General License Class

Chapter 2 Procedures & Practices

HF Operating Techniques

- Basic Operating
  - HF bands (except 60m) not channelized.
    - Equipment designed for continuous tuning
    - VFO = Variable Frequency Oscillator

HF Operating Techniques

- Basic Operating
  - Making a Contact
    - CQ – General call to any station
      - Restricted CQ's
        - By location -- CQ DX, CQ Europe, CQ Texas, etc.
        - Other – CQ Contest, CQ Field Day, etc.

HF Operating Techniques

- Basic Operating
  - Making a Contact
    - Calling CQ on phone:

      CQ CQ CQ this is *<your call> <your call> <your call>*

      CQ CQ CQ this is *<your call> <your call> <your call>*

      CQ CQ CQ this is *<your call> <your call> <your call>* over

      - Use the ICAO phonetic alphabet to send your call.
    - Calling CQ on CW:

      CQ CQ CQ DE *<your call> <your call> <your call>*

      CQ CQ CQ DE *<your call> <your call> <your call>*

      CQ CQ CQ DE *<your call> <your call> <your call>* K

HF Operating Techniques

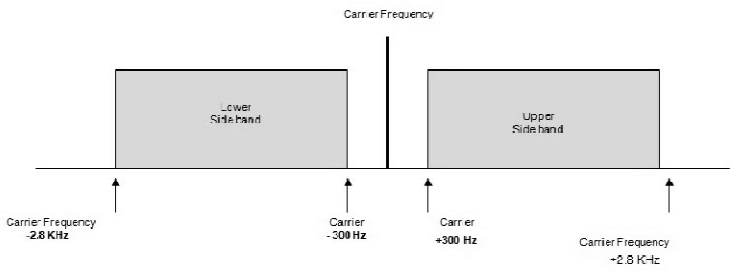
- Basic Operating
  - Making a Contact.
    - Answering a CQ on phone:

      ***<his call>* this *is <your call> <your call> <your call>* over**
      - Send <your call> phonetically using ICAO phonetic alphabet.
    - Answering a CQ on CW:

      ***<his call>* this *is <your call> <your call> <your call>* K**
    - Breaking into an existing conversation:
      - Send <your call> phonetically during a break between transmissions.
      - KN

HF Operating Techniques

- Good Practices
  - Selecting a Frequency
    - **Be aware of the band edges!**



HF Operating Techniques

- Good Practices
  - Selecting a Frequency
    - Signal Separation

Mode	Separation
CW	150-500 Hz
SSB	Approx 3 kHz
RTTY	250-500 Hz
PSK31	150-500 Hz

HF Operating Techniques

- Good Practices
  - Selecting a Frequency
    - No single operator or group of operators has priority on a given frequency.
    - If a conflict arises, move to a different frequency.
      - Change in propagation causes conflict.
      - Schedules or nets.
      - **Courtesy Rules!**

HF Operating Techniques

- Good Practices
  - Selecting a Frequency
    - In Summary:
      - Be sure frequency is authorized to General class licensees.
        - **Be aware of the band edges!**
      - Follow the band plan, if possible.
      - **Listen before transmitting!**

HF Operating Techniques

- Good Practices
  - Nets & Schedules
    - Nets – Regularly scheduled gatherings of amateur radio operators on the air for a specific purpose.
      - Traffic Nets
      - Service Nets
      - Social Nets
      - Topical Nets
        - Every topic you can think of & a few you can't!
      - Emergency Nets
        - Obviously, not normally scheduled.

HF Operating Techniques

- Good Practices
  - Nets & Schedules
    - Schedules – Agreement by 2 or more operators to meet on a specific frequency at a specific time.

HF Operating Techniques

- Good Practices
  - Band plans
    - Gentlemen's agreements specifying what segments of a band are used for what mode or type of operation.
    - NOT regulations, but guidelines.
      - FCC considers band plans to be "good amateur practice" to be followed when practical.

HF Operating Techniques

- Good Practices
  - Housekeeping and Operating Support
    - Logs
      - Not required by FCC, but useful if FCC makes inquiries into station operation.
      - Necessary for exchanging QSL cards.
      - Necessary for award tracking.
      - Necessary for contests.

HF Operating Techniques

- Good Practices
  - Housekeeping and Operating Support
    - Logs
      - Normally contain:
        - Date & time of contact.
        - Band or frequency of contact.
        - Call sign of station worked.
        - Signal reports sent/received.
      - May contain any other desired information.
        - Name & QTH of station contacted, guest operator, etc.

HF Operating Techniques

- Managing Interference
  - Types of Interference
    - Incidental interference
      - Propagation changes
      - Not maintaining proper frequency separation
    - Harmful interference
      - Prohibited by FCC Rules & Regulations
    - Malicious (intentional) interference
      - Prohibited by FCC Rules & Regulations

HF Operating Techniques

- Managing Interference
  - Avoiding Interference
    - Be smart.
    - Know band conditions.
      - Propagation
      - Busy times
    - Use directional antenna.

HF Operating Techniques

- Managing Interference
  - Reacting to Interference
    - Change frequency or antenna.
    - Have back-up plan.
    - **Keep cool!!!**

HF Operating Techniques

- Modes
  - CW
    - Continuous wave.
    - Best mode for weak-signal conditions.*
    - Permitted on ANY amateur frequency.
      - Courteous operators stay in segments specified for CW in the band plan.

HF Operating Techniques

- Modes
  - AM and SSB Phone
    - SSB most common mode on HF.
    - SSB narrower bandwidth than AM.
    - SSB more power efficient than AM.
    - AM higher fidelity than SSB.

HF Operating Techniques

- Modes
  - AM and SSB Phone
    - SSB – Which sideband?
      - 60m -- USB only (FCC Regulation)
      - On all other bands, sideband is dictated by convention, not by regulation.

HF Operating Techniques

Conventional Sideband Usage

Band	Sideband
160m	LSB
80m	LSB
40m	LSB
20m	USB
17m	USB
15m	USB
12m	USB
10m	USB
VHF/UHF	USB

HF Operating Techniques

- Modes
  - Digital Modes
    - RTTY
    - PSK31
    - PACTOR
    - Olivia
    - JT65
    - Many, many more!

HF Operating Techniques

- Modes
  - Image Modes
    - Slow-Scan Television (SSTV)
      - Bandwidth ≤ 3 kHz
      - Allowed in phone segments of HF bands.
    - Fast-Scan Television (ATV)
      - Bandwidth 6 MHz or greater.
      - Restricted to 432 MHz band and above.

G1B08 -- When choosing a transmitting frequency, what should you do to comply with good amateur practice?

A. Insure that the frequency and mode selected are within your license class privileges
B. Follow generally accepted band plans agreed to by the Amateur Radio community
C. Monitor the frequency before transmitting
➡ D. All of these choices are correct

G2A01 -- Which sideband is most commonly used for voice communications on frequencies of 14 MHz or higher?

