Using Repeaters

- Technicians commonly make contacts through *repeaters*
- To find repeaters in your area, you'll need a listing sorted by area …
  - ARRL Repeater Directory (www.arrl.org)
  - Repeater Book (www.repeaterbook.com)
- You can use the *scanning function* of your radio to listen for activity on repeater or simplex channels
- To access a repeater you will need to know three things …
  1. Repeater transmitter's *output* or *transmit frequency*
  2. Repeater receiver's *input* or *receive frequency*
  3. Frequency of any *access control tones*

Repeater Offset (Shift)

- To *listen* to a repeater, tune to its *output* frequency
- To *send* a signal through the repeater, you must transmit on the repeater's *input* frequency
- The *difference* between repeater input and output frequencies is called the repeater's *offset* or *shift*
  - For 2 meters, usually ±600 kHz
  - For 70 centimeters, usually ±5 MHz

Linked Repeater Systems & Access Tones

- To extend their range, repeaters sometimes use remote receivers
- Repeaters can also be *linked* to other repeaters (by sharing the signals each receives and retransmitting them)
- Most repeaters won't pass a signal from the receiver to the transmitter for retransmission unless it contains an *access tone*
  - Also called *Continuous Tone Coded Squelch System* (CTCSS), *PL* (for Private Line, the Motorola trade name) or *sub-audible*
  - Your radio's operating manual will explain how to select and activate the tone
    - There may be several tone options, such as tone squelch and digital code squelch (DCS)
- Troubleshooting repeaters … *If you can hear a repeater's signal, but it can't hear you …*
  - Make you're sure you are using the right offset
  - Make sure you have your radio set up to use the right type or frequency of access tone (CTCSS)
  - Make sure your radio's digital code squelch settings are correct (DCS)

PRACTICE QUESTIONS

What does the scanning function of an FM transceiver do?

A. Checks incoming signal deviation
B. Prevents interference to nearby repeaters
C. Tunes through a range of frequencies to check for activity
D. Checks for messages left on a digital bulletin board

T4B05 C 6-10

What is a common repeater frequency offset in the 2 meter band?

A. Plus or minus 5 MHz
B. Plus or minus 600 kHz
C. Plus or minus 500 kHz
D. Plus or minus 1 MHz

T2A01 B 6-11

What is a common repeater frequency offset in the 70 cm band?

A. Plus or minus 5 MHz
B. Plus or minus 600 kHz
C. Plus or minus 500 kHz
D. Plus or minus 1 MHz

T2A03 A 6-11

What is meant by “repeater offset”?

A. The difference between a repeater’s transmit and receive frequencies
B. The repeater has a time delay to prevent interference
C. The repeater station identification is done on a separate frequency
D. The number of simultaneous transmit frequencies used by a repeater

T2A07 A 6-11

Which of the following describes a linked repeater network?

A. A network of repeaters in which signals received by one repeater are transmitted by all the repeaters in the network
B. A single repeater with more than one receiver
C. Multiple repeaters with the same control operator
D. A system of repeaters linked by APRS

T2B03 A 6-12

What term describes the use of a sub-audible tone transmitted along with normal voice audio to open the squelch of a receiver?

A. Carrier squelch
B. Tone burst
C. DTMF
D. CTCSS

T2B02 D 6-12

Which of the following could be the reason you are unable to access a repeater whose output you can hear?

A. Improper transceiver offset
B. You are using the wrong CTCSS tone
C. You are using the wrong DCS code
D. All these choices are correct

T2B04 D 6-12

Digital Repeater Systems

- Ham radio and the Internet can link repeaters and communicate nearly anywhere on Earth … some of these systems include:
  - IRLP (Internet Radio Linking Project)
  - EchoLink
  - WIRES II — a proprietary system of the Yaesu company
  - D-STAR — a system based on the public D-STAR standard
  - DMR — Digital Mobile Radio

Digital Repeater Systems (cont.)

- IRLP and EchoLink contacts differ from a regular repeater contacts … *initiating station must know the repeater control code to request an IRLP connection* … a sequence of DTMF or *Dual-tone Multi-Frequency* tones
- WIRES II uses voice-only standard developed by radio manufacturer Yaesu
- D-STAR combines digital voice and data communications
- DMR is a technique for time-multiplexing two digital voice signals on a single 12.5 kHz repeater

Digital Repeater Systems (cont.)

