Amateur Radio Service General Class

Exam Preparation Class
October 17, 2019
Session 1
Roland K. Smith K7OJL

These slides are uploaded to my website

https://k7ojl.com/class-course-materials/general-class-course-materials/

just before class each week. Depending on how the class goes, they may get updated after the class.

The General Class Question Pool (all questions and answers) is posted to my website

https://k7ojl.com/class-course-materials/general-class-question-pool

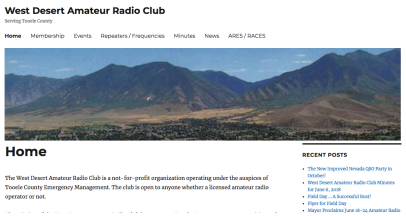
Class Overview

- Introduction
- History
- Band Plan
- Exam
- Rules and regulations

- Voice Operations
- CW Operations
- Digital Operations
- Emergency Operations

Get The Most Out of Your License!

- Join a club
  - The local club is the West Desert Amateur Radio Club which meets on the 1st Wednesday of each month at the EOC
- Participate in weekly nets
  - WDARC every Thursday at 7pm (changing to 9pm effective January 31st)
  - Various Church nets (talk to your stake emergency preparedness person)



History of the Amateur Radio Service

Guglielmo Marconi

- 12 December 1901 Marconi claims to have successfully sent the Morse Code 'S' character from England to Nova Scotia
  - Claim not witnessed
- Duplicated the test in February 1902
- Wireless communication was now a reality

He used a spark-gap transmitter at about 850 kHz into a 500 foot kite-supported antenna

https://www.youtube.com/watch?v=YSf93g0heUA

US History

- Radio Act of 1912 established license classes and callsigns. Amateurs relegated to frequencies shorter than 200 meters (0.67 MHZ)
- World War 1: all amateur radio operations banned
- 1919: Federal Radio Commission formed, amateur radio authorized
- 1927: International Telecommunications Union formed, regulates callsigns, frequency allocations worldwide
  - Amateur radio classes ‘A’ (Advanced), ‘B’ (General), and ‘C’ (Conditional) established
- 1934: FCC established, FRC abolished.
- 1944 WWII: all amateur radio operations banned
- 1949: Amateur radio operations re-authorized

History, Continued

- 1951: Amateur radio classes reorganized into 6 classes
  - Novice (1 year, non-renewable 5wpm Code, 20 question test)
  - Technician (no code, 35 question essay test, VHF and up only)
  - General (5 year, 13wpm code, 35 question essay test, broad HF privileges, limited VHF and up)
  - Conditional (same as General but not tested by the FCC)
  - Advanced (5 year, 20wpm Code, 35 question essay test, HF and VHF privileges)
  - Extra (20wpm Code, 50 question essay test, full privileges)

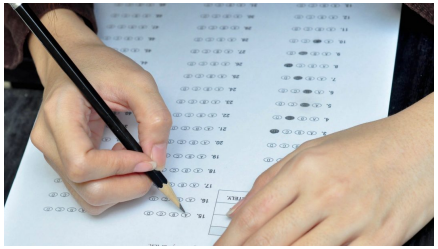
And More History

- 1979: ITU dropped Morse Code requirement for frequencies above 30 MHz
- 1991: US dropped Morse Code requirement for Technician Class licenses
  - Technicians who passed a 5wpm code test were designated as “Technician Plus” and given same HF privileges as Novice licenses
- 1998: FCC restructured the amateur license classes, dropped all Morse Code requirements, grandfathered Novice and Advanced, merged Technician Plus into General
  - Three license classes: Technician, General, Amateur Extra

The Exam

The Exam

- The amateur exam is made up of four elements:
  - Element 1: Morse Code (no longer required)
  - Element 2: Technician Exam
  - Element 3: General Exam
  - Element 4: Amateur Extra Exam
- The General Exam comes entirely from Element 3.
  - Contains 484 possible questions
  - 35 will be on the exam

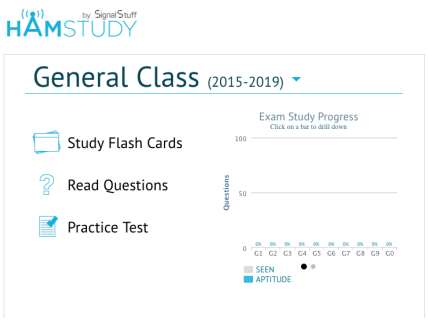


Test Topics

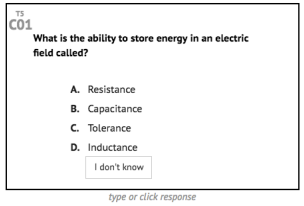
Topic	Total Question	Exam Questions
Commission’s Rules	64	5
Operating Principles	60	5
Radio Wave Propogation	36	3
Amateur Radio Practices	67	5
Electrical Principles	43	3
Circuit Components	27	2
Practical Circuits	40	3
Signals and Emissions	38	3
Antennas and Feedlines	54	4
Electrical and RF Safety	25	2

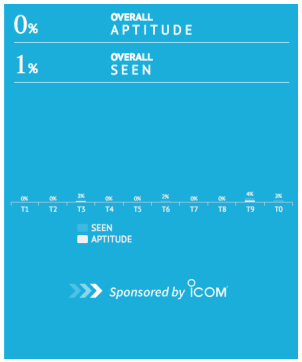
HamStudy.org

- This class will teach the fundamentals and information that the Amateur Radio Operator needs to know
  - It doesn't "teach the test"
- www.hamstudy.org is where you'll study the actual test questions and take practice tests
  - If you will spend three hours/ week in class and 1-2 hours/ week on hamstudy.org, you will pass the test