➡ A. Upper sideband
B. Lower sideband
C. Vestigial sideband
D. Double sideband

G2A02 -- Which of the following modes is most commonly used for voice communications on the 160-meter, 75-meter, and 40-meter bands?

A. Upper sideband
➡ B. Lower sideband
C. Vestigial sideband
D. Double sideband

G2A03 -- Which of the following is most commonly used for SSB voice communications in the VHF and UHF bands?

➡ A. Upper sideband
B. Lower sideband
C. Vestigial sideband
D. Double sideband

G2A04 -- Which mode is most commonly used for voice communications on the 17-meter and 12-meter bands?

➡ A. Upper sideband
B. Lower sideband
C. Vestigial sideband
D. Double sideband

G2A05 -- Which mode of voice communication is most commonly used on the high frequency amateur bands?

A. Frequency modulation
B. Double sideband
➡ C. Single sideband
D. Phase modulation

G2A06 -- Which of the following is an advantage when using single sideband as compared to other analog voice modes on the HF amateur bands?

A. Very high fidelity voice modulation
➡ B. Less bandwidth used and higher power efficiency
C. Ease of tuning on receive and immunity to impulse noise
D. Less subject to static crashes (atmospherics)

G2A07 -- Which of the following statements is true of the single sideband voice mode?

A. Only one sideband and the carrier are transmitted; the other sideband is suppressed
B. Only one sideband is transmitted; the other sideband and carrier are suppressed
C. SSB is the only voice mode that is authorized on the 20-meter, 15-meter, and 10-meter amateur bands
D. SSB is the only mode that is authorized on the 160-meter, 75-meter and 40-meter amateur bands

G2A08 -- Which of the following is a recommended way to break into a conversation when using phone?

A. Say "QRZ" several times followed by your call sign
B. Say your call sign during a break between transmissions from the other stations
C. Say "Break Break Break" and wait for a response
D. Say "CQ" followed by the call sign of either station

G2A09 -- Why do most amateur stations use lower sideband on the 160-meter, 75-meter and 40-meter bands?

A. Lower sideband is more efficient than upper sideband at these frequencies
B. Lower sideband is the only sideband legal on these frequency bands
C. Because it is fully compatible with an AM detector
➡ D. Current amateur practice is to use lower sideband on these frequency bands

G2A11 -- What does the expression "CQ DX" usually indicate?

A. A general call for any station
B. The caller is listening for a station in Germany
➡ C. The caller is looking for any station outside their own country
D. A distress call

G2B01 -- Which of the following is true concerning access to frequencies in non-emergency situations?

A. Nets always have priority
B. QSO's in process always have priority
➡ C. Except during FCC declared emergencies, no one has priority access to frequencies
D. Contest operations must always yield to non-contest use of frequencies

G2B03 -- If propagation changes during your contact and you notice increasing interference from other activity on the same frequency, what should you do?

A. Tell the interfering stations to change frequency
B. Report the interference to your local Amateur Auxiliary Coordinator
➡ C. As a common courtesy, move your contact to another frequency
D. Increase power to overcome interference

G2B04 -- When selecting a CW transmitting frequency, what minimum separation should be used to minimize interference to stations on adjacent frequencies?

A. 5 to 50 Hz

➡ B. 150 to 500 Hz

C. 1 to 3 kHz

D. 3 to 6 kHz

G2B05 -- What is the customary minimum frequency separation between SSB signals under normal conditions?

A. Between 150 and 500 Hz

➡ B. Approximately 3 kHz

C. Approximately 6 kHz

D. Approximately 10 kHz

G2B06 -- What is a practical way to avoid harmful interference on an apparently clear frequency before calling CQ on CW or phone?

A. Send "QRL?" on CW, followed by your call sign; or, if using phone, ask if the frequency is in use, followed by your call sign
B. Listen for 2 minutes before calling CQ
C. Send the letter "V" in Morse code several times and listen for a response or say "test" several times and listen for a response
D. Send “QSY” on CW or if using phone, announce “the frequency is in use”, then send your call and listen for a response

G2B07 -- Which of the following complies with good amateur practice when choosing a frequency on which to initiate a call?

A. Check to see if the channel is assigned to another station
B. Identify your station by transmitting your call sign at least 3 times
C. Follow the voluntary band plan for the operating mode you intend to use
D. All of these choices are correct

G2B08 -- What is the “DX window” in a voluntary band plan?

A. A portion of the band that should not be used for contacts between stations within the 48 contiguous United States
B. An FCC rule that prohibits contacts between stations within the United States and possessions in that portion of the band
C. An FCC rule that allows only digital contacts in that portion of the band
D. A portion of the band that has been voluntarily set aside for digital contacts only

G2C04 -- What does the Q signal "QRL?" mean?

A. "Will you keep the frequency clear?"
B. "Are you operating full break-in" or "Can you operate full break-in?"
C. "Are you listening only for a specific station?"
D. "Are you busy?", or "Is this frequency in use?"

G2D08 -- What is a reason why many amateurs keep a station log?

A. The ITU requires a log of all international contacts
B. The ITU requires a log of all international third party traffic
C. The log provides evidence of operation needed to renew a license without retest
➡ D. To help with a reply if the FCC requests information

G2D09 -- What information is traditionally contained in a station log?

A. Date and time of contact
B. Band and/or frequency of the contact
C. Call sign of station contacted and the signal report given
➡ D. All of these choices are correct

HF Operating Techniques

- HF Receiving
  - FM receivers normally only have volume, squelch, & frequency (channel) controls.
  - SSB/CW receivers have MANY more controls to adjust operation.

HF Operating Techniques

- HF Receiving
  - Selectivity
    - Ability to reject strong signals close to the desired frequency.
    - More important than sensitivity.
      - Primary noise source is atmosphere rather than receiver circuitry.

HF Operating Techniques

- HF Receiving
  - Receiver Incremental Tuning (RIT)
    - Tunes receiver slightly off of transmit frequency.
  - Transmitter Incremental Tuning (XIT)
    - Tunes transmitter slightly off of receive frequency.
  - Overload & Intermodulation

HF Operating Techniques

- HF Transmitting
  - Phone
    - VOX – Voice-operated transmit.
      - Allows “hands-free” operation.
      - 3 Controls
        - VOX Gain
        - VOX Delay
        - Anti-VOX

HF Operating Techniques

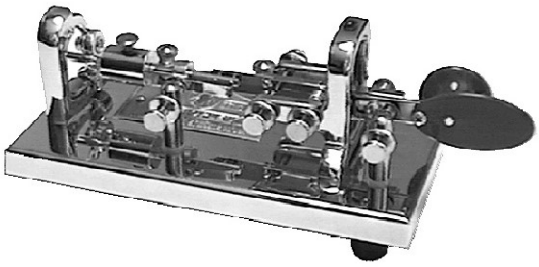
- HF Transmitting
  - Phone Procedures & Abbreviations
    - Prowords
    - “Q” Signals
    - No “10-Codes”

