

Amateur Radio FM Repeater Basics

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For a list of frequencies of operation for Canadian Amateur Radio operations, refer to RBR-4 “Standards for the Operation of Radio Stations in the Amateur Radio Service” which can be found on the Industry Canada website at:

<http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/en/sf05478e.html>

Schedule I lists frequencies for the various “ham bands” in use (Canada is in IARU Region 2). The bands most often used for FM repeater operations (listed in order of popularity) are:

144 – 148 MHz	referred to as the “2 meter” band (2M band)
430 – 450 MHz	referred to as the “440 band” or the “70cm band”
50 – 54 MHz	referred to as the “6 meter band”
28 – 29.7 MHz	referred to as the “10 meter band”
220 – 225 MHz	referred to as the “220 band” or “1 ¼ meter band” or “125 cm band”
902 – 928 MHz	referred to as the “900 band”
1240 – 1300 MHz	referred to as the “23 cm band”

Note that the name “2 meter”, “70 cm” etc. refers to the approximate wavelength of the radio wave.

Within these frequency ranges, “standards” have been created as to what frequencies can be used for repeater transmit (output) and receive (input).

In most cases, FM (frequency modulation) is used with repeater operations. The most popular transceivers available today will either be “2M only” or “2M/440 dual-band”, with the occasional model offering three or even four bands of operation.

Simplex

When you wish to talk to another ham without using a repeater, a “simplex” frequency is used. Simplex refers to the fact that everyone involved in the radio communications are both transmitting and receiving on the same “single” frequency. In simplex communications, only one person can talk (transmit) at a time, and he cannot hear (receive) anyone else while he is transmitting.

Popular designated simplex frequencies are (you may find others in various parts of Canada/U.S.):

2 meter band FM simplex frequencies

146.520 MHz (often called “52” or “652”) This frequency is also the “national calling frequency”

146.550 MHz

146.580 MHz

There are also 6 less common simplex frequencies from 147.420 through 147.570 (30 KHz spacing)

Note that 146.565 MHz is reserved for fox-hunts (hidden transmitter hunts) in Canada and the U.S.

440 band FM simplex frequencies

446.000 MHz national calling frequency

446.000 through 446.175 MHz (25 KHz spacing is often used)

6 meter band FM simplex frequencies

52.525 MHz national calling frequency

51.100 through 51.600 MHz, most common being 51.500, 51.520, 51.540, 51.560, 51.580, 51.600

10 meter band FM simplex frequencies

29.600 MHz national calling frequency

29.610 MHz

29.500 MHz

220 band FM simplex frequencies

223.400 through 223.520 MHz (20 KHz spacing)

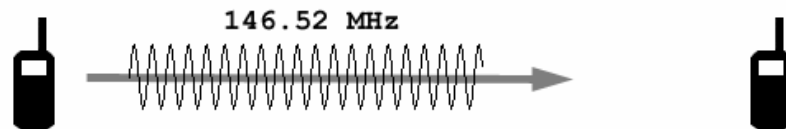
900 band FM simplex frequencies

906.500 MHz national calling frequency

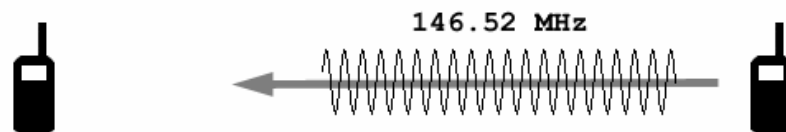
23 cm band FM simplex frequencies

1294.500 MHz calling frequency

First this...



then this...



