

ORWG Civil Air Patrol Communications 101



Voice of Command

LtCol David A. Rudawitz
Oregon Wing Director of Communications
October 2019

Agenda



- Basic Topics
- Why does radio work
- CAP Radio Systems
- Using a Radio
- EF Johnson Radios
- ICS Functional Identifiers
- Air Crew Communications
- Troubleshooting
- Interoperability
- Cross Repeater Operation
- CAP Tactical/Airborne Repeaters

Basic Topics

CAP Communications Manuals and Guides



- CAPR 100-1 Volume I: Communications
- CAPR 100-1 Volume III Civil Air Patrol Radiotelephone Procedures Guide
- Oregon Wing Annual Communications Plan

Mission of CAP Communications



The mission of the CAP Communications Program is to organize and maintain a reliable, nationwide, point-to-point, air-to-ground, and ground mobile radio capability in support of the missions of CAP.

Purposes of CAP Communications



- Primary Purpose of a CAP Communications Facility:
 - To provide the commander with the means for controlling his/her units and their activities
- Additional Purpose of a CAP Communications Facility:
 - To provide the commander at each echelon the ability to communicate with superior and subordinate commanders.

Principles of Civil Air Patrol Communications



- Survivability
- Reliability
- Flexibility
- Maintainability
- Speed
- Security

Uses of CAP Communications Facilities



- CAP Communications Facilities are used in support of:
 - Emergencies
 - Flying
 - Administration
 - Training
 - Support to Other Agencies



Table of Allowances (TA)

- USAF approved allowances of radio equipment for CAP
- Used to support funding from the USAF for radio equipment
- Controls who (individual/function) can have what equipment
- Supports SAR/DR and CAP command and control requirements

Why does radio work?

When I talk on the radio, how does my voice get from here to there???



Radio Basics

- Radio electronics convert audio sounds (your voice) into electromagnetic waves
- The audio sounds are converted into a feature of the wave that can be decoded at the receiver
- AM – Amplitude Modulation
- FM – Frequency Modulation



AM – Amplitude Modulation

- Audio information is encoded with changes in the “size” or “amplitude” of the radio signal being transmitted
- Changes are very small and occur within the allowed power (output) of the radio
- The louder the audio the larger the modulation.
- Aircraft band and HF radios use AM.

FM – Frequency Modulation



- Audio information is encoded with changes in the frequency being transmitted
- Changes are very small and occur within the allowed bandwidth of the assigned central frequency.
- CAP land mobile radios use FM



VHF - Very High Frequency

- 136 – 174 MHz
- Short-range, line-of-sight
- Allows for multiple conversations on the same frequency, throughout the country, concurrently.
- Provides excellent, dependable, short-range communications which are readily adaptable to ground and air mobile operation.
- CAP land mobile radios operate in the VHF band



HF - High Frequency

- Can be Long-range (cross-country) or Medium-range.
- Travels long distances, so not appropriate for short-range communications.
- Will reflect (bounce) off the ionosphere which allows the signal to travel long distances.

CTCSS



- Tone-Coded Squelch System (CTCSS) or Digital- Coded Squelch (DCS).
- CTCSS is also known by proprietary names such as Private Line™ (PL) or Channel Guard™ (CG).
- CTCSS mixes a subaudible tone with the audio from the microphone and transmits the resulting signal.

CTCSS



- When a radio receives a signal with tone-coded squelch, the CTCSS decoder attempts to match the tone present in the received signal with the desired tone.
- If the correct tone is present, the receiver is unsquelched, and audio is routed to the speaker.



Disadvantages of CTCSS

- Since users cannot hear transmissions from other groups, they may assume that the frequency is open when it is not and transmit simultaneously with another user, thus accidentally overriding or interfering with the other group's transmission.
- Depending on several factors (locations, power, etc.), the two simultaneous transmissions could easily interfere with each other--resulting in one or both not being clearly understood.
- The more separate groups that share a single frequency and the more frequently that they transmit, the more likely that this accidental interference will occur.



