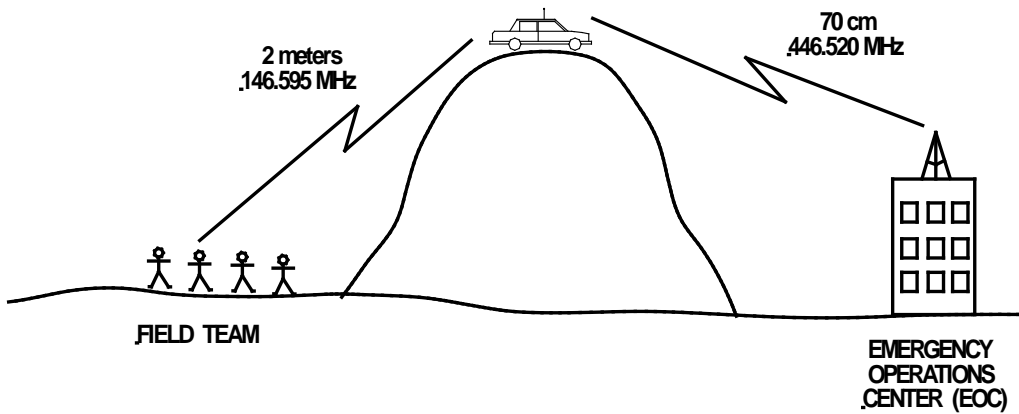


# Cross Band Repeating

By

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# Cross Band Repeating

Cross band repeating is a relatively inexpensive means for extending the range of handheld radios.

The purpose of a cross band repeater is the same as any radio repeater. It allows stations to communicate that ordinarily would not be able to do so because of the distance or terrain between them. In Figure 1, for example, people with handheld radios on the left side of the hill are able to talk to net control at the Emergency Operations Center (EOC) by communicating through the cross band repeater located in the vehicle parked on the hill top. If the cross band repeater were not present, the folks with the handhelds could not talk to net control because the hill would block their signals.

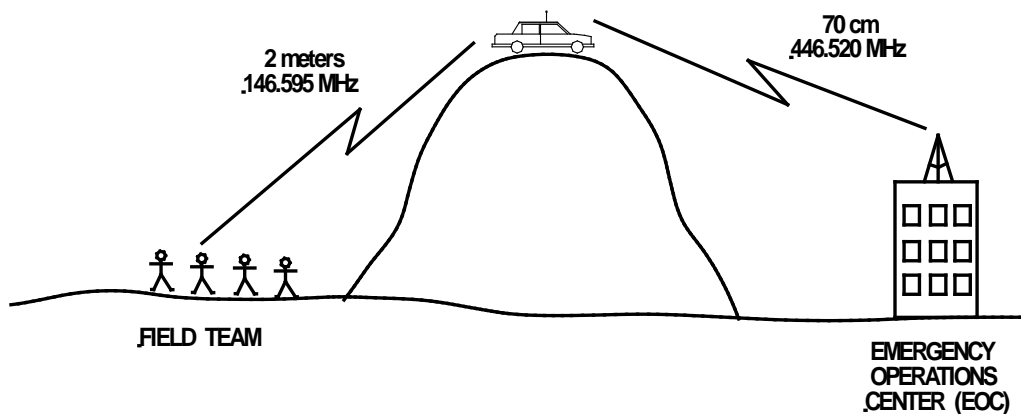


Figure 1 Cross Band Repeater Concept

A cross band repeater is similar in function to a standard repeater in that it contains a receiver and a transmitter that are linked together, but which operate on different frequencies. Voice signals that the repeater receives on its input frequency are automatically retransmitted on its output frequency. A repeater is a relay station.

A cross band repeater is implemented using a dual band 2 meter - 70 cm radio. The repeater receives signals on one amateur radio band (for example 70 cm) and retransmits those signals on a second amateur band (2 meters). Thus the name cross band repeater.



Figure 2 A Typical Cross Band Repeater Installation

A cross band repeater is far less expensive than a conventional repeater. A conventional repeater can cost several thousand dollars. It is expensive because it operates on a single frequency band, 2 meters for example. As a result, its transmit and receive frequencies are only separated by a few hundred KHz. (600 KHz. on 2 meters). This close frequency spacing requires the receive section of the repeater to have extremely narrow filters that are quite expensive. The narrow filters are needed so that the repeater can continue to receive on its input frequency (for example 147.285 MHz) while transmitting on its output frequency (147.885 MHz). If it were not for these expensive filters, the repeater's receive section would be immediately overloaded by its own transmitter, as soon as it began to transmit. Once overloading occurs, the repeater can no longer receive input signals and thus ceases to operate as a relay station.