- You don't need different radios for each digital voice system … *hot spots* are used that link your digital transceiver to the internet, and software in the hot spot makes the connection
- WIRES II/System Fusion, D-STAR, DMR, P25, and NXDN all use talk groups in one form or another
  - To join a talk group, you'll need to know the group's identification code or number
  - You'll also have to enter your own identification code (and call sign for D-STAR) into the transceiver

Nets

- In the early days of radio, *nets* helped stations meet on the air to share news and messages
- Today's nets include support for emergency communications and public service activities
- Nets usually have two purposes:
  1. Pass emergency messages
  2. Coordinate reporting and response activities
- Net messages are called *traffic*, which often have built-in routing information to get the message to the right place

Net Structure and Participation

- A *Net Control Station* (NCS) directs the net by calling it to order and directing communications between stations checking into the net
- A station with *emergency traffic* should break in at any time
- Do not transmit unless you are specifically requested or authorized to do so or a request is made for capabilities or info that you can provide

Exchanging Messages on the Net

- The most important job during emergency and disaster net operation is the ability to accurately relay or *pass* messages
- Messages are often formatted as *radiograms*
- The *preamble* or *header* contains bits of information about the message so that it can be handled and tracked appropriately (see following slide for header details)
- Following the preamble is the text of the radiogram … to ensure accuracy, names are

Message Headers Contain …

- Number —number assigned by the station that creates the radiogram
- Precedence — a description of the nature of the radiogram
- Handling Instructions
- Station of Origin — the sending station's call sign
- Check — the number of words and word equivalents in the radiogram
- Place of Origin — the name of the town

PRACTICE QUESTIONS

What type of signaling uses pairs of audio tones?

A. DTMF
B. CTCSS
C. GPRS
D. D-STAR

T2B06 A 6-13

How can you join a digital repeater's "talkgroup"?

A. Register your radio with the local FCC office
B. Join the repeater owner's club
C. Program your radio with the group's ID or code
D. Sign your call after the courtesy tone

T2B07 C 6-13

What is the purpose of the color code used on DMR repeater systems?

A. Must match the repeater color code for access
B. Defines the frequency pair to use
C. Identifies the codec used
D. Defines the minimum signal level required for access

T2B12 A 6-13

What function is performed with a transceiver and a digital mode hot spot?

A. Communication using digital voice or data systems via the internet
B. FT8 digital communications via AFSK
C. RTTY encoding and decoding without a computer
D. High-speed digital communications for meteor scatter

T4A10 A 6-13

What does a DMR “code plug” contain?

A. Your call sign in CW for automatic identification
B. Access information for repeaters and talkgroups
C. The codec for digitizing audio
D. The DMR software version

T4B07 B 6-13

How is a specific group of stations selected on a digital voice transceiver?

A. By retrieving the frequencies from transceiver memory
B. By enabling the group's CTCSS tone
C. By entering the group's identification code
D. By activating automatic identification

T4B09 C 6-13

Which of the following must be programmed into a D-STAR digital transceiver before transmitting?

A. Your call sign
B. Your output power
C. The codec type being used
D. All these choices are correct

T4B11 A 6-13

How is over the air access to IRLP nodes accomplished?

A. By obtaining a password that is sent via voice to the node
B. By using DTMF signals
C. By entering the proper internet password
D. By using CTCSS tone codes

T8C06 B 6-13

What is Voice Over Internet Protocol (VoIP)?

A. A set of rules specifying how to identify your station when linked over the internet to another station

B. A technique employed to “spot” DX stations via the internet

C. A technique for measuring the modulation quality of a transmitter using remote sites monitored via the internet

T8C07 D 6-13

D. A method of delivering voice

What is the Internet Radio Linking Project (IRLP)?

A. A technique to connect amateur radio systems, such as repeaters, via the internet using Voice Over Internet Protocol (VoIP)

B. A system for providing access to websites via amateur radio

C. A system for informing amateurs in real time of the frequency of active DX stations

D. A technique for measuring signal strength of an amateur transmitter via the internet

T8C08 A 6-13

Which of the following protocols enables an amateur station to transmit through a repeater without using a radio to initiate the transmission?

A. IRLP
B. D-STAR
C. DMR
D. EchoLink

T8C09 D 6-13

What is required before using the EchoLink system?

A. Complete the required EchoLink training
B. Purchase a license to use the EchoLink software
C. Register your call sign and provide proof of license
D. All these choices are correct

T8C10 C 6-13

What is a Talkgroup on a DMR repeater?

A. A group of operators sharing common interests

B. A way for groups of users to share a channel at different times without hearing other users on the channel

C. A protocol that increases the signal-to-noise ratio when multiple repeaters are linked together

T8D02 B 6-14

D. A net that meets at a specified time

Which of the following describes DMR?

A. A technique for time-multiplexing two digital voice signals on a single 12.5 kHz repeater channel
B. An automatic position tracking mode for FM mobiles communicating through repeaters
C. An automatic computer logging technique for hands-off logging when communicating while operating a vehicle

T8D07 A.6-14

D. A digital technique for transmitting on two

What does the term “traffic” refer to in net operation?

A. Messages exchanged by net stations
B. The number of stations checking in and out of a net
C. Operation by mobile or portable stations
D. Requests to activate the net by a served agency

T2C05 A 6-16

Which of the following is standard practice when you participate in a net?