HF Operating Techniques

- HF Transmitting
  - CW
    - Straight Key

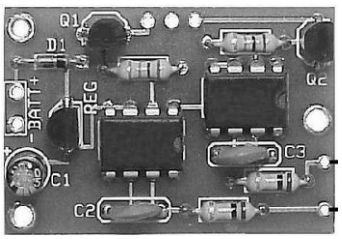
HF Operating Techniques

- HF Transmitting
  - CW
    - Semi-Automatic Key or “Bug”



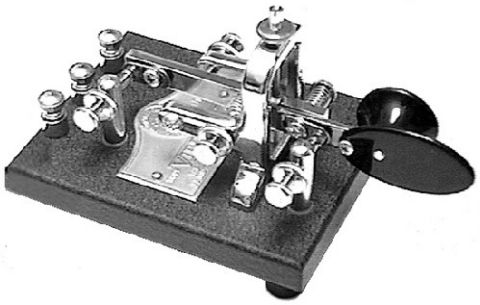
HF Operating Techniques

- HF Transmitting
  - CW
    - Electronic Keyer
      - Creates strings of “dits” & “dahs”.
      - Built into most modern transceivers.



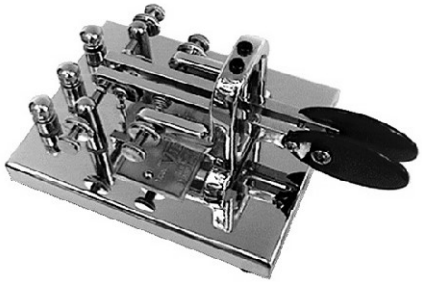
HF Operating Techniques

- HF Transmitting
  - CW
    - Single-Paddle Key



HF Operating Techniques

- HF Transmitting
  - CW
    - Dual-Paddle Key (Iambic)



HF Operating Techniques

- HF Transmitting
  - CW
    - Keyboard

HF Operating Techniques

- HF Transmitting
  - CW
    - T-R Switching
      - MOX
      - Semi Break-In (Semi QSK)
      - Full Break-In (Full QSK)

HF Operating Techniques

- HF Transmitting
  - CW & Digital Procedures & Abbreviations
    - Abbreviations are used to shorten common words:

RX = Receive
XMT = Transmit
WX = Weather
TX = Transmit
DE = This Is
ES = And
FB = Fine Business (OK)
FER = For
CUL = See You Later
AGN = Again

HF Operating Techniques

- HF Transmitting
  - CW Procedures & Abbreviations
    - Prosigns are used to organize/control communications:

AR = End of Message
AS = Wait
BK = Break in Transmission
BT = Pause or Separator
CL = Closing Station
K = Go Ahead
KN = Go Ahead (Only)
R = Received ("Roger")
SK = End of Contact
SOS = Distress Signal

HF Operating Techniques

- HF Transmitting
  - CW Procedures & Abbreviations
    - Q-Signals replace an entire sentence or phrase with a group of 3 letters.
      - Originally developed for the commercial radiotelegraph service. (circa 1909)
      - Add a "?" to change statement to a question.

HF Operating Techniques

Q-Signal	Definition
QRL / QRL?	I am busy. / Are you busy? This frequency is in use. / Is this frequency in use?
QRM / QRM?	I have interference. / Do you have interference?
QRN / QRN?	I am troubled by static. / Are you troubled by static?
QRO / QRO?	Increase power. / Shall I increase power?
QRP / QRP?	Decrease power. / Shall I decrease power?
QRQ / QRQ?	Send faster. / Shall I send faster? (Can add speed in wpm)
QRS / QRS?	Send more slowly. Shall I send more slowly? (Can add speed in wpm)
QRT / QRT?	Stop sending. / Shall I stop sending?
QRV / QRV?	I am ready. / Are you ready?

HF Operating Techniques

Q-Signal	Definition
QRX / QRX?	I will call you again at <time> on <freq>. Shall I call you again at <time> on <freq>? Also: Stand-By or Wait.
QRZ / QRZ?	<call> is calling you on <freq>. / Who is calling me?
QSB / QSB?	Your signals are fading. / Are my signals fading?
QSK / QSK?	I can hear you between my signals. Can you hear me between your signals?
QSL / QSL?	I am acknowledging receipt. / Can you acknowledge receipt?
QST	Here is a broadcast message for all amateurs.
QSY / QSY?	Change frequency. / Shall I change frequency? (Can add frequency or frequency offset.)
QTH / QTH?	My location is <location>. / What is your location?

HF Operating Techniques

- Signal Reports
  - Readability, Strength, Tone (RST)
    - Used to exchange information about the strength & quality of radio transmissions.
    - In contests “cut” numbers are often used.
      - A = 1
      - N = 9
      - T = 0

HF Operating Techniques

- Signal Reports

Readability	
1	Unreadable
2	Barely readable, occasional words distinguishable
3	Readable with considerable difficulty
4	Readable with practically no difficulty
5	Perfectly readable

HF Operating Techniques

- Signal Reports
  - "S"-Meter on radio is an attempt to quantify signal strength readings.
  - "S9" defined as 50µV signal at antenna terminals.

Strength	
1	Faint signal, barely perceptible
2	Very weak
3	Weak
4	Fair
5	Fairly good
6	Good
7	Strong
8	Moderately strong
9	Very strong signals

HF Operating Techniques

- Signal Reports

	Tone
1	60Hz AC or less, very rough and broad
2	Very rough AC, very harsh and broad
3	Rough AC tone, rectified but not filtered
4	Rough note, some trace of filtering
5	Filtered rectified AC but strongly ripple-modulated
6	Filtered tone, definite trace of ripple modulation
7	Near pure tone, trace of ripple modulation
8	Near perfect tone, slight trace of modulation
9	Perfect tone, no trace of ripple or modulation of any kind

HF Operating Techniques

- Signal Reports
  - Tone is omitted on phone.
  - “C” at end indicates unstable tone or “chirp”.
  - “K” at end indicates key clicks.
  - “X” at end indicates exceptionally stable tone. (Not normally used any more.)

G2A10 -- Which of the following statements is true of voice VOX operation versus PTT operation?

A. The received signal is more natural sounding
B. It allows "hands free" operation
C. It occupies less bandwidth
D. It provides more power output

G2C01 -- Which of the following describes full break-in telegraphy (QSK)?

A. Breaking stations send the Morse code prosign BK
B. Automatic keyers are used to send Morse code instead of hand keys
C. An operator must activate a manual send/receive switch before and after every transmission
D. Transmitting stations can receive between code characters and elements

G2C02 -- What should you do if a CW station sends "QRS"?

➡ A. Send slower
B. Change frequency
C. Increase your power
D. Repeat everything twice

G2C03 -- What does it mean when a CW operator sends "KN" at the end of a transmission?

