Cross-band Repeating

Santa Clara County ARES®/RACES
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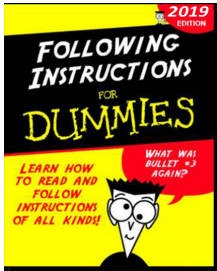
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HOUSEKEEPING

- Introductions
- Pen/pencil & paper
- Cell phones
- Side conversations
- Questions
- Breaks
- Restrooms
- In case of emergency
- Security and COVID-19 protocol; stay in this area of the building.

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Final Assignment

Please complete the course evaluation within one-week.

To get course credit you need to:
  A) Attend at least 90% of the class
  B) Participate in class discussion
  C) Complete the on-line class evaluation

If you do these, you will get credit for the course.

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Online Class Evaluation

LOG INTO **HTTPS://WWW.SCC-ARES-RACES.ORG/ACTIVITIES/EVENTS.PHP**
CLICK "SUBMIT CLASS EVALUATION" IN EVENTS

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Agenda

- What is Cross-band repeating
- How it can be deployed
- The factors necessary to do it legally
- How the FCC addresses cross-band repeating
- Operating considerations
- Radio Example

- Objective: after taking this class you should be able to configure a radio to do Cross-band repeating

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Why do we Care?

- It may enable you to set up communications where
  - Using an HT is difficult
  - A clear signal path is not available
  - Personal mobility away from a base station is needed

- F2, N2, S2 credential requirement that you demonstrate setting up and troubleshooting a cross-band repeater

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Review: A repeater receives a signal and re-broadcasts it

- On the same frequency with a time delay
  - Digipeater, simplex voice repeater
- On the same band, simultaneously, but different frequency
  - Standard voice repeater like AA6BT or W6ASH
- On a different band
  - Cross-band repeater
  - Linked radios on the same repeater controller like K6FB

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Why Cross-band Repeating

- Quick and easy to set up
- One Antenna (dual band)
- Easily relocated (can be mobile)
- A cross-band repeater is far less complex than a conventional repeater
  - No expensive filters or duplexers
  - Used for space satellite repeaters (uplink-downlink)
  - Full duplex is possible
- No coordination issues
  - Uses simplex channels, operator at control point

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Examples of Communication Problems

1. I can't hear simplex net control because of the interference around me but they can hear me
2. I can hear the voice repeater but I can't reach it
3. A group of field operators must communicate with each other but some do not have a direct path to other team members
4. I'm in the foothills of a mountain range and can't reach the command net repeater because of the terrain
5. I need to move around inside the EOC, ICP or venue, or as a shadow at an event

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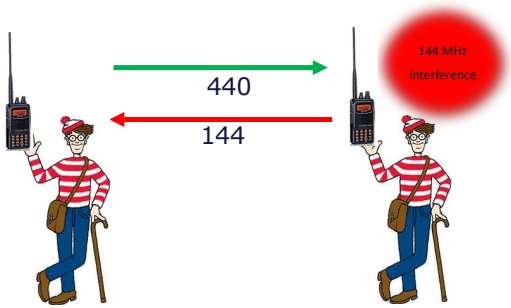### 1. I can't hear simplex net control because of the interference around me but they can hear me

- Cross-band operation can solve this problem
  - Transmit on one band – they can hear me
  - Receive on another band with no interference
  - Simplex operation
- Example – Event at a convention hall
  - Net Control can hear you on 144 in the parking lot
  - You can't hear Net Control on 144 because of local interference in the hall, but 440 is clear, however no 440 repeaters available
- So,
  - Net Control transmits on 440, listens on 144
  - You transmit on 144, and listen on 440
  - Program this into your radio using your memory channels
  - Or use a dual receive HT

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Cross-band Operation Example

440

144

144 MHz Interference

Net Control

* Most Amateur Radio Satellites in Space use this mode

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2. I can hear the voice repeater but I can't reach it

- Locked-band repeater (LBR) is used
  - LBR receives on band A, re-transmits on band B
  - LBR does not receive on band B and re-transmit on band A
  - You listen to band A direct
  - Simplex operation
- Example:
  - You want to use AA6BT but you are inside concrete building
    - You can hear the repeater output
    - Your 1.5w HT can not be picked up by the repeater
  - Use a locked-band repeater to take your low power HT and re-broadcast it at a higher power
- Configuration
  - You transmit to a mobile rig in the parking lot on 440
  - The mobile rig re-broadcasts on 144 to the voice repeater
  - You receive the voice repeater directly

