

# Repeater 101

- What are they
- How they work
- Repeater lingo
- How to use them
- Where they are,
- and what you can access



# What are repeaters?

An **amateur radio repeater** is an electronic device that receives a weak or low-level amateur radio signal and retransmits it at a higher level or higher power, so that the signal can cover longer distances without degradation.

# What are repeaters?

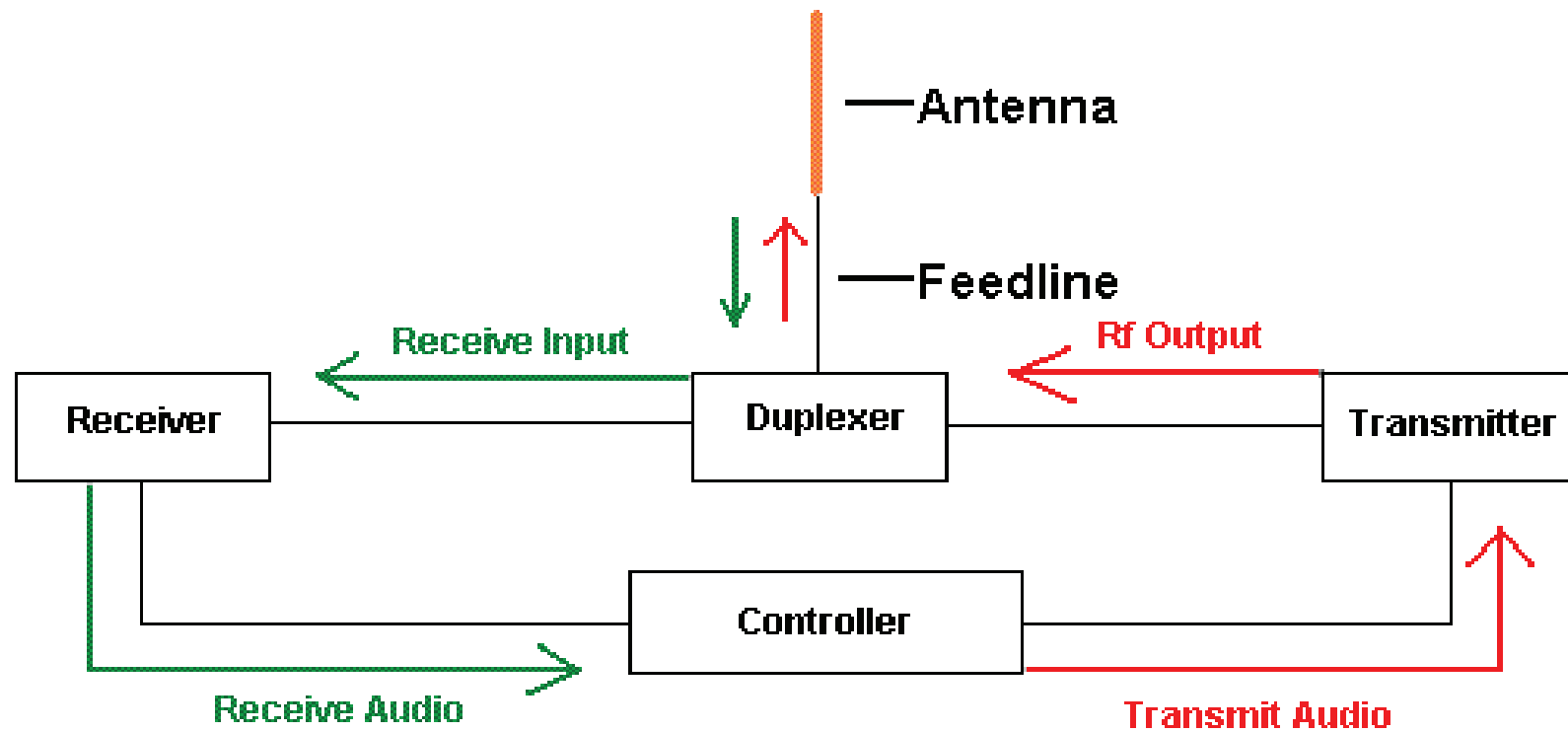
Many repeaters are located on hilltops or on tall buildings as the higher location increases their coverage area, sometimes referred to as the radio horizon, or "footprint". Amateur radio repeaters are similar in concept to those used by public safety entities (police, fire department, etc.), businesses, government, military, and more. Amateur radio repeaters may even use commercially packaged repeater systems that have been adjusted to operate within amateur radio frequency bands, but more often amateur repeaters are assembled from receivers, transmitters, controllers, power supplies, antennas, and other components, from various sources.

