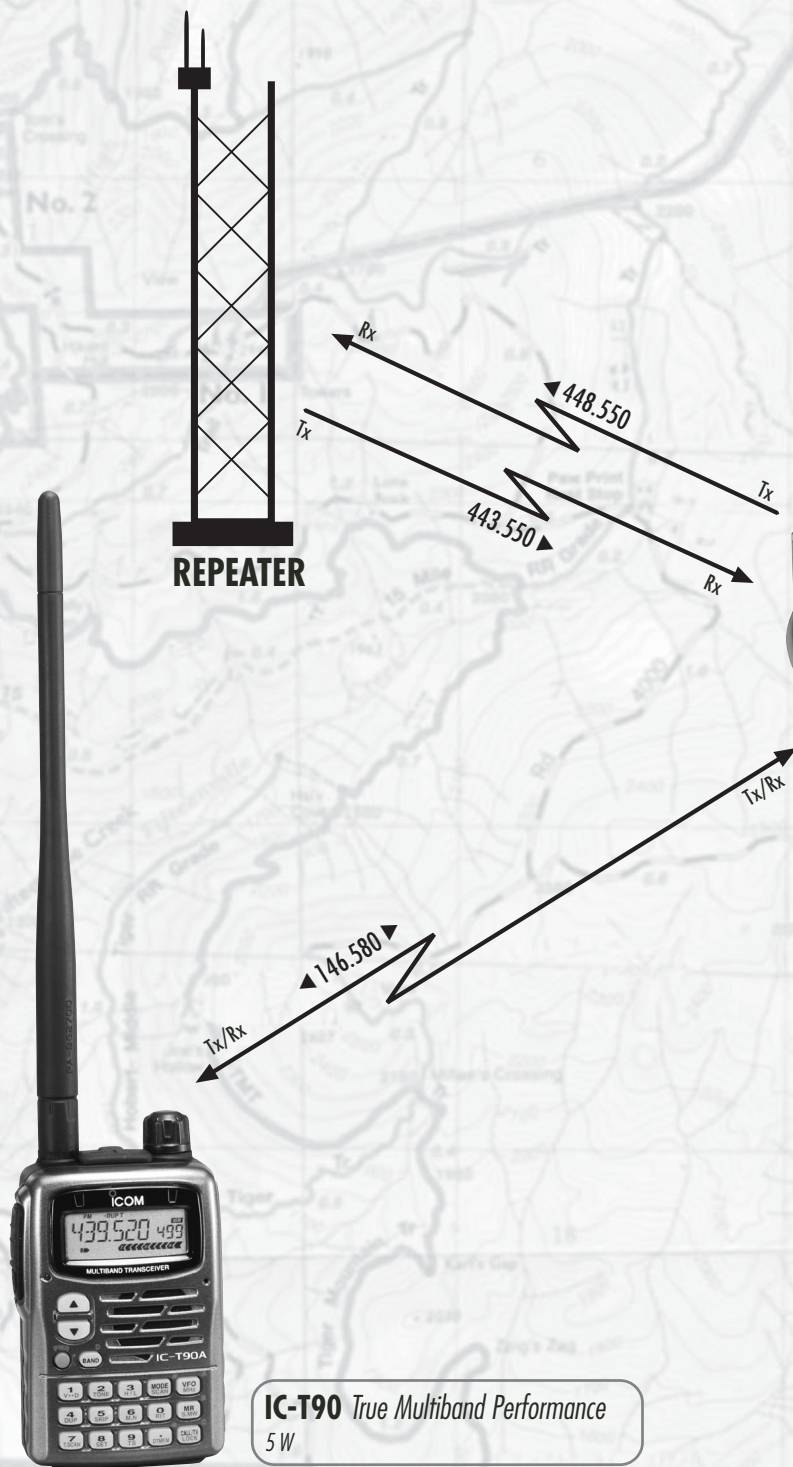


# Information On Icom Crossband Repeating Products

If you have ever wanted to know more about crossband repeating, turn to Icom! Inside you'll find a QST article on this subject, as well as more information on Icom's crossband repeating radios!