Simplex operation

- Buildings, trees and hills can block simplex signals after a few miles
- On the other hand, simplex signals can go as far as “line-of-sight” allows
- Transmitting from a mountain top allows simplex signals to go for *hundreds* of kilometers
- Roof-top (and car roof-top) antennas help simplex signals go farther
- Remember, when using simplex - “the higher, the better”

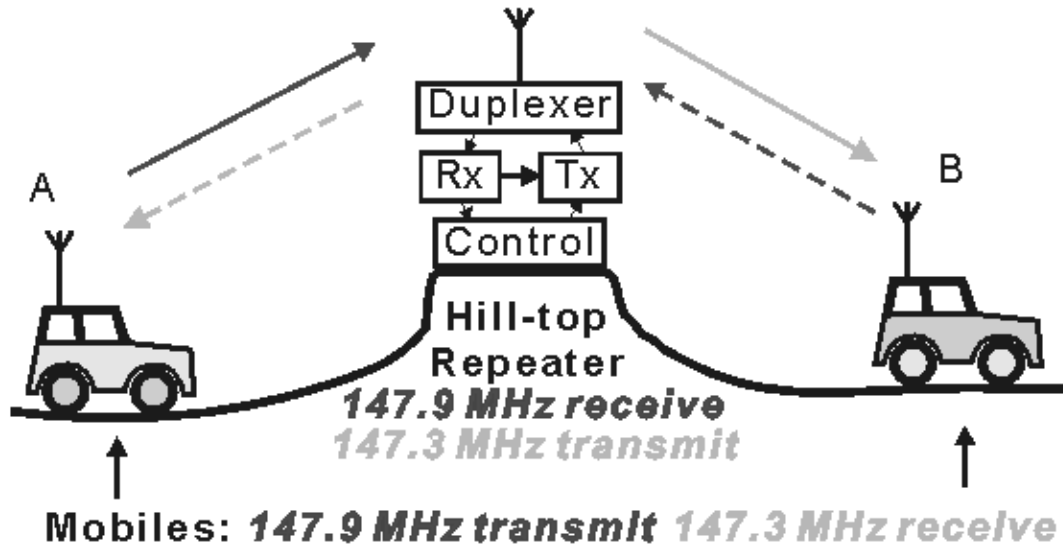
Full-duplex

This mode is generally not used by Amateur Radio Operators. Full duplex permits simultaneous transmitting and receiving (talking and listening) the same as on a normal house telephone. In radio communications, separate transmit and receive frequencies must be used for full-duplex – note that there will be no “push-to-talk” microphone button. A repeater operates in a full-duplex mode.

Half-duplex

Used by Amateur Radio operators when communicating through repeaters; where two separate frequencies are used for transmitting and receiving as in full-duplex, but the transceiver can only transmit or receive (not both simultaneously). A push-to-talk button on the microphone is used to switch the transceiver from the receive mode to the transmit mode.

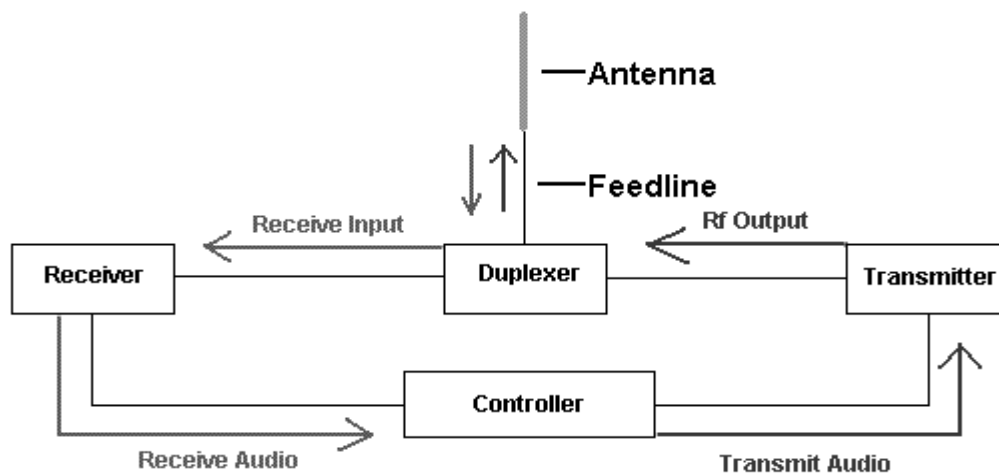
What is a repeater?



