

FM/VHF Operating Guide

By Bob Witte, KØNR

(C) Copyright 1992-2012 Robert Witte

This guide is intended to assist new amateur radio operators in figuring out what VHF FM and repeater operation is all about. (When I say “VHF”, I really mean VHF and UHF, most any frequency above 50 MHz.) This is written based on my own personal biases and experience operating in the Midwestern and Western states of the US. Some references are specific to my state of Colorado. You may find that certain operating practices are different in your area. I encourage all new hams to *do a lot of listening* when they first get their equipment. Try and figure out what the standard operating norms are in your location. And make sure to try to emulate the best quality operating practices and avoid the poor practices that are often found on the ham bands. (Note that “old timers” are often just as guilty or *more guilty* of sloppy operating.)

REPEATER OPERATING

Repeater operation is a little bit different than other forms of amateur radio communication. Usually the signals are strong and clear so some of the practices used on the other bands are not necessary on VHF FM.

CHECKING INTO THE REPEATER: If you are out mobile (or just hanging around the ham shack) and want to talk to someone, flip to the repeater frequency and see if anyone is around. It's not necessary to give a long call on VHF FM. Most stations indicate their availability for a call by transmitting and saying “KØABC monitoring”. Sometimes the term “monitoring” is interpreted as “I am here if anyone wants to talk to me” as opposed to “calling any station”. You might try saying “This is KØABC, anyone around?” If you have a specific request, such as traffic or weather information, say so. Someone will be much more likely to jump in on a specific request for help.

IDENTIFICATION: FCC regulations require an amateur operator to identify at the end of a series of transmissions and at least every ten minutes during a series of transmissions. It is considered good practice to identify your station when you first come on the air (even though the FCC doesn't require it). This lets other stations know who you are right from the start.

BREAKING: Breaking in on a conversation is just that, interrupting someone else when they are talking. A repeater is a shared resource, so we should expect that other people may have a need to use the machine while we are on the air. No one has exclusive rights to the frequency and repeater.

The best way to break into a conversation is to simply give your call sign in between transmissions. Some operators use the word “break” which is somewhat controversial. In some circles it is perfectly acceptable, while in others it is reserved for emergency communications.

Usually, if you have time to squeeze the word “break” in, you can just as well squeeze in your call. Using your call sign instantly identifies yourself to the stations using the repeater and often results in a “Go ahead, Joe” instead of “Is there someone trying to break in?”.

During ARES operations, the local ARES organization reserves the word “break” for emergencies. When an emergency net gets busy, multiple stations may need to break in. If three stations end up saying “break”, the net control station has a hard time sorting things out. If call signs are used, the net control can make sure all stations are acknowledged and their traffic handled. Reserving the word “break” for emergencies is a good habit to adopt for general repeater use.

Of course, if operators using the repeater make it a point to pause between transmissions, it makes breaking in that much easier and more orderly. Most repeaters have a “courtesy beep” of some sort which forces operators to wait for a short time between transmissions. If they don’t wait, they run the risk of timing out the machine and having it shut down on them.

Most FM repeater operating can be done with a minimum of slang and jargon. Plain language works quite well. Try to avoid the overuse of Q signals, phonetics, etc. such as “Roger, roger, Joe, I QSL your QSL and thanks for the QSO from your QTH, roger, roger.”

PURPOSE OF A REPEATER: In the strictest sense, the purpose of a repeater is to extend the range of handheld and mobile stations. Base stations with reasonable antennas often don’t need the extended range afforded by a repeater. However, it is common practice for all types of stations to make use of repeaters. We need to think of the repeater as a valuable resource (especially wide coverage repeaters). If you are talking with someone who is within simplex range, go ahead and switch over to a simplex frequency and free the repeater up for other people to use. This is especially true if you are going to ragchew for quite a while.

A repeater is a shared resource. It takes a considerable amount of time and money to keep a repeater up and running and there are many people who use the machine. Thus, courtesy is the order of the day. Yield the frequency to someone who needs it. Also, try not to interrupt another conversation on the repeater needlessly. Cooperate with other operators to keep the repeater operation fun and useful. Think about the content of your repeater conversations since many other radio operators and non-licensed individuals may be monitoring the frequency. If you’ve run out of useful things to say, it’s probably time to sign clear! The most important two things to remember about repeater operation (for that matter, any amateur radio operation) are common sense and courtesy.

SIMPLEX OPERATION

Repeaters are very powerful and useful tools for amateur communications. They can dramatically extend the range of a handheld or mobile transceiver and they offer extended capabilities such as autopatch, weather station access, internet linking, etc. All of the emphasis on the utility of repeaters can lead the new ham to conclude that repeaters are *the only thing* worth using on the VHF/UHF bands.