- Use virtually any Icom handheld to contact your Icom dual band mobile back in your vehicle. Then your mobile can relay your transmission to a repeater in the vicinity for even greater range!
- Receiving a signal back is just as simple: the repeater sends it to your mobile, which relays it to your handheld!

A list of older Icom crossband repeating products is listed on the back page. For more information, contact the Icom dealer nearest you and visit our website: [www.icomamerica.com](http://www.icomamerica.com)

  
**ICOM**<sup>®</sup>

# Crossband-Repeater Operation

New dual-band VHF/UHF rigs offer flexible operating capabilities, as pointed out in the September 1992 FM/RPT column. Here's how to take advantage of this feature and avoid potential problems.

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Lansdale, PA 19446

Would you like to be able to check into that distant 2-meter repeater swap net while taking a walk in your neighborhood? How about monitoring 52.525-MHz FM simplex activity with your 440-MHz hand-held transceiver while tinkering with your car? Do you need quick repeat/relay capability for public service or emergency communications?

If you have a 440-MHz hand-held transceiver and one of the dual-band FM transceivers that offers crossband-repeater (CBR) operation, all of the above is possible with, in most cases, only a minor modification to the dual-band transceiver to activate the CBR mode. In some cases no modifications are necessary. See your rig's operating manual or contact the manufacturer for details on modifications and activation procedures.

## What is Crossband-Repeater Operation?

Unlike normal repeater operation which takes place using two frequencies on one band (Fig 1A), a CBR uses one frequency on each of two bands (Fig 1B).

When CBR operation is activated, the transceiver's receiver switches between the two bands. When a signal is received on one band, such as 2 meters, it connects the audio output of the 2-meter receiver to the audio input of the 440-MHz transmitter and keys the 440-MHz transmitter. (On some equipment, such as the Yaesu FT-470 hand-held transceiver, there's no direct audio connection for CBR—the audio is acoustically coupled.) When the input signal disappears, the transmitter is unkeyed and the transceiver goes back to alternating receive on the two bands until a signal is again received and the transmit cycle is repeated (no pun intended).

## Crossband-Repeater Operating Modes

Depending on the radio, there are three types of CBR operation:

### Simplex-to-Simplex CBR

In simplex-to-simplex CBR operation (Fig 2), the transceiver is set for simplex frequency operation on both bands. This is a good way to keep track of activity on a local frequency when you're away from the base rig.

### Simplex-to-Repeat CBR

In simplex-to-repeat CBR operation (Fig 3) the transceiver is set for simplex

operation on one band and repeater frequency offset operation on the other. On some transceivers, such as the Kenwood TW-4100A, simplex-to-repeat CBR is only possible with standard frequency offset repeaters—though this shouldn't be a problem for most users. In this mode, you're dependent on the characteristics of the repeater you'll be operating with.

### One-Way CBR

An additional mode, one-way CBR, is shown in Fig 4. This mode, available on some late-model dual-band rigs, such as the Kenwood TM-741, provides a way to remotely monitor activity. Because this could be considered one-way transmitting, I recommend that the transmit side (band) of the rig be connected to a dummy load during

operation. This greatly limits the effective range of the transmitter, while still providing receive coverage close to the dual-band rig and dummy load.

### Using It

Read the sidebar "The Law Says..." before you begin operation.

### Base/Mobile CBR with Hand-Held Transceivers

Repeaters you can hit with a more powerful base or mobile rig may not be accessible from a hand-held radio. With CBR, you can extend the range of your portable rig. If you have specific areas or directions of operation in mind, choose antennas that favor those directions. For example, if there's a distant 2-meter repeater due west that you'd like to be able to reach via CBR and your primary hand-held transceiver operation is located due north of your CBR's location, you'd equip the CBR with a 440-MHz beam pointed north at your portable location and a 2-meter beam pointed west at the distant repeater to provide optimum operation with minimum operating power. If your operation is limited to your immediate vicinity, consider feeding the local—usually 440-MHz—transmit side of your dual-bander into a dummy load to limit the transmit range and limit the ability of undesired signals to access your system.

### Hand-Held CBR with a Hand-Held Transceiver

You may be able to put a hand-held radio at a temporary location to provide CBR coverage where it wouldn't be practical to operate a higher-powered base or mobile transceiver.

