2. PROCEDURES AND PRACTICES – AI6JB

Chapter 2 Part 1 of 1

ARRL General Class
Sections 2.1, 2.2

HF Operating Techniques

Technician class operators focus skills for VHF and higher bands

Although 10 meters (voice) and 80, 40, and 15 meters (CW) are HF options for technicians

General class operators have the advantage of using HF

A General license opens up many more frequencies, modes, and activities

Almost everything you know about operating courtesy and good practices from VHF and UHF can be applied to HF

Selecting a Frequency

Check FCC Part 97 for frequency & mode restrictions

Refer to Band Plan in Chapter 1

Remember that no group or amateur has priority access to any frequency except in the case of emergency communications

On HF, perfectly clear channels are rare

Goal: Find a frequency that minimizes interference to adjacent stations (and, vice versa) – see recommended signal separation table …

RECOMMENDED SIGNAL SEPARATION	
CW:	150-500 Hz
SSB:	2-3 kHz
RTTY:	250-500 Hz
PSK31:	150-500 Hz

Selecting a Frequency (cont.)

Once a frequency is found, check if another station is using it …

Listen for 10-20 seconds ... then …

- Voice Mode: Is this frequency in use? This is [your call].
- CW/Digital Modes: QRL? DE [your call].

Frequency selection summary …

Confirm frequency is authorized for your license privileges

Follow the band plan under normal circumstances

Listen to avoid interfering with ongoing communications

Split / Dual Frequency Operation

When a rare or interesting station is on the air with many calling stations, it's common to operate split …

Set transceiver to listen on one frequency and transmit on another

Allows for more orderly/effective operating

Doesn't work on all transceivers

Referred to as a dual-VFO feature on a transceiver

More Info … HF Operating Techniques

HF equipment is designed for continuous tuning

The control used for continuous tuning is called a VFO or Variable Frequency Oscillator

The minimum frequency change is called step size or step rate

For short-range contacts, use 80 or 40 meters

Using long-distance bands for short-range contacts needlessly occupies radio spectrum space (signal will be heard over much wider range than you're using)

Longer range contacts, use 30 through 10 meters

Frequencies	*Modes/Activities*
1.800-2.000	CW
1.800-1.810	Digital Modes
1.810	QRP CW calling frequency
1.843-2.000	SSB, SSTV and other wideband modes
1.910	SSB QRP calling frequency
1.995-2.000	Experimental
1.999-2.000	Beacons
3.500-3.510	CW DX window
3.560	QRP CW calling frequency
3.570-3.600	RTTY/Data
3.585-3.600	Automatically controlled data stations
3.590	RTTY/Data DX
3.790-3.800	DX window
3.845	SSTV
3.885	AM calling frequency
3.985	QRP SSB calling frequency
7.030	QRP CW calling frequency
7.040	RTTY/Data DX
7.070-7.125	RTTY/Data
7.100-7.105	Automatically controlled data stations
7.171	SSTV
7.173	D-SSTV
7.285	QRP SSB calling frequency
7.290	AM calling frequency
10.130-10.140	RTTY/Data
10.140-10.150	Automatically controlled data stations
14.060	QRP CW calling frequency
14.070-14.095	RTTY/Data
14.095-14.0995	Automatically controlled data stations
14.100	IBP/NCDXF beacons
14.1005-14.112	Automatically controlled data stations
14.230	SSTV
14.233	D-SSTV

Frequencies	*Modes/Activities*
14.236	Digital Voice
14.285	QRP SSB calling frequency
14.286	AM calling frequency
18.100-18.105	RTTY/Data
18.105-18.110	Automatically controlled data stations
18.110	IBP/NCDXF beacons
18.162.5	Digital Voice
21.060	QRP CW calling frequency
21.070-21.110	RTTY/Data
21.090-21.100	Automatically controlled data stations
21.150	IBP/NCDXF beacons
21.340	SSTV
21.385	QRP SSB calling frequency
24.920-24.925	RTTY/Data
24.925-24.930	Automatically controlled data stations
24.930	IBP/NCDXF beacons
28.060	QRP CW calling frequency
28.070-28.120	RTTY/Data
28.120-28.189	Automatically controlled data stations
28.190-28.225	Beacons
28.200	IBP/NCDXF beacons
28.385	QRP SSB calling frequency
28.680	SSTV
29.000-29.200	AM
29.300-29.510	Satellite downlinks
29.520-29.580	Repeater inputs
29.600	FM simplex
29.620-29.680	Repeater outputs

ARRL band plans for frequencies above 28.300 MHz are shown in *The ARRL Repeater Directory* and on **arrl.org.**

Band-by-Band Frequency Guide

General Class License Manual, Tenth Edition, Page 2-3

Very Common Q Codes

Memorize these!