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Locked-Band Repeater Example

146.115

446.500

146.715

Operator		Locked Band Radio -Voice Repeater				Repeater - AA6BT	
		Side A	Side B				
RCV Freq	146.115	446.500 RCV Freq	RCV Freq	146.115		146.715	RCV Freq
XMT Freq	446.500	446.500 XMT Freq	XMT Freq	146.715		146.115	XMT Freq
Sql Type	Tone	Tone SQL Sql Type	Sql Type	Tone		Tone SQL	Sql Type
Tone Freq	100	100 Tone Freq	Tone Freq	100		100	Tone Freq
		N/A Man SQL	Man SQL	Sql for no sig			

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3. A group of field operators must communicate with each other but some do not have a direct path to other team members

- Everyone transmits on 440
- Everyone receives on 144
- A locked-band radio is placed where it provides full area coverage
- The locked-band radio
  - Receives on 440 and simultaneously transmits on 144 one way (simplex on both sides)

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Locked–band Field Use Example

446.500 → radio → **147.540**

Operator			Locked Band Radio Field Repeater					Local Field Team	
			Side A		Side B				
RCV Freq	147.540		446.500	RCV Freq	RCV Freq	N/A		147.540	RCV Freq
XMT Freq	446.500		N/A	XMT Freq	XMT Freq	147.540		446.500	XMT Freq
Sql Type	Tone		ToneSQL	Sql Type	Sql Type	Tone		Tone	Sql Type
Tone Freq	107.2		107.2	Tone Freq	Tone Freq	107.2		107.2	Tone Freq
			N/A	Man SQL	Man SQL	Sql for no sig			

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4. I'm in the foothills of a mountain range and can't reach the command net repeater because of the terrain
- AA6BT is the voice repeater
  - Transmits on 146.115, receives on 146.715
- A cross-band radio is added to the path to provide access to the voice repeater
- You transmit and receive on 440 simplex
- The cross-band repeater radio
  - Receives on 440 and simultaneously transmits on 146.715
  - Receives on 146.115 and simultaneously transmits on 440
  - Note: For the AA6BT side of the radio, these are your normal repeater settings

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Cross-band Repeater Example

446.500 ← / **446.500** →   **146.115** ← / **146.715** →

Operator			Cross Band Radio To Voice Repeater					Repeater - AA6BT	
			Side A		Side B				
RCV Freq	446.500		446.500	RCV Freq	RCV Freq	146.115		146.715	RCV Freq
XMT Freq	446.500		446.500	XMT Freq	XMT Freq	146.715		146.115	XMT Freq
Sql Type	Tone		ToneSQL	Sql Type	Sql Type	Tone		Tone SQL	Sql Type
Tone Freq	100		100	Tone Freq	Tone Freq	100		100	Tone Freq
			N/A	Man SQL	Man SQL	Sql for no sig			

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5. I need to move around inside the EOC or ICP, or venue, or as a shadow at an event

- Same functional setup as Use Case 4
- A cross-band radio is added to the path to provide access to the voice repeater, most likely using the radio in your vehicle outside the building

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Keeping it Legal

- CAVEAT: Not a lawyer, nor an expert on FCC rules.
- Technically: A cross-band repeater is not a 'repeater' – it's officially considered a remote base station, so it follows Auxiliary Station rules
- Input is considered control and voice uplink, therefore must comply with 97.201
- Operator must be able to control the station.
- If operator is remote, a 3 min timeout timer must be employed.
- Don't forget your RF safety evaluation for the cross-band repeater radio

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WHAT DOES THE FCC SAY?

§ 97.119 Station identification.
(a) Each amateur station…., must transmit its assigned call sign on its transmitting channel at the end of each communication, and at least every 10 minutes during a communication, for the purpose of clearly making the source of the transmissions from the station known to those receiving the transmissions. No station may transmit unidentified communications or signals, or transmit as the station call sign, any call sign not authorized to the station…..