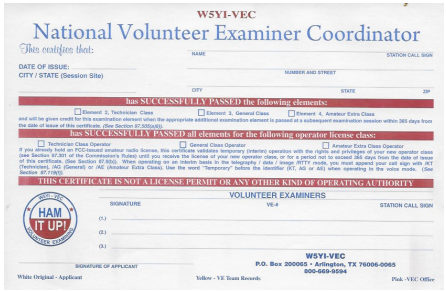
hamstudy.org
Demonstration





Your CSCE Form

- Your proof of successfully completing the Element 3 Exam
  - Good for one year
  - Use until the FCC Callsign database is updated
- Until the FCC database is updated, sign with your callsign / AG (acting General)
- You have all General Class privileges as soon as the form is signed and issued


WSYI-VEC

National Volunteer Examiner Coordinator

This certifies that:

NAME

STATION CALL SIGN

DATE OF ISSUE:

CITY / STATE (Session Site)

NUMBER AND STREET

CITY

STATE

ZIP

has SUCCESSFULLY PASSED the following elements:

Element 2, Technician Class

Element 3, General Class

Element 4, Amateur Extra Class

and will be given credit for this examination element when the appropriate additional examination element is passed at a subsequent examination session within 365 days from the date of issue of this certificate. (See Section 97.505(c)(2))

has SUCCESSFULLY PASSED all elements for the following operator license class:

Technician Class Operator

General Class Operator

Amateur Extra Class Operator

If you already hold an FCC-issued amateur radio license, this certificate validates temporary (interim) operation with the rights and privileges of your new operator class (see Section 97.397 of the Commission's Rules) until you receive the license of your new operator class, or for a period not to exceed 365 days from the date of issue of this certificate. (See Section 97.9(b)). When operating on an interim basis in the telegraphy / data / image (RTTY mode, you must append your call sign with /KT (Technician), /AG (General) or /AE (Amateur Extra Class). Use the word "Temporary" before the identifier (KT, AG or AE) when operating in the voice mode. (See Section 97.119(f)(2))

THIS CERTIFICATE IS NOT A LICENSE PERMIT OR ANY OTHER KIND OF OPERATING AUTHORITY

VOLUNTEER EXAMINERS

SIGNATURE

VE #

STATION CALL SIGN

(1.)

(2.)

(3.)

HAM IT UP!

WSYI-VEC

P.O. Box 200065 • Arlington, TX 76006-0065

800-669-9594

SIGNATURE OF APPLICANT

White Original - Applicant

Yellow - VE Team Records

Pink -VEC Office

License Expired? Two year grace period to renew.
More than 2 years? Show proof of license (e.g., CSCE) and take the Technician (Element 2 Exam)

CSCE: Certificate of Successful Completion of Examination

G1D01, G1D03, G1D06, G1D09, G1D11

FCC Rules Governing the Amateur Radio Service

- The Amateur Radio Service is regulated under FCC Regulation Part 97
  - It's actually written in understandable English!
- Must operate to conform to good engineering and good amateur practices
  - FCC decides what "good" means
- In the FCC jurisdictions outside of Region 2 (like Guam), frequency allocations may differ

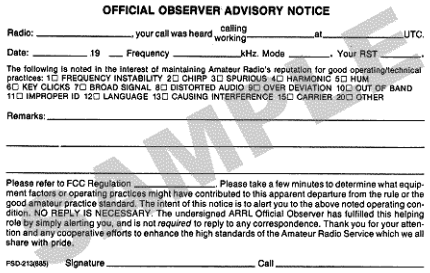
Before Transmitting:
Am I within my privileges?
Am I within the band plan?
Is the frequency clear?

The FCC also requires that you identify yourself with your call sign every ten minutes and at the end of a conversation. Even during a contest that's the only requirement.
Station logs are no longer required although most amateurs keep some kind of a log which would be helpful with a reply if the FCC requests information.

G1A14, G1B11, G2D08, G2D09

What is the Amateur Auxiliary?

- The Amateur Auxiliary is composed of approximately 700 ARRL volunteer-appointees, known as Official Observers (OO) and the Local Interference Committee (LIC) who monitor the bands and notify Amateur Radio Operators of technical and operating discrepancies.
- OOs are helpers and advisors, not "band cops." In cases involving serious rule violations, such as malicious interference, they are trained and certified to gather and forward evidence that can be used by the FCC in enforcement actions. The program is based on a formal agreement between the FCC and the ARRL.



OFFICIAL OBSERVER ADVISORY NOTICE

Radio: _____, your call was heard calling / working _____ at _____ UTC.

Date: _____ 19 __ Frequency _____ kHz. Mode _____. Your RST _____.

The following is noted in the interest of maintaining Amateur Radio's reputation for good operating/technical practices: 1☐ FREQUENCY INSTABILITY 2☐ CHIRP 3☐ SPURIOUS 4☐ HARMONIC 5☐ HUM 6☐ KEY CLICKS 7☐ BROAD SIGNAL 8☐ DISTORTED AUDIO 9☐ OVER DEVIATION 10☐ OUT OF BAND 11☐ IMPROPER ID 12☐ LANGUAGE 13☐ CAUSING INTERFERENCE 15☐ CARRIER 20☐ OTHER

Remarks: _____

_____

_____

Please refer to FCC Regulation _____. Please take a few minutes to determine what equipment factors or operating practices might have contributed to this apparent departure from the rule or the good amateur practice standard. The intent of this notice is to alert you to the above noted operating condition. NO REPLY IS NECESSARY. The undersigned ARRL Official Observer has fulfilled this helping role by simply alerting you, and is not *required* to reply to any correspondence. Thank you for your attention and any cooperative efforts to enhance the high standards of the Amateur Radio Service which we all share with pride.

