



Airborne Crossband Repeater Project

by WA7NBF
Clallam County, Washington
State

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Summary of Flight Tests:

In the summer of 2008, several experiments and flights were made to establish if a crossband repeater could be utilized to extend the range of Clallam County's emergency communications capability. The idea being that if an airplane carrying a Cross Band Repeater (CBR) flying around 5,000 feet above the West end of lake Crescent could cover all points in the county, then we would have no loss of contact with any area within our responsibility. Antenna used would be either a window mounted VHF/UHF rubber ducky or the aircraft's 130 Mhz aviation antenna shared with other equipment through an RF splitter. The objective was simple, carry the portable repeater onboard, connect antenna through the splitter, connect 12 volt power, place in cross band mode with frequencies pre-established and off you go.

The final test was a success with certain reservations considered. We determined that reliable communications could be maintained out to about 40 miles (3 watts) from the airplane.

The outside mounted aviation antenna was superior in performance even with great inefficiencies of mismatch. The UHF performance was the weakest link but we were able to make contact to all points. It should be understood that ground stations need to be more than simple handhelds unless they are within 25 miles of the aircraft. Were talking about established base stations or mobiles for effective communications at the fringes. Increase in intermod products was observed particularly close to the airport when using the shared antenna.

Airborne Cross-Band Repeater

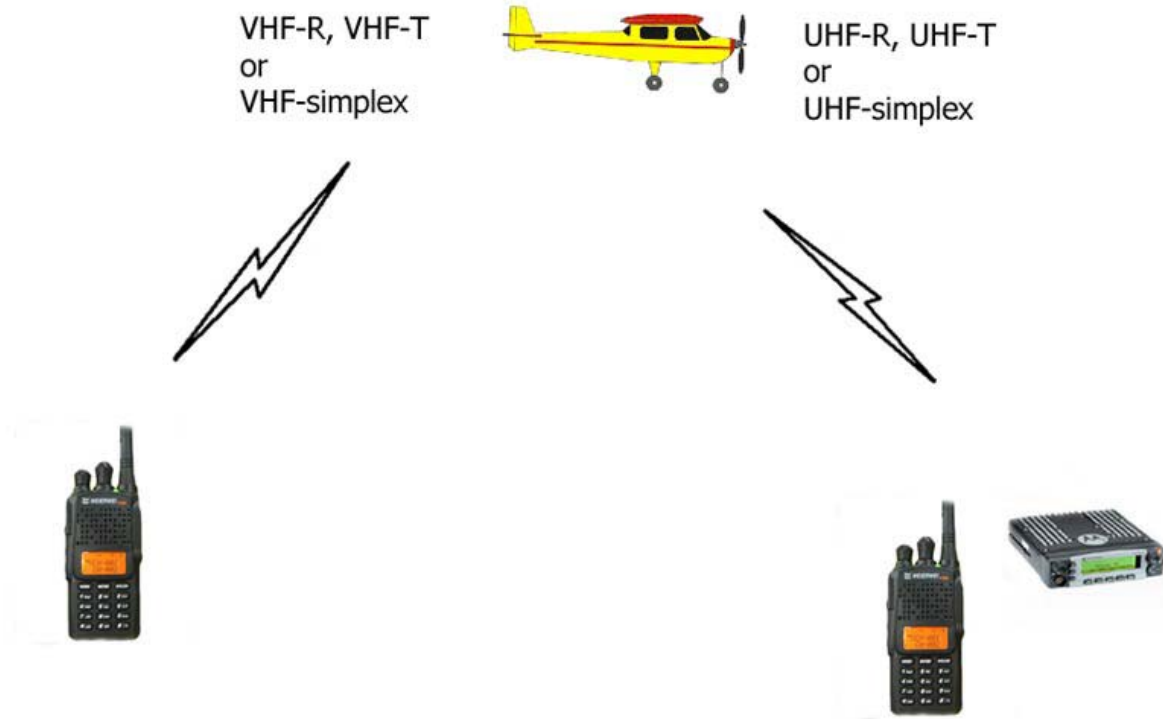


Figure 1

Detailed flight information is available along with sound recordings for those wishing details. Anyone attempting this should be sure and understand FAA limitations and what you can and can't do aboard small aircraft. Concern and respect should be made to navigation equipment, particularly ILS.