# How they work

It's a two-way radio system that receives on one frequency, then re-transmits what it receives on another frequency; at exactly the same time. It's nothing more than a "dumb electronic machine" with some smart people behind it.

# How they work

Here's a simple block diagram of a repeater below:



BASIC REPEATER BLOCK DIAGRAM

N4UJW

# The Basic Repeater Components:

## Receiver

**Receives the incoming signal. This receiver is generally a very sensitive and selective one which helps weaker stations to be heard better by the repeater. It is set to receive the input frequency. It's also where CTCSS (Continuous Tone Coded Squelch System) or "PL" decoding takes place.**

## Transmitter

**Most "machines", as repeaters are sometimes called, have a transmitter composed of an exciter and a power amplifier. The exciter modulates the audio coming from the receiver which is tuned to the transmitting stations's frequency at the proper transmit frequency, and the power amplifier simply boosts its level so the signal will travel further. Some repeaters use 100 watts or more. It simply takes the weaker received frequency from say a mobile or ht and re-transmits it (repeats) at a higher power level on a different frequency. .**

# The Basic Repeater Components:

## Antenna

Most repeaters use only one antenna. The antenna is used on transmit and receive signals that are going into and out of the repeater. It usually is a high performance, high gain, heavy duty, and very efficient antenna located as high on a tower or structure as we can get it above the surrounding terrain.

Lots of repeater system antennas are located on a high hill or mountain. Antenna systems for repeater use are usually very costly and have an omni-directional pattern.

## Feed line

The feed line used on most repeaters is not just a piece of standard 50 ohm coax cable. A type of specialized feed line called "hard line" is usually used. It is very similar to cable tv line that you see strung between power poles around town. Look just above the telephone lines and you will see much larger "aluminum" cable. The signal loss with hard line versus regular coax is much lower than in standard coax, so more power gets to the antenna and weaker signals can be received due to the very low loss of the "hard line".

# The Basic Repeater Components:

## Duplexer

**This device serves a major role in a repeater. The duplexer separates and isolates the incoming signal from the outgoing and vice versa. It prevents the receiver and transmitter from hearing one another by the isolation it provides. A duplexer has the shape of large tall cans and is designed to pass a very narrow range of frequencies and to reject others. It helps to reject very strong nearby frequencies from other repeaters or rf producers from getting into the repeater system.**

## Controller

**This is the brain of the repeater. It handles repeater station ID using either CW or voice, activates the transmitter at the appropriate times, and sometimes performs many other functions depending on the sophistication of the repeater. Some also have a DVR (Digital Voice Recorder) for announcements and messages. The controller is a small computer that's programmed to control a repeater.**



# Repeater terms

Offset

Positive or Negative noted as + or -

PL's CTCSS

Squelch, Squelch-tail, Squelch delay

Repeater Time-out

## **What is Offset? So exactly what is a repeater offset you may ask?**

**In order to listen and transmit at the same time, repeaters use two different frequencies. One for it's transmit frequency and another for it's receive frequency. On the 2 meter ham band these frequencies are 600 kHz (or 600 kilohertz) apart. On other bands, the offsets are different. As a general rule, if the output frequency (transmit) of the repeater is below 147 MHz, then the input frequency (listening) is 600 kilohertz lower. This is referred to as a negative offset. If the output is 147 MHz or above, then the input is 600 kilohertz above. This is referred to as a positive offset. Virtually all ham radios sold today set the offset once you have chosen the operating frequency automatically. Example: If the repeater output is 146.790 MHz. The input, or the frequency the repeater receiver listens on is 146.190 MHz ( 600 kilohertz below 146.790MHz).**

**If you have your radio tuned to 146.790 MHz, (the repeater's output frequency), when you push the mic button, your radio automatically transmits on 146.190 MHz, 600kHz down from 146.790. When you release the mic button to listen, your radio switches back to 146.790 MHz to listen on the repeater's output frequency. Note: There are exceptions to the rule so check your local repeater listings.**

# **Standard Repeater Input/Output Offsets**

## **Band Offset**

**6 meters 500 kHz**

**2 meters 600 kHz**

**1.25 meters 1.6 MHz**

**70 cm 5 MHz**

**33 cm 12 MHz**

**23 cm 20 MHz**

**(Note that input/output offsets are voluntary among local and regional "Frequency Coordination Groups".**

**They are not fixed in stone by the FCC! They are "recommended" offsets for a particular area.**

**Your area may be different.**

# Positive or Negative noted as + or -

Most bands use a negative offset in  
Southern California

The exception is 2 Meters

Repeaters from 144.505 to 145.895 and  
146.610 to 147.735 are -

Repeaters from 147.750 to 147.990 are +

There are a few exceptions and non conforming pairs.