A. Listening for novice stations
B. Operating full break-in
➡ C. Listening only for a specific station or stations
D. Closing station now

G2C05 -- What is the best speed to use answering a CQ in Morse Code?

A. The fastest speed at which you are comfortable copying
➡ B. The speed at which the CQ was sent
C. A slow speed until contact is established
D. At the standard calling speed of 5 wpm

G2C06 -- What does the term "zero beat" mean in CW operation?

A. Matching the speed of the transmitting station
B. Operating split to avoid interference on frequency
C. Sending without error
➡ D. Matching your transmit frequency to the frequency of a received signal.

G2C07 -- When sending CW, what does a "C" mean when added to the RST report?

➡ A. Chirpy or unstable signal

B. Report was read from S meter reading rather than estimated

C. 100 percent copy

D. Key clicks

G2C08 -- What prosign is sent to indicate the end of a formal message when using CW?

A. SK

B. BK

➡ C. AR

D. KN

G2C09 -- What does the Q signal "QSL" mean?

A. Send slower
B. We have already confirmed by card
➡ C. I acknowledge receipt
D. We have worked before

G2C10 -- What does the Q signal "QRN" mean?

A. Send more slowly
➡ B. I am troubled by static
C. Zero beat my signal
D. Stop sending

G2C11 -- What does the Q signal "QRV" mean?

A. You are sending too fast
B. There is interference on the frequency
C. I am quitting for the day
➡ D. I am ready to receive messages

G4A10 -- What is the purpose of an electronic keyer?

A. Automatic transmit/receive switching
➡ B. Automatic generation of strings of dots and dashes for CW operation
C. VOX operation
D. Computer interface for PSK and RTTY operation

Emergency Operation

- Emergency operations are one of the basic purposes of the Amateur Radio Service.
- The ability to assist with emergencies is the primary reason that many individuals get their license.
- All amateurs should be prepared to respond properly if an emergency arises.

Emergency Operation

- Can provide communications for broadcasters only if:
  - Necessary to save lives or protect property.
  - No other means of communications available.

Emergency Operation

- ARES & RACES

Emergency Operation

- Amateur Radio Emergency Service (ARES)
  - Part of ARRL field organization.
  - Open to any amateur radio operator regardless of ARRL membership.
  - No official recognition in FCC rules.

Emergency Operation

- Radio Amateur Civil Emergency Service (RACES)
  - Part of FEMA/SEMA/EMA.
  - Established by FCC Rules & Regulations (§97.407).
  - President's War Emergency Powers.

Emergency Operation

- Distress Calls
  - Responding to a Distress Call.
    - Make certain that you are the station who can best handle the traffic.
    - Immediately acknowledge calling station.
    - Accurately copy information.
    - Notify proper authorities.
    - Stay in contact with calling station until help arrives.

Emergency Operation

- Distress Calls
  - Placing a Distress Call.
    - Send the distress call proword or prosign 3 times.
      - Phone proword = MAYDAY
      - CW Prosign = SOS
    - Send your callsign 3 times.
      - On phone, use the ICAO phonetic alphabet.
    - Send the location & nature of the emergency.
    - End with the appropriate proword or prosign.
      - Phone proword = Over
      - CW prosign = K

Emergency Operation

- Distress Calls
  - Placing a Distress Call.
    - During the existence of the emergency, you may use ANY frequency available without regard to radio service or license class.
    - During the existence of the emergency, you may contact ANY station without regard to radio service.

Emergency Operation

- Distress Calls
  - Do what is necessary to accomplish communication & ask forgiveness later.
    - ANY frequency (not just amateur).
    - Contact ANY station (not just amateur).

G1B04 -- Which of the following must be true before amateur stations may provide communications to broadcasters for dissemination to the public?

➡ A. The communications must directly relate to the immediate safety of human life or protection of property and there must be no other means of communication reasonably available before or at the time of the event

B. The communications must be approved by a local emergency preparedness official and conducted on officially designated frequencies

C. The FCC must have declared a state of emergency

D. All of these choices are correct

G2B02 -- What is the first thing you should do if you are communicating with another amateur station and hear a station in distress break in?

A. Continue your communication because you were on frequency first

➡ B. Acknowledge the station in distress and determine what assistance may be needed

C. Change to a different frequency

D. Immediately cease all transmissions

G2B09 -- Who may be the control operator of an amateur station transmitting in RACES to assist relief operations during a disaster?

➡ A. Only a person holding an FCC issued amateur operator license

B. Only a RACES net control operator

C. A person holding an FCC issued amateur operator license or an appropriate government official

D. Any control operator when normal communication systems are operational

G2B10 -- When may the FCC restrict normal frequency operations of amateur stations participating in RACES?

A. When they declare a temporary state of communication emergency
B. When they seize your equipment for use in disaster communications
C. Only when all amateur stations are instructed to stop transmitting
➡ D. When the President's War Emergency Powers have been invoked

G2B11 -- What frequency should be used to send a distress call?

➡ A. Whatever frequency has the best chance of communicating the distress message
B. Only frequencies authorized for RACES or ARES stations
C. Only frequencies that are within your operating privileges
D. Only frequencies used by police, fire or emergency medical services

G2B12 -- When is an amateur station allowed to use any means at its disposal to assist another station in distress?

A. Only when transmitting in RACES
B. At any time when transmitting in an organized net
C. At any time during an actual emergency
D. Only on authorized HF frequencies

Break

General License Class

Chapter 6

Digital Modes

Introduction to Digital Modes

- Exchange digital data via radio between two computing systems.
  - E-mail, files, keyboard-to-keyboard, messages, etc.
- New modes being developed all the time.
- More and more amateurs are using digital modes.

Introduction to Digital Modes

- Where to Find Digital Activity
  - Restricted to CW/data segments of each band.
  - Usually close to the top end of the CW segment, but check the band plan.
    - 160m -- bottom end of band.
    - 60m – center of each channel.
    - 10m – middle of CW segment.

Introduction to Digital Modes

Band	Digital Mode Frequencies
160m	1.800 MHz to 1.810 MHz
80m	3.570 MHz to 3.600 MHz
60m	Center of each channel.
40m	7.035 MHz to 7.045 MHz (ITU Regions 1 & 3) 7.080 MHz to 7.125 MHz (ITU Region 2)
20m	14.070 MHz to 14.0995 MHz (14.070 MHz = PSK31) 14.1005 MHz to 14.112 MHz
17m	18.100 MHz to 18.110 MHz
15m	21.070 MHz to 21.110 MHz
12m	24.920 MHz to 24.930 MHz
10m	28.070 MHz to 28.150 MHz

Introduction to Digital Modes

- Digital Voice & Image Modes
  - Digital voice systems are considered voice modes by the FCC.
    - FreeDV, D-Star, SystemFusion, WinDRM, etc.
    - Operations in voice/image sections of the band.
  - SSTV operations are converting from current analog systems to digital file transfers, but still considered image mode.