Code	Meaning
QRL	Are you busy? / I am busy.
QSO	Can you communicate? / I can communicate. (Sometimes “conversation”)
QRP	Shall I decrease transmit power? / Decrease transmit power.
QRO	Shall I increase transmit power? / Increase transmit power.
QSL	Can you receive? / Confirm received.
QRM	Are you bothered by non-natural noise/interference? / I am bothered …
QRN	Are you bothered by natural noise/interference/static? / I am bothered …
QRV	Are you ready to receive? / I am ready …
QRZ	QRZ? (Who is calling me?) / QRZ _ _ _ _ _ (QRZ _ _ _ _ _ is calling you.)
QTH	What is your location? / My location is.

Making Contacts

Calling CQ is rare* on VHF/UHF FM channels, but the method many contacts are initiated on HF

To call CQ on phone/voice …

"*CQ CQ CQ, this is* [your call repeated a few times with phonetics]"

- Example (KØILP): *CQ CQ CQ, this is kilo-zero-india-lima-papa, kilo-zero-india-lima-papa*

Pause for a response

If no response, repeat your CQ

To call CQ on CW …

"*CQ CQ CQ DE* [your call without phonetics]"

** Calling CQ is rare on VHF/UHF, but acceptable to use.*

Making Contacts, CQ Variations

CQ DX (DX means distant stations)

If you hear CQ DX from a station on the US mainland, it means the person calling is looking for stations outside the lower 48 states

On HF, it generally refers to any station outside the caller's country

During CQ contests, you'll generally hear …

"CQ Contest", "CQ test", or *"CQ from special event station"*

CQ for stations from certain areas …

"CQ North America" or *"CQ California"*

Joining an Ongoing QSO (Contact)

Joining a QSO (also called breaking in) is common

- On phone/voice, just say your call sign
- On CW / digital modes, send BK (break) followed by your call sign

Same rules apply during contests and competitive events

DX Windows

Originally designed to give operators from countries with restricted privileges band space to make DX contacts outside their countries

Only a few kHz wide on some bands

Now less common with increasing world-wide frequency allocations … but …

50.1 to 50.125 MHz is the place to listen for long-distance contacts outside the contiguous 48 states

Nets & Schedules

There are many on-the-air activities scheduled in advance

Although no individual has exclusive access to frequencies, we should be courteous and accommodating

Avoid scheduling contacts on national calling frequencies and popular bands

Check contesting calendars on ARRL.org and other sites

If you're "net control" and discover the net's chosen frequency to be occupied, find a nearby clear frequency or change to the net's backup frequency

Logging Contacts

No longer required, but most amateurs keep a log to verify contacts for awards and to record items of interest – see NOTE below

Typical log: time, date, frequency or band, mode of the contact (USB, PSK, etc.), call sign, signal reports, names, and equipment used

Establishes identify of control operator and can be useful in providing info requested by the FCC

NOTE: When operating on 60 meters with an antenna other than a dipole, FCC requires you to keep a record of antenna gain calculations or manufacturer's data (ensures meeting 100 W ERP restrictions).

Managing Interference

Interference is going to occur on HF …

Frequencies aren't channelized

There are many amateurs using the frequencies

Occurs due to crowding, propagation, personal choice, atmospheric conditions, and consumer electronics

Learning how to make contacts under these conditions is part of becoming a good operator

Types of Interference

Harmful

Defined by FCC 97.3(a)(23) as “interference which … seriously degrades, obstructs or repeatedly interrupts a radio communication service operating in accordance with the Radio Regulations”

- It’s not always illegal, but needs to be resolved to keep communicating

Malicious, deliberate or willful

Specifically forbidden by FCC 97.101(d)

Avoiding Interference

Learn what bands are crowded and when

Learn characteristics of each band (propagation & noise)

Learn how to use your equipment (understand strengths & weaknesses)

Check published calendars for major operating events

Reacting to Interference

Be flexible … no one has a claim to any frequency

Have a back-up plan (especially for scheduled events … nets, etc.)

- Do this in advance!

Keep a cool head … don’t allow harmful interference to turn into deliberate interference!

Modes

CW (continuous wave) … found in lower ranges for each HF band. However, CW operation is permitted throughout all amateur bands.

AM & SSB (single-side band)

SSB is the most common voice mode or phone signal

Has displaced AM as the preferred HF voice modulation method

SSB signals use less spectrum space than AM (3 kHz vs. 6 kHz … this increases efficiency … results in SSB having a greater range than AM

Amateurs use many different modes of communication. The invention of these various modes is a example of amateur radio fulfilling its mission to "contribute to the state of the radio art." (per Part 97.1b)

Modes (cont.)