Note: In northern CA 440 Meter band is +

# What's all those tones about?

## What is a PL or CTCSS Tone?

PL, an acronym for Private Line, is Motorola's proprietary name for a communications industry signaling scheme called the Continuous Tone Coded Squelch System, or CTCSS. It is used to prevent a repeater from responding to unwanted signals or interference. **Tone Squelch is an electronic means of allowing a repeater to respond only to stations that encode or send the proper tone.** In other words, if a repeater is set up to operate only when a PL tone of say, 123.0 Hz is heard by its receiver, then it will allow the transmitting station access. If your station, (your mobile, base or hand held) does not transmit the tone that the repeater receiver has been programmed for, when you key up, then the receiver of the repeater does not hear you and will not be usable by your station until you set the proper tone in your radio to be transmitted when you key your mic. Any modern station may be set up to transmit this unique **low frequency** tone that allows the repeater to operate. If a repeater is "In PL mode" that means it requires a CTCSS tone (PL tone) to activate the repeater. Due to severe congestion of ham repeaters in some areas, most repeaters are "PL'ed".

## **TABLE OF COMMON PL TONES (in Hz)**

<b>67.0</b>	<b>94.8</b>	<b>131.8</b>	<b>171.3</b>	<b>203.5</b>
<b>69.3</b>	<b>97.4</b>	<b>136.5</b>	<b>173.8</b>	<b>206.5</b>
<b>71.9</b>	<b>100.0</b>	<b>141.3</b>	<b>177.3</b>	<b>210.7</b>
<b>74.4</b>	<b>103.5</b>	<b>146.2</b>	<b>179.9</b>	<b>218.1</b>
<b>77.0</b>	<b>107.2</b>	<b>151.4</b>	<b>183.5</b>	<b>225.7</b>
<b>79.7</b>	<b>110.9</b>	<b>156.7</b>	<b>186.2</b>	<b>229.1</b>
<b>82.5</b>	<b>114.8</b>	<b>159.8</b>	<b>189.9</b>	<b>233.6</b>
<b>85.4</b>	<b>118.8</b>	<b>162.2</b>	<b>192.8</b>	<b>241.8</b>
<b>88.5</b>	<b>123.0</b>	<b>165.5</b>	<b>196.6</b>	<b>250.3</b>
<b>91.5</b>	<b>127.3</b>	<b>167.9</b>	<b>199.5</b>	<b>254.1</b>

**A few use a digital code system called *DCS*, *DCG* or *DPL* (a Motorola trademark).**

**Our repeaters use these tones.**

**146.790 – 123.0 , 445.300 – 100.0 Mad Mountain**

**146.970 - 100.0 Castic Lake Water District headquarters**

# Squelch, Squelch-tail, Squelch delay

In telecommunication, **squelch** is a circuit function that acts to suppress the audio output of a receiver in the absence of a sufficiently strong desired input signal. Squelch is widely used in two way radios and radio scanners to suppress the sound of channel noise when the radio is not receiving a transmission. Squelch can be 'opened', which allows all signals entering the receiver's discriminator tap to be heard. This can be useful when trying to hear distant, or otherwise weak signals.

**Squelch-tail** is the time delay from when a repeater stops receiving to when it stops transmitting.

**Squelch-delay** is the time delay for the squelch circuit to start or stop working.

# Repeater time out or “you talked to long”!

A timer in the repeater controller is set to limit the continuous use time of a repeater. This limits the transmit time of the repeater.

1. So it won't over heat.
2. Limits individual transmissions.
3. Turns the repeater off in case of a stuck mike or system failure.

This is why when you here me do the Monday night net, I set the system timers off. When we transmit Newslines a segment lasts up to 10 minutes. After the net, the timer is restored. Normally our repeaters are set for 3 minutes.