Introduction to Digital Modes

- Digital Mode Overview
  - Communicating by encoding characters as combinations of bits.
  - Consists of a protocol and a method of modulation.
    - Protocol – Rules for encoding the data.

Introduction to Digital Modes

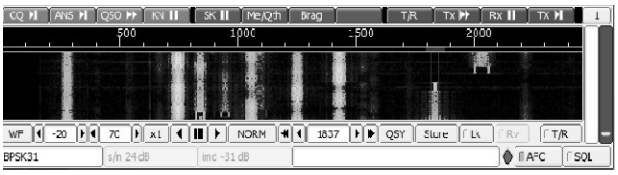
- Digital Mode Overview
  - Maximum data rates determined by FCC regulations.
    - FCC considering changing to bandwidth limits.
  - If you create your own digital code, you must make the protocol rules public.

Introduction to Digital Modes

- Radioteletype (RTTY).
  - Oldest digital mode.
  - Adapted from land-line teletype system.
    - Frequency shift keying (FSK).
    - Audio frequency shift keying (AFSK).
  - 5-bit Baudot code.
    - Letters A-Z.
      - No lower case.
    - Numbers 0-9.
    - Some punctuation.

Introduction to Digital Modes

- PSK31.
  - Phase shift keying.
  - 31.25 baud.
  - Narrowest bandwidth of any mode, including CW.
  - Very effective in noisy conditions.



Introduction to Digital Modes

- PACTOR
  - Developed by Special Communications Systems GmBH.
  - PACTOR I.
    - Open technology → Relatively inexpensive modems.
      - $50.00 to $150.00.
  - PACTOR II, PACTOR III, & PACTOR IV.
    - Proprietary technology → Very expensive modems.
      - $1000.00 to >$1600.00.
  - Used in NTS digital message handling system.

Introduction to Digital Modes

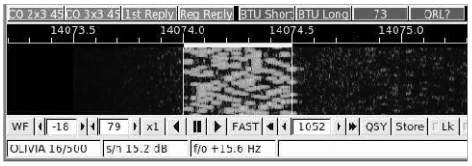
- WINMOR & Winlink
  - WINMOR = Windows Messaging Over Radio
    - Ability to detect and correct errors.
  - Winlink
    - Uses gateways to connect to internet for passing messages.
    - Radio-based e-mail.

Introduction to Digital Modes

- Packet.
  - Oldest of “modern” digital modes.
    - Became widely popular in 1980’s.
    - Still popular on VHF.
      - 1200-9600 baud on 2m.
    - Not practical on HF.
      - Limited to 300 baud.
      - Very slow when band is busy or conditions are noisy.

Introduction to Digital Modes

- Amateur Digital Modes.
  - Olivia.
    - Variation of MFSK.
    - Very effective at poor signal-to-noise levels.
      - S/N = -14 dB.
    - Relatively slow but robust.



Introduction to Digital Modes

- Amateur Digital Modes.
  - MFSK.
    - Multi-tone frequency shift keying.
    - Forward error correction (FEC).
      - Extra information sent to allow reconstruction of original data in the presence of data.

Introduction to Digital Modes

- Digital Modes
  - Miscellaneous Digital Modes
    - WSJT and JT44/JT65
      - Designed for VHF/UHF meteor scatter and moonbounce communications.
      - Adapted for HF
      - Can decode signals below noise level.

Introduction to Digital Modes

- Miscellaneous Digital Modes
  - Hellscreiber
    - Used for sending images encoded as digital data.
  - JT65 & JT9
    - Variations of WSJT family of modes.
    - Can decode weak signals in presence of noise.
  - WSPR (Whisper)
    - Very low signal-to-noise ratios.

Digital Basics

- Errors in Digital Modes.
  - Error Correction.
    - Forward Error Correction (FEC).
      - Adds extra information so that data can be reconstructed.
        - e.g. - MFSK-16
    - Automatic Repeat Request (ARQ).
      - If error detected, asks sending station to retransmit data.
        - e.g. – Packet, WINMOR

G2E04 -- What segment of the 20-meter band is most often used for digital transmissions?

A. 14.000 - 14.050 MHz
B. 14.070 - 14.100 MHz
C. 14.150 - 14.225 MHz
D. 14.275 - 14.350 MHz

G2E07 -- What segment of the 80-meter band is most commonly used for digital transmissions?

➡ A. 3570 – 3600 kHz

B. 3500 – 3525 kHz

C. 3700 – 3750 kHz

D. 3775 – 3825 kHz

G2E08 -- In what segment of the 20 meter band are most PSK31 operations commonly found?

A. At the bottom of the slow-scan TV segment, near 14.230 MHz

B. At the top of the SSB phone segment near 14.325 MHz

C. In the middle of the CW segment, near 14.100 MHz

➡ D. Below the RTTY segment, near 14.070 MHz

G2E13 -- Which communication system sometimes uses the Internet to transfer messages?

➡ A. Winlink
B. RTTY
C. ARES
D. Skywarn

G8C01 -- Which of the following digital modes is designed to operate at extremely low signal strength on the HF bands?

A. FSK441 and Hellschreiber
➡ B. JT9 and JT65
C. Clover
D. RTTY

Digital Basics

- Definitions
  - Mode.
    - Amateur transceivers designed for voice transmission can be used to send digital information (data) as a series of tones.
    - Data modes consist of:
      - Modulation method.
        - How tones are added to RF signal.
      - Protocol.
        - Rules governing how data is converted to tones.

Digital Basics

- Definitions
  - Bit Rate vs. Baud.
    - Bit Rate = Number of bits per second.
    - Baud = Number of symbols per second.
      - Symbol = signal characteristic(s) that make up a distinct state of transmitted signal.
    - In simple codes, 1 symbol = 1 bit, & bit rate = baud.
      - ASCII, Baudot, etc.
    - In more complex codes, 1 symbol may encode more than one bit, & bit rate > baud.

Digital Basics

- Frequency Shift Keying (FSK)
  - Individual data bits represented by two or more discreet frequencies.
    - Older modes use 2 frequencies.
      - Frequencies called “mark” & “space”.
      - RTTY, Packet, etc.
    - New modes use more than 2 frequencies.
      - Olivia, MFSK-16, MFSK-32, etc.
      - 16 or 32 most common on HF.
      - 128 & 256 being used by VOA to send images.
      - MFSK32 uses 32 frequencies.

Digital Basics

- Frequency Shift Keying (FSK)
  - FSK – In true FSK, the data bits are applied directly to transmitter VFO to shift the carrier frequency.
    - a.k.a. – Direct FSK.
    - Only possible for modes where only one tone sent at a time.
  - AFSK – Data bits are converted to tones used to modulate an SSB or FM transmitter.
    - Convenient.
    - Can be used with any digital mode.

Digital Basics

- Phase Shift Keying (PSK)
  - Individual data bits represented by phase shifts in signal.
    - Most common type is inversion (180° phase shift).
    - Phase shift can be referenced to same signal at earlier point in time or to another tone.
    - Sounds like raspy buzz or noise.
    - PSK31, etc.

