

It is rarely useful to acknowledge that you are suffering from the DQRM because it can cause misunderstandings. Sadly, admitting the problem may also give unnecessary encouragement to those seeking your attention by causing the DQRM. Avoid explaining the reason why you are changing the frequency. The stations causing the DQRM will stop if they get no reaction. Ignore them and continue consistent operation.

17.6 Example DXpedition QSOs

DXpedition QSOs, during a pile-up, are some of the shortest and most economical ones that you will hear on the air. They can be even shorter than contest QSOs because there is no information that must be exchanged other than the call signs and a cursory signal report or a confirmation. The perfect RST code, 59 or 599, is often used as a form of an acknowledgement, rather than as a real report. However, in a more relaxed situation,

without a demanding pileup, operators may exchange further comments and provide actual, realistic signal reports.

The DXpedition's overs are marked with a solid • bullet, and their caller's overs are marked with a hollow ◦ one.

17.6.1 Phone

- *CQ BS7HDX up 5 to 10*
- *OA4O*
- *OA4O 59*
- *Thank you, 59*
- *BS7HDX up*

17.6.2 CW and RTTY

- CQ BS7HDX UP 1 3
- OA4O
- OA4O 599
- 599
- TU UP

17.6.3 FT8 and FT4

- CQ BS7HDX OK85
- BS7HDX OA4O FH17
- OA4O BS7HDX -17
- BS7HDX OA4O R-21
- OA4O BS7HDX RR73

Please note that when the RR73 is sent, the DX station logs the QSO, and the caller should do the same.

18 Away from Home

For many radio amateurs there is nothing better than putting their gear in the back of a vehicle or into a backpack, along with cables, antennas, and batteries, and heading out to play radio away from home and in the open. Some amateurs also like to operate abroad on vacation or while traveling for work. This chapter highlights some of the additional issues to consider when operating away from your fixed home station, especially when crossing international borders.

18.1 Field Days

Field days are annual events in the amateur radio calendar, typically held during the spring or summer. They let operators showcase their skills, test their equipment, and demonstrate the capabilities of amateur radio for emergency communication.

During a field day, amateur radio operators set up temporary stations in outdoor locations such as parks, fields, or even in their own backyard. These stations can range from simple setups with portable antennas and battery-powered radios to more elaborate configurations with generators and shelters. The goal is to simulate real-world operating conditions in the field without relying on commercial power sources.

Once set up, operators participate in hours of continuous on-air activity. They make as many contacts as possible with other amateur radio operators across the country and around the world. Contacts are logged, and points are awarded based on factors such as the number of QSOs, the type of power source used, and the number of different stations contacted.

A field day is not just about making contacts – it is also about camaraderie and community. Many clubs and organisations pool their resources and expertise to set up multi-operator stations and to share their knowledge and experience. Social activities, campfires, and shared meals foster fellowship and help to build the human connections that are essential when emergency communications become necessary.

18.2 Portable Operation

When you are on a beach, or in a park, perhaps activating a Parks on the Air (POTA) or a Summits on the Air (SOTA) location, you are operating portable. Regulations in many countries make it optional and desirable for you to suffix your call sign /P, *stroke portable*. However, in some countries you are not allowed to use this suffix, whilst in others its use is compulsory.

Somewhat confusingly, amateurs in the USA who operate from another district can also use the term "portable" even if they are in another fixed station. Although optional, this is common. You will recognise that by a numeric suffix indicating the district they are operating from, for example, /6, pronounced *portable six,* for operation from California. When they operate actual portable equipment, rather than a fixed station in another district, you can hear the more traditional /P, *portable,* or sometimes both /P

and a district number. If you participate in a field day, or an international contest, you are likely to hear all those forms.

Operating portable requires resourcefulness. Effective techniques include optimising antenna placement for maximum signal propagation, efficiently managing power consumption to conserve battery life, and adapting to changing weather.

Public places also provide an opportunity to introduce amateur radio to other people. Passers-by may be curious about the setup and the activities, leading to engaging conversations. Young people are fascinated by Morse keys and vintage technology. You are an ambassador of amateur radio when operating portable. Consider bringing a leaflet with you to hand out to anyone who shows interest.