USB vs. LSB (upper and lower side band)

- Good amateur practices is to use USB above 9 MHz (20 thru 10 meters) and LSB elsewhere except on 60 meters
  - USB is used on VHF and UHF

FM is generally not used on HF because higher noise hurts intelligibility

- Exception: FM repeaters can be found on the higher frequencies of 10 meters (above 29 MHz) where cross-continent and DX contacts can be made when the band is open

Modes (cont.)

Digital Voice …

- Relatively new on HF bands
- Operator's voice converted to and from a digital stream via modem or sound card. Modem connects to a regular SSB transceiver.
- Fidelity comparable to regular SSB signals, but less affected by fading
- Most popular digital voice modes: FreeDV and protocol developed by G4GUO (Charles Brain)

Modes (cont.)

Digital Modes …

- Packet radio common on VHF and UHF to exchange digital data, but also common on HF
- FT8: Most popular
- FT8, PSK63 and PSK31: Effective at low power levels … all widely used
- RTTY: Oldest, and still common (radioteletype)
- PACTOR or WINMOR: Used for semi-automatic and automatic messaging for small files

More info on digital modes in Chapter 6

Modes (cont.)

Image Modes

- Image mode transmissions on HF encode photos & graphics to tones
- These tones are reconstructed as an image on a display
- Allowed on same frequencies as voice, except for 60 meters
- Most common image mode: Slow-scan television (SSTV)
  - Called slow because each image takes several seconds
- Fast-scan amateur television (ATV) allows full motion video
  - Restricted to 432 MHz and higher frequency bands (due to wide bandwidth)

Mode Comparison

More details in Chapters 5 & 6

Table 2.2
Mode Comparison

Mode	*Bandwidth*	*Examples*	*Data Rate*	*Notes*
CW	Up to 150 Hz		Up to 60 WPM	
AM	6 kHz			Can be higher fidelity than SSB
SSB	3 kHz			
Narrow Bandwidth HF Digital	Up to 500 Hz	RTTY, PSK31 JT65 or FT8	Up to 100 WPM	Keyboard-to-keyboard
Wide Bandwidth HF Digital	Up to 2.3 kHz	PACTOR	Up to 5,200 bit/s	Keyboard-to-keyboard and file transfer
VHF/UHF Digital	Up to 100 kHz	Packet, D-STAR SystemFusion, Digital Mobile Radio (DMR)		Max bandwidth varies by band
Narrow Bandwidth Image	3 kHz max on HF	SSTV		
Video (full motion)	6 MHz max	NTSC, HDTV		UHF and microwave only

HF Receiving

On VHF, FM receivers have 3 basic controls …

- Frequency (channel), squelch, volume

SSC/CW receivers have additional controls to accommodate non-channelized, continuous-tuning operation (must be able to receive signals in the presence of noise and interference from adjacent channels). Examples …

- Selectivity: Ability to discriminate between closely-spaces signals
- Sensitivity: Ability to detect a signal

Examples of Additional HF Transceiver Controls

Natural or atmospheric noise (QRN) is much more common on HF than VHF/UHF. This natural noise includes some man-made sources (sparks from motors & generators). Hence, the importance of ***SELECTIVITY****.*