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Identification Techniques

- Automatic CW ID if the radio supports it
  - Several Kenwood radios support CW ID
- Voice ID
  - Control operator identifies
    - using cross-band radio microphone
    - on both cross-band radio output frequencies
  - Users identify with their call and call of cross-band station at end of series of transmissions
    - "W6XRL4 via W6ABC5 Auxiliary"
- The control operator of the cross band repeater is responsible for ID, not the user

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Operating Considerations

- When operating through standard repeater, squelch tail must be very short. Cross-band repeater will not switch from TX to RX until repeater drops
- Manually adjust squelch settings to prevent unintended cross-band transmissions
- Always configure Tone Squelch on the simplex input of your locked-band or cross-band repeater to avoid unintended transmissions on the output frequency.
- All users must transmit tone when talking through the cross-band repeater.
- Some radios open the local microphone when cross-banding, so consider unplugging the microphone in this case

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Operating Considerations (2)

- When operating in cross-band mode, cross-band repeater will have a very high duty-cycle. All traffic on both UHF and VHF causes cross-band repeater to transmit
  - Be careful of battery usage on cross-band repeater, especially if you're using your car's battery.
  - Best to use dedicated battery so you don't get stranded with a dead battery.
  - Be careful of over-heating. Many mobiles are not designed for high duty-cycle, high-power operations.
  - Smart location choice or placement of cross-band repeater may allow you to transmit at lower power.

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Operating Considerations (3)

- When possible, use locked-band mode
  - Uses less battery power – only transmits when traffic is on the input
  - Reduces squelch-tail problems – monitoring received signal directly, so no need to wait for cross-band repeater to switch from TX->RX
  - Easier to stay legal – no need to ID on the 'downlink'
- Use tone squelch on locked-band or cross-band repeater's input to avoid accidental triggers
- Use tone encode only on the HT so you can hear if the frequency is in use by others

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Frequency Choice

- ARRL band-plan:
  - 445.00-447.00 Shared by auxiliary and control links, repeaters and simplex (local option)
  - Several states' band-plans advise 445.975 and 446.025 for cross-band
- NARCC NorCal repeater coordinator shows all of 445-447 as allocated to repeater inputs.
  - NARCC database shows only 446.000, 446.500 and 441.000 as simplex
  - Will need to disable auto repeater offset on most radios
  - Or program simplex frequency into memory
  - Avoid odd harmonics (e.g., 147.5 and 442.5)

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Partial list of Cross-band Capable Radios

- Yaesu- FT-8800, FT-8900, FTM-350 (one line in manual), FTM-300DR, FTM-400 (not in manual)
- Kenwood- TM D710, TM D700, TM V71A, TS 2000
- ICOM- IC 2730H, IC2730A, W32a (not in manual)
- ADI- AT-600
- Alinco- DR635

- Not a complete list and may not be current

- List of radios with auto ID: TM D710, TM V71A, TS 2000

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Lab Sessions this afternoon

Live, today in the Parking Lot after 12:30pm, instructions were sent in e-mail

Contact me if you want a session at a later time/date: Connect to Zoom session with a tablet or phone that you can move around

Instructions and frequencies will be sent to you in e-mail

Get your cross-band repeater radio ready (read the manual), plus an HT

Point your camera at the equipment to show instructor what is happening, I will attempt to help you out in case it does not work

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Thank You!

Don't forget to fill out your evaluation forms
Questions, comments, suggestions?
Andreas Ott – andreas@naund.org

Credits: Logan Zintsmaster KE7AZ and Scott Morse KC6SKM

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Reference

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General Settings

- Set Transmit Power Level
- Set Frequency
- Set Offset or enable/disable Auto Repeater Offset
- Turn on Tone or ToneSquelch
- Set Left and Right side of radio (if applicable), use memory channels
- Set RF or Audio Squelch
- Turn speaker volume down
- Unplug or disable microphone, if applicable

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Kenwood TM-D710 and TM-V71A

- Instructions in PDF on Disk
  - Cross-band (K Type)-E.PDF
  - May need to turn off the built-in TNC
- Multiple Menu Modes
  - Menu Mode 403 for Cross-band
  - Menu Mode 404 for TX HOLD
  - Menu Mode 406 for TX ID
  - Menu Mode 405 for entering Repeater ID
- In Cross-band mode, 3 min TX timer is locked on.
- Turning off does not cancel Cross-band
- Must turn off and press [Tone] + Power on to reset
- auto-ID function