A repeater is a full-duplex radio which receives signals on one frequency and simultaneously re-transmits them on another frequency, usually with higher power and from a better location with greater communications coverage range. A repeater greatly extends the operating range of amateur mobile and hand-held transceivers.

In the drawings, the repeater is shown broken down into its main parts:

- a transmitter (TX)
- a receiver (RX)
- a duplexer filter assembly which allows the transmitter and receiver to both operate at the same time through a single antenna (prevents the repeater TX from desensitizing the RX).
- a repeater controller (the brains), which takes care of keying up the TX when a signal appears at the RX input, periodically transmitting identification in morse code or voice etc.



BASIC REPEATER BLOCK DIAGRAM

N4UJW

In order to have your hand-held or mobile radio signal retransmitted by the repeater, your radio must receive on the repeater's transmit frequency and transmit on the repeater's receive frequency. When in the receive mode, your radio will be tuned to the repeater output frequency. If you press the push-to-talk button, the radio will automatically change to the repeater input frequency and begin transmitting.

The repeater input (receive) frequency can be either higher or lower in frequency than the repeater output (transmit) frequency. If it is lower (such as 146.850 output/146.250 input) then the repeater frequency is written as 146.850 – (the minus sign indicating that the repeater input is below the output frequency). If it is higher (such as 147.000 output/147.600 input) then the frequency is written as 147.000 + (the plus sign indicating that the repeater input is above the output frequency).

Standard FM repeater “offsets” (difference between output and input frequencies) are:

2 meter band	600 KHz
440 band	5 MHz
6 meter band	1 MHz
10 meter band	100 KHz
220 band	1.6 MHz
900 band	12 MHz
23 cm band	12 MHz

Note that all modern transceivers will automatically select the proper offset for the frequency you use.

Designated FM repeater frequencies

A listing of most of the repeaters in this part of Ontario can be found on the “Western New York - Southern Ontario Repeater Council” website at: <http://www.wnysorc.org/repeaterlist.html>

Note that this list only includes repeaters that have been registered with the WNYSORC by the club or Ham Radio Operator that operates it (so some that can be heard in this area may be missing from the list).

2 meter band

output: 145.100 to 145.500 MHz	input: 144.500 to 144.900 MHz
146.610 to 147.000	146.010 to 146.400
147.000 to 147.390	147.600 to 147.990

440 band

output: 442.000 to 445.000 MHz	input: 447.000 to 450.000 MHz
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6 meter band

output: 53.000 to 54.000 MHz	input: 52.000 to 53.000 MHz
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220 band

output: 223.910 to 225.000 MHz	input: 222.310 to 223.400 MHz
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10 meter band (repeater output/input frequencies)

29.620/29.520 MHz	29.630/29.530 MHz
29.640/29.540 MHz	29.650/29.550 MHz
29.660/29.560 MHz	29.670/29.570 MHz
29.680/29.580 MHz	29.690/29.590 MHz

Repeater Etiquette

The first and most important rule before using a repeater is to LISTEN FIRST – make sure the volume on your radio is turned up and that the squelch level is not set too high. Nothing is more annoying than someone that "keys up" in the middle of another conversation without first checking to make sure the repeater is free. If the repeater is in use, wait for a pause in the conversation (when no one is keying the repeater) and simply announce your callsign and wait for one of the other stations to acknowledge your call.

Remember that this is not CB, so refrain from using CB lingo such as 10-4, "what's your handle", or BREAKER. The word BREAKER or BREAK, BREAK on Ham Radio is commonly used to indicate that you have priority or emergency information to pass.

When you are using the repeater, leave a couple of seconds between exchanges to allow other stations to join in or make a quick call. Most repeaters have a "Courtesy Tone" (a short beep or series of beeps) that will help in determining when the repeater has un-keyed.

