

Amateur Radio Technician Class License Study Guide

Week 4

SUBELEMENT T2 – Operating procedures

March 28, 2023

Question pool sections: T2

Terms and concepts:

T2A - Station operation: choosing an operating frequency, calling another station, test transmissions; Band plans: calling frequencies, repeater offsets

T2B – VHF/UHF operating practices: FM repeater, simplex, reverse splits; Access tones: CTCSS, DTMF; DMR operation; Resolving operational problems; Q signals

T2C – Public service: emergency operations, applicability of FCC rules, RACES and ARES, net and traffic procedures, operating restrictions during emergencies, use of phonetics in message handling

Corresponding pages of Gordon West book

T2: 62, 63, 69-73, 75, 77, 80-82, 85-89, 113, 126, 130

Subelement 2: Operating Procedures

Basic Operating Procedures

FM & Repeaters

Making a contact

Emergency operations

In this section we'll discuss procedures commonly followed by amateur radio operators and information that you'll need to know before getting on the air.

FM and Repeaters:

There are 2 common ways to communicate on the VHF/UHF bands. The simplest is to use a "simplex" frequency. *Simplex is the term that describes an amateur station that is transmitting and receiving on the same frequency.* This is also known as working direct. One problem, however, is the limited range available with simplex, perhaps 1 – 2 miles, depending on power levels and terrain. Mobile to mobile, or mobile to base, this could increase to 5 – 25 miles or more, depending on power and antennas.

The FCC, however, allows the use of booster or "repeater" stations. Repeaters are special stations that listen on one frequency and retransmits what ever they hear on another frequency. So the stations working through a repeater all transmit on one frequency and listen on another. This is known as working in "duplex" mode. While most repeaters are supported by clubs or organizations to defray the operating costs, many are open for general use (no membership required), thus are referred to as "open" repeaters.

Before using a repeater you need to know some basic information about the repeater. First you need to know if it is open, then you need to know the repeater's transmit frequency (the frequency that you listen on). Next, you need to know the repeaters receive frequency (this is the frequency that you will transmit on). *The difference between the transmit and receive frequencies is known as the repeater "offset".* Note that the receive offset may be +/- from the transmit frequency.

All repeaters use some kind of the squelch circuit. *The purpose of a squelch function is to mute the receiver audio when a signal is not present.* Some repeaters use a "carrier squelch", where the receiver audio is muted until an RF signal is present. Once the squelch is opened, the repeater retransmits the received signal. Other systems may require a sub-audible tone transmitted along with normal voice audio to open the squelch of the receiver, known as CTCSS or "PL" These systems are used to reduce interference when nearby repeaters share input frequencies. All of the above information (repeater transmit frequency, frequency offset, and PL tone (if required) needs to be set on your radio before you can access the repeater. *If you are unable to access a repeater whose output you can hear, you may be using an improper transceiver offset, the wrong CTCSS tone or DCS access code.*

Standard offsets used on the common VHF/UHF bands are shown below.

Band	Frequency	Standard offset
2 meters	146 MHz	+/- 600 KHz
1 ¼ meters	222 MHz	+/- 1.6 MHz
70 centimeters	450 MHz	+/- 5.0 MHz

The standard repeater offsets are part of the VHF/UHF band plans. *Band plans, beyond the privileges established by the FCC, are voluntary guideline for using different modes or activities within an amateur band.* Band plans are a type of “gentlemen’s agreement” established by hams, and often include suggested “calling frequencies” for each band and mode. An example is *146.520 MHz, the national calling frequency for FM simplex operation in the 2-meter band.*

Since a repeater is a shared resource, there are some common sense conventions that should be followed. Conversations should be kept fairly short, with breaks between transmissions to allow other stations, perhaps with urgent traffic, to break in. During busy times, such as during a commute rush hour, repeaters should be kept clear for traffic information and emergencies. *Simplex channels designated in the VHF/UHF band plans so stations within range of each other can communicate without tying up a repeater.*

One way to see if simplex communication is possible during a repeater contact, is to listen on the input frequency of the repeater. If you can hear the station on the repeater input, you can probably communicate on simplex. *A VHF/UHF transceiver’s “reverse” function may be used to listen on a repeater’s input frequency.*

Repeaters may be linked to one another. *A network of repeaters in which signals received by one repeater are transmitted by all the repeaters in the network is known as a linked repeater network.* Mendocino County is blessed to have an excellent linked repeater network, commonly referred to as “countywide”. The five repeaters, located near Laytonville, Willits, Hopland, Fish Rock Road, and Upper Lake, are tied together via UHF links. This allows someone in Laytonville to talk to the South Coast, or most anywhere else in the county. The Fort Bragg/Mendocino area is fortunate to have a pair of linked repeaters that enhance North coast amateur communications.

Repeaters may also be linked to one another by the Internet, using VoIP technology. These IRLP (Internet Relay or Radio Linking Project) repeaters, can be connected to other IRPL repeaters or “nodes”. The commands to control such a repeater (ie: connect to a specific node, or to disconnect) are sent by DTMF tones (touchtones). As the name implies, *DTMF* (dual tone, multi frequency) *signaling uses pairs of audio tones.* Most handheld radios and many hand microphones have a DTMF pad built in, allowing numerals or other command codes to be transmitted.