Although these test were done with airborne use in mind, the system can and most often will be used for terrestrial applications. Thats the more common usage. Lets face it, it will be quite a disaster to force the flight of an aircraft in times of distress but it certainly has happened in the past.

Terrestrial use:

Antennas, weight, bulk and power supplies are unique in aircraft and have a set of rules that must be followed but its easy to take the repeater and apply it for terrestrial use since its already packaged and easy to carry. Often, the antenna can be a rooftop mount on a vehicle or a more elaborate one for emergency portable use such as found with a WINLINK station. When using a crossband repeater the antenna must be tuned as a dual band unit. In other words, if the two bands used say are 144 Mhz and 440 Mhz, the antenna must be a reasonable radiator on both bands. Otherwise, loss of efficiency will

ocurr plus possible damage to the radio due to high VSWR. Battery power can be supplied from the vehicle or a separate 12 VDC source which is preferred.

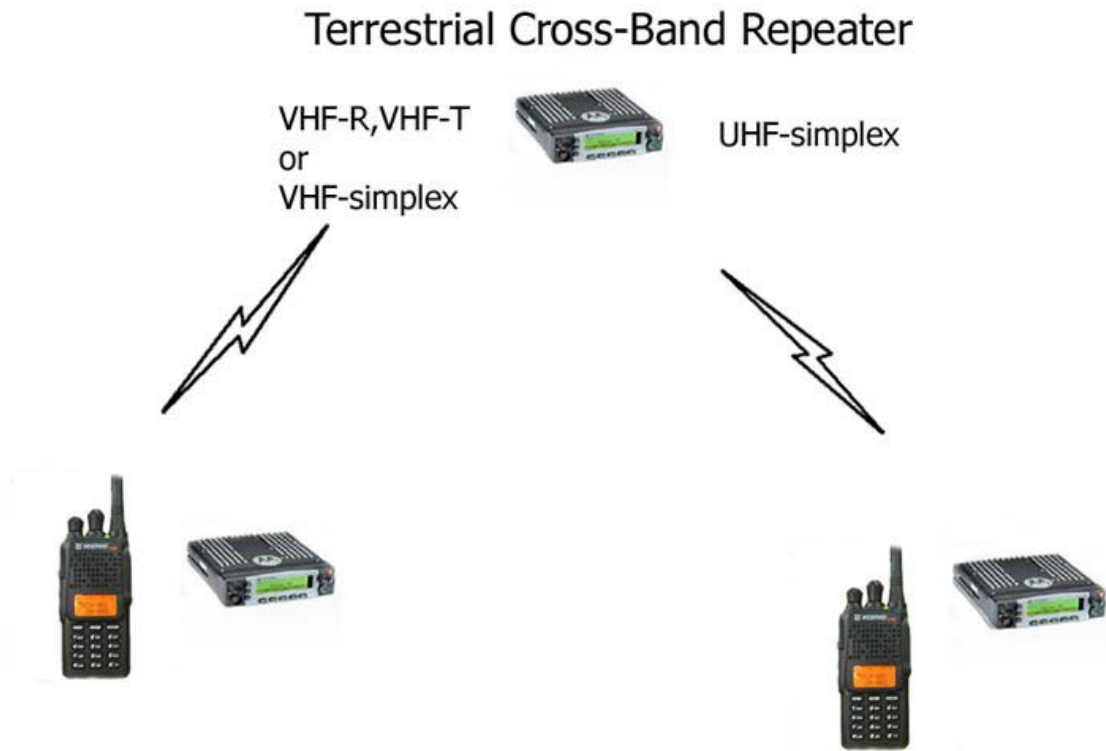


Figure 2

The nice thing about modern crossband units is they can handle simplex, duplex channels along with CTCSS tones as needed by simple programming. You can interface and extend the range of either a ground based repeater or simplex channels. In an emergency, the CBR could be programmed on the spot to satisfy a unique situation where radio coverage has been lost from a geographical area. The intent is to reestablish that coverage with the CBR on a temporary basis. You can even program for terrestrial to terrestrial repeater linking but its not encouraged because of the complex audio path the signals have to pass through. Distortion is often increased to marginal levels.

The CBR must have tight control of power output because it will work twice as hard as a normal station. Most radio's including those with a crossband capability are intended for intermittant use. If you run at higher duty cycle you run the risk of damaging it. Most operators limit power to 10 watts maximum. For public Service events, 5 watts is more than adequate.