Adhere to the regulations governing the use of public spaces, such as parks or natural areas. Stay within their opening hours. Avoid forbidden areas. Obtain any necessary permits before setting up your equipment.

The presence of the general public requires you to be particularly careful about general safety, including electrical, mechanical, and EMF safety. You may be asked questions about the precautions that you have taken. Some locations may also require you to obtain a public liability insurance before you can set up your station, and you may need to complete a risk assessment in advance of your event. Portable operation in some countries also imposes stricter power limits.

Public land is for everyone – make sure to show your respect for the rights and the interests of other visitors who may not be interested in radio activities. Minimising any disruptions ensures a positive experience for all and helps to promote goodwill towards the amateur radio community.

18.3 Mobile, Maritime, and Aeronautical

Mobile operation in amateur radio includes communication from land, sea, and air, offering exciting opportunities to use our bands while on the move. Aeronautical mobile operation, usually denoted by the suffix /AM, involves communication from aircraft. Maritime mobile, /MM occurs aboard vessels at sea and, in some countries, on rivers and lakes. Land mobile operation, /M, takes place from land-based vehicles such as cars, trucks, or motorcycles.

Not all types of mobile operation are permitted in every country. Regulations can be very specific. Many countries limit power levels and the choice of bands that can be used for mobile communications, especially maritime and aeronautical mobile. While a land-based vehicle is in or near a port, or an airport, amateur operation can be prohibited. If operating from a vessel or aircraft, it is crucial to obtain permission from the person responsible for it, such as the captain or ship master before commencing, whether near a port or away from it.

The rules governing operation far from land, once in international waters or airspace, are complex. They depend on the regulations of the ITU region in which the vessel is travelling and the country of the vessel's registration, where your licence must also be valid. Aeronautical and maritime mobile operators must also adhere to additional safety regulations. In particular, the use of the vessel's own radio equipment is rarely permitted for amateur use, and, similarly, the presence of an amateur station does not replace the

need for the vessel to have its own dedicated radio equipment. You must also consider unique safety aspects of the vessel, including antenna placement, EMF, power management, battery safety, and any emergency procedures.

18.4 Operating Abroad

Your amateur licence entitlements, and its conditions, apply in the country for which it was issued. Thankfully, there are international agreements that may permit you to operate when you are travelling abroad for a short visit. [80] Some groups of countries, including the CEPT [81] and CITEL [82] offer a standardised approach that allows operating whilst abroad, in addition to offering country-by-country reciprocal agreements. Because there are many countries and many agreements between them, and many licence types, it can be complex. You need to research the current rules before you travel.

! You must obey the laws and the regulations of the country you are visiting, even if they differ from and are more restrictive than your own licence. Additionally, do not assume that visitor's rights are the same as those of locally licensed amateurs.

In the absence of an outright operating agreement between some countries, you may need to apply for a short-term visitor's licence from the foreign regulator. Apply well in advance, because it can take some time. In some cases, it may be impossible unless you take and pass their licensing exams.

- Contact the foreign regulator or national radio society for visitor guidelines [83, 84]
- Region 1, 2, and 3 guidance: *IARU Operating Abroad* guide [85]

18.4.1 Moving Permanently Abroad

If you are planning to relocate to another country, you will need to obtain a new, permanent amateur radio station licence, as you would no longer be considered a short-term visitor. Some countries, including those which use the Harmonised Amateur Radio Examination Certificate (HAREC), have additional agreements that make it quick and easy to get a new, permanent licence. [86] You may also be able to obtain a reciprocal licence if

80 Each country determines the maximum duration of a short visit. For CEPT licences it is usually up to three months. A visitor's licence can be issued for longer, even as much as one year in some countries.