A. When first responding to the net control station, transmit your call sign, name, and address as in the FCC database

B. Record the time of each of your transmissions

C. Unless you are reporting an emergency, transmit only when directed by the net control station

T2C07 C 6-16

D. All these choices are correct

Which of the following are typical duties of a Net Control Station?

A. Choose the regular net meeting time and frequency
B. Ensure that all stations checking into the net are properly licensed for operation on the net frequency
C. Call the net to order and direct communications between stations checking in

T2C02 C 6-16

D. All these choices are correct

What technique is used to ensure that voice messages containing unusual words are received correctly?

A. Send the words by voice and Morse code
B. Speak very loudly into the microphone
C. Spell the words using a standard phonetic alphabet
D. All these choices are correct

T2C03 C 6-17

Which of the following is a characteristic of good traffic handling?

A. Passing messages exactly as received
B. Making decisions as to whether messages are worthy of relay or delivery
C. Ensuring that any newsworthy messages are relayed to the news media
D. All these choices are correct

T2C08 A 6-17

What information is contained in the preamble of a formal traffic message?

A. The email address of the originating station
B. The address of the intended recipient
C. The telephone number of the addressee
D. Information needed to track the message

T2C10 D 6-17

What is meant by "check" in a radiogram header?

A. The number of words or word equivalents in the text portion of the message
B. The call sign of the originating station
C. A list of stations that have relayed the message
D. A box on the message form that indicates that the message was received and/or relayed

T2C11 A 6-17

Communications for Public Service

ARES & RACES

- The two largest Amateur Radio emergency response organizations are ARES (*Amateur Radio Emergency Service*) and RACES (*Radio Amateur Civil Emergency Service*)
- ARES consists of licensed amateurs who have registered their qualifications and equipment for duty in the public service
  - Sponsored by ARRL
- RACES is a special part of the FCC Part 97 Amateur service to provide civil defense

Threats to Life and Property

FCC Part 97.403 states …

"No provision of these rules prevents the use by an amateur station of any means of radiocommunication at its disposal to provide essential communication needs in connection with the immediate safety of human life and immediate protection of property when normal communication systems are not available."

In an emergency, you may use any means possible to address that risk, including operating outside the frequency privileges of your license.

You are bound by FCC rules at all times, even if using your radio in support of a public safety agency.

Satellite Operating

- International Space Station
  - Most astronauts hold an amateur radio license
  - Any amateur licensed to use 2 meter and 70 cm bands can communicate with ISS (this means Technician)
  - To call the space station, call sign NA1SS, transmit on 145.990 MHz and listen on 145.800 MHz
- Amateurs have built more than 50 satellites since 1961
- Amateur satellites are nicknamed OSCAR for Orbiting Satellite Carrying Amateur Radio

Satellite Definitions

- Apogee — The point of a satellite's orbit that is farthest from Earth
- Beacon — A signal from the satellite containing information about a satellite
- Doppler shift — An observed change in signal frequency caused by relative motion between the satellite and the Earth station
- Elliptical orbit — An orbit with a large difference between apogee and perigee
- LEO — A satellite in low-Earth orbit
- Perigee — The point of a satellite's orbit that is nearest the Earth

Tracking a Satellite

- A *satellite tracking program* is used to determine satellite schedules
- The tracking program needs certain bits of data about the satellite's orbit called the *Keplerian elements*
- The software can provide real-time maps of the satellite's location, the trajectory the satellite will follow across the sky, and the amount of *Doppler shift* the signals will experience

Operating via Satellites

- Most satellites only have one operational *mode*
  - Specified as two letters separated by a slash
  - The uplink for a satellite in U/V mode is in the UHF band (70 cm) and a downlink is in the VHF band (2 meters)
  - Satellites can use any amateur mode … most common are SSB, FM, CW, and data
- You can tell when the satellite is within range by listening for the *beacon* (transmitted via CW or RTTY)
- This *telemetry data* from the satellite contains information on the health and status of the satellite

PRACTICE QUESTIONS

What is the Radio Amateur Civil Emergency Service (RACES)?

A. A radio service using amateur frequencies for emergency management or civil defense communications
B. A radio service using amateur stations for emergency management or civil defense communications
C. An emergency service using amateur operators certified by a civil defense organization as being enrolled in that

T1A10 D 97.3(a)(38), 97.407

What is RACES?

A. An emergency organization combining amateur radio and citizens band operators and frequencies
B. An international radio experimentation society
C. A radio contest held in a short period, sometimes called a “sprint”
D. An FCC part 97 amateur radio service for civil defense communications during national

T2C04 D 6-18

What is the Amateur Radio Emergency Service (ARES)?