FSO-212(955) Signature _____ Call _____

SAMPLE

The Amateur Auxiliary is being reorganized by the ARRL and the OO program is being completely replaced. This change occurred after the General Class question pool was updated.

Many clubs organize hidden transmitter hunts to help train amateur radio operators to use direction finding capabilities to locate stations violating FCC rules in support of the Amateur Auxiliary.

The objectives of the Volunteer Monitoring Program (now being updated) were to encourage amateur radio operators to self-regulate and comply with the rules.

G2D01, G2D02, G2D03

Be A Volunteer Examiner

If you are 18 years or older and hold a General Class license you may become certified as a Volunteer Examiner to proctor Technician Class exams. Certification is done by a VEC.

The West Desert Amateur Radio Club is affiliated with the W5YI Volunteer Examiner Coordinator.

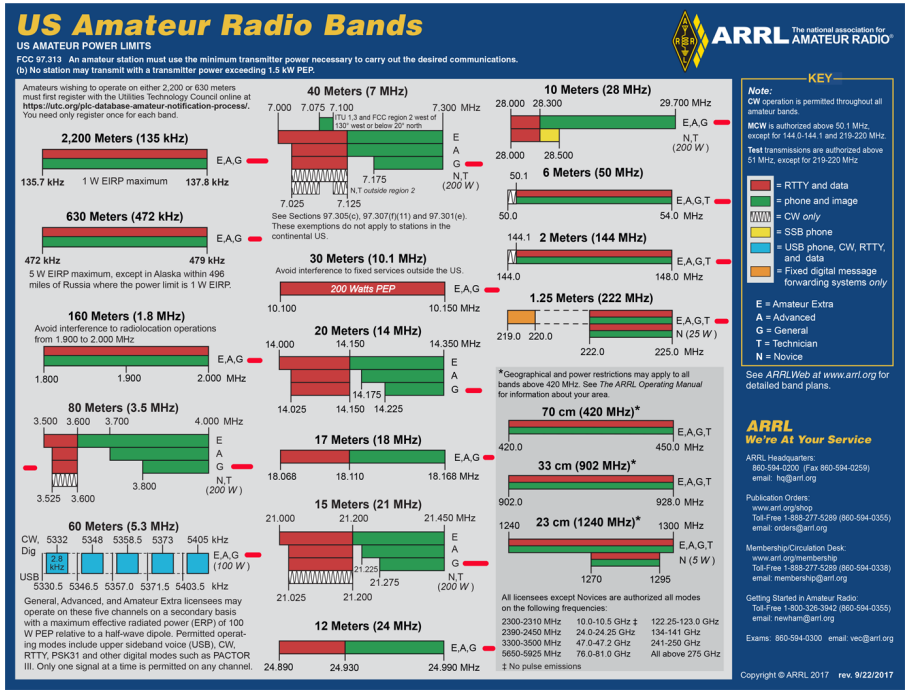
Three or more General Class or higher certified VE's are required to administer a Technician Class exam.

There is a small certification fee and an application form. See one of the club's VE's for more information.

VEC: Volunteer Exam Coordinator. There are several, including the ARRL, W5YI, Laurel, and Saturn.
A non-US citizen can be a VE if they hold an FCC granted license of General class or above.