# How to use a repeater

**Let's "key up" a repeater and see what sequence of events are created within the repeater equipment when someone makes a transmission:**

**You set your transceiver controls for the 146.79 "machine" and listen to see if it is in use...nothing heard. You key your mic and throw out your callsign...."This is N6ZXJ listening on the 146.79 machine". Then you release the mic button.**

**Assuming your station is within range of the repeater....The repeater antenna which is usually high on a mountain top, picked up your signal with its antenna on 146.19 (your transmit frequency set to the standard offset for this part of the 2 meter band of -600kHz, and the repeater's receive frequency) and sent it down the feed line to the duplexer.**

**From there it was sent to the repeater receiver and converted to an audio signal (just like the sounds coming from your speaker)....sent to the controller (the brains of the repeater), then sent to the repeater transmitter and turned back into a much greater amplified radio signal on 146.79mhz (the output of the repeater)....sent to the duplexer...then thru the feedline to the antenna and out over the air. So your little pip squeak ht running only 1 watt may be increased to 20, 30, 50 or 100 watts, our 2meter repeater runs 25 watts output using the repeater transmitter and its much higher gain antenna and high location!**

**A mobile, ht or base station that happened to be within range and monitoring the '79' machine heard your transmission on 146.79mhz (the repeater output frequency).**

**Since radio waves travel at about the speed of light....at the split second that you first keyed your mic, the above events took place and the repeater was receiving your signal on one frequency and re-transmitting your signal on a different frequency at the same time!**

**The mobile station that was listening on the output frequency of the repeater heard your callsign....keyed his mic and came back to you starting the process all over again!**

# How do you make a call on an Amateur Repeater?

First, LISTEN AND LISTEN SOME MORE..... to make sure that the repeater is not already in use. When you are satisfied that the repeater is not in use, **set your transmitter power to the minimum and increase only as needed to make contact with the repeater**, begin with the callsign of the station you are trying to contact followed by your callsign. e.g. "KK6MLY, N6ZXJ. (The N6ZXJ is your callsign). If you don't establish contact with the station you are looking for, wait a minute or two and repeat your call. If you are just announcing your presence on the repeater it is helpful to others that may be listening if you identify the repeater you are using AND your callsign. e.g. " This is N6ZXJ listening on the 79 machine or you could also say This is N6ZXJ listening on 146.79 Santa Clarita or the location of the repeater if known. This allows people that are listening on radios that scan several repeaters to identify which repeater you are using. If the repeater you are using is a busy repeater you may consider moving to a simplex frequency (transmit and receive on the same frequency.... see more below), once you have made contact with the station you were calling. Repeaters are designed to enhance communications between stations that normally wouldn't be able to communicate because of terrain or power limitations. If you can maintain your conversation without using the repeater, going "simplex" (both stations on same frequency in a different part of the band) will leave the repeater free for other stations to use that can't establish simplex communications!

# Bands and Band Plans

Arrl band plans <http://www.arrl.org/band-plan>

Southern California Repeaters, Who's in charge  
6 Meter, 440Mhz, 900Mhz, 1.2Ghz &  
Amateur Television

SCRRBA <http://www.scurrba.org/>

2 Meter TASMA <http://www.tasma.org/>

220 Mhz. 220SMA <http://220sma.org/>

## **220SMA BAND PLAN**

CHANNEL SPACING IS 20 kHz UNLESS INDICATED OTHERWISE.

### **FREQ. USAGE**

- 219.000 – 220.000 POINT TO POINT DIGITAL LINKS (100 kHz CHANNELS)
- 222.000 – 222.110 WEAK SIGNAL , CW, & SSB (NO CHANNEL PLAN)
- 222.000 – 222.025 EME
- 222.050 – 222.060 PROPAGATION BEACONS
- 222.100 NATIONAL SSB CALLING FREQUENCY
- 222.120 – 222.140 FM VOICE SIMPLEX (NO AUTOMATED BASE STATIONS)
- 222.160 – 223.380 REPEATER INPUTS
- 223.400 – 223.520 FM VOICE SIMPLEX
- 223.500 NATIONAL FM CALLING FREQUENCY
- 223.540 – 223.600 DIGITAL CHANNELS
- 223.540 INTER - AREA LINKING / SIMPLEX DX CLUSTER LINKING
- 223.560 SIMPLEX LAN / GENERAL USE / BBS USER PORT
- 223.580 INTER - AREA LINKING / SIMPLEX METRONET
- 223.600 GENERAL USE / KEYBOARD TO KEYBOARD
- 223.620, 223.635, 223.650, 223.665 LOW-LEVEL, LOW-POWER (<5W)  
AUTOMATED SIMPLEX STATIONS (IRLP, ELINK, AUTOPATCH)
- 223.680, 223.695, 223.710, 223.725, 223.74  
COORDINATED AUX LINKS / CONTROL CHANNELS
- 223.760 – 224.980 REPEATER OUTPUTS