A. A group of licensed amateurs who have voluntarily registered their qualifications and equipment for communications duty in the public service

B. A group of licensed amateurs who are members of the military and who voluntarily agreed to provide message handling services in the case of an emergency

C. A training program that provides licensing courses for those interested in obtaining an

T2C06 A 6-18

When do FCC rules NOT apply to the operation of an amateur station?

A. When operating a RACES station
B. When operating under special FEMA rules
C. When operating under special ARES rules
D. FCC rules always apply

T2C01 D 97.103(a) 6-19

Are amateur station control operators ever permitted to operate outside the frequency privileges of their license class?

A. No
B. Yes, but only when part of a FEMA emergency plan
C. Yes, but only when part of a RACES emergency plan
D. Yes, but only in situations involving the immediate safety of human life or protection of property

T2C09 D 6-19

Which amateurs may contact the International Space Station (ISS) on VHF bands?

A. Any amateur holding a General class or higher license

B. Any amateur holding a Technician class or higher license

C. Any amateur holding a General class or higher license who has applied for and received approval from NASA

D. Any amateur holding a Technician class or higher license who has applied for and

T1B02 B 97.301,97.207(c) 6-

Who may be the control operator of a station communicating through an amateur satellite or space station?

A. Only an Amateur Extra Class operator
B. A General class or higher licensee with a satellite operator certification
C. Only an Amateur Extra Class operator who is also an AMSAT member
D. Any amateur allowed to transmit on the satellite uplink frequency

T1E02 D 97.301,97.207(c) 6-

What is the FCC Part 97 definition of a space station?

A. Any satellite orbiting Earth
B. A manned satellite orbiting Earth
C. An amateur station located more than 50 km above Earth's surface
D. An amateur station using amateur radio satellites for relay of signals

T1A07 C 97.3(a)(41) 6-23

What is a satellite beacon?

A. The primary transmit antenna on the satellite
B. An indicator light that shows where to point your antenna
C. A reflective surface on the satellite
D. A transmission from a satellite that contains status information

T8B05 D 6-23

What is Doppler shift in reference to satellite communications?

A. A change in the satellite orbit
B. A mode where the satellite receives signals on one band and transmits on another
C. An observed change in signal frequency caused by relative motion between the satellite and Earth station
D. A special digital communications mode for some satellites

T8B07 C 6-23

What causes spin fading of satellite signals?

A. Circular polarized noise interference radiated from the sun
B. Rotation of the satellite and its antennas
C. Doppler shift of the received signal
D. Interfering signals within the satellite uplink band

T8B09 B 6-23

What is a LEO satellite?

A. A sun synchronous satellite
B. A highly elliptical orbit satellite
C. A satellite in low energy operation mode
D. A satellite in low earth orbit

T8B10 D 6-23

Which of the following are provided by satellite tracking programs?

A. Maps showing the real-time position of the satellite track over Earth
B. The time, azimuth, and elevation of the start, maximum altitude, and end of a pass
C. The apparent frequency of the satellite transmission, including effects of Doppler shift
D. All these choices are correct

T8B03 D 6-24

Which of the following are inputs to a satellite tracking program?

A. The satellite transmitted power
B. The Keplerian elements
C. The last observed time of zero Doppler shift
D. All these choices are correct

T8B06 B 6-24

What telemetry information is typically transmitted by satellite beacons?

A. The signal strength of received signals
B. Time of day accurate to plus or minus 1/10 second
C. Health and status of the satellite
D. All these choices are correct

T8B01 C 6-24

What is the impact of using excessive effective radiated power on a satellite uplink?

A. Possibility of commanding the satellite to an improper mode
B. Blocking access by other users
C. Overloading the satellite batteries
D. Possibility of rebooting the satellite control computer

T8B02 B 6-24

What mode of transmission is commonly used by amateur radio satellites?

A. SSB
B. FM
C. CW/data
D. All these choices are correct

T8B04 D 6-24

What is meant by the statement that a satellite is operating in U/V mode?

A. The satellite uplink is in the 15 meter band and the downlink is in the 10 meter band
B. The satellite uplink is in the 70 centimeter band and the downlink is in the 2 meter band
C. The satellite operates using ultraviolet frequencies
D. The satellite frequencies are usually variable

T8B08 B 6-24

Who may receive telemetry from a space station?

A. Anyone
B. A licensed radio amateur with a transmitter equipped for interrogating the satellite
C. A licensed radio amateur who has been certified by the protocol developer
D. A licensed radio amateur who has registered for an access code from AMSAT

T8B11 A 6-24

Which of the following is a way to determine whether your satellite uplink power is neither too low nor too high?

A. Check your signal strength report in the telemetry data
B. Listen for distortion on your downlink signal
C. Your signal strength on the downlink should be about the same as the beacon
D. All these choices are correct

T8B12 C 6-24

END OF MODULE 6

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