G1D02, G1D04, G1D05, G1D07, G1D08, G1D10

General Information


US Amateur Radio Bands
US AMATEUR POWER LIMITS
FCC 97.313 An amateur station must use the minimum transmitter power necessary to carry out the desired communications.
(b) No station may transmit with a transmitter power exceeding 1.5 kW PEP.
ARRL The national association for AMATEUR RADIO
Amateurs wishing to operate on either 2,200 or 630 meters must first register with the Utilities Technology Council online at https://utc.org/plc-database-amateur-notification-process/. You need only register once for each band.
2,200 Meters (135 kHz)
E,A,G
135.7 kHz
1 W EIRP maximum
137.8 kHz
630 Meters (472 kHz)
E,A,G
472 kHz
479 kHz
5 W EIRP maximum, except in Alaska within 496 miles of Russia where the power limit is 1 W EIRP.
160 Meters (1.8 MHz)
Avoid interference to radiolocation operations from 1.900 to 2.000 MHz
E,A,G
1.800
1.900
2.000 MHz
80 Meters (3.5 MHz)
3.500 3.600 3.700 4.000 MHz
E
A
G
N,T
(200 W)
3.525 3.600 3.800
60 Meters (5.3 MHz)
CW, Dig 5332 5348 5358.5 5373 5405 kHz
2.8 kHz
E,A,G
(100 W)
USB 5330.5 5346.5 5357.0 5371.5 5403.5 kHz
General, Advanced, and Amateur Extra licensees may operate on these five channels on a secondary basis with a maximum effective radiated power (ERP) of 100 W PEP relative to a half-wave dipole. Permitted operating modes include upper sideband voice (USB), CW, RTTY, PSK31 and other digital modes such as PACTOR III. Only one signal at a time is permitted on any channel.
40 Meters (7 MHz)
7.000 7.075 7.100 7.300 MHz
ITU 1,3 and FCC region 2 west of 130° west or below 20° north
E
A
G
N,T
(200 W)
7.175
N,T outside region 2
7.025 7.125
See Sections 97.305(c), 97.307(f)(11) and 97.301(e). These exemptions do not apply to stations in the continental US.
30 Meters (10.1 MHz)
Avoid interference to fixed services outside the US.
200 Watts PEP
E,A,G
10.100 10.150 MHz
20 Meters (14 MHz)
14.000 14.150 14.350 MHz
E
A
G
14.175
14.025 14.150 14.225
17 Meters (18 MHz)
E,A,G
18.068 18.110 18.168 MHz
15 Meters (21 MHz)
21.000 21.200 21.450 MHz
E
A
G
21.225
N,T
(200 W)
21.275
21.025 21.200
12 Meters (24 MHz)
E,A,G
24.890 24.930 24.990 MHz
10 Meters (28 MHz)
28.000 28.300 29.700 MHz
E,A,G
N,T
(200 W)
28.000 28.500
6 Meters (50 MHz)
50.1
E,A,G,T
50.0 54.0 MHz
2 Meters (144 MHz)
144.1
E,A,G,T
144.0 148.0 MHz
1.25 Meters (222 MHz)
E,A,G,T
N (25 W)
219.0 220.0 222.0 225.0 MHz
*Geographical and power restrictions may apply to all bands above 420 MHz. See The ARRL Operating Manual for information about your area.
70 cm (420 MHz)*
E,A,G,T
420.0 450.0 MHz
33 cm (902 MHz)*
E,A,G,T
902.0 928.0 MHz
23 cm (1240 MHz)*
1240 1300 MHz
E,A,G,T
N (5 W)
1270 1295
All licensees except Novices are authorized all modes on the following frequencies:
2300-2310 MHz 10.0-10.5 GHz ‡ 122.25-123.0 GHz
2390-2450 MHz 24.0-24.25 GHz 134-141 GHz
3300-3500 MHz 47.0-47.2 GHz 241-250 GHz
5650-5925 MHz 76.0-81.0 GHz All above 275 GHz
‡ No pulse emissions
KEY
Note:
CW operation is permitted throughout all amateur bands.
MCW is authorized above 50.1 MHz, except for 144.0-144.1 and 219-220 MHz.
Test transmissions are authorized above 51 MHz, except for 219-220 MHz
= RTTY and data
= phone and image
= CW only
= SSB phone
= USB phone, CW, RTTY, and data
= Fixed digital message forwarding systems only
E = Amateur Extra
A = Advanced
G = General
T = Technician
N = Novice
See ARRLWeb at www.arrl.org for detailed band plans.
ARRL
We're At Your Service
ARRL Headquarters:
860-594-0200 (Fax 860-594-0259)
email: hq@arrl.org
Publication Orders:
www.arrl.org/shop
Toll-Free 1-888-277-5289 (860-594-0355)
email: orders@arrl.org
Membership/Circulation Desk:
www.arrl.org/membership
Toll-Free 1-888-277-5289 (860-594-0338)
email: membership@arrl.org
Getting Started in Amateur Radio:
Toll-Free 1-800-326-3942 (860-594-0355)
email: newham@arrl.org
Exams: 860-594-0300 email: vec@arrl.org
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The Bands

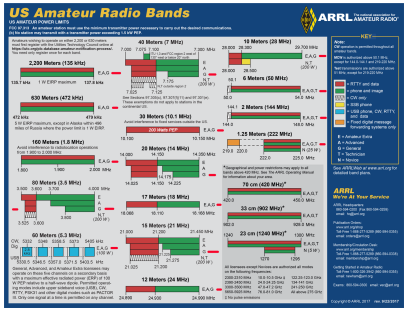
- You're expected to know where you may transmit
  - You should follow the voluntary band plan
- You're expected to know how much power you may use
  - The overall rule is the minimum power needed to complete the contact
- You're expected to know what modes may be used on each band
- You're expected to know the 3rd Party communication rules as well as know which countries you may contact
- You're expected to understand limitations of cross-band repeaters

If a Technician Class license holder is using a 2-meter repeater that has a 10-meter output, the control operator of the 10-meter repeater must be at least a General Class license holder
You may contact with amateurs in any country except those whose administrations have notified the ITU that they object to such communications (North Korea, for example)

G1A01, G1B12, G1E02, G2B07

Which Frequencies Are Available?

- There will be a question about whether or not you can transmit on a particular frequency
- General Class privileges on the popular bands (80/75, 40, 20, 15) is segmented
- Note that there are no phone privileges on the 30 meter band
- The 60 meter band is divided into specific channels
- There is one potential question about ITU Regions. We are in ITU Region 2 (North and South America)



Amateur Radio is secondary on 60 and 30 meters. We may not interfere with the primary user of the band.

If asked which bands a General Class license holder is granted all amateur frequency privileges, pick the answer with the most bands: 160,60,30,17,12,10. Don't pick an answer that has 80/75, 40, 20, or 15 meters.

Some of the gigahertz frequencies (such as 2.4 GHz and 5.2 GHz) are shared with unlicensed Part 15 devices which are required to accept our emissions and not interfere with our emissions. However, amateurs are not allowed to communicate with non-licensed WIFI stations.

Generally, when General class licensees are not permitted to use the entire voice portion of a band, the upper frequency end is available to them.

The portion above 29.5 in the 10-meter band is available for repeater use

Some bands have voluntary band plans which include DX windows, or frequencies specifically for making contacts outside the 48 contiguous states. On 6 meters that window is 50.1-50.125 MHz

G1A04, G1A05, G1A06, G1A07, G1A08, G1A09, G1A10, G1A11, G1A12, G1A13, G1A15, G1C03, G1E06, G1E07, G2B08, G8C01

60 and 30 Meters
Special Cases

30 Meters

- CW and digital data modes only
  - No image transmissions
- Maximum of 200 watts output
- Must avoid interfering with fixed services outside the US
- Very popular band for CW enthusiasts
- Good DX opportunities

60 Meters

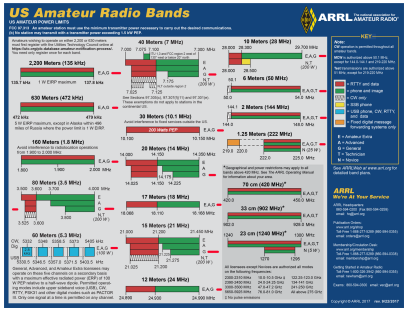
- CW, Digital, and USB allowed
- Maximum effective radiated power (ERP) of 100 watts relative to a half-wave dipole. If you use an antenna other than a dipole, you must keep a record of the antenna gain
- Channelized operation. VFO frequency on each channel depends on mode
- Only one signal at a time on any channel
- Amateur radio is secondary to the military and must relinquish use to them

The FCC changed the channel alignment a couple of years ago. Some older transceivers may no longer have the correct frequency settings to operate on 60 meters

G1A02, G1A03, G1C12, G1C14

How Much Power Can I Use?