Digital Waveforms – P25

- In addition to FM and AM, there are many digital waveforms
- Audio signal is converted to/from digital format with a “vocoder” and then transmitted/recieved
- CAP and most other agencies use P25
- All radios in a conversation have to use the same digital waveform in order to communicate.
- Different waveforms are not compatible
- Digital waveforms are not the same as encryption



Encryption

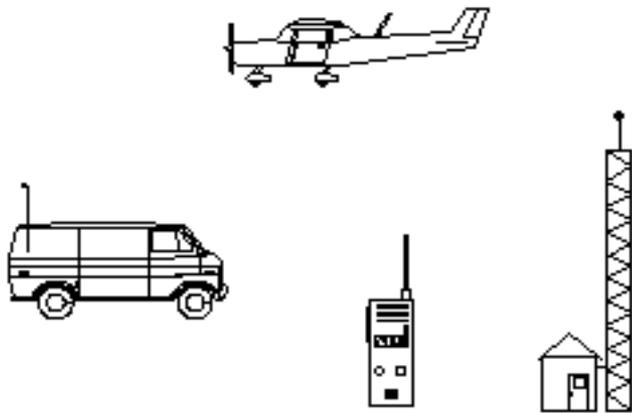
- “Scrambles” the audio information in the radio before it is converted to AM/FM/P25
- Uses an algorithm that combines a shared “key” to encrypt and decrypt the audio information
- CAP standard is AES which is not classified only FOUO

CAP Radio Systems

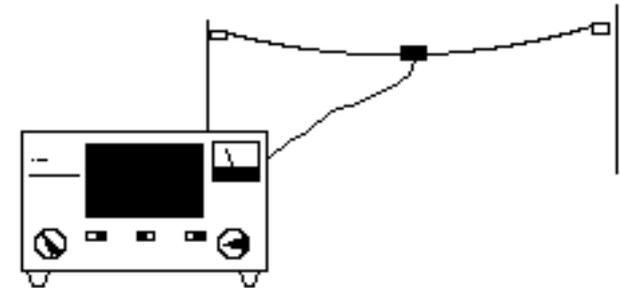
CAP Communications Systems



SHORT-RANGE VHF-FM



LONG-RANGE HF-SSB



Voice is Primary Mean of Communication



Voice Operating Modes

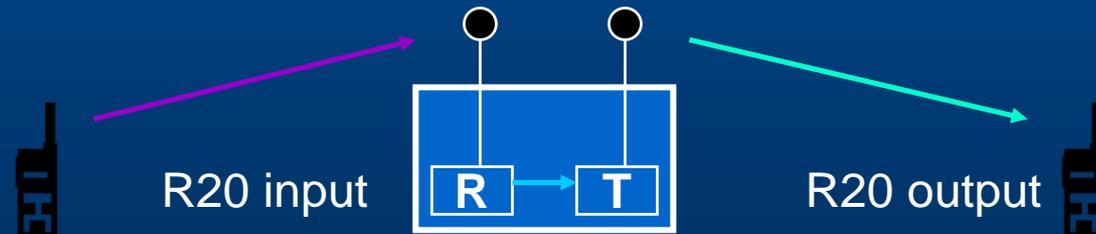
SIMPLEX

Single Frequency - One Station at a Time



REPEATER

Two Frequencies - One Station at a Time



Repeater Operation



Repeaters increase the range of mobile stations due to their high profile location



Inside the Repeater

- Repeater will only turn on its transmitter if it hears one of two tones:
(CTCSS – Continuous Tone Coded Squelch System)
- Repeater site specific tone for each repeater



The **Tone Decoder** “listens” for either of the two tones on the incoming signal

The **Tone Decoder** “presses” the Push To Talk (PTT) button to turn on the transmitter.