G8A01 -- How is an FSK signal generated?

A. By keying an FM transmitter with a sub-audible tone

➡ B. By changing an oscillator's frequency directly with a digital control signal

C. By using a transceiver's computer data interface protocol to change frequencies

D. By reconfiguring the CW keying input to act as a tone generator

G8C11 -- How are the two separate frequencies of a Frequency Shift Keyed (FSK) signal identified?

A. Dot and Dash
B. On and Off
C. High and Low
➡ D. Mark and Space

Character-Based Modes

- The simplest form of digital communications is where the operator enters a character & that character is transmitted to the receiving station.
  - a.k.a. – Keyboard-to-keyboard communications.
    - CW
    - RTTY
    - PSK31

Character-Based Modes

- Radioteletype (RTTY).
  - Baudot code.
    - Start bit, 5 data bits, & stop bit.
    - A-Z, 0-9, CR, LF, LTRS, FIGS, punctuation, & control codes.

Character-Based Modes

- Radioteletype (RTTY).
  - Standard tones:
    - 2125 Hz (mark)
    - 2295 Hz (space).
    - Shift = 170 Hz.
  - Standard speeds:
    - 60 wpm (45 baud) – Most common
    - 75 wpm (56 baud
    - 100 wpm (75 baud).

Character-Based Modes

- Multiple Frequency Shift Keying (MFSK).
  - Uses more than 2 tones to encode the data.

Mode	Number of Tones	Bandwidth
MFSK-32	32	500 Hz
MFSK-32	64	1 kHz
MT63-1KL	64	1 kHz
MT63-2KL	64	2 kHz
Olivia	4 to 64	250 Hz to 2 kHz

Character-Based Modes

- PSK31.
  - Most popular phase-shift keying mode.
  - Single-tone.
  - Symbol is phase reversal of tone.
    - Symbol rate (baud) = 31.25
  - Variable length code (Varicode).
    - Shorter codes for more common characters.
    - Upper case letters have longer codes than lower case.
  - PSK63 (symbol rate = 63) becoming popular.

G2E06 -- What is the most common frequency shift for RTTY emissions in the amateur HF bands?

A. 85 Hz

➡ B. 170 Hz

C. 425 Hz

D. 850 Hz

G8C02 -- How many data bits are sent in a single PSK31 character?

➡ A. The number varies

B. 5

C. 7

D. 8

G8C04 -- Which of the following describes Baudot code?

A. A 7-bit code with start, stop and parity bits
B. A code using error detection and correction
➡ C. A 5-bit code with additional start and stop bits
D. A code using SELCAL and LISTEN

G8C08 -- Which of the following statements is true about PSK31?

A. Upper case letters make the signal stronger
➡ B. Upper case letters use longer Varicode signals and thus slow down transmission
C. Varicode Error Correction is used to ensure accurate message reception
D. Higher power is needed as compared to RTTY for similar error rates

G8C09 -- What does the number 31 represent in "PSK31"?

➡ A. The approximate transmitted symbol rate

B. The version of the PSK protocol

C. The year in which PSK31 was invented

D. The number of characters that can be represented by PSK31

G8C12 -- Which type of code is used for sending characters in a PSK31 signal?

➡ A. Varicode

B. Viterbi

C. Volumetric

D. Binary

Packet-Based Modes

- Packet-based or structured modes are derived form early computer-to-computer (internet) data transfer protocols.
  - Amateurs modified these protocols to develop Packet, PACTOR, WINMOR, & other communications systems.

Packet-Based Modes

- Packet Basics.
  - Packet transmission means that the data is divided up into “chunks” & transmitted a “chunk” at a time.
  - Additional data is added to each “chunk” to facilitate the transfer of the data.
  - Each chunk along with the additional data is called a “packet”.

Packet-Based Modes

- Packet Basics.
  - All packet-based systems have the same basic structure for the packets:
    - Header – Placed before the data & contains bit patterns to synchronize the receiver, control & routing information, and sometimes error detection/correction information.
    - Data – The data being sent, usually ASCII characters.
    - Trailer – Additional control & status information, and information used for error detection.

Packet-Based Modes

- Packet Basics.
  - The process of encapsulating data into a packet allows for error detection.
    - Cyclic Redundancy Check (CRC) – Data in trailer of packet calculated based on all other data in the packet.
    - If CRC does not match, then data was not received correctly.

Packet-Based Modes

- Packet Basics.
  - Error Detection & Correction.
    - Automatic Repeat Request (ARQ) – If CRC or other error detection mechanism fails, then receiving station asks for the packet to be sent again.
      - ACK character sent by receiving station when packet was received correctly.
      - NAK character sent by receiving station when packet needs to be repeated.

Packet-Based Modes

- Packet Basics.
  - Error Detection & Correction.
    - Forward Error Correction (FEC) – Additional information is sent with additional data to allow receiving station to correct for some types of error.

Packet-Based Modes

- Packet Basics.
  - ARQ systems designed to exchange information between 2 stations.
    - Receiving station has to acknowledge each packet was received correctly.
    - Only one station can send the acknowledgement.
    - Cannot “break in” to QSO between stations using ARQ.
    - Other stations can use monitor mode (MON) to “listen in” without having the benefits of error detection.

Packet-Based Modes

- Packet Basics.
  - ARQ systems provide a “broadcast” or “unconnected” mode so that a station can announce its presence (call “CQ”).
    - APRS consists entirely of unconnected packets.

Packet-Based Modes

- Packet Radio.
  - Used almost exclusively on VHF or UHF FM.
    - 1200 or 9600 baud.
  - Based on the internet X.25 protocol.
    - AX.25 protocol.
  - Not suitable for HF.
    - Limited to 300 baud by FCC.
    - Errors due to noise & fading result in numerous repeat requests .

Packet-Based Modes

- PACTOR and WINMOR.
  - No error detection/correction possible with RTTY.
  - Teletype-over-radio (TOR) modes developed to overcome this shortcoming.

Packet-Based Modes

- PACTOR and WINMOR.
  - PACTOR
    - Packet-based.
    - PACTOR-I uses FSK.
    - PACTOR-II, PACTOR-III, & PACTOR-4 use PSK.
      - PACTOR-4 not legal for amateur use in US.
  - WINMOR
    - Uses either FSK or PSK.

Packet-Based Modes

- PACTOR and WINMOR.
  - Both use ARQ for error detection/correction.
  - Preferred methods for transferring large amounts of data over amateur radio.
  - Preferred methods of transmission for WinLink.

G2E02 -- How can a PACTOR modem or controller be used to determine if the channel is in use by other PACTOR stations?

A. Unplug the data connector temporarily and see if the channel-busy indication is turned off

➡ B. Put the modem or controller in a mode which allows monitoring communications without a connection

C. Transmit UI packets several times and wait to see if there is a response from another PACTOR station

D. Send the message: "Is this frequency in use?"

G2E09 -- How do you join a contact between two stations using the PACTOR protocol?