- Generally, with some exceptions, amateur radio operators may use up to a maximum of 1,500 watts PEP
- Those exceptions:
  - 2200 meters: 1 watt
  - 630 meters: 5 watts
  - 60 meters: 100 watts
  - 30 meters: 200 watts
  - Spread Spectrum: 10 Watts



The FCC rules that regulate maximum output power specify Peak Envelope Power (PEP).

PEP is the highest power level emitted at the output of a transmitter regardless of modulation and other variables.

G1C01, G1C02, G1C05, G1C06, G1C15, G1E08

No, no, NO!

- No obscured communications … no codes or cyphers
  - Except when controlling a space station or remote controlled vehicle
- No music, not even incidental background music
  - Except from the International Space Station
- No broadcasting. All communications must be among licensed amateur radio operators. The one exception is transmissions to assist learning Morse code
- Occasional retransmission of weather and propagation forecast information from US. government station is permitted.
- All test transmissions must include ones call sign
- Retransmission of amateur station signals are allowed only by auxiliary repeater, and space stations

G1B04, G1B05, G1B07

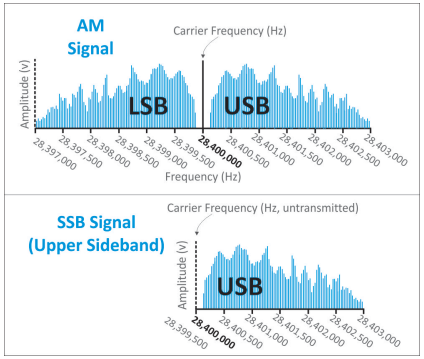
Voice Operations

While many will use funky phonetics for their callsign (for example, kilo zero shake the house), when having a QSO with a non-native English speaker please use the standard NATO Phonetic Alphabet: Alpha, Bravo, Charlie, Delta, etc.

G2D07

Voice Modes

- Amplitude Modulation is most commonly used on the HF amateur radio bands
- AM is generated by the instantaneous variation of the power level of the RF signal
- Generally AM signals are 6 kHz wide
- AM emissions have a central carrier and two sidebands. Each sideband is a mirror of the other sideband
- Single Sideband emissions have the central carrier and one of the sidebands suppressed
- SSB's advantage is lower bandwidth and greater power efficiency



- Lower sideband is common below 30 meters and upper sideband above 30 meters, including VHF/UHF
- Exception is digital operations, most of which are on upper sideband

If the center frequency is 7.178 MHz, a LSB signal extends from 7.175 to 7.178 MHz

If the center frequency is 14.230 MHZ, an USB signal extends from 14.230 to 14.233 Mhz

Many transceivers have a time delay in the transmitter keying circuit to allow time for the transmit-receive changeover operations to complete before RF output is allowed

In the days of purely analog radios, the use of lower sideband on lower frequencies and upper sideband on higher frequencies was dictated by the circuitry. Modern transmitters don't have that limitation. However, it is good amateur practice to use the proper sideband

G2A01, G2A02, G2A03, G2A04, G2A05, G2A06, G2A07, G2A09, G4A09, G8A05

Band Edges

- A single sideband signal is 3 kHz wide. When selecting an SSB transmitting frequency, the minimum separation should be approximately 3 kHz to minimize interference to stations on adjacent frequencies
- Stay at least 3 kHz above the bottom edge of the band when using lower sideband
- Conversely, stay at least 3 kHz below the top edge of the band when using upper sideband
- AM signals are 6 kHz wide

Take particular note of the band edges for General Class license holders on 80/75 meters, 40 meters, and 20 meters

G2B05, G4D08, G4D09, G4D10, G4D11, G8A07

General Rules

- No one owns a frequency. First come, first served (except during an emergency)
- Break into a QSO by giving your callsign during a break
- Before calling CQ, ask if frequency is clear
- Follow the generally accepted voluntary band plan
- If using VOX, be aware of extraneous noises
- If someone is calling “CQ DX” they’re interested in contacting a station in another country
- Only the minimum power necessary to carry out the desired communications should be used

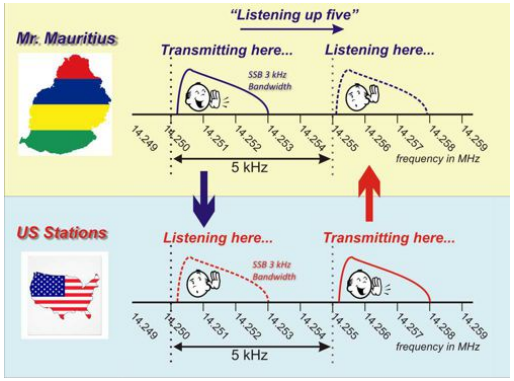
G1B08, G1C04, G2A08, G2A11, G2B01, G2B06, G2D05

Operating “Split”

Very popular stations will operate “split” where the station transmits on one frequency and listens on a different frequency (usually 5kHz up or down).