Identifying repeaters:

The FCC defines requirements the control operator must meet if running a cross band repeater:

- Must ID both transmitters of the CBR every 10 minutes if in use
- Must always have control of the CBR and be able to turn it off either in person or by remote control at any time.
- Control operator must disable operation if users are violating amateur radio rules or the repeater causes interference. Some flexibility may be allowed in emergency situations but you may be required to defend your actions or lack thereof.

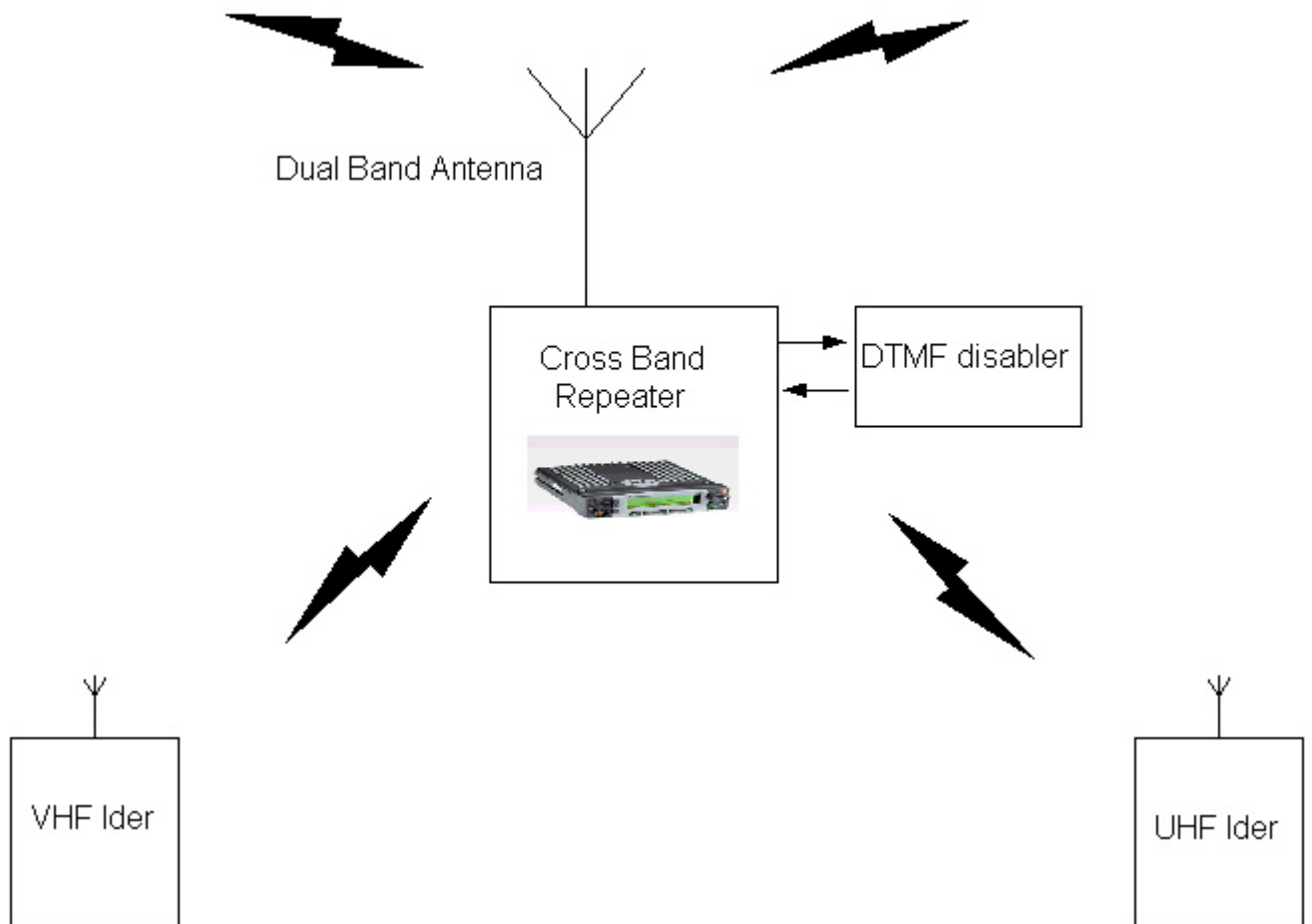


Figure 3

Most CBR's manufactured today have minimal "hooks" or provisions for meeting FCC rules in CBR mode. In short, this means you'll have no provision for ID and no remote means of disabling it. You'll have to provide these yourself.