The coverage advantage provided by a hand-held at a choice location may be superior to that provided by the location obtainable by a higher-powered mobile. As with any hand-held operation, battery consumption is an important consideration. If a particularly good location is available, CBR operation with a low power setting may be sufficient.

### Application Examples

#### Operation from Inside a Partially Shielded Building

Fig 5 shows an example that, unfortunately, most of us are familiar with. Computers have brought an increasing level of RFI that's

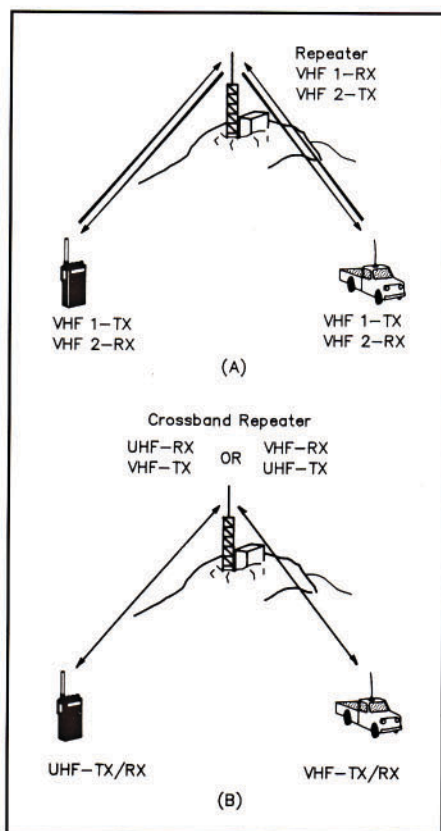
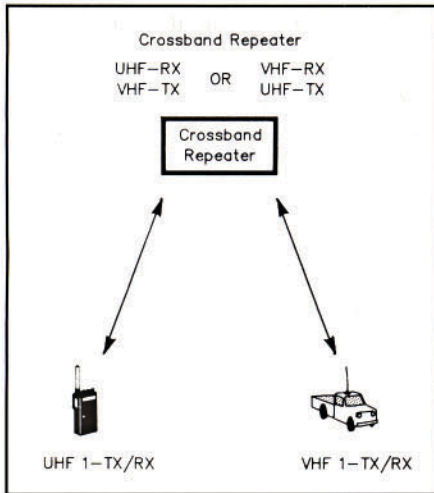


Fig 1—Normal Repeater Operation (A)  
Crossband repeater operation (B)



**Fig 2—Simplex-to-Simplex Operation**  
In this mode, each band has the same frequency for input and output.

made operation near them difficult—especially inside a building that may already be partially shielded—providing difficult repeater operation. With a mobile rig operating as a CBR just outside in the parking lot, hand-held access to your favorite 2-meter repeater from inside the building is easy.

#### Access Assist

With the high sensitivity of modern hand-held transceivers and the increasingly tough RF environment provided at repeater sites, balanced repeater operation is often impractical, even with mobile equipment. It's often possible to hear a repeater easily but not be able to access it with a hand-held transceiver. Fig 6 shows how CBR operation with a dual-band hand-held can provide access-assist capability. Operating this way eliminates several problems associated with normal repeater-carrier tails. For example, CBR autopatch operation is possible when operating this way, provided your dual-band rig in CBR mode passes the DTMF tones without too much distortion. The disadvantage of this approach is that there may be audio feedback. You can minimize this by using an earphone or by operating CBR without simultaneous-receive/full-duplex operation.

#### Remote Monitor

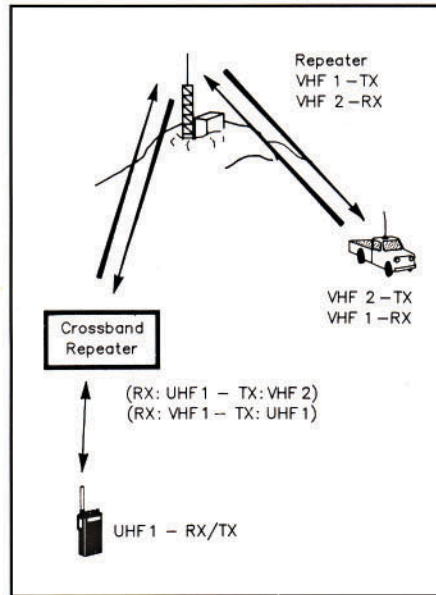
One-way monitoring is possible. Fig 7 shows how, with the addition of a receive converter (in this case, a 6-meter converter), CBR can be used to provide remote-receive capability that lets you listen while walking around with a hand-held radio.