Selecting a Particular Repeater

- Repeaters are activated by CTCSS
(Continuous tone-coded squelch system)
Tones, aka PL (private line)
 - A subaudible tone system which, when added to a carrier, allows a receiver to "decide" to accept a signal.
- The radio operator must set the radio for the correct tone to activate the desired repeater

PL is a registered trademark of the Motorola Corporation



Aircraft Use of Repeaters

- Primary mode of operation should be simplex.
- Only use the repeater if simplex is not possible.
- Selectively use a repeater through use of its assigned access tone
- The key is to limit use to a single repeater
- ORWG radios are set to normal squelch for ORWG repeaters
 - You hear all repeaters on the output channel for your selected repeater (odd or even)

Using a Radio



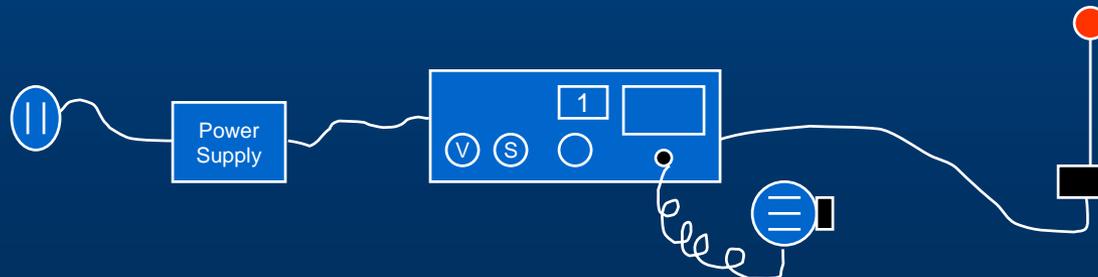
Radio Operation Summary

➤ Common Controls:

- Volume
- Squelch
- Channel Selector
- Mike with Push to Talk Switch

➤ Radio Setup

- Radio Transceiver (VHF-FM, HF-SSB, SAR)
- Power Supply (110 VAC or 12 Volt DC)
- Antenna (Vertical, Magnetic Mount, Dipole)



Normal Operation Setup Sequence



- Power on
- Verify/Set channel
- Set volume, squelch
- Verify power high or low as appropriate.
- Verify *NOT* in RTA.
- Verify Normal or Selective squelch.
- Radio check as required.

CAP VHF-FM Radio Operation



➤ Before Transmitting

- Listen on Channel -- don't transmit if conversation is in progress

➤ To Transmit

- Press push-to-talk button
- Hold microphone about 1" from mouth
- Speak in a normal tone of voice

E.F. Johnson 5300 Mobile Radio



Radio Features

- Four different editable scan lists
- Alpha channel display
- 256 channel capacity
- Narrowband and Digital (P25) capability

Basic Use



- Radio performs “SELF TEST” when it powers-up
- Home channel on power-up will be the last channel used before the radio was shutdown

Basic Use



- Channel and Zone selection is done with the “SELECT” knob
- The cursor over the first number selects the zone
- The cursor over the second number selects the channel

Basic Use



- The “SELECT” knob is pushed to change the curser and turned to change the zone or channel
- The “SELECT” knob has other functions when other features are activated

Scan



- There are four scan lists available on the radio.
- Each list has a different type of scan
- Each list is user editable
- Any channel programmed in any zone in the radio may be scanned

Scan 1 & 4



- “SCAN LIST 1” and “SCAN LIST4” have no “PRIORITY” channels
- The receiver will lock on to any active channel and stay there until there is at least 3 seconds of no signal



Button Functions

TX PWR

SCAN

SCN ED

SEL SQ

BKLHT

RTA

- TX PWR – Toggles power between high (50 watts/ Low 10 watts)
- SCAN – Toggles scan on/off
- SCN ED – Toggles on editing the scan lists
- SEL SQ – Toggles CTCSS on/off
- BKLHT – Changes backlilght level (Low/Medium/High)
- RTA – Toggles between repeater and simplex on repeater output

Other Functions



- By pressing and holding the SCN ED and SCAN buttons, you can adjust the contrast of the display screen with the Select knob.

Important Operating Considerations

- ALWAYS turn the radio off before turning the ignition off.
 - Protects the radio
 - Writes the current settings to memory so it comes back up on the same channel it was on.
 - Prevent dead batteries in vehicles where both the main power and ignition sense are wired to the battery.