DX Operations almost always operate “split”.

The operator will announce the “split”.



Most HF radios have “split” capability.
Read the manual carefully.

Many HF radios also have 2 VFOs which is very useful for listening on two frequencies.

G4A03, G4A12

Interference: QRM

- Again, no one owns a frequency, but nets are often regular users of a specific frequency. They may ask you to move. You don't have to do that….
- On bands where Amateur Radio is secondary we must NOT interfere with the primary user
- If propagation deteriorates and you begin interfering with another station, courtesy says that you need to move to a different frequency
- A coordinated repeater has priority over an uncoordinated repeater and the uncoordinated repeater owner is obliged to resolve the interference
- Electrical arcing on loose or broken connectors will cause QRM across a wide range of frequencies

Distorted speech would be heard from an audio device or a telephone if there's interference from a nearby SSB transmitter

G2B03, G4C02, G4C03

Avoiding Creating Interference

- Amateur Radio operators must take specific steps to avoid harmful interference:
  - When operating within one mile of an FCC Monitoring Station
  - When using a band where the Amateur Service is secondary
  - When a station is transmitting spread spectrum emissions

G1E04

Managing QRM and QRN

- Many receivers have a noise blanker which reduces receiver gain during a noise pulse
- Newer receivers will have digital signal processing available with adjustable filters
- Many receivers have the ability to shift IF frequencies to move interfering signals outside of the pass band
- A directional antenna will help minimize interference

G4A16, G9C11

Continuous Wave Emissions

CW Lives!

- CW emissions are about 150 Hz wide. Operators general space themselves 150 - 500 Hz apart
  - Use a 300 Hz or narrower filter to improve the signal to noise ratio
- “Zero Beat” is the process of matching your transmit frequency with the other station(s) transmit frequency
- When responding to a CW CQ, send no faster than the other operator

CW can cause QRM on nearby radios. It appears as clicking or humming on the signal

When a CW has been Zero Beat, the received signal has no audio frequency. Most HF radios either add a “side tone” to CW signals or have an ability to slightly offset the receive frequency from the transmit frequency

Many modern receivers have a “**reverse CW**” mode, essentially switching the CW signal sideband. This is often useful when there is an adjacent strong signal

Full break-in telegraphy (QSK) means that transmitting stations can receive between code characters and elements

G2B04, G2C01, G2C05, G2C06, G4A02, G4C04

“Q” Codes and Pro Codes

- Common Q codes used in CW operations:
  - **QRS**: slow down
  - QRQ: send faster
  - **QRN**: static interference
  - **QRL**: frequency clear
  - **QRP**: reduce power
  - QRO: increase power
  - QRT: stop sending
  - **QSL**: acknowledge
  - **QRV**: ready to receive
- Common Pro Codes:
  - K: finished transmitting
  - **KN**: finished, listening for a specific station only
  - **AR**: end of a formal message
- Other common abbreviations:
  - pse: please
  - btu: back to you
  - btw: by the way

Each of the Q codes can be either a question or a response

QRP when sent is usually a request to reduce power. It has also come to mean operating at low power, generally 10 watts or less. 5 watts is very common.

G2C02, G2C03, G2C04, G2C08, G2C09, G2C10, G2C11, G2D10

RST Codes

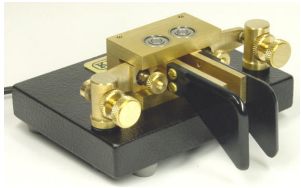
- R: Readability (1-5)
  - Unreadable to Perfectly Readable
- S: Signal Quality (1-9)
  - Very Rough to Perfect DC Tone
- T: Signal Strength (1-9)
  - Faint to Extremely Strong
- ‘C’ at the end means the signal has a ‘chirp’, usually due to low voltage to the transmitter or a faulty transmitter

RS codes are also used in voice operations. During contests, it is always a ’59’ or ‘599’ regardless of signal quality

G2C07

Straight Key or a Paddle?

- Straight Key:
  - You make the dits and dahs
  - You control the speed
  - Potentially “sloppier” code
  - Least expensive option
- Paddle:
  - Requires a “keyer” to make the dits and dahs
  - Keyer controls the speed
    - Some keyers are difficult to change speed
  - Paddles are more expensive



Many modern HF radios have a built-in keyer which is managed through menu settings. Since the speed is one of the menu settings, changing the speed to match someone else’s speed or responding to a QRS or QRQ request means getting into the menu and making the adjustment.

Most “dedicated” CW operators have an external keyer with multiple “canned” memories so they can send “CQ” with the touch of a button, or respond to a CQ with the touch of a different button. These are very useful during “radio sports”.

G4A10

Beacons

- Intended for the “observation of propagation and reception”
- Maximum power is 100 watts
- No more than one beacon signal transmitting in the same band from the same station location
- Beacon stations are located all around the world
- Don’t operate on any of the beacon frequencies (or where your signal may overlap the frequency)

Beacon frequency bands are specified by the FCC. The only HF frequency band is in the 10 meter band from 28.20 to 28.30 MHz. All others are in the VHF or higher bands.