# Different kinds of Repeaters

Analog FM

Digital,

DRM, Fusion, D-Star and others

Digi-peaters

ATV Amateur Television Repeaters

Cross-band repeaters

Satellite repeaters

Simplex repeaters,

Store-and-forward systems

Repeater networks, Linked systems

# Repeater networks, Linked systems

## The Condor Connection

<http://www.condor-connection.org/index/md.html>

Site	Location	Frequency	Callsign	PL
MT. ROSE	RENO, NV	224.30	W7DED	156.7
THE GEYSERS	Calistoga, CA	223.80	AC6VJ	156.7
MT. VACA	Vacaville, CA	223.84	AC6VJ	156.7
MT. HAMILTON	San Jose, CA	224.60	KB6ABM	156.7
GOAT MOUNTAIN	San Joaquin Valley, CA	224.90	WB6BRU	156.7
SHIRLEY PEAK	Lake Isabella CA	224.64	WB6RHQ	156.7
FRAZIER MOUNTAIN	Gorman, CA	224.72	N6XKI	156.7
QUARTZITE MOUNTAIN	Victorville, CA	223.84	K7GIL	156.7
RASNOW PEAK	Thousand Oaks, CA	223.94	WB6RHQ	156.7
SANTIAGO PEAK	Orange County, CA	224.82	K8BUW	156.7
TORO PEAK	Palm Desert, CA	224.18	WB6RHQ	156.7
LYONS PEAK	San Diego, CA	223.94	W2IRI	141.3
GUADALUPE PEAK	Quartzsite, AZ	224.88	KF6BM	156.7
WHITE TANKS	Phoenix, AZ	224.60	KD7TKT	156.7

# Repeater networks, Linked systems

PAPA System <http://www.papasys.com/>

**DMR** KI6KQU - Mt Lukens "Los Angeles" 449.380  
N6JVH - Oat Mtn "San Fernando Valley" 447.26  
KI6KQU - Mt Woodson "San Diego" 445.960  
K6IFR - Edom Hill "Desert Hot Springs" 446.5800  
KI6MGN - Palomar Mtn. "San Diego" 445.8600  
WA6LIF - Santiago Peak "Santa Ana" 446.8200  
N6WZK - Sunset Ridge "Claremont - LA County" 449.3600  
N6WZK - Saddle Peak Malibu "Santa Monica" 446.0800  
KK6GFX - Santa Ynez Pk "Santa Barbara" 446.9800  
AA4CD - San Marcos Pk "San Marcos" 445.88-  
AA4CD - Otay Mnt. "Otay" 447.2600

## Analog

**S. 144.460** Simplex

1. **446.580** Oat Mtn 127.3
2. **224.400** Oat Mtn 156.7\*
3. **446.760** Santiago Pk 100.0\*
4. **445.420** Saddle Pk 127.3
6. **446.760** Santa Ynez 156.7\*
8. **445.140** Mt Wilson 127.3
9. **446.580** San Marcos 156.7\*
10. **448.540** Palomar 91.5\*
11. **449.380** Otay 100.0
12. **224.400** Otay 100.0
14. **446.980** Blue Ridge 156.7
18. **445.860** Edom Hill 100.0

## D-Star

**S1 145.615** Simplex

- D3 446.560 Santiago Pk.  
D4 445.855 Saddle Pk.  
.. 1286.800  
.. 1298.900 DD  
D6 447.840 Santa Ynez Pk.  
D9 447.190 San Marcos  
D10 147.570 Mt. Palomar  
.... 1287.050  
.... 1299.500 DD  
D11 446.980 Otay Mtn.  
.... 1286.825  
.... 1298.700 DD  
D14 447.835 Blue Ridge  
D15 447.845 Mt. Woodson  
D16 447.140 Edom Hill



**Enjoy our Repeaters**

**Have Fun**

**Be Curteous**

**Todd Hitzeroth N6ZXJ**

**Wikipedia, Amateur radio repeater**

**[https://en.wikipedia.org/wiki/Amateur\\_radio\\_repeater](https://en.wikipedia.org/wiki/Amateur_radio_repeater)**

**A New Ham's Guide, How to Use Amateur  
(Ham Radio) Repeaters by N4UJW**

**<http://www.hamuniverse.com/repeater.html/>**