Simplex operation is direct station-to-station radio communication without the use of an intermediate relay station (i.e., repeater). The range is much more dependent on antenna type, antenna height and power output than repeater operation but significant distance can be covered. Two mobiles having a QSO on flat land can typically cover 15 to 20 miles. If one station is on a hill, the range can be much longer. If you happen to be standing on top of Pikes Peak (at 14,110 feet about sea level), you can contact someone *several hundred miles away*. Which leads me to my next point: simplex operation can be fun. It is a challenge to see how far your signal can go (yes, *without* some powerful repeater extending your range).

So don't forget about simplex. Some of the best contacts I have ever had were on simplex. One of the reasons is the challenge of seeing how far your signal will go. The other factor is that there are fewer people listening on simplex. There is less of the "party line atmosphere" that can exist on a repeater where everyone within repeater range will hear every word of every station. (Also, you are not tying up the precious resources of the repeater.) Often, this leads to a longer and more meaningful discussion between you and the operator on the other end.

For the best performance on simplex, use SSB (single-sideband) or CW (continuous wave, Morse Code). You will find that all of the really serious VHF weak-signal operators use SSB and CW. The focus of this document has been on the FM mode, so I won't go into great detail here. But I must point out that for getting the most out of simplex operation, you'll want to check out the non-FM modes.

Give simplex a try.

MAKING CONTACT

Sometimes new hams find that no one answers their call. So they try again. Again, there is no answer. After a few days of trying this, they figure that the local ham operators are ignoring them, probably because they have a "new" callsign. Yeah, they've heard about the oldtimers being rude to the newcomers, so they assume that's happening to them. Well, they may be right, but probably not. Keep in mind that hams that have been on the air for a long time often view their radio as a means of accomplishing certain things...like talking to their buddies or checking into their favorite nets. The thrill of meeting new, unknown people may be gone. So they become reluctant to grab the mike to answer every new call. But they aren't out to get you.

My advice? Chill out. Don't put a chip on your shoulder if people don't flock to respond to your call. You've just walked into an electronic cocktail party and sometimes it is difficult to strike up a conversation. Listen for when someone else checks in on the frequency and call them instead. Make sure you have something interesting to say besides "The rig here is a BelchFire 602 running 1kW into a melted rubber duck antenna." Try to find other people that have interests in common with you. Another strategy is to attend one of the local ham clubs and get to know a few people. Volunteer for club activities, attend Field Day and, in general, be willing to help out. Once you get to know people face to face, the on-the-air contacts are more frequent and meaningful.

TRANSMITTER TESTING

Try to keep test transmissions off the air by using a good dummy load instead. Be aware that even a slight amount of radio energy leaking from a dummy load may activate a sensitive repeater. Use a transmit frequency other than the repeater input even when testing with a dummy load. Some tests must be performed on the air, such as tuning an antenna for best match. Use a repeater frequency that is not used in your vicinity or a not-too-popular simplex frequency.

If your intent is to key the repeater to see how strong its signal is, don't kerchunk it. Instead, transmit and say "KØABC testing". Remember, unidentified transmissions are illegal and annoying. Also, most repeaters have special circuitry which detects kerchunking and sends out a powerful signal that causes the offending radio to burst into flames.

INTERFERENCE

Most repeaters in Colorado are blessed with very few malicious interference problems. If you do hear this sort of thing (jamming, foul language, etc.), NEVER acknowledge it on the air. Giving the person some kind of response only encourages the behavior. Also keep in mind that interference may not be intentional. Most operators have at one time or another accidentally keyed the mike or have mistakenly left the receiver volume turned down and transmitted on top of someone. Assume good intentions until proven otherwise.

PROPAGATION

Both 2 Meters and 440 MHz normally exhibit line-of-sight propagation. This means that the signal travels to the optical horizon (and perhaps a little farther). Increased Height Above Average Terrain (HAAT) increases the distance to the horizon and propagation distance. This is why repeaters are located on the tops of mountains or tall buildings.

The front range of Colorado enjoys excellent VHF & UHF repeater coverage due to the close proximity of the mountains to the flat plains where much of the population is concentrated. Propagation characteristics of 144 MHz and 440 MHz are similar, with 440 MHz more susceptible to the shadowing effects of hills and other obstructions.

On some occasions, VHF and UHF propagation enhancement occurs and signals propagate significantly further than line-of-sight. These propagation modes include tropospheric ducting, sporadic E-skip and meteor scatter. Most of the long-distance VHF/UHF work is done using single-sideband or CW on the low end of the bands.

SIGNAL REPORTS

FM signal reports are often given in terms of receiver quieting. A strong signal will fully quiet an FM receiver, while a weak one will be quite noisy. A "Full quieting" report is given to a signal which exhibits no background noise or hiss. Signal reports are often given in terms of "percent quieting"

to give the transmitting station a better idea of the signal quality.