EF Johnson 5100 Handheld



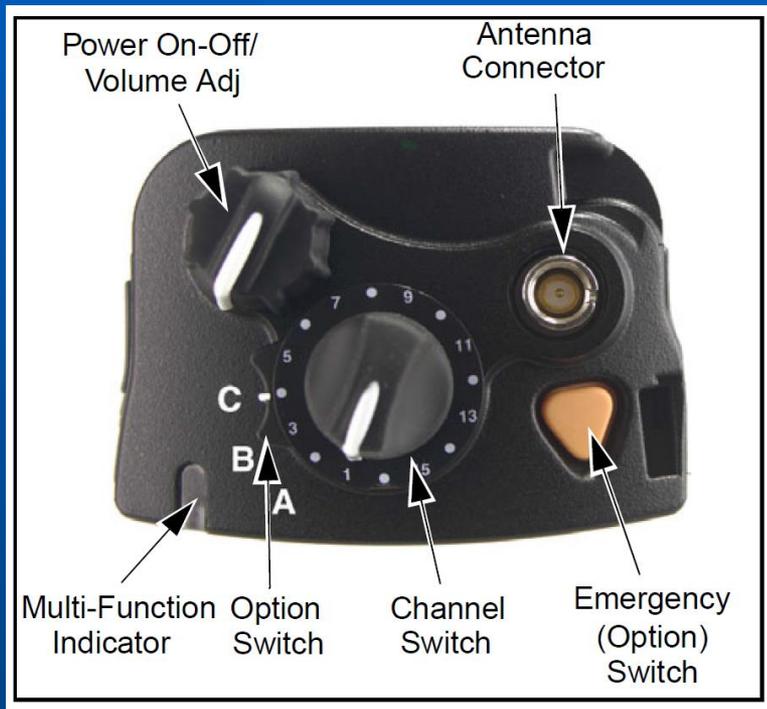
- Handheld version of the mobile radio
- Programmed with the same zones and channels in the same locations!
- Limited to ICs and ground teams
- 1/5 watts of power

Front Panel Controls



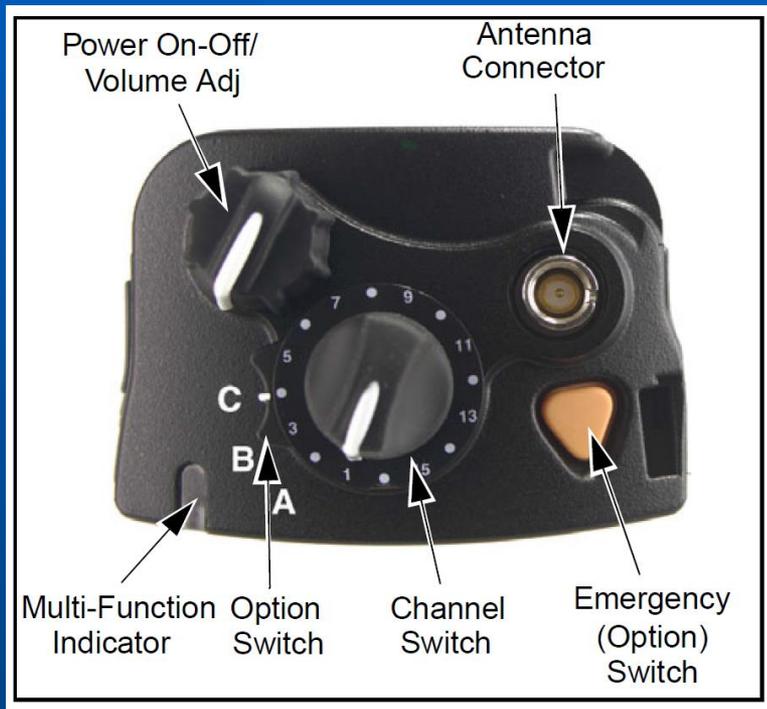
- F1 – Backlight on
- F2 – Menu
- F3 – High/Low Power
- F4 – SQ Select (PL)