Repeaters usually have a time-out function that will shut down the transmitter if the repeater is held in transmit mode for too long a time (normally two to four minutes). This ensures that if someone's transmitter is stuck on for any reason, it won't hold the repeater's transmitter on indefinitely. Of course this also means that if someone is too long-winded, and doesn't periodically un-key his microphone to reset the time-out timer, those listening to him will hear the repeater controller announcement "REPEATER TIME OUT" followed by silence and then "TIME OUT CANCEL" when he does finally un-key his microphone.

Some Repeater Definitions and Ham Radio Slang

access code - one or more numbers and/or symbols that are keyed in with a telephone key pad to activate a repeater function e.g autopatch, link to another repeater etc

adjacent channel interference – the interference resulting when a strong signal from another repeater occurs close to the repeater frequency you are monitoring. Your transceiver receiver is unable to reject this signal which may be only 15 or 20 KHz off frequency (see also co-channel interference and desense).

autopatch - a device that interfaces a repeater to the telephone system to permit repeater users to make telephone calls. Often called a "patch"

boat anchor – old, usually big radio equipment (often using tubes)

break - the word used to interrupt a conversation on a repeater , often to indicate that there is an emergency

brick – a small, solid state amplifier

bureau – clearing house for QSL cards

cans - headphones

carrier - an unmodulated (no speech) transmitter signal

clear – finished with the frequency, as in "VE3GCB clear"

CTCSS (Continuous Tone-Coded Squelch System) - This is a sub-audible tone transmitted by your radio in addition to your voice signal. When it is equipped with a CTCSS decoder, a repeater will not function unless it hears the CTCSS tone and the "carrier" signal from your transmitter. Different CTCSS tones are in use for different repeaters or areas. These may be applied to input or output frequencies, or both. CTCSS tones are used to minimize the effects of co-channel interference due to band-openings causing reception of distant signals

Common CTCSS tone frequencies in Hz

67.0	74.4	82.5	91.5	100.0	114.8	127.3	141.3	156.7	179.9	203.5	218.1	233.6
69.3	77.0	85.4	94.8	107.2	118.8	131.8	146.2	162.2	186.2	206.5	225.7	241.8
71.9	79.7	88.5	97.4	110.9	123.0	136.5	151.4	173.8	192.8	210.7	229.1	250.3

channel - the pair of frequencies (input and output) used by a repeater

channel spacing - the frequency spacing between adjacent frequency allocations - may be 50, 30, 25, 15 or 12.5kHz, depending upon the convention in use in the area of the repeater

clear – a word meaning I'm finished with this frequency, someone else can use it (as in "VE3GCB clear")

closed repeater - a repeater whose access is limited to a select group (see also open repeater)

cloud warmer – an antenna that radiates mostly straight up

co-channel interference - the interference resulting when a repeater receives signals meant for a distant repeater on the same frequency pair (or when you hear a distant repeater on the same frequency pair as the local repeater)

controller - the control system (computer) within a repeater which may include turning the repeater on-off, timing transmissions, sending the identification signal, controlling the autopatch and CTCSS encoder/decoder

control operator - the amateur radio operator who is designated to control the repeater

courtesy tone - an audible indication that the repeater has unkeyed, and a user may go ahead and transmit

coverage - the geographic area within which the repeater provides communications

cross-band - the process of transmitting on one ham band and receiving on another

DTMF - see tone pad

desense (desensitization) - the reduction of receiver sensitivity due to overload from a nearby transmitter (usually on a different frequency from the one you are monitoring)

double – to “double” with someone occurs when two people both start transmitting at the same time. The one that un-keys his transmitter first will hear the other person continuing to talk and realize he had doubled with him. A third ham would hear either the stronger signal only, or if they are similar in signal level into the repeater – an unintelligible garble of noise.

dropping out - the situation, while using a repeater, when your signal does not have enough strength to keep the repeater keyed up (see also picket fencing)

duplex - a mode of communication in which you transmit on one frequency and receive on another frequency (see also half and full duplex)

duplexer - highly selective filter (sometimes called a cavity filter) which allows a repeater's transmitter and receiver to share one antenna without interfering with each other

DX – stations in far off countries

DXing – the art of working stations in far off countries (primarily applies to HF)