A. Send broadcast packets containing your call sign while in MONITOR mode

B. Transmit a steady carrier until the PACTOR protocol times out and disconnects

➡ C. Joining an existing contact is not possible, PACTOR connections are limited to two stations

D. Send a NAK response continuously so that the sending station has to pause

G8C03 -- What part of a data packet contains the routing and handling information?

A. Directory
B. Preamble
➡ C. Header
D. Footer

G8C05 -- In the PACTOR protocol, what is meant by an NAK response to a transmitted packet?

➡ A. The receiver is requesting the packet be retransmitted
B. The receiver is reporting the packet was received without error
C. The receiver is busy decoding the packet
D. The entire file has been received correctly

G8C07 -- How does the receiving station respond to an ARQ data mode packet containing errors?

A. It terminates the contact
B. It requests the packet be retransmitted
C. It sends the packet back to the transmitting station
D. It requests a change in transmitting protocol

G8C10 -- How does forward error correction (FEC) allow the receiver to correct errors in received data packets?

A. By controlling transmitter output power for optimum signal strength
B. By using the varicode character set
C. By transmitting redundant information with the data
D. By using a parity bit with each character

Receiving and Transmitting Digital Modes

- All digital modes except for RTTY are transmitted as USB signals.
  - When RTTY is sent using AFSK, it is transmitted as a LSB signal.

NOTE: The book is wrong!

Receiving and Transmitting Digital Modes

- Bandwidth of Digital Modes.
  - The FCC defines the bandwidth of digital signals the same as for any other mode.
  - Bandwidth depends on symbol rate.
    - Higher symbol rate ➔ Wider bandwidth.
    - Some protocols can adjust symbol rate & bandwidth during a contact as conditions change.

Receiving and Transmitting Digital Modes

- Bandwidth of Digital Modes.

Mode	Bandwidth
PSK31	50 Hz
RTTY	200 Hz
MFSK16	300 Hz
JT65	350 Hz
DominoEX	524 Hz

Mode	Bandwidth
Olivia	1000 Hz
WINMOR	1600
MT63	2000 Hz
PACTOR-III	2300 Hz
PACTOR-4	2300 Hz

Receiving and Transmitting Digital Modes

- Bandwidth of Digital Modes.
  - Be aware of the band edges!
    - If running RTTY using AFSK, keep the VFO frequency at least 2.3 kHz above the lower limit of the data segment or band.
    - For other modes, keep VFO frequency below the lower limit of the data segment or band by an amount greater than the highest frequency being transmitted.
      - $> f_C + 0.5f_{BW}$

Receiving and Transmitting Digital Modes

- Transmitter Duty Cycle.
  - Average power output of a transmitter depends on the duty cycle of the mode.
    - CW ≈ 40%
    - SSB ≈ 25-40%
    - AM ≈ 50%
    - FM = 100%
    - RTTY & Digital = 100%

Receiving and Transmitting Digital Modes

- Transmitter Duty Cycle.
  - Most HF amateur transceivers are rated for Intermittent Commercial and Amateur Service (ICAS).
    - Cannot run at full power output for long transmissions without overheating.
    - Should reduce output power to about 50% of rated output when operating RTTY or other digital modes to prevent damage.

Receiving and Transmitting Digital Modes

- Digital Mode Signal Quality.
  - Same concerns as with SSB or CW for interfering with other nearby QSO's.
  - Too much signal from soundcard to transmitter microphone input causes distortion.
    - Splatter & other spurious emissions.
    - Receiving station cannot decode signal.
    - Shows up as additional lines on receiving station's waterfall display.

Receiving and Transmitting Digital Modes

- ALC and Digital Modes.
  - By design, ALC distorts signal to avoid excessive power output.
    - Added distortion acceptable compromise for voice.
    - Added distortion not acceptable for digital signals.
      - Signals are difficult to decode.
      - Generates spurious signals.
  - Disable ALC or lower microphone gain so that ALC never activates.

G2E01 -- Which mode is normally used when sending an RTTY signal via AFSK with an SSB transmitter?

A. USB
B. DSB
C. CW
➡ D. LSB

G2E05 -- What is the standard sideband used to generate a JT65 or JT9 digital signal when using AFSK in any amateur band?

A. LSB
➡ B. USB
C. DSB
D. SSB

G2E11 -- What is indicated on a waterfall display by one or more vertical lines adjacent to a PSK31 signal?

A. Long Path propagation
B. Backscatter propagation
C. Insufficient modulation
➡ D. Overmodulation

G2E14 -- What could be wrong if you cannot decode an RTTY or other FSK signal even though it is apparently tuned in properly?

A. The mark and space frequencies may be reversed
B. You may have selected the wrong baud rate
C. You may be listening on the wrong sideband
➡ D. All of these choices are correct

G4A14 -- What is likely to happen if a transceiver's ALC system is not set properly when transmitting AFSK signals with the radio using single sideband mode?

A. ALC will invert the modulation of the AFSK mode

➡ B. Improper action of ALC distorts the signal and can cause spurious emissions

C. When using digital modes, too much ALC activity can cause the transmitter to overheat

D. All of these choices are correct

G8B05 -- What is the approximate bandwidth of a PACTOR3 signal at maximum data rate?

A. 31.5 Hz

B. 500 Hz

C. 1800 Hz

➡ D. 2300 Hz

G8B08 -- Why is it important to know the duty cycle of the mode you are using when transmitting?

A. To aid in tuning your transmitter

➡ B. Some modes have high duty cycles which could exceed the transmitter's average power rating

C. To allow time for the other station to break in during a transmission

D. All of these choices are correct

G8B10 -- What is the relationship between transmitted symbol rate and bandwidth?

A. Symbol rate and bandwidth are not related

➡ B. Higher symbol rates require wider bandwidth

C. Lower symbol rates require wider bandwidth

D. Bandwidth is always half the symbol rate

Digital Operating Procedures

- Listen First.
  - Just like all other modes, listen first to make certain the frequency is clear.
    - Look for signals on waterfall.

Digital Operating Procedures

- Initiating and Terminating Digital Contacts.
  - Essentially same as for CW contacts.
  - Calling CQ:
    - CQ CQ CQ de K9DUR K9DUR K9DUR
      CQ CQ CQ de K9DUR K9DUR K9DUR k
  - Answering a CQ:
    - W9GWC W9CWC de K9DUR K9DUR K9DUR k

Digital Operating Procedures

- Initiating and Terminating Digital Contacts.
  - Digital mode QSO's use same procedures, prosigns, & Q-signals as CW contacts.

Digital Operating Procedures

- Initiating and Terminating Digital Contacts.
  - Some digital modes are "connected" modes.
    - Packet, PACTOR, WINMOR, etc.
    - Specific "connect" message sent to establish connection between 2 stations.
    - Specific "disconnect" message sent to end contact & close connection.
      - Connection may be closed automatically if excessive transmission attempts or timeout occurs.