The cost of a repeater drops significantly if its input and output frequencies are separated by several hundred MHz instead of a few hundred KHz.. With a wide spacing between the input and output frequencies, expensive input filters are no longer required. The frequency spacing between the 2 meter (147 MHz) amateur radio band and the 70 cm (447 MHz) band is 300 MHz. With this wide spacing, the standard low cost input filters on a 70 cm radio will prevent the receive section of the radio from being overloaded by a close 2 meter transmitter and visa versa. Manufacturers of dual band 2 meter - 70 cm mobile transceivers quickly picked up on this fact and added cross band repeating functions to their radios. When in the cross band repeating mode, a signal received on 70 cm is retransmitted on 2 meters, and visa versa. Generally, however, a transceiver can only transmit on one frequency at a time. Thus if signals are received on both 2 meters and 70 cm, the signal heard first is the only one retransmitted.

As mentioned above, a cross band repeater is an effective way to expand the range of a handheld radio. The following example illustrates this point. Our ARES (Amateur Radio Emergency Services) team in Thousand Oaks, California provided radio communications support during a recent CROP Walk sponsored by Thousand Oaks area churches. The base station for the radio net was located at Nygreen Hall on the California Lutheran University (CLU) campus, the start and finish point for the walk. Two rest stops with water for the walkers were set up along the course. ARES radio operators were placed at each rest stop to provide communications from the rest stop back to Nygreen Hall. In addition, two mobile radio units drove along the course looking for people who needed help and also providing the rest stops with additional supplies (water and cups) as needed. Two meter simplex radio communications was used to avoid tying up the local Thousand Oaks repeaters. A handheld radio was used at Rest Stop 1 on the corner of Moorpark and Janss roads since there was not room on this street corner to set up a portable radio station and antenna. The hills between Rest Stop 1 and Nygreen Hall, combined with the handheld's low power and inefficient antenna, made radio communications between the two locations impossible. To overcome this problem, the car shown in Figure 2, with a dual band radio configured for cross band repeating, was parked across the street from Rest Stop 1 in the McDonalds parking lot. By using the cross band repeater, Rest Stop 1 could easily communicate with Nygreen Hall, Rest Stop 2, and the two radio equipped mobile units. The handheld at Rest Stop 1 communicated with the car on 70 cm and from the car to the 2 meter simplex net via cross band repeating.

In the more general case, shown in Figure 1, the vehicle containing the cross band repeater is parked on a hill to provide communications between net control and handheld units that can not reach net control because of distance, terrain, or both. One important observation is that people with handhelds can not only talk with net control via the cross band repeater, they can also communicate with each other. This capability is particularly usefully for Boy Scout troops, hikers, and search and rescue missions. People with dual band 2 meter - 70 cm handheld radios, capable of receiving on both bands simultaneously, can hear everyone on the net. Anyone anywhere on the net transmitting on 2 meters will be picked up by the cross band repeater and retransmitted on 70 cm. A person with a dual band handheld will receive the transmission on either 2 meters, or 70 cm, or both. Likewise, someone anywhere on the net transmitting on 70 cm will be picked up by the cross band repeater and retransmitted on 2 meters. A person with a dual band handheld will receive the transmission on ether 70 cm, or 2 meters, or both. People with single band 2 meter or 70 cm radios will not have quite as good coverage. Those with single band 70 cm radios can hear everyone who is transmitting on 2 meters since everything that the cross band repeater hears on 2 meters will be retransmitted on 70 cm. However, if a handheld person transmits on 70 cm, the cross band repeater will retransmit on 2 meters. Others with only 70 cm capability of course can not hear the 2 meter transmission. They will hear the 70 cm transmission only if they are in line of site with the person transmitting on 70 cm. A similar situation occurs if single band 2 meter handheld radios are used. In this case, the 2 meter handheld people can hear, via the cross band repeater, everything that is transmitted on 70 cm and those 2 meter transmissions which are in their line of sight.

Obviously, the best situation is to use dual band handheld radios since people with these radios can hear everything that is transmitted on the net.