(Instructions verified by Steve KC6RSC)

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Icom IC-2730H

- Instructions from county drill by Neil K2LL, see details on addendum sheet
  http://icom.custhelp.com/ci/fattach/get/2822/0/filename/IC-2730+Cross-Band+Repeat+Addendum.pdf
- Exclusive operation: enable cross-band features, then turn on and off. Once enabled cross-band will stay enabled until radio is reset.
- To enable
  - Power off, press both "main band" and "moni" plus power on. If successful the EXMENU > OTHERS > RPT M menu will be enabled.
  - Recommended to turn on time-out timer (TOT) to 3 minutes or less
- To turn on
  - set left and right sides of the radio to be the two different channels. Ensure they are on different bands.
  - Menu > EXMENU > OTHERS > RPT M > START
  - Press the MW button
  - Rotate tuning knob to "YES", then press MW button again.
  - You will see "rPt" on both sides of the display
- To turn off
  - Press Menu. You will see "EXIT?". Rotate tuning knob to show "YES", then press MW button.
- "Locked Band" or "One Way":
  - This radio doesn't support one way cross-band repeating. To fake it, program the remote side to listen for a PL tone it won't receive.

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Icom IC-2730A

- Instructions contributed and verified by John W6JMK, see details on this addendum sheet
  https://static.dxengineering.com/global/images/technicalarticles/ico-ic-2730a_tz.pdf
- The instructions assume you begin with the radio powered off. So you hold down the buttons and then power it on.
- The CTCSS tone is passed through the ICOM, so to trigger the repeater the ICOM must receive the CTCSS tone that the repeater input requires. The ICOM can also be configured to require the same input tone (to prevent unwanted repeating).

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Yaesu FTM-350R

- Disable APRS by turning the APRS modem OFF (Set E05)
- Set frequency and squelch for left and right, VHF/UHF
- To Activate
  - Turn OFF
  - Hold the button left of the yellow power button
  - Additionally press Power button to turn ON
  - Select Special Menu 11 XBAND-RPTR with left dial
  - Rotate left dial to ON, press left dial (radio will reboot itself)
- To disable
  - Turn OFF
  - Hold the button left of the yellow power button
  - Additionally press Power button to turn ON
  - Select Special Menu 11 XBAND-RPTR with left dial
  - Rotate left dial to OFF, press left dial (radio will reboot itself)

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Yaesu   FTM-400DR/XRD/DE/XDE
FTM-300DR

- Disable APRS by turning the APRS modem OFF
- Set frequency and squelch for top and bottom (VHF/UHF)
- Disconnect microphone, turn volume down
- To Activate
  - Turn OFF
  - Hold the DISP, F, and GM buttons
  - Additionally hold Power button, release when radio turns on
  - X-Repeater message is displayed (upper left corner)
- To disable
  - Turn OFF
  - Hold the DISP, F, and GM buttons
  - Additionally hold Power button, release when radio turns on
  - X-Repeater message is not displayed

Credits: Vicky Pelton AB6CJ (FTM-400), Victor Denisov N6DVS (FTM-300)

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Yaesu FT-8800

- First set up VHF* on Left and UHF* on Right
  - * Either band may be on either side
  - Freq, squelch type, squelch freq
  - Override repeater offset
- Press SET
  - Rotate main dial to menu 45 (X-RPT)
- Press main dial knob will show X-start
- Press main dial knob again to activate
- To exit press SET

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Alinco DR-635 and DR-735

- Details on http://www.alinco.com/pdffiles/Tech/Crossband/dr_635_XBND.pdf
- Turn the power on while holding the BAND key pressed.
- ★ and R icons appear on the screen. Repeat the same sequence to exit from the XBR mode.

(Instructions verified by Thomas KK6FPP)

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Your Radio could be listed here

- Most of the instructions are crowd-sourced
- Send e-mail describing verified procedure to Andreas Ott, K6OTT, <andreas@naund.org>

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