Top Panel Controls



- **Multi-Function Indicator - Indicates the following conditions:**
 - Steady Red - Transmitter keyed.
 - Flashing Red - Low battery in receive mode.
 - Steady Green - Carrier detected in receive mode.
- **On-Off/Volume –**
- **Channel Switch - This 16-position switch selects up to 16 channels in the current zone.**
- **Rotary Option Switch - This is a three-position switch that can be programmed to control various options.**

Top Panel Controls



- Emergency button – Toggle Keypad Lockout
- Rotary Option Switch
 - A – RTA off
 - B – RTA on
 - C – RTA on

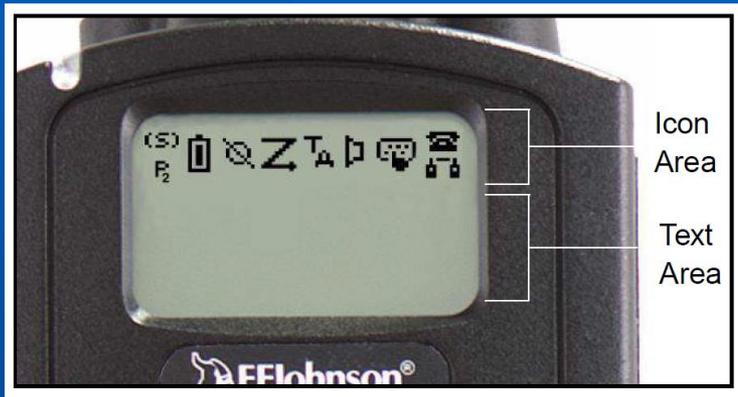


Side Controls and Jacks



- PTT (Push-To-Talk) Switch - This switch is pressed to turn the transmitter on to transmit a message. It is then released to listen. Transmitting is indicated when the top panel indicator is constant red.
- Option Switches 1, 2, and 3
 - 1 – Monitor
 - 2 – Scan
 - 3 – Toggle Backlight

Display



Low battery indication



Voice encryption is enabled



Standard or radio wide scanning is enabled



Repeater talk-around is enabled



Monitor mode is enabled



Keypad programming or another mode is enabled



When the scan or the scan list edit mode is enabled, indicates that the displayed channel is in the scan list and scanned normally



When the scan or the scan list edit mode is enabled, indicates that the displayed channel is a priority channel.

ICS Functional Identifiers

Functional Designators/Identifiers



- May be used only on formal CAP incidents (missions) and activities
- Consist of duty assignment or location.
 - Examples: ICP, IC, Air Ops, Ground Ops, Ground Team 1, [Town name] Base.
- Standard list used in ICS

Standard ICS Identifiers



ICS Position	ICS Functional Call Sign
Incident Communications	"location" COMMUNICATIONS
Incident Commander	COMMAND
Chaplain	CHAPLAIN
Public Affairs Officer	PUBLIC AFFAIRS
Safety Officer	SAFETY
Liaison Officer	LIAISON
Operations Section Chief (OSC)	OPERATIONS
Air Operations Branch Director (AOBD)	AIR BRANCH
Ground Operations Branch Director (GBD)	GROUND BRANCH
Flight Line Supervisor	FLIGHT LINE
Planning Section Chief (PSC)	PLANNING
Finance/Admin Section Chief (FASC)	FINANCE/ADMIN
Logistics Section Chief (LSC)	LOGISTICS
Service Branch Director (SVBD)	SERVICE
Communications Unit Leader (COML)	COMMUNICATIONS
Medical Unit Leader (MEDL)	MEDICAL
Support Branch Director	SUPPORT
Facilities Unit Leader (FACL)	FACILITIES
Ground Support Unit Leader	GROUND SUPPORT
Supply Unit Leader (SUPL)	SUPPLY



Air Crew Communications

Before Take Off



- Check radio and communications equipment
- Confirm assigned frequencies are programmed in radio
- Conduct radio check with incident communications

TDFM-136 Radio





Initial Radio Check

- Use assigned repeater or simplex
- If your radio is not working DO NOT DEPART
- Report problem to Air Ops and Communications
- No radio = no Sortie!!