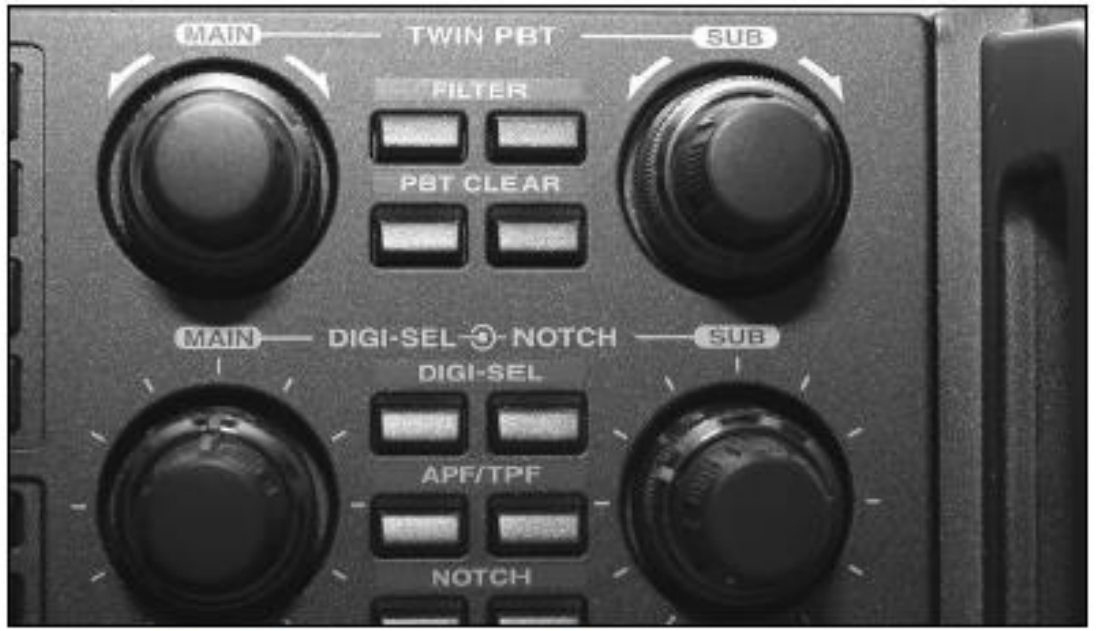

Figure 2.3 — HF transceivers have a variety of controls to help minimize interference on crowded bands. These may include notch filters, passband filters, audio peak filters and similar features.

Signal Reporting

Exchanged between stations at beginning of a contact (lets stations know how well they're being received so adjustments can be made)

Most common is RST

- Readability: Scale of 1 to 5 (5 = best)
- Strength: Scale of 1 to 9 (9 = best)
- Tone: Also 1 to 9 scale. Only used for CW and digital mode contacts.
  - Indicates signal purity; Values less than 9 indicate transmitter problems
- A C added after RST indicates an unstable signal or chirp

HF Receiving … More Information

HF receivers use sharp filters to reject unwanted signals

Because HF operation is not channelized, you'll encounter signals close enough in frequency to be audible as low- or high-pitched speech fragments. This is QRM interference.

A steady tone from a station tuning up or a broadcast carrier can be rejected by a notch filter

HF Transmitting – PHONE

Putting transceiver into transmit mode is called keying the transmitter

- The PTT (push-to-talk) button works the same as on FM
- Foot switches are often used during busy operating periods

Some HF operators use voice-operated transmit or VOX

- Allows hands-free operation
- Common for mobile operators

HF Transmitting – CW

CW operators use prosigns (2-letter shortcuts)

- Example: $\overline{AR}$ (means End of Message)

Respond to a CQ at the fastest speed you're comfortable, up to the speed of the CQ (sending station)

- Reply with QRS to request sender slow down (QRQ = speed up!)

As with voice, give call sign every 10 minutes and end of contact

CW (cont.)

Most CW operators begin by using a straight key but most graduate to an electronic keyer

The keyer is operated by a paddle to automatically generate the strings of Morse code elements — dots and dashes

Under some circumstances, it is more convenient to be able to hear what is going on between Morse characters

- Some radios include a full break-in option in which the radio switches between transmit and receive … full break-in is referred to as QSK

CW (cont.)

When communicating, try to match your transmitting frequency with the received signal (called zero beat)

Once you are in contact with another station, the prosign KN is used instead of K to prevent other stations from breaking in during the contact

- “Only the specific station or stations I am contacting should respond.”
- Prosign SK ends the message

Other useful CW Q codes:

- QRV = I’m ready to receive
- QSL = I acknowledge receipt

CW Additional Information

FISTS: www.fists.org

CWOps: www.cwops.org

ARRL: www.arrl.org/cw-mode

Learn CW Online: https://lcwo.net

Emergency Operation

Amateurs should be familiar with emergency rules and procedures

See Table 2.4 (General Class License Manual, Pages 2-16, 2-17)

- FCC 47 CFR § 97.401 Operating during a disaster
- FCC 47 CFR § 97.403 Safety of life and protection of property
- FCC 47 CFR § 97.405 Station in distress
- FCC 47 CFR § 97.407 Radio amateur civil emergency service

ARES & RACES
Amateur Radio two primary emergency response organizations

ARES = Amateur Radio Emergency Services (sponsored by ARRL)

- Mission: provide communications assistance to local and regional government and relief agencies
- www.arrl.org/ares

RACES (sponsored by FEMA)

- Mission: provide essential communications for State and local governments in time of emergency
- Only a licensed amateur may be the control operator of a RACES station

Distress Calls

If you receive a call for help …

- Immediately suspend your existing contact
- Immediately acknowledge to the station calling for help
- Stand by to receive the location of the emergency and the name of the assistance required
- Relay the info to the proper authorities and stay on frequency

Distress Calls (cont.)

If you're the station making the distress call …

- On voice mode, say MAYDAY MAYDAY MAYDAY. On CW or digital send SOS SOS SOS followed by Any station come in please.
- Identify the transmission with your call sign
- State your location and the nature of the situation
- Describe the type of assistance required

FCC 47 CFR § 97.405 allows the distress station to use ANY means of communication available, even frequencies, mode, or power level outside your normal privileges

QUESTIONS?

ONLINE EXAM REVIEW AND PRACTICE QUESTIONS:

http://www.arrl.org/examreview