81 See CEPT ECC document T/R 61-01. As of April 2025, it can be found at docdb.cept.org/document/925

82 The International Amateur Radio Permit (IARP) regulations are outlined in the CITEL document A-62, see www.oas.org/en/sla/dil/inter_american_treaties_A-62_international_radio_permit.asp. Only a few countries are covered, www.oas.org/en/sla/dil/inter_american_treaties_A-62_radio_permit_signatories.asp

83 The German society DARC maintains a comprehensive list of licence privileges, frequencies, and permitted power levels in CEPT-related countries, see files.darc.de/index.php/s/CKT38kZP6miK7xf

84 The American society ARRL guide *US Amateurs Operating Overseas* covers the IARP and some CITEL countries, see www.arrl.org/us-amateurs-operating-overseas

85 IARU R1: www.iaru-r1.org/reference/operating-abroad IARU R2: www.iaru-r2.org/en/reference/operating-abroad IARU R3: www.iaru-r3.org/reference/operating-abroad

86 CEPT ECC document T/R 61-02 covers HAREC. As of April 2025, see docdb.cept.org/document/926

there is an agreement with your home country. If that is not possible, you will need to take the licensing exams again.

18.4.2 Call Signs While Abroad

A key principle of the ITU regulations ensures that the call sign used for a radio transmission always reflects the country where the radio transmitter is active, regardless of where the call sign was issued or where the operator is physically located.

Unless you have been provided with a visitor's call sign by the country you are visiting, you may need to follow special rules to amend your call sign. You may be required to prefix or to suffix your call sign with additional characters. For example, holders of CEPT-equivalent licences must prefix their call sign when visiting participating countries. For example, if ZL6HQ wanted to operate a transmitter in mainland Ireland, they would use EI/ZL6HQ as their call sign. [87]

In some countries you may be also required to use regional indicators, which are additional numbers or letters that denote the state, province, nation, island, or a region of the country you are visiting. [88]

18.4.3 Band Plans Abroad

Because the national band plans always take precedence over the IARU Band Plans, make sure to study them carefully before you travel. There may be significant differences, especially on the 160 m and the lower bands, and on VHF, UHF, and the higher bands. If you are travelling to another ITU region, HF band edges will also be different. Some bands that you use at home might even be entirely unavailable to you as a visitor.

18.4.4 Power Limits Abroad

Limits of transmit power differ greatly between countries, even neighbouring ones. Differences may apply across the whole band, or within a section of a band, for example, in sections of the 160 m band. You must always obey the limits of the country being visited, even if they are lower than what your licence permits in your home country. A complexity arises if the power limit is higher than what your licence would permit at home. Sometimes your licence's lower limit applies. Seek guidance before travelling. Additional power restrictions may apply to portable and mobile operation.

87 The required prefixes can be found in Annexes 2 and 4 of CEPT ECC document T/R 61-01.

88 For example, a CEPT licence holder visiting the USA prefixes their call sign with the region-specific characters, e.g. W9/EI0HQ for Illinois. However, when visiting Canada, they would suffix their call sign with the region-specific prefix, e.g., EI0HQ/VE3 when visiting Ontario. Different rules apply to Canadians visiting the USA, who continue to use the Canadian approach of suffixing. Use of regional indicators is required in some countries, like the USA, or optional but recommended in others, like in Italy. Check local guidance before you operate.

19 VHF AND UHF

VHF FREQUENCY RANGE covers 30–300 MHz while UHF spans 300 MHz–3 GHz. They are popular amongst radio amateurs. Some countries even offer novice or entry-level amateur radio licences that grant access to VHF and UHF only. These bands offer many opportunities without the need for complex equipment or large antennas. However, VHF and UHF are also used for more advanced, challenging, and experimental techniques, as well as for accessing the amateur satellite service.

Amateur radio frequency allocations do not stop at UHF. They continue into microwaves and the millimetre band, and even as high as 275 GHz, at present. [89] Those much higher bands can be used for many purposes, but some are very specialised, offering interesting challenges to a more advanced radio amateur.

This chapter provides only a brief overview of VHF and UHF. There are specialised operating procedures, additional etiquette, and unique conventions when working these bands which are not covered in this chapter. If you are interested, study the IARU VHF Handbook and other resources provided by your national society. [90]

19.1 Small Signal Operation

Small signal operation focuses on weak signals, especially at the receiving end. Using small VHF or UHF signals requires good station design and attention to detail. It is attractive for those looking for a technical challenge, especially when experimenting. Small signal CW and SSB operation tends to be focused on a range of frequencies, with nominated centres of activity. As propagation changes and activity increases, contacts should be made on frequencies further away from the mode-specific VHF and UHF centres of activity.