Cross band repeating works best in simplex networks. Cross band repeating can be used on a standard repeater network, as shown in Figure 3, however, if this is done, more discipline is required by those operating on the net. The problem is that the cross band repeater will not switch into the 70 cm receive mode until after the carrier of the main 2 meter repeater has dropped. This makes the turn around times on the net (the time between the last person speaking and the next person beginning) abnormally long. If people on the main 2 meter net begin talking before the repeater carrier has dropped, the people with 70 cm handheld radios will rarely get a chance to speak. To provide for fairness on the net, anyone wishing to speak must wait until the repeater carrier has dropped before beginning to talk.

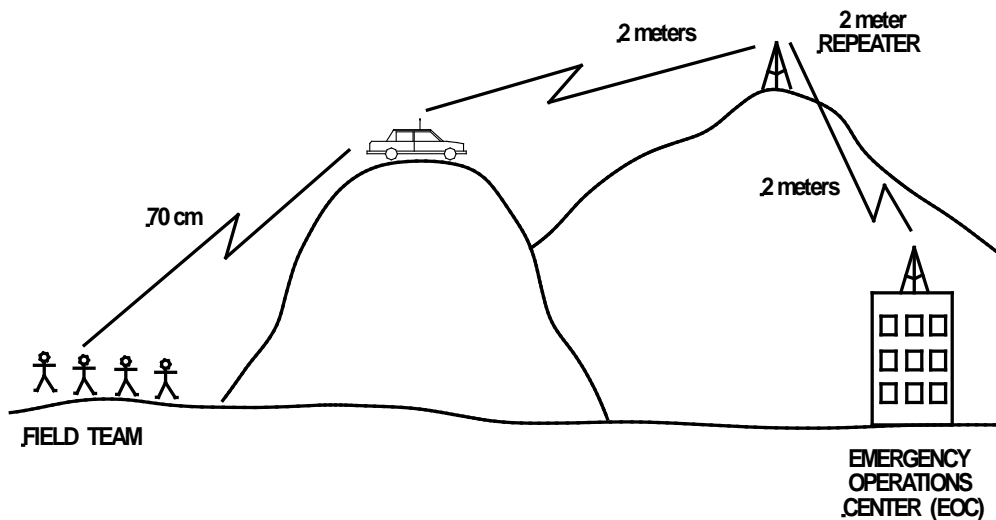


Figure 3 Cross Banding to a Standard Repeater

There is a mode of cross band repeating that can allow people with dual band handhelds to avoid the long turn around delay. This mode is called (by Kenwood) locked-band repeating. This mode can be used when those with handhelds can hear the primary repeater (on 2 meters for example), but the low power and inefficient antennas of their handhelds prevent them from reaching the primary repeater directly. I experienced this situation at the Moorpark rest stop during one of the Cruisin Conejo Bike rides. The Bozo 2 meter repeater was used for communications supporting the bike ride. I could hear the Bozo repeater on my handheld, but the transmit power of my handheld was not adequate to reach Bozo. In the locked-band mode, the cross band repeater receives only on 70 cm and transmits only on 2 meters (or visa versa). Thus anything that a handheld transmits on 70 cm is immediately retransmitted by the locked-band repeater on 2 meters. The result is that the handheld sounds to everyone as if it were actually operating on 2 meters. There is no unusual turn around delay with locked-band repeating. However, nothing is free. The problem with this mode occurs

at the handheld. As the person with the handheld speaks, he hears his voice, slightly delayed, being transmitted by the 2 meter repeater. This is very annoying. I solved this problem by using a hand mic/speaker unit plugged into my handheld. Whenever I push the mic push to talk key, the speaker is cut off so that I do not hear my voice repeated by the 2 meter repeater. This arrangement works very well.

Two final note. As with standard repeaters, cross band repeaters should be set up with a receive CTCSS tone on the frequency used by the handhelds. This should be done so that other stations on nearby frequencies do not inadvertently trigger the cross band repeater. This is important when the cross band repeater is working into a larger standard repeater net, particularly if it is a controlled net. Most dual band radios with cross band repeater capability support the standard CTCSS tones on the receive side of the radio as well as on transmit.

Second, the control operator for the cross band repeater must transmit an ID call sign on the repeater every 10 minutes to comply with FCC regulations. For example, "Cross Band Repeating, KJ6RZ".