Remember that when using a repeater there are two communication paths at work — the path from the transmitting station to the repeater and the path from the repeater to the receiving station. Either one of these paths can exhibit noise due to a weak signal. If the receiving station has a strong S-meter indication but the transmitting station sounds noisy, the transmitting station is probably weak into the repeater. Remember that the signal strength indicated by your S meter is due to the repeater and not the transmitting station.

A frequency modulated transmitter used on the VHF/UHF amateur bands should be set for a maximum frequency deviation of 5 kHz with full modulation. Unlike SSB transmitters, the signal strength of an FM signal is independent of modulation level. That is, a dead carrier produces just as much power as a fully-modulated signal. Excessive modulation of an FM transmitter does not improve the reception of the signal and often degrades it. On the other hand, inadequate FM deviation causes weak received audio. The level of audio heard on the receive end is relatively independent of received signal strength. This means that changing transmitter power does not affect the loudness of the audio at the receive end.

PHONETICS

The use of phonetics is not usually required due to the clear audio normally associated with frequency modulation. Still, sometimes it is difficult to tell the difference between similar sounding letters such as “P” and “B”. Under such conditions, use the standard ITU phonetics to maintain clarity. Many nets specifically request the use of standard phonetics to make it easier on the net control station.

The ITU Phonetics are

**Alpha Bravo Charlie Delta Echo Foxtrot Golf Hotel India Juliet Kilo Lima Mike November Oscar
Papa Quebec Romeo Sierra Tango Uniform Victor Whiskey X-Ray Yankee Zulu**

Q SIGNALS

Q signals are normally not required on phone and especially not on VHF. However, they are part of the amateur radio culture and are used on the air. The following is a short list of common Q signals, as used on VHF.

QSY “I am changing frequency”

QRZ? “Who is calling?”

QSL “I acknowledge receipt.”, “I understand your message.”

QSO A radio conversation, as in “I had a QSO with Fred yesterday.”

QTH “My location is _____”

EMERGENCIES

Radio amateurs have a long history of helping out when emergencies occur. These emergencies tend to fall into two categories: 1) Disaster situations when the ARES or RACES organizations are activated and 2) Short-term emergencies that a single radio op happens upon. Radio amateurs are urged to participate in their local ARES or RACES organizations to be fully prepared for the first type of emergency.

The second category of emergencies will be discussed further here. First, be aware that in areas with good mobile phone coverage, it will be more effective to report an emergency situation via telephone.

Some things that you need to think about in an emergency:

Where are you?

What is the nearest mile marker, intersection or landmark?

Are there any injuries? (The authorities want to know whether to dispatch medical or not.)

VHF/UHF BAND PLANS

The general band plan for the amateur 2-Meter band as proposed by the ARRL VHF-UHF Advisory Committee is:

- 144.00-144.05 EME (CW)
- 144.05-144.06 Propagation beacons
- 144.06-144.10 General CW and weak signals
- 144.10-144.20 EME and weak signal SSB
- 144.20 National SSB calling frequency
- 144.20-144.30 General SSB operation
- 144.30-144.50 OSCAR sub-band
- 144.50-144.60 Linear translator inputs
- 144.60-144.90 FM repeater inputs
- 144.90-145.10 Weak signal and FM simplex (includes packet radio)
- 145.10-145.20 Linear translator outputs
- 145.10-145.50 FM repeater outputs
- 145.50-145.80 Misc. and experimental modes
- 145.80-146.00 OSCAR sub-band
- 146.01-146.37 Repeater inputs
- 146.40-146.58 FM simplex
- 146.61-147.39 Repeater outputs
- 147.42-147.57 FM simplex
- 147.60-147.99 Repeater inputs

Note that the 2-Meter band includes both FM and weak-signal (SSB/CW) operation. FM users of

the band should not stray into the weak-signal or OSCAR (satellite) sub-bands.

Specific FM frequencies used in Colorado have 15 kHz spacing. All repeater output frequencies below 147 MHz have the repeater input -600 kHz relative to the repeater output. All repeater output frequencies above 147 MHz have repeater inputs +600 kHz relative in the repeater input. Most modern 2-Meter transceivers are tuned by selecting the repeater output frequency and then selecting the transmit offset (+ or – 600 kHz).

Standard simplex frequencies in Colorado are:

146.415, 146.430, 146.445, 146.460, 146.475, 146.490, 146.505, 146.520, 146.535, 146.550, 146.565, 146.580, 146.595, 147.420, 147.435, 147.450, 147.465, 147.480, 147.495, 147.510, 147.525, 147.540, 147.555, 147.570, 147.585 MHz

The National Simplex (Calling) Frequency is 146.52 MHz.