G1B02, G1B03, G1B09, G1B10, G1E10

Radio Beacon Stations

Slot	Country	Call	14.100	18.110	21.150	24.930	28.200	Operator
1	United Nations	4U1UN	00:00	00:10	00:20	00:30	00:40	UNRC
2	Canada	VE8AT	00:10	00:20	00:30	00:40	00:50	RAC
3	USA	W6WX	00:20	00:30	00:40	00:50	01:00	NCDXF
4	Hawaii	KH6WO	00:30	00:40	00:50	01:00	01:10	UHRO
5	New Zealand	ZL	00:40	00:50	01:00	01:10	01:20	NZART
6	Australia	VK8	00:50	01:00	01:10	01:20	01:30	W1A
7	Japan	JA21CY	01:00	01:10	01:20	01:30	01:40	JARL
8	China	BY	01:10	01:20	01:30	01:40	01:50	CRSA
9	Russia	UA	01:20	01:30	01:40	01:50	02:00	TBO
10	Sri Lanka	4S7B	01:30	01:40	01:50	02:00	02:10	RSSL
11	South Africa	ZS6DN	01:40	01:50	02:00	02:10	02:20	ZS6DN
12	Kenya	5Z4B	01:50	02:00	02:10	02:20	02:30	RSK
13	Israel	4X6TU	02:00	02:10	02:20	02:30	02:40	U of Tel Aviv
14	Finland	OH2B	02:10	02:20	02:30	02:40	02:50	U oh Helsinki
15	Madeira	CS3B	02:20	02:30	02:40	02:50	00:00	ARRM
16	Argentina	LU4AA	02:30	02:40	02:50	00:00	00:10	RCA
17	Peru	OA4B	02:40	02:50	00:00	00:10	00:20	RCP
18	Venezuela	YV5B	02:50	00:00	00:10	00:20	00:30	RCV

The 10-second, phase-3, message format is: "W6WX dah-dah-dah-dah" — each "dah" lasts a little more than one second. W6WX is transmitted at 100 watts, then each "dah" is attenuated in order, beginning at 100 watts, then 10 watts, then 1 watt, and finally 0.1 watt.
Courtesy CQ Magazine

Let’s Go Digital

Most digital operations are found on the lower portion of the band. For instance, on 20 meters digital modes are concentrated between 14.070 to 14.112 MHz. On 80 meters it is 3570 - 3600 kHz

The FCC rules about digital modes allows any mode that is publicly documented. No experimental or special petitions are required

G1C13, G2E04, G2E07

Computer, Interface, Radio

Computer software generates the signal to the radio and decodes the signal from the radio

Sound card interface isolates the radio from the computer and generates the PTT signal

Radio transmits the audio when the PTT is activated, otherwise is in receive mode

The sound card interface is often an USB interface

Some newer radios have the sound card interface built into the radio.

Some modern radios have RTTY built into the radio (that is, a built-in “terminal node controller”) … all that is needed is a “dumb terminal”

If only doing RTTY, substitute a TNC for the sound card interface and a dumb terminal for the laptop

FLDIGI is the most popular software for many digital modes (RTTY, PSK, Olivia, etc.)

All digital modes except RTTY operate on Upper Sideband. RTTY is the exception and operates on Lower Sideband

The audio cable carrying the signals between the computer and the sound card interface should be a shielded cable otherwise it may pick up the transmitted RF. Symptoms of this problem include frequent connection timeouts, the VOX circuit doesn’t un-key the transmitter, and the transmitter signal is distorted.

G2E05, G4A15

Baud Rate / Symbol Rate

Symbol Rate is the number of symbol changes, waveform changes, or signaling events, across the transmission medium per time unit using a digitally modulated signal. The symbol rate is measured in baud (Bd) or symbols per second.

Amateur Band	Max Baud Rate
160 - 12 meters	300 baud
10 meters	1200 baud
6 and 2 meters	19,600 baud
1.25 and 0.70 meters	56,000 baud
33cm and higher	not specified

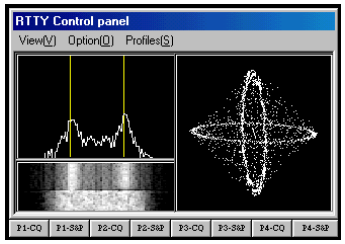
The higher the symbol rate, the wider the bandwidth required

The ARRL is petitioning the FCC to drop the symbol rate and adopt a maximum bandwidth requirement in its place. The FCC has not yet acted on that petition

G1C07, G1C08, G1C09, G1C10, G1C11, G8B10

Radio Teletype

- Transmits a Baudot code
  - 7 bit code with start, stop, and parity bits
- Uses frequency (or audio) shift emissions
  - 170 Hz shift
  - Called Mark and Space
  - Audio shift is sent using LSB
- If your system can't decode RTTY
  - Mark and Space may be reversed
  - Baud rate may be incorrect
  - May be listening on the wrong sideband



- Digital modes are usually found at the lower portion of the band
- Check the band plan as most modes have well-known "watering holes"

G2E01, G2E06, G2E14, G8C04, G8C11

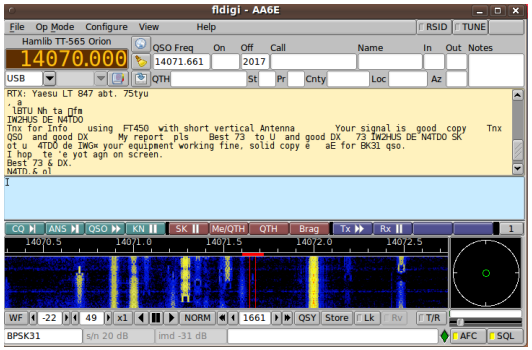
Frequency vs Audio Shift

- Computer can’t tell the difference
- Frequency shift is generated in the radio by physically changing the oscillator frequency
- Audio shift is generated in the computer and sent as audio tones to the radio
- The amount of the shift is dictated by the mode

G8A01

PSK 31

- Varicode: variable data bits per character (similar to Morse Code). Common to use only lower case. Upper case will slow down the transmission.
- “31” refers to the approximate symbol rate
- Narrow bandwidth mode. Should appear on the waterfall as a single thin line
- PSK 31 is considered a weak signal mode