DXpedition – a trip by a group of hams to a usually remote location in the world to work as many stations as possible

Elmer – an experienced ham who helps newcomers to the hobby

ERP (effective radiated power) - radiated power, allowing for transmitter output power, line losses and antenna gain

Eyeball QSO – a face-to-face conversation between hams (see also QSO)

Final – could mean the power amplifier output tubes or transistors, but is often used to mean the final communication – as in “I’ll turn it over to you for your final”

frequency coordinator - an individual or group responsible for assigning channels to new repeaters with minimal interference to existing repeaters

frequency modulation (FM) - a method of modulation, where the strength of the signal is constant, but the frequency varies with the strength of the voice, and the rate of frequency change varies with the pitch of the voice

full duplex - a mode of communication in which you transmit on one frequency while you simultaneously receive on another frequency

full quieting - a received signal that contains no noise (no hiss). If your signal is not full quieting into a repeater, the repeater will retransmit your voice along with any noise or hiss it receives. Increase TX power until full quieting is reached

GHz (Gigahertz) – a unit of frequency measurement equal to 1000 megahertz (MHz)

half duplex - a mode of communication in which you transmit at one time on one frequency and receive at another time on another frequency

hand-held - a portable transceiver small enough to fit in the hand, clipped to your belt, or in your shirt pocket

hard line (or heliax) – a type of low-loss coax cable often used on repeater antenna systems

hole mount – refers to a type of mobile antenna which requires drilling a hole in the car body (one common type is the NMO mount which requires a ¾ inch hole)

homebrewed – home made equipment

ID (identification) - the means by which a station identifies its call sign by Morse code or speech

input (frequency) - the frequency of the repeater's receiver

intermod (intermodulation distortion or IMD) - interference that results when strong signals from nearby transmitter(s) mix with the desired signal inside a radio receiver

isolation - the difference in level (measured in dB) between a transmitted and received signal due to filtering

jamming - the action of deliberate illegal interference with a repeater operation

kHz (kilohertz) - a unit of frequency measurement equal to 1,000 cycles per second (Hertz)

kerchunk - to key up a repeater without identifying

key pad - see tone pad

key up - to turn on the repeater by transmitting on its input frequency

linking - the process of connecting repeaters in a permanent network, or one controlled by access codes

MHz (megahertz) - a unit of frequency measurement equal to 1,000,000 cycles per second (Hertz)

Lid – a very inconsiderate operator

machine - a slang expression meaning a repeater system

magnetic mount (mag-mount) - an antenna with a magnetic base that permits quick installation and removal from a metallic surface, including an automobile body

negative offset - the repeater input frequency is lower than the output frequency

NiCd (or NiCad) - a nickel cadmium battery that may be recharged many times; often used in handheld transceivers

NiMH - new technology nickel metal hydride battery that has advantages over NiCd, but is more expensive

odd split - unconventional frequency separation between input and output frequencies.

offset - see separation

OM – Old Man, any male ham (regardless of age), a husband

open repeater - a repeater whose access is not limited

output frequency - the frequency of the repeater's transmitter (and your receiver)

over – a word used to indicate that it's your turn to talk, I'll listen

out – a word used to indicate that I am finished communicating and am turning off my radio. Never use “over and out” as that would mean “it's your turn to talk but I'm turning off my radio”

phone – used to indicate voice communications (as opposed to CW or morse code)

picket fencing – repetitive fading of signal into repeater caused by moving car antenna near edge of coverage (see also dropping out)

pile up – lots of stations calling one station at the same time and on the same frequency

polarization – can refer to the direction a vertical antenna (such as on a handheld) is pointing. If held vertical to the ground, then it is producing a vertically polarized signal; if held horizontally to the ground, then it is producing a horizontally polarized signal. Since repeater antennas use vertical polarization, it is important to keep the antenna vertical to the ground for best signal into the repeater.

positive offset - the repeater input frequency is higher than the output frequency

PTT (push to talk) - the use of the microphone button or control line to key the transmitter on

PL - Private Line (trademark of Motorola Inc) see CTCSS

Q signals or codes - abbreviations developed for use on Morse code transmissions (eg. QTH which means location). Not generally recommended for voice communications, although some Q signals are often used.