While the vast majority of FM repeaters are analog (the carrier frequency is modulated or changed, in direct response to the audio waveform of your voice), there is an increasing number of digital repeaters on the air, where the audio is converted to data. A digital transmission heard on an analog receiver will sound like a burst of static or noise. One example of a VHF/UHF digital voice mode is Digital Mobile Radio (DMR). *To join a digital repeater’s “talk group”, simply program your radio with the group’s ID or code.* Another feature of DMR repeater systems is the use of a “color code”. *The color code used must match the repeater color code for access on some DMR repeater systems.*

While the use of a dummy load is recommended when making transmitter adjustments, there are times *that on-the-air test transmissions* are needed. As with any amateur transmission, *these must be identified by the transmitting station.* So if you key your 2-meter radio to see if

you can access a repeater, you need to identify that transmission with your call sign (more on that next week).

As noted previously, a common problem on FM is “over deviation”. Excessive deviation occurs when the amplitude of the modulating signal is too great. This causes the signal to occupy more bandwidth (get wider), which can cause distortion. *It can also cause your transmission into a repeater to be distorted on voice peaks.* So if a repeater user tells you this is happening, *you are talking too loudly.* Speak more softly or hold the microphone further from your mouth.

Making a contact

One of the next things you’ll need to know before getting on the air is how to initiate and answers calls. Procedures are similar on all bands, with minor differences on the HF bands.

Before making a call on ANY frequency, **listen!** You should listen for at least 15 – 30 seconds to make sure that you are not interrupting a conversation already in progress. Remember, if two amateurs want to use the same frequency, both have equal rights to the frequency. *If two stations transmitting on the same frequency interfere with each other, the stations should negotiate continued use of the frequency.* Obviously, emergency traffic should have priority over casual conversation.

On the HF bands, contact is initiated by calling “CQ” (*seek you*). *The procedural signal “CQ”, is a way of saying “calling any station”, inviting any station to respond to your call. Before calling CQ, listen first to be sure that no one else is using the frequency, ask if the frequency is in use, and make sure you are authorized to use that frequency. To respond to a station calling CQ, transmit the other station’s call sign followed by your call sign.*

While CQ calls are used on HF and simplex or weak signal work on VHF/UHF, they are generally not used on repeaters. *A station that gives their call sign, followed by the word “monitoring” indicates that the station is listening on a repeater and looking for a contact. An appropriate way to call another station on a repeater if you know the other station’s call sign is to say the station’s call sign, then identify with your call sign.* If you get no answer, simply say your call followed by “clear”, to let others know that you are done with the repeater. If you want to join a conversation in progress, wait for a pause between the stations then key the microphone and say your call, or the word “comment”. Saying the word “break” during the pause should be done only when there is an urgent need to use the repeater.

In addition to “CQ”, several other procedural signals are commonly used by amateur operators. These include a whole series of three letter abbreviations that start with the letter Q, which were developed for CW. The ones you may hear most often include *QRM (receiving interference from other stations), and QSY (indicates you are changing frequency).*

Emergency Procedures

Proper handling of emergency communications is vital. Remember, that even in the event of an emergency, *FCC rules ALWAYS apply to the operation of an amateur station. Amateur station control operators are permitted to operate outside the frequency privileges of their license class only in situations involving the immediate safety of human life or protection of property.*

There are thousands of amateur organizations that support emergency communications, Mendocino Auxiliary Communication Service (MACS) being one of them in Mendocino County. Two national organizations, which may provide communications during emergencies, are the Radio Amateur Civil Emergency Service (RACES) and Amateur Radio Emergency Service (ARES). *RACES is defined as an FCC part 97 amateur radio service for civil defense communications during national emergencies. ARES is a bit less formal, consisting of a group of licensed amateurs who have voluntarily registered their qualifications and equipment for communications duty in the public service.*

Emergency communications are usually handled in a “net”, with a “net control station” (NCS) directing the communications. *Typical duties of a Net Control Station are to call the net to order and direct communications between stations checking in. Good standard practice when you participate in a net is transmit only when directed by the net control station, unless you are reporting an emergency.* Do not clutter the frequency with unnecessary chatter. In order to get the immediate attention of a net control station when reporting an emergency, the accepted practice is to begin your transmission by saying "Priority" or "Emergency" followed by your call sign.

In net operation, messages exchanged by net stations is known as “traffic”. A characteristic of good traffic handling is passing messages exactly as received. If there any doubt about the content of a message, ask for clarification before transmitting it. Formal traffic uses specific protocols to ensure accuracy. This includes a “preamble” containing information needed to track the message, and a “check” in a radiogram header, which indicates the number of words or word equivalents in the text portion of the message. *Spelling words using a standard phonetic alphabet is a technique used to ensure that voice messages containing unusual words are received correctly.* The phonetic alphabet is also a good way to clarify the letters in your call sign. While law enforcement and military stations use slightly different phonetics, amateurs should use the international standard.

It’s a good idea to plan ahead for an emergency, as one never knows when disaster will strike. Several sets of charged batteries is one of the most important accessories for a hand-held during an emergency. Most hand-held radios have an optional battery pack that allows you to run your radio on standard AA cells. This is a good investment, as a radio will typically run 2 – 3 times longer on AA alkaline cells than the rechargeable battery packs.

Most amateur equipment is capable of operating on 12 volts DC. Many hams keep a 12V rechargeable battery available, in case the commercial power is lost. This type of battery may be recharged, even if the commercial power is out, by connecting it in parallel with a vehicle’s battery and running the engine.