Fig 8 shows the concept of Fig 7 taken a step further. Instead of the receive converter, a transverter is used. In Fig 8, a 6-to-2-meter transverter used with a dual-band transceiver in CBR mode provides 6-meter remote-base capability.

#### Operating Practice: Avoiding Problems

##### Long Repeater-Carrier Tails

A major potential problem with simplex-to-repeat CBR is operation with repeaters that

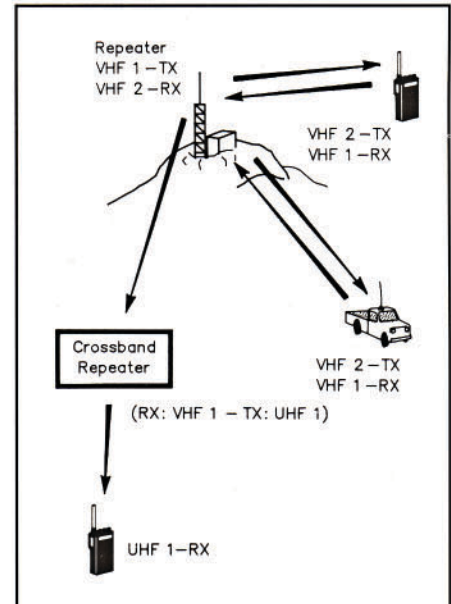


**Fig 3—Simplex-to-Repeater Operation**  
In this mode, UHF has the same input and output frequency, and VHF has different input and output frequencies (differs by repeater offset).

have long transmitter carrier tails. The long repeater carrier tail (originally called a “squelch tail”) came about when the reset function for repeater control system time-out timers switched from repeater carrier-transmitter drop to received signal-carrier drop, which spares users the squelch crashes associated with the repeater carrier dropping between input transmissions. The “courtesy beep” replaces this characteristic on many repeaters and the repeater carrier remains on the air. Because of the way CBR works, you can't respond to someone on a repeater until its transmitter carrier drops. It's frustrating to have to wait 10-15 seconds before being able to respond, and it sure limits rapid exchanges. A short (one-second) carrier-tail repeater facilitates rapid CBR mode exchanges.

#### Two-Way CBR and Repeater Autopatches

CBR makes it essentially impractical to

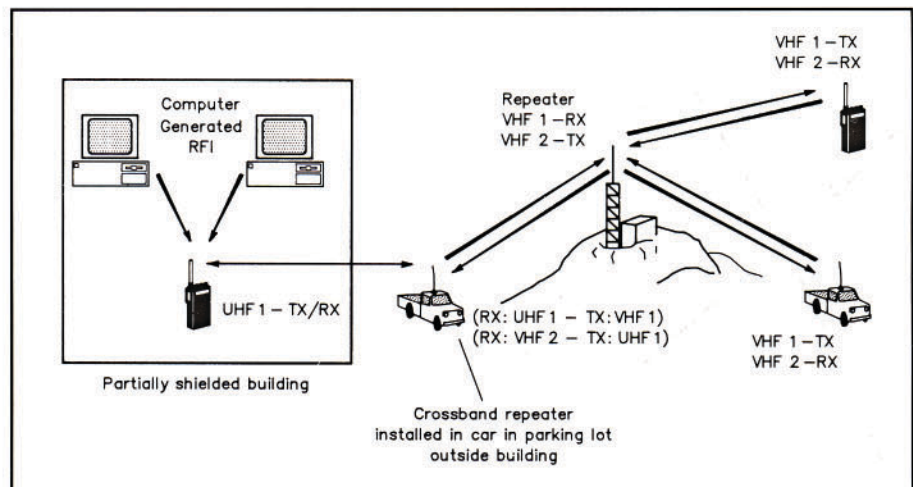


**Fig 4—One-Way Repeat Operation**  
In this CBR mode, VHF is designed as receive and UHF as transmit. Reverse operation is not activated.

use an autopatch through a remote repeater. Initiating an autopatch call in this mode typically times out the patch. Once the patch is activated, it looks for signals from your transmitter for control. Unfortunately, your CBR's receiver still hears the repeater's transmitted carrier, preventing the transceiver's transmitter from functioning. Without a dial or disconnect signal, the repeater's autopatch will eventually (hopefully) self-disconnect.