Digital Operating Procedures

- Initiating and Terminating Digital Contacts.
  - Gateway and mailbox stations.
    - An automatic message-handling system has been established to pass messages from origin to destination by automatic relay.
      - A gateway station transfers messages to or from the internet.
      - A mailbox station stores messages for pick up by the recipients at a later time.

Digital Operating Procedures

- Initiating and Terminating Digital Contacts.
  - Gateway and mailbox stations.
    - Some digital messaging stations are unmanned & operate under automatic control.
      - In the US, automatically-controlled digital stations are restricted to certain band segments on frequencies below 220 MHz.
      - Your station may communicate with an automatically-controlled non-US station operating outside of the specified band segments, but your station must be under local or remote control.

Digital Operating Procedures

Band	Segment
80m	3.585 MHz – 3.600 MHz
40m	7.100 MHz – 7.105 MHz
30m	10.140 MHz – 10.150 MHz
20m	14.0950 MHz – 14.0995 MHz 14.1005 MHz – 14.1120 MHz
17m	18.105 MHz – 18.110 MHz
15m	21.090 MHz – 21.100 MHz
12m	24.925 MHz – 24.930 MHz
10m	28.120 MHz – 28.189 MHz
6m	50.1 MHz – 50.4 MHz
2m	144.1 MHz to 148 MHz

Digital Operating Procedures

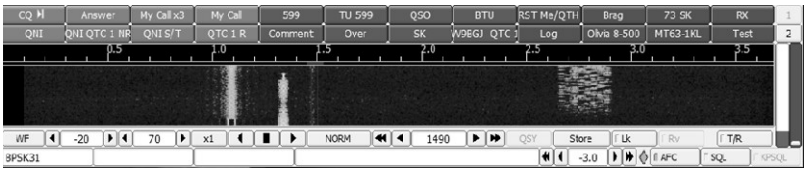
- Initiating and Terminating Digital Contacts.
  - Gateway and mailbox stations.
    - Contacts with automatically-controlled stations are initiated by sending a “CONNECT” message.
    - Once connection is established, message may be transmitted.

Digital Operating Procedures

- During the Contact.
  - Operating Displays.
    - Almost all digital mode software programs provide a type of display know as a “waterfall”.
      - A portion of the received RF spectrum is displayed as a horizontal line. The color and/or brightness of the line indicates the signal strength.
      - As each line is drawn, the previous line(s) are pushed down on the screen & the new line added at the top, giving the impression of a waterfall as the signals flow from top to bottom in the display.

Digital Operating Procedures

- During the Contact.
  - Waterfall Display

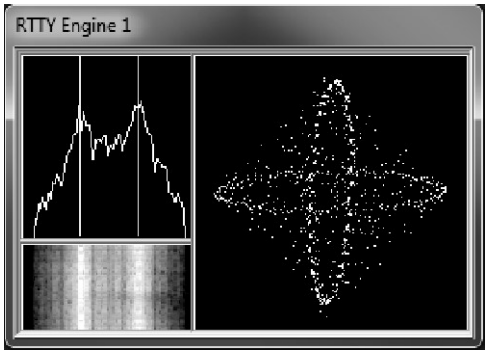


Digital Operating Procedures

- During the Contact.
  - Operating Displays.
    - A more accurate display for RTTY signals is the “crossed ellipse” display.
      - Many software programs provide the crossed-ellipse display in addition to the normal waterfall display.
        - Sometimes called “scope” (short for oscilloscope).
      - When the two ellipses are at right angles to each other (vertical & horizontal) then signal is properly tuned in.
        - Size of ellipses indicates signal strength.
        - Unequal sizes indicates selective fading is occurring.

Digital Operating Procedures

- During the Contact.
  - RTTY Display



Digital Operating Procedures

- During the Contact.
  - Third-Party Traffic.
    - Same rules apply to digital messages as for voice or CW.
      - International messages only if third-party agreement exists.
    - Use of gateways must be carefully limited.

Digital Operating Procedures

- During the Contact.
  - Interfering Signals.
    - Like voice or CW signals, digital signals are subject to interference.
      - Human brain can recover CW or voice signals in presence of interference.
      - Digital software may not be able to decode the desired signal.
    - When using keyboard-to-keyboard modes, user may be able to “fill in the blanks” in the received signal.

Digital Operating Procedures

- During the Contact.
  - Interfering Signals.
    - When using connected modes, signal must get through in its entirety or transmission fails.
      - Cannot establish a connection.
      - Frequent retries with resulting delays.
      - Timeouts or dropped connections.

G1E03 -- What is required to conduct communications with a digital station operating under automatic control outside the automatic control band segments?

➡ A. The station initiating the contact must be under local or remote control

B. The interrogating transmission must be made by another automatically controlled station

C. No third party traffic maybe be transmitted

D. The control operator of the interrogating station must hold an Extra Class license

G1E11 -- Which of the following is the FCC term for an unattended digital station that transfers messages to and from the Internet?

A. Locally controlled station
B. Robotically controlled station
➡ C. Automatically controlled digital station
D. Fail-safe digital station

G1E12 -- Under what circumstances are messages that are sent via digital modes exempt from Part 97 third party rules that apply to other modes of communication?

➡ A. Under no circumstances
B. When messages are encrypted
C. When messages are not encrypted
D. When under automatic control

G1E13 -- On what bands may automatically controlled stations transmitting RTTY or data emissions communicate with other automatically controlled digital stations?

A. On any band segment where digital operation is permitted
B. Anywhere in the non-phone segments of the 10-meter or shorter wavelength bands
C. Only in the non-phone Extra Class segments of the bands
➡ D. Anywhere in the 1.25-meter or shorter wavelength bands, and in specified segments of the 80-meter through 2-meter bands

G2E03 -- What symptoms may result from other signals interfering with a PACTOR or WINMOR transmission?

A. Frequent retries or timeouts
B. Long pauses in message transmission
C. Failure to establish a connection between stations
➡ D. All of these choices are correct

G2E10 -- Which of the following is a way to establish contact with a digital messaging system gateway station?

A. Send an email to the system control operator
B. Send QRL in Morse code
C. Respond when the station broadcasts its SSID
➡ D. Transmit a connect message on the station's published frequency

G2E12 -- Which of the following describes a waterfall display?

A. Frequency is horizontal, signal strength is vertical, time is intensity
B. Frequency is vertical, signal strength is intensity, time is horizontal
➡ C. Frequency is horizontal, signal strength is intensity, time is vertical
D. Frequency is vertical, signal strength is horizontal, time is intensity

G8C06 -- What action results from a failure to exchange information due to excessive transmission attempts when using PACTOR or WINMOR?

A. The checksum overflows

➡ B. The connection is dropped

C. Packets will be routed incorrectly

D. Encoding reverts to the default character set

Questions?

Next Week

Chapter 3

Rules & Regulations