Because propagation greatly affects weak signals, VHF beacons can be particularly useful when operating this way. The varying transmission power of a beacon is a good indicator of the current conditions. They can also be used to calibrate equipment frequency. [91]

19.2 Channelised Operation

Channelised phone operation, both analogue and digital, has fixed-width channels, with a pre-agreed channel spacing, typically 12.5–25 kHz on VHF and UHF, with some exceptions on the 10 m band. Band plans nominate one of the fixed channels as a calling

89 The range of bands with amateur radio allocations differs around the world, but generally spans from Low Frequency (LF) 30–300 kHz, through Medium Frequency (MF) 300 kHz–3 MHz, High Frequency (HF) 3–30 MHz, VHF, UHF, and into Super High Frequency (SHF) 3–30 GHz, Extremely High Frequency (EHF) 30–300 GHz, and just below the Tremendously High Frequency (THF) 300 GHz–3 THz band where infrared radiation starts.

90 The current VHF Handbook can be found at www.iaru-r1.org/reference/handbooks

91 www.iaru-r1.org/on-the-air/beacon

channel. Once communication is established on the calling channel, the frequency should be changed to the one just agreed upon, allowing others to use the calling channel.

19.3 Voice Repeaters

Voice repeaters allow radio amateurs to make contacts using simple, inexpensive handheld radios. For many newly licensed amateurs, their very first QSOs are made this way, through their local repeater.

Repeaters simultaneously retransmit a signal received on an input channel to a different output channel. They can be analogue or digital. When using voice repeaters, consider the following guidelines.

- If possible, connect to the other station directly, using simplex, without a repeater.
- Two fixed stations should use repeaters only if the QSO is not possible without them.
- Do not monopolise the repeater because others may want to use it.
- Keep your contacts short and to the point.
- Keep your overs short, and pause until the carrier drops out, or a beep is heard, to avoid accidentally simultaneous transmissions, also known as doubling.
- Pausing resets the repeater's timer, avoiding a time-out that would interrupt your transmissions. It also allows new stations to identify themselves.
- If it is busy, wait for a pause between transmissions to announce your call sign.
- Avoid using the term *break* to interrupt a QSO. Remain patient and wait for your turn.
- In an emergency, say *break break break with emergency traffic*. See Section 3.1.
- If you use a repeater often, contact its keeper and ask if you can support its operation.
- Repeaters should not serve as an alternative to using a mobile phone or a messaging service. They are a part of amateur radio service, and your transmissions should follow the customs and regulations outlined in Chapter 9.
- Do not interrupt a contact unless you have something to add.
- Always identify yourself, even if breaking into or interrupting a conversation.

19.3.1 Networked Repeaters

Some repeaters are interconnected into a network that increases their effective coverage area. The interconnection method could be a gateway, a reflector, an Internet relay, an audio-enabled chat room, or an app. The reach of such a network can be international. Make sure to understand the interconnection method and disconnect it if a contact does not require it.

! You must identify your transmissions using a call sign that is valid where the networked repeater transmits using amateur bands. Contact its administrator for further guidance.

19.4 Time-Synced Digital Modes

Contacts using digital modes such as FT4 and FT8 are conducted within predefined frequency segments, which, like those on HF, are built into the software. While operation is

similar, there are additional, mode-specific optimisations for VHF and UHF propagation. For example, there are conventions that take antenna direction into account when selecting transmit time slots.

19.5 Automatic Packet Reporting System (APRS)

Automatic Packet (or Position) Reporting System (APRS) is an automated system that carries geographical data derived from the Global Positioning System (GPS) satellites. It is also used to carry other types of information and data, such as weather, telemetry, and other messages. Modern VHF and UHF mobile and handheld radios can receive the GPS satellite signals and retransmitting positional data, which can be received by APRS gateways. This data can also be carried via the network of digital repeaters worldwide. Individual stations' positional data can then be shared on the Internet and displayed in graphical or tabular form on websites. [92]

19.6 Special Techniques

Contacts made with special techniques, such as meteor scatter (MS), or Earth-Moon-Earth (EME), also known as moon-bounce, can be prearranged to coincide with the expected propagation or astronomical conditions. They generally take place around their nominated centre of activity. Increasingly, those techniques rely on time-synced digital modes designed for VHF and UHF, such as MSK144 for meteor scatter, or JT4 and JT65 for EME.