#### Don't Link Two Repeaters

Because of the way CBR works, it isn't possible to link two normal repeaters. A “normal” repeater means a machine that has a carrier tail. If two such repeaters are CBR linked, once the first outside signal keys one of the repeaters, the repeaters will be ping-ponged on and off by each other's carrier tails—not a desirable condition.



**Fig 5—CBR Assists Operation From Inside Building**

### "Open" Transceiver Mike in CBR Mode

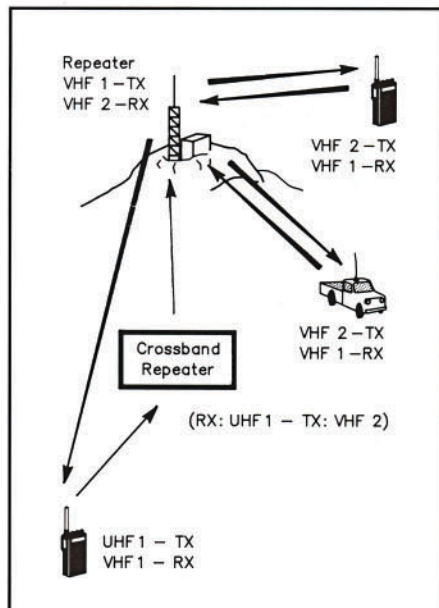
Check your dual-band transceiver's operating manual to determine the method for CBR audio connection and the effect of CBR operation on front-panel controls. Some radios require special consideration:

When operating the Kenwood TW-4100A in CBR mode, you'll probably want to disconnect the microphone because it's "live," though the push-to-talk switch isn't functional, when the transmitter is activated. If you don't disconnect it, local audio will mix with the repeat audio and possibly cause feedback, depending on factors such as your speaker volume setting. You could use this to mix in ID audio.

The same open-mike precaution applies to the Yaesu FT-470 hand-held transceiver. In the CBR mode, repeated audio is acoustically coupled, with no direct audio connection, so the microphone is open to all local audio, not just that picked up from the speaker.

### Transmit Power and Duty Cycles

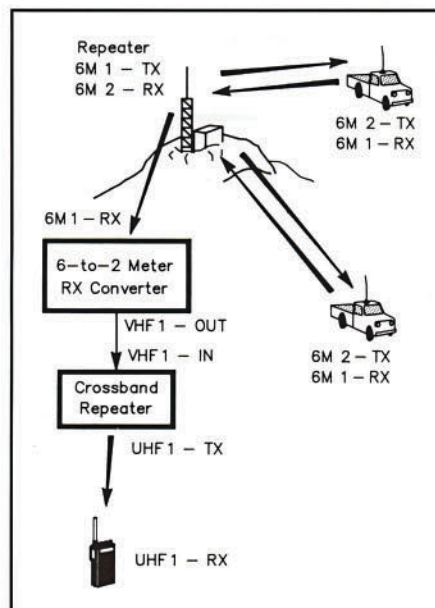
If a repeater you operate with in CBR mode has a lot of activity, lower your transceiver's transmit-power level. Most FM transceivers aren't designed for continuous high-power transmission. Consider the heat-dissipation environment of your rig's installation, too: The typical mobile installation on a hot summer day isn't an ideal environment! Check the rating of the power source you use to avoid overheating it or running down your car's battery in a stationary mobile situation with the engine off.



**Fig 6—Access-Assist Operation**  
In this CBR mode, the crossband repeater permits access to a repeater not normally accessible by hand-held power levels, but within hand-held receive range.