On 20 meters, PSK31 is usually found at 147.020, just below RTTY

On a waterfall display, one or more vertical lines on either side of a digital signal indicate that the signal is overmodulated

On a waterfall display, frequency is across the horizontal axis. Signal strength is intensity (blue to red), and time is vertical (current time is at the top)

PSK31 has several subsets including BPSK31 and QPSK31. The latter has approximately the same bandwidth as BPSK31, it includes error correction and is very sideband sensitive

G2E08, G8A06, G8C08, G8C09, G8C12, G8C13, G8C14

Weak Signal Modes

- Joe Taylor's WSJT-X suite
  - JT65, JT9, FT8, WSPR
  - Can often be decoded even when signal is below the average noise floor
  - Revolutionized Earth->Moon->Earth and meteor scatter signal bounce
  - Relies on very accurate computer time setting
  - FT-8 is the most popular of the weak signal modes
    - Using 8-tone frequency shift keying it reliably decodes well below the noise floor

WSPR (Weak Signal Propagation Reporting) network is designed for sending and receiving low-power transmissions to test propagation paths on the MF and HF bands.

Typical exchanges on FT8 are limited to call signs, grid locators, and signal reports.

G2E11, G2E15, G8A09, G8A12, G8C02

Packet Radio

- Developed before the Internet, still quite popular
- Modeled after TCP/IP protocols
  - Packet contains a header and data
  - **Header** contains routing and handling information
- Packet “bulletin boards” are available to provide message handling, store and forward capabilities, and email routing (via the Internet, if available
- The mode used is RTTY
- Automatically controlled stations handling traffic and routing are found in the 1.25 meter and shorter bands as well as in specified segments of the 80 - 2 meter bands
  - There are automatically controlled digital stations that transfer information to and from the Internet called “Gateways”
  - Connection is made by sending a connect message on the gateway’s frequency

Winlink is a very popular method of sending and receiving email messages via radio. Very useful for ships at sea.

Automatically controlled stations transmitting RTTY or data emission to communicate with other automatically controlled stations are allowed anywhere in the 6-meter or shorter wavelength bands and in limited segments of some of the HF bands. Most packet stations and Winlink gateways are automatically controlled stations

A station initiating contact with an automatically controlled station that is operating outside the automatic control band segments must be under local or remote control

G1E03, G1E11, G2E10, G2E13, G8C03

PACTOR

- Developed in order to improve the reception of digital data when the received signal was weak or noisy
- PACTOR combines the bandwidth efficiency of packet radio with error-correction (CRC) and automatic repeat request (ARQ)
- PACTOR connections are limited to two stations
  - No break-in. Must wait for the message handling to complete then send a connect message. Always be certain the frequency is clear
  - Interference will cause frequent retries, long pauses, and connection failures
- PACTOR2 and PACTOR3 are now most common. PACTOR3 is relatively fast, about 2300 Hz wide (about the same as SSB), and requires a proprietary modem

G2E03, G2E09, G8B05, G8C07

PACTOR Protocol

- Forward Error Correction (FEC): by transmitting redundant information, the receiver can correct errors in received information packets
- ACK/NAK packets identify packets that were either received correctly or that need to be retransmitted
  - High error rates will cause the connection to drop
- Automatic Repeat Request (ARQ) packets are automatically sent when errors are detected during reception
- To determine if a channel is in use put the modem or controller in a mode which allows monitoring communications without a connection

G2E02, G8C05, G8C06, G8C10

NOTE:
3rd party rules apply regardless of mode! There are no exceptions.

Except that if a 3rd party's amateur license has been revoked and not reinstated, that person may not participate in stating a message over an amateur radio station

Remember: The types of messages for a third party in another country may only be messages relating to Amateur Radio, remarks of a personal character, or messages relating to emergencies of disaster relief.

G1E01, G1E05, G1E09

Connectors!

- Serial interfaces usually use a DB-9 connector
  - Most modern computers don't have a DB-9 connector anymore
- RCA connectors are commonly used for audio signals
- DIN connectors are a family of multiple-circuit connectors suitable for audio and control signals

DIN connectors are common in modern transceivers. Each manufacturer has a different connection scheme. In some cases, voltage may be present on one or more pins.

More new radios are abandoning the DIN connector for an RJ-45 connector. Again, each manufacturer has a different connection configuration.

G2E12, G6B12

Software Defined Radios

- Radios where most major signal processing is performed by software
- May have controls, display, computer all in one unit (Elecraft)
- May have different modules for controls, sampling, processing (Flex Radio)
- Many inexpensive USB devices available (SDRPlay)

G7C11

I and Q Signals

There is an odd question in the question pool:

What is an advantage of using I and Q signals in software-defined radios (SDRs)?

A. The need for high resolution analog-to-digital converters is eliminated

B. All types of modulation can be created with appropriate processing

C. Minimum detectible signal level is reduced

D. Converting the signal from digital to analog creates mixing products

I and Q signals are quadrature signals that are used to describe the phase of a waveform (the phase difference between the I and Q signals is **90 degrees**).

The only possible answer is:

"All types of modulation can be created with appropriate processing."

G7C10, G7C09

Emergency Operations

- An amateur radio operator may use any means at his disposal to assist a station in distress (must be an actual emergency, tho)
- You may use whichever frequency has the best chance of getting through
- Only licensed amateur radio operators may be the control operator at a RACES station and must operate within the operator's privileges
- Only messages related to immediate safety of human life or the protection of property can be transmitted by amateur radio operators on behalf of pubic broadcasters, and then only when no there means is available
- You must yield the frequency to anyone who breaks in with an emergency. Provide whatever assistance you can.

G2B02, G2B09, G2B10, G2B11


Questions? Comments?