Report Wheels Up



- Actual Time of Departure
- Report as soon as possible after take off
- “Aurora Communications, this is CAP 3618 wheels up at 15 after the hour”



Report in Grid

- “in Grid” can mean
 - Actually in assigned grid
 - Starting your route search
 - On assignment as HIGHBIRD
 - At assigned location

“Medford Communications this is CAP 3618
in Grid 45 15.5 123 14.6”

HIGHBIRD



- You are HIGHBIRD when you are in position to perform as HIGHBIRD
- You must announce your transition
“CAP 3626 is in position and assuming HIGHBIRD”



OPS Normal

- Operations Normal reports every 30 minutes
 - Any communications with the ICP will reset the timer
 - Always give you location coordinates
- “Bend Communications this is CAP 3618
OPS Normal 45 15.5 123 14.6”

Return to Base (RTB)



- Contact communications when you are disengaging from your assignment and returning to base

“Aurora Communications, this is CAP 3618
RTB location 45 15.5 123 14.6”



Wheels Down

- Report your wheels down status as soon as possible.
- Typically use TAC1 for this report if you are landing at the search base.

Troubleshooting

**What to do when things do not
work like they should**

Topics



- Basic problems at startup
- I hear them but they do not hear me



Basic problems at Startup

- Radio does not turn on
 - Check all power connectors and wires for breaks or damage
 - Check that there is power going into the power wires
 - For mobile EFJ radios, many require the ignition to be on or in accessory (small flat connector needs power)

I hear them but they do not hear me



- Basic

- Could be any number of issues
- Check that the red transmit comes on when you key the microphone
 - no red light, radio is not transmitting or has low voltage
 - Needs repair or better power.
- Check antenna and connections – loose, corroded, etc. Fix and retry.

I hear them but they do not hear me



- Repeaters

- Check that you can hear the repeater – green light comes on and you hear a response from the repeater.
- No response, you are not accessing the repeater. Make sure that you are on the correct channel for the repeater you want to use.
- You may be farther away from the repeater than the other station.
 - Repeaters “hear” better and transmit further than base/mobile/HTs
 - You may be out of luck at your location

I hear them but they do not hear me



- Repeaters

- You and the other station are accessing different repeaters with the same output frequency (odds and evens)
 - You can hear both repeaters and they can only hear the one that they have selected.
 - Always identify the repeater you are transmitting on
 - Try switching to the other repeater
 - Both stations should be on channel normal (selective squelch off on EFJ radios [C/S or SEL SQ])
 - You may be out of range

I hear them but they do not hear me -



Simplex

- You may be too far away from the other station
 - Check that you are transmitting on high power (TX PWR)
 - Try to move to a higher/better location
 - You may be out of luck at your location

I hear them but they do not hear me

– Aircraft Radio



- You are hearing both a guard channel and a main channel but you are transmitting on the wrong channel (guard vs main)
 - Make sure that you are transmitting on the channel you think you are communicating on



Lost Contact

- Make sure that your radio is working properly
- Return to the last location where you had contact

Interoperability



Oregon SAR Channels

- Used pursuant to an MOU with the Oregon Office of Emergency Management.
- Used during Oregon SAR incidents and training for interoperability with other SAR resources.
- May not used for internal CAP communications except as necessary when already being used on an actual incident or training activity.
- Naming - (ORSAR color) and NA SAR FM

Oregon SAR Channels



Display	Description	Frequency
OR SAR BRN	OR SAR BROWN Training - Mission overflow	155.7975
OR SAR ORG	OR SAR ORANGE OR SAR Primary Channel	155.8050
OR SAR GRN	OR SAR GREEN Mission overflow	155.8125
OR SAR PRP	OR SAR PURPLE Training - Mission overflow	155.1525
OR SAR YLW	OR SAR YELLOW Mission overflow	155.1675
NA SAR NFM	National SAR channel and WA State SAR channel	155.1600

Cross Repeater Operation



Cross Repeater Operation