### Check Your Arithmetic!

Harmonically related frequencies won't work in CBR mode. For example, if you monitor the output of a repeater on 442.5 MHz using a simplex frequency of 147.5 MHz, you'll run into trouble because 442.5 MHz is the third harmonic of 147.5 MHz ( $147.5 \times 3 = 442.5$ ), which will interfere with



**Fig 7—Remote-Monitor Operation**  
In this CBR mode, one band is designated as receive, with an external converter and the other band as transmit. Two-way transmit is not activated.

reception of the 442.5-MHz signal.

### Finding a Clear Frequency

Observe the band plans when selecting your simplex frequency for CBR operation. Carefully select a CBR frequency to avoid interference problems. You're responsible for what's retransmitted by your station! The old

## The Law Says...

A full discussion of the Part 97 rules covering repeater operation is beyond the scope of this piece, but the following review should help you avoid problems:

Part 97.3 (a)(35) defines a repeater as "An amateur station that automatically retransmits the signals of other stations." CBR operation is repeater operation. Because the CBR is a repeater, it's essentially under automatic control. Transmitters under automatic control must be able to be shut off if anything goes wrong. Wherever you set up your CBR, be sure you're in a position to turn it off in a timely manner if a problem arises. Review the following sections of Part 97 to avoid violating FCC rules:

### Part 97.205 Repeater Station Requirements:

- Permitted control operator license classes (Novice not permitted).
- Permitted operating frequencies.
- Automatic control operation permitted.
- It's okay to limit repeater access to certain users and CTCSS access is allowed.

### Part 97.119 Identification Requirements:

- You should identify the CBR by voice when operating, eg, "W3RW clear via W3RW Repeater."

### Part 97.109 Station Control Requirements:

- Automatic control.

Although this article is targeted at CBR operation using 146/440-MHz dual-band rigs, the same type of operation is possible with 146/222-MHz dual-band transceivers. A Novice operator, however, may not be the licensee or control operator of any repeater.

Aside from the basic FCC rules, there are other important considerations to look at before you fire up your shiny new dual-bander as a crossband repeater. Established, recognized band plans set aside specific frequencies and band segments for repeater inputs and outputs. On top of this, your local repeater-coordination or spectrum-management group is responsible for keeping track of what repeaters are operating on which frequencies. In some areas, there are *no* available repeater frequencies on a given band.

Flipping a couple of switches on your mobile or hand-held rig may not seem like a major undertaking, but it *is* essentially the same thing as installing a regular repeater. If you suddenly appear on a well-known repeater input or output frequency, or one used for established simplex, packet, RTTY, weak-signal work, satellite contacts or other purposes, you aren't going to make many friends! Also, the FCC says that in matters of interference between repeaters, the repeater recommended by a recognized coordinator is given preference and the licensee of the noncoordinated repeater has primary responsibility to resolve the interference (ie, shut down, move or face possible charges of malicious interference). See the FCC rules, Section 97.205(c). Contact your local repeater coordinator for details; addresses are published in the latest ARRL *Repeater Directory*. The *Directory* also lists band plans and specific repeater frequency pairs.

Use your head—after carefully checking for a clear frequency (and one authorized for repeater operation), operating a low-power, restricted-range crossband repeater temporarily in a remote area may be okay. Randomly kicking your dual-band mobile into CBR mode while cruising through a congested metropolitan area is asking for trouble. Enjoy CBR operation when it's an advantage, not an annoyance.

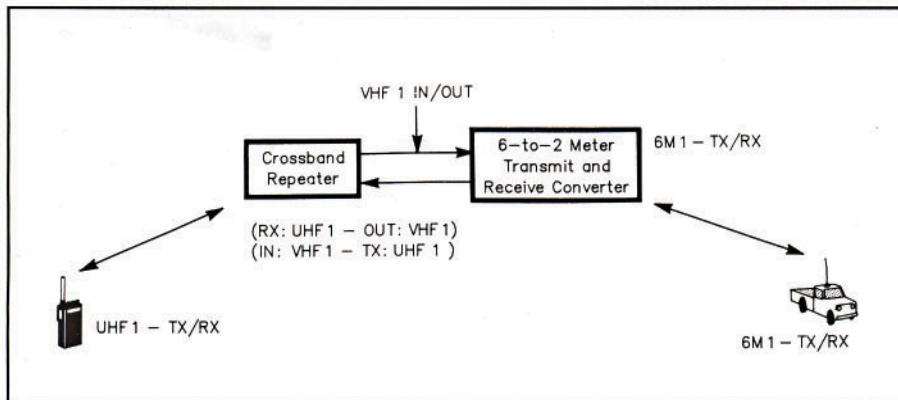


Fig 8—6-Meter CBR Remote Base Operation In this mode—a variation of simplex-to-simplex operation—a 2- to 6-meter transverter provides 6-meter operation.