There are many other propagation mechanisms unique to VHF, UHF, and the higher bands. Those include tropospheric propagation also known as space wave, tropospheric ducting, troposcatter, aircraft scatter, sporadic E, and auroral reflection and scatter. Each of those mechanisms offers long-distance opportunities, however, it also requires more advanced knowledge, experience, and perhaps some additional equipment. While day-to-day VHF may be limited to just a hundred kilometres for a casual, low-land operator, those techniques work over thousands of kilometres, even as much as 20000 km for EME.

19.7 Amateur Satellite Service

Amateur radio satellites offer an interesting form of communication with good propagation because VHF and UHF are less affected by the ionospheric layers than HF. [93] They act like repeaters in the sky. Significant distances are possible with low Earth orbit (LEO) satellites, and even longer ones with geostationary orbits.

There were over 20 satellites carrying amateur radio transponders at the time of writing, and more planned to launch. Most are part of the Orbiting Satellite Carrying Amateur Radio (OSCAR) scheme. They can be used to transmit CW, phone, and data.

92 For example, on aprs.fi
93 en.wikipedia.org/wiki/Amateur_radio_satellite

OSCAR is coordinated by the Radio Amateur Satellite Corporation (AMSAT).[94] Together with national amateur satellite societies, they support radio amateurs interested in space communications. The IARU R1 Amateur Radio Space Exploration Working Group (ARSPEX) also offers support and learning resources.[95]

Amateur Satellite Service is regulated by the ITU. Holders of amateur radio licences issued in many countries do not require any additional permits to point their antenna, even a small, hand-held Yagi, at the sky to explore radio in space. However, check your national regulations, as an additional authorisation may be required to use some satellite uplink frequencies.

When using amateur satellites, consider these guidelines:

- Share the satellite's pass. Since FM satellites only allow one user to transmit at a time, be mindful of others trying to make contacts during the time the satellite is making a pass over your location.
- Let other QSOs finish. Avoid calling another station before the current QSO is complete.
- Minimise repeat QSOs. Be considerate of others and avoid working the same station multiple times during a pass.
- Avoid calling CQ. Instead, call a specific station or listen for others to respond to a call.
- Use standard phonetics to state your call sign and the call sign you are trying to contact.
- Prioritise rare and portable stations. Be mindful of stations operating from rare grid squares or DX locations.
- Use minimum power. 5 W from a handheld transmitter with a directional antenna is often sufficient.
- When working a satellite that uses a linear transponder, use very little power, and never be louder than its beacon signal, to extend the satellite's lifetime.
- Listen before transmitting. Do not transmit if you cannot hear the satellite.
- Follow the satellite's path. Be ready to tune the radio as the satellite moves across the sky.
- Be aware of the Doppler shift. Adjust your transmit and receive frequencies to compensate for the satellite's rapid movement.
- Use full-duplex capabilities. If possible, transmit and receive at the same time to monitor your signal and the Doppler shift.
- Experiment with antenna position and rotation as polarisation changes during the satellite's pass.
- Optimise antenna's height and ground plane for good signal reception and transmission.
- Check for real-time information. Follow AMSAT updates. If you use social media, monitor online channels.
- Be patient and persistent. It may take time to master satellite operating techniques.

94 amsat.org
95 www.iaru-r1.org/about-us/committees-and-working-groups/arspex/amateur-satellites

20 Testing Your Station

Correct operation of your station is essential for effective communications, legal compliance, and to show your respect for fellow radio amateurs. You will often find it necessary to check that it works as it should by transmitting test signals. Your transmissions, including the tests, should not cause interference, and they must comply with the regulations, including the requirement to identify them.