Figure 3 shows a diagram of how I solved this. Being an enthusiast of foxhunting, solving the IDer issue was relatively easy. I build small radio transmitters with voice ID that are used in our "bunny" hunts. They're highly portable with self contained battery and can be set for multiple frequencies. They don't have to be physically close to the CBR but need to be within radio range. Each transmits once every 10 minutes and is programmed by "dip" switches with built in microphone for audio recording.

Also, borrowing from my transmitter hunting toolbox is the DTMF decoder. Hidden transmitters are often controlled remotely by the use of DTMF tones transmitted to the fox receiver. The controller decodes these tones and then determines the action needed. The most important one for this application is to disable the transmitters. That function is already built into the software. Unlike the IDer, the DTMF controller must be physically close to the CBR since it has to borrow audio and disable PTT circuit in the repeater.

When using it in an airborne mode, neither the IDer 's nor the DTMF decoder is needed since it would be assumed that the passenger would be a licensed amateur radio operator and in full control of the radio at all times. He would personally ID the transmitters and cut them off if problems were to develop.

Yaesu FT8900-R:

One of the best radio's for doing cross band operation is the Yaesu FT8900-R. Its a quad bander that has 29, 50, 144 and 440 Mhz capability with cross band operation on any two bands. All you need for compatability is a dual band antenna that matches the frequencies you wish to use. This radio operates in a bi-directional mode so it can transmit on UHF and receive on VHF as well as transmit on VHF and receive on UHF.

Useage:

This repeater has three uses that come to mind with the most likely listed first:

1. Extend handheld communications over a greater range for public service events. Activities such as Marathons can cover many miles which would often require regular hilltop repeaters. Having a CBR strategically placed will avoid this and allow you to be self contained in support of public service events.

Practicing using the CBR for these events gives proficiency in its use by all involved. Important for a more serious application at some later date.

2. In times of windstorms, floods, earthquakes or other emergencies that cut out normal communications, we often rely on amateur radio repeaters to cover our hilly country side. If an emergency cuts this capability, which it often does, its nice to have a portable backup that can be setup from a vehicle at a strategic location. Even at someones house if they live at a high spot or at the repeater site in the extreme case. Being battery operated means availabilty of 120 VAC is not

a concern. Loss of power or an antenna failure is the usual reason a permanent repeater is down.

3. An emergency which would involve airborne operation. It was tested and designed with this in mind but, realistically, this is the least likely of the three scenarios.

The nice thing about CBR's is that their operation is nearly identical to normal full duplex repeaters. About the only thing you have to learn is the switch from VHF to UHF (or UHF to VHF) when you stop transmitting might take a few 10's of milliseconds longer. Operators just need to hesitate a little longer between transmissions.

On the otherhand, simplex repeaters, the other type of portable repeater, have a steep learning curve for the uninitiated. Simplex units rebroadcast the previous transmission on the same channel and cause considerable confusion. Not the kind of thing you need in an emergency involving people that have not used one before. Most people that have tried simplex repeaters end up dropping them for this reason.

Putting it all together:

The photo shows the complete terrestrial version of the repeater. Only the dark green "ammo can" in the upper right hand corner which contains the radio would be needed for the airborne version since it would obtain power off the aircraft and use the outside mounted antenna. A few extra connectors and adapters should be included to be sure there are no last minute surprises. The IDer would not be needed as long as the passenger ID's the repeater per FCC rules. Can't get much simpler than this one box implementation plus cables and microphone.

The rest of the equipment is for the ground based implementation. Included is the IDer in the small "ammo can", the white "stick" which is a dual band "J" pole antenna, the gray breakdown stand, and the 75 AHR 12 volt DC battery. This configuration can be placed on a hilltop if a weather covering is provided for the battery. The rest of the equipment is already in waterproof containers. On the otherhand, it might not be a good idea to simply put it out in the woods because the radio is expensive. I have reached a point that if

it can't be locked up in a vehicle or on someone's property, it's not worth the risk. Individual situations must be considered.

Transmitters for foxhunting are much less expensive and we often make the antennas very stealthy.....they look like tree limbs even at close range. The transmitter and



controller are covered in biomass so its virtually impossible to find them by accident.
Only good foxhunters have a chance.

73's,

Neil Robin, WA7NBF
Port Angeles, Wa.

Neil A. Robin, WA7NBF