adage applies: “Listen before transmitting!” Monitor your selected frequency for as long as possible—at least a few weeks or so, preferably a couple of months—to determine how clear it is of activity. Once you’ve picked a

relatively clear frequency, it may be your best bet to operate CBR using continuous-tone-coded squelch system (CTCSS) on your receive frequency to eliminate undesired access.

### Do it Right and Have Fun

These are just a few uses for CBR. Many of these could be used to expand repeater access in emergencies and in normal operating situations.

The CBR capability available in many dual-band mobile and hand-held FM transceivers can be used to improve your communications capability. By following simple guidelines, potential operating, equipment and FCC problems can be avoided. Experiment and let me know if you come up with any new applications. This is one part of ham radio I find interesting, as do many operators of “regular” repeaters.

### References

*FCC Rule Book*, 8th Ed (Newington: ARRL, 1991).

Kenwood USA Corp *TW-4100 Repeater Operation Supplement*.

Witmer, R., “Kenwood 4100A Crossband Repeater Operation,” *73 Amateur Radio*, November 1988, p 39.

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## Handhelds, Mobiles, Bases

These Icom handhelds are capable of contacting your crossband repeating radio.

All older handhelds can also be a part of your crossband repeating. See the last page of this brochure for a list.



IC-Q7A

IC-T90

IC-W32A

IC-T7H

IC-T2H

IC-V8

IC-T22

This Icom mobile can perform crossband repeating.

All older mobiles can also be a part of your crossband repeating. See the last page of this brochure for a list.

Note: additional accessories may be required to perform certain specialized functions.



IC-2720H

The IC-910H can be used for crossband repeating.



IC-910H

See the last page of this brochure for a list of older rigs capable of crossband repeating.

## FCC Rules & Regulations

Before setting up crossband repeating, make sure you are familiar with the FCC regulations which govern repeaters and "remote bases". For more information about FCC regulations, visit their site: [www.fcc.gov](http://www.fcc.gov)

### Older Icom crossband repeating products:

#### Handheld Radios

2m		1.25m	70cm	Dual Band		Multi Band
IC-02AT	IC-2SRA	IC-03AT	IC-4GAT	IC-T7A	IC-X2A**	IC-T8A
IC-2AT	IC-P2AT	IC-2GAT	IC-P4AT	IC-V21AT*	IC-X21AT	IC-Δ1A**
IC-2GAT	IC-T2A		IC-4iA	IC-W2A	IC-W31	IC-T81A**
IC-2GXAT	IC-T21A		IC-4SAT	IC-W21A	IC-Z1A	
IC-2iA			IC-4SRA	IC-W21AT		
IC-2SAT			IC-P4AT			

#### Mobile Radios

Dual Band	Multi Band
IC-24AT	IC-2700H
IC-2230A*	IC-2710H
IC-2340H	IC-2800H
IC-2350H	IC-3230A
IC-2410H	IC-3230H

#### Base Stations

IC-970H  
IC-820  
IC-821

\*1.25m

\*\*1.2GHz

Note: additional accessories may be required to perform certain specialized functions and more complex crossband repeating operations.

#### DTMF Control Codes\*\*\*

Remote on	B,000, #	High power	6
Remote off	B*	Low power	9
Crossband on	DB*	Voice	DC
Crossband off	DB, 000, #	Enter	D
Call	1	Up	#
Memory	2	Down	*
VFO	3	Clear	A

• The 000 may be your own 3 digit DTMF security code

• Direct keyboard entry of frequency or memory channel

\*\*\*Note: Not all Icom Mobiles have remote capability. Please check your owners manual for more details.

• For more information and to find the Icom dealer nearest you, please call (425) 450-6088 and visit our web site: [www.icomamerica.com](http://www.icomamerica.com) •

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