QRM – man-made noise or interference such as a “Lid” tuning up his transmitter on a frequency that is in use

QRN – nature made noise or interference such as lightning static crashes

QRP – a Q signal used to mean “low power operation”, typically 5W or less CW, or 10W or less SSB

QRT – to “go off the air” or turn off your transmitter as in “I'm going QRT”

QSO – a Q signal used to mean a communication or radio conversation between two hams (often pronounced Q-so)

radio direction finding (RDF) - the art and science of locating a transmitter, such as someone jamming a repeater.

Rag chew – shooting the breeze, just chatting

Reading the mail – listening to a conversation without transmitting

repeater - an automatic relay station, generally in a high location, which is used to increase the range of mobile and handheld FM transmitter/receivers

repeater directory - a repeater list for a particular area (RAC publishes one for Canada and neighbouring states)

reverse – sometimes used as “listen on reverse” meaning to monitor the repeater input frequency to see if you can hear the other person directly.

reverse patch - when a call is received on its incoming telephone line this special autopatch rings over the air and may be answered by tone access

Rig – slang for the radio equipment or transceiver

Rock bound – using a rig that uses fixed crystal frequencies and cannot be tuned

rubber duck(y) - slang term for the flexible rubber-covered antenna supplied with handheld radios

separation (split) - the difference, in kHz, between the repeater's transmit and receive frequencies.

Shack – room where the ham station is set up

Silent key – a ham who has passed on to “the big ham shack in the sky”

simplex - a mode of communication in which you take turns to transmit and receive on the same frequency. A frequency set aside for non-repeater use (such as 146.52 MHz)

Sky hook – slang for the antenna

squelch - a circuit within a radio that keeps the speaker silenced (squelched) until the signal level exceeds a certain point, set by the squelch control. Normally you set the squelch to just block out noise and allow signals to pass.

sub-audible tone - see CTCSS

tail (squelch tail) - the brief signal often consisting of receiver noise transmitted by a repeater transmitter after someone stops talking (un-keys their transmitter).

Tail-gating – transmitting quickly, immediately after someone else’s transmission

Ticket – Amateur Radio License

time-out - to cause the repeater, or a repeater function, to turn off because you have transmitted too long

timer - a device which measures the length of each transmission and causes the repeater, or a repeater function, to turn off, after a transmission has exceeded the preset time.

tone pad - an array of 12 or 16 numbered keys that generate the standard telephone dual-tone multi-frequency (DTMF) dialing signals

touch tone - trade mark of AT&T. See DTMF

triggering - to activate a repeater by transmitting on its input frequency (see also key up)

trunk lip mount – a type of mobile antenna mount which attaches to the edge of the automobile trunk

vhf (very high frequency) - the region of the radio spectrum between 30 and 300 megahertz (MHz)

vertical polarization - the antenna elements are vertical (used at vhf/uhf for FM and repeater operation)

uhf (ultra high frequency) - the region of the radio spectrum between 300 and 3000 MHz or 3 GHz

VSWR (voltage standing wave ratio) – a measurement of how close an antenna is to the optimum 50 ohm impedance at the frequency of operation. A VSWR of 1.5:1 is good, 1.2:1 is better.

Wallpaper – ham radio awards and certificates for working many stations or countries etc.

work – to communicate with, as in “I worked VE3GCB on 40M last night”

XYL – ex young lady (married woman)

YL – Young Lady, term used for a single woman (although can be used as a complement for a married woman also)

73 – “best regards”, or “best wishes”

88 – “hugs and kisses”, or “love and kisses”

807 – beer, as in “I’m going to the fridge for a nice cold 807”

Another article you may find interesting is “My Search for the Ultimate VHF/UHF Station” found at:
http://www3.sympatico.ca/alduncan/ham/Ultimate_VHF_UHF_station.pdf