20.1 Dummy Load

A dummy load is a very useful device. It allows you to test or tune your equipment, such as radios and power amplifiers, without transmitting any signals on the air. Running a transmitter without a proper load attached to it can damage its expensive components, including the final stage power transistors or valves. An attached dummy load lets you engage the transmitter safely. It allows you to adjust and to test many aspects of your station, such as modulation, distortion, presence of key clicks, power levels, etc. When using it, pay attention to its frequency range and the maximum power rating. It can become hot after prolonged use, and if you exceed the ratings, it can burn out.

Dummy loads are also useful for diagnosing faults. For example, you can use them to find out what is the cause of an unexpectedly high standing wave ratio (SWR) that may be preventing you from being able to transmit. You can identify the faulty component by placing a dummy load at various points along your station's signal path, such as at the transmitter's output, amplifier, transmission line, or at the antenna's feed point.

20.2 Test Transmissions

You may hear stations transmitting *test, test, test.* However, this can be ambiguous, because *test* is a common abbreviation for *contest,* leading others to think you are calling *CQ contest.* Instead, use a more explicit way to indicate that you are transmitting a test sequence. Bearing in mind the need to identify yourself, you could say:

- *This is 4U1UN performing station testing*
- *This is a station test from 4U1UN*

For CW tests, the ITU recommends using letters VVV. The VVV sequence is easily recognisable and unambiguous. [96] For example, transmit:

- VVV VVV DE 4U1UN

96 ITU-R M.1170-1

20.3 Checking Your Transmissions Online

It is not always easy to find a fellow amateur who has the spare time to monitor your transmission quality. Many free, online services can help you to monitor your transmissions and check your antennas. They listen live and can even upload data to real-time databases. By analysing where your signal is being received, and with what strength, you can understand how your station is operating, letting you make immediate adjustments.

20.3.1 Online Receivers

When you need to check your transmissions with no one around to help, you can use the online listening services, including those mentioned in Section 7.1.1. Find an online receiver in a part of the world where your signal is strong. This may be near or far away from your location, depending on the band and the propagation conditions. Tune both your radio and the selected online receiver to a clear frequency. Make sure to follow the usual steps to ask if the frequency is in use, see Section 12.5.2 Selecting a Clear Frequency.

Press the record button on your browser and key your transmitter for a test. Make sure to identify yourself and to state that you are performing a station test. Afterwards, listen to the recording to analyse how your transmissions have been received.

This method can also be applied to CW and all other modes. Recording your signals from a distant location can tell you much about your station and the quality of your modulation. Collect recordings over a period of time to assess how they have changed in response to your experiments and to the evolving conditions.

20.3.2 Reverse Beacon Network

A reverse beacon is an automated monitoring system that listens to and reports signals transmitted by amateur radio operators. A popular implementation is the Reverse Beacon Network (RBN), which uses a worldwide network of receivers, known as skimmers, to listen for CW and digital signals, including PSK31 and RTTY. They decode the signals they hear, capturing the call sign, frequency, signal strength, and other relevant information. All the data is made available in real-time through the Reverse Beacon Network website and other interfaces, including clusters, see Section 12.5.1. [97]

Operators can search the database for their own call signs to see where their signals are being heard, to understand real-time propagation, and to check the activity of others. Data is available in many formats, including a live map, tables, and downloadable files.

20.3.3 PSK Reporter

PSK Reporter functions similarly to the Reverse Beacon Network. Although it supports many conversational digital modes, including CW, PSK, and RTTY, its primary use today is for reporting time-synced modes. [98] A brief CQ call lasting just a few seconds is

97 reversebeacon.net
98 pskreporter.info

sufficient to be heard by the monitoring stations if the conditions are favourable. However, if you only need to test propagation, without calling CQ, consider using the WSPR mode. [99]

Software modems used for time-synced modes often let you participate in the PSK Reporter network by reporting the signals that you receive. Configuring it is usually as easy as ticking a checkbox in the settings. You can even do that as a listener, before you get your licence, letting you build a station without having to transmit anything.

99 See WSJT-X User Guide Section "WSPR Mode", available from wsjtx.github.io/wsjtx/index.html and also en.wikipedia.org/wiki/WSPR_(amateur_radio_software)

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