The 440-MHz band plan as proposed by the ARRL VHF-UHF Advisory Committee is:

420.00-426.00 ATV repeater or simplex, control links and experimental

426.00-432.00 ATV simplex

432.00-432.07 EME

432.07-432.08 Propagation beacons

432.08-432.10 Weak signal CW

432.100 SSB calling frequency

432.10-432.125 Mixed mode and weak signal

432.125-432.175 OSCAR inputs

432.175-433.00 Mixed mode and weak signal

433.00-435.00 Auxiliary/repeater links

435.00-438.00 Satellite only

438.00-444.00 ATV repeater input and repeater links

442.00-445.00 Repeater inputs and outputs

445.00-447.00 Auxiliary and control links, repeaters and simplex

446.00 National Simplex (Calling) Frequency

447.00-450.00 Repeater inputs and outputs

Standard 440 MHz FM frequencies are spaced 25 kHz apart. In Colorado, the transmit offset on 440 MHz repeaters is – 5 MHz (that is, the repeater input frequency is 5 MHz below the output frequency).

REPEATER DIRECTORY

The American Radio Relay League (ARRL) publishes a repeater directory every year. This directory lists the VHF/UHF repeater frequencies for the entire United States, Canada, the Caribbean, Central and South America and the Pacific islands under U.S. jurisdiction. This directory is highly recommended for radio amateurs who travel outside their local area. Contact

the ARRL at <http://www.arrl.org/>.

ANTENNAS FOR HANDHELD RADIOS

Almost everyone routinely uses a “rubber duck” antenna for handheld transceivers (HT). This antenna is essentially a quarter-wave which is shrunk down to about 1/4 of its usual length. Think of this antenna as a leaky dummy load, because its effectiveness is not much better than that. Its short length and the lack of a ground plane (which is required for a 1/4-wave style antenna) makes its performance quite poor. Only the high sensitivity of FM repeaters make handheld radios with rubber duck antennas so useful.

For hiking, public service events, and other activities where radio range is important, a longer antenna is very helpful. Although there are full-size 1/4-wave and 5/8-wave models available, experience has shown that one of the most effective handheld antennas is the end-fed 1/2-wave. The telescoping 1/2-wave antenna with a BNC connector on the end is available from several manufacturers. This type of antenna can easily make the difference between having an unreadable signal and being full-quieting into the repeater.

When a good antenna is attached to an HT, the receiver often exhibits problems due to the much strong signals present. Strong signals (typically paging transmitters) will come blasting through the receiver and interfere with the desired signal. Radio amateurs usually refer to this as “intermod”, short for “intermodulation”. In reality, intermodulation has a specific technical definition that describes only some of these noise and interference problems. Independent of the name, the end result is that the HT receiver is overloaded by these strong signals. One solution to the problem is to use an external filter to block out signals outside the ham band. This type of filter will also block police, fire, weather and other non-ham signals, too.

GLOSSARY

ARES – Amateur Radio Emergency Service, an organization which provides public service and emergency communications via amateur radio.

AUTOPATCH – a device which interfaces a repeater to the telephone system, permitting radio amateurs to make telephone calls via the repeater.

BREAK – the term used to interrupt a conversation, normally reserved for priority or emergency traffic.

COURTESY BEEP – the audible beep (or other signal) that occurs after the repeater’s timeout timer is reset. Repeater users should pause between transmissions to let this reset occur and to let others break in.

CTCSS – Continuous-Tone-Coded Squelch System, subaudible tones used for accessing some repeaters. These tones are in the frequency range of 67 Hertz to 250.3 Hertz.

DIGIPEATER – a digital packet repeater for retransmitting packet radio signals.

DTMF tones – Dual-Tone Multi-Frequency tones which are produced by pressing a telephone or radio keypad (otherwise known as Touchtones, which is an AT&T trademark).

DUPLEX – operation using a pair of frequencies, one for transmit and one for receive, as when using a repeater.

FM – Frequency Modulation. Modulation technique which places information on a transmitted signal by modulating (varying) the frequency.

FULL QUIETING – a received signal having no noise in it.

INPUT FREQUENCY – the frequency that a repeater listens on (and the frequency that a repeater user transmits on).

KERCHUNK – to key a repeater without identifying your station, often followed by the offending transceiver bursting into flames.

MACHINE – slang for repeater or repeater system.

OUTPUT FREQUENCY – the frequency that a repeater transmits on (and the frequency that a repeater user listens on).

PL – Private Line, the Motorola trademarked name for CTCSS.

RACES – Radio Amateur Civil Emergency Service, an emergency communications group operating under a special section of the Amateur Service regulations.

SIMPLEX – radio communications using the same transmit and receive frequency (as in communication between two stations without the use of a repeater).

TRANSMIT OFFSET – the difference between the repeater user's transmit and receive frequencies. This offset is either + or – 600 kHz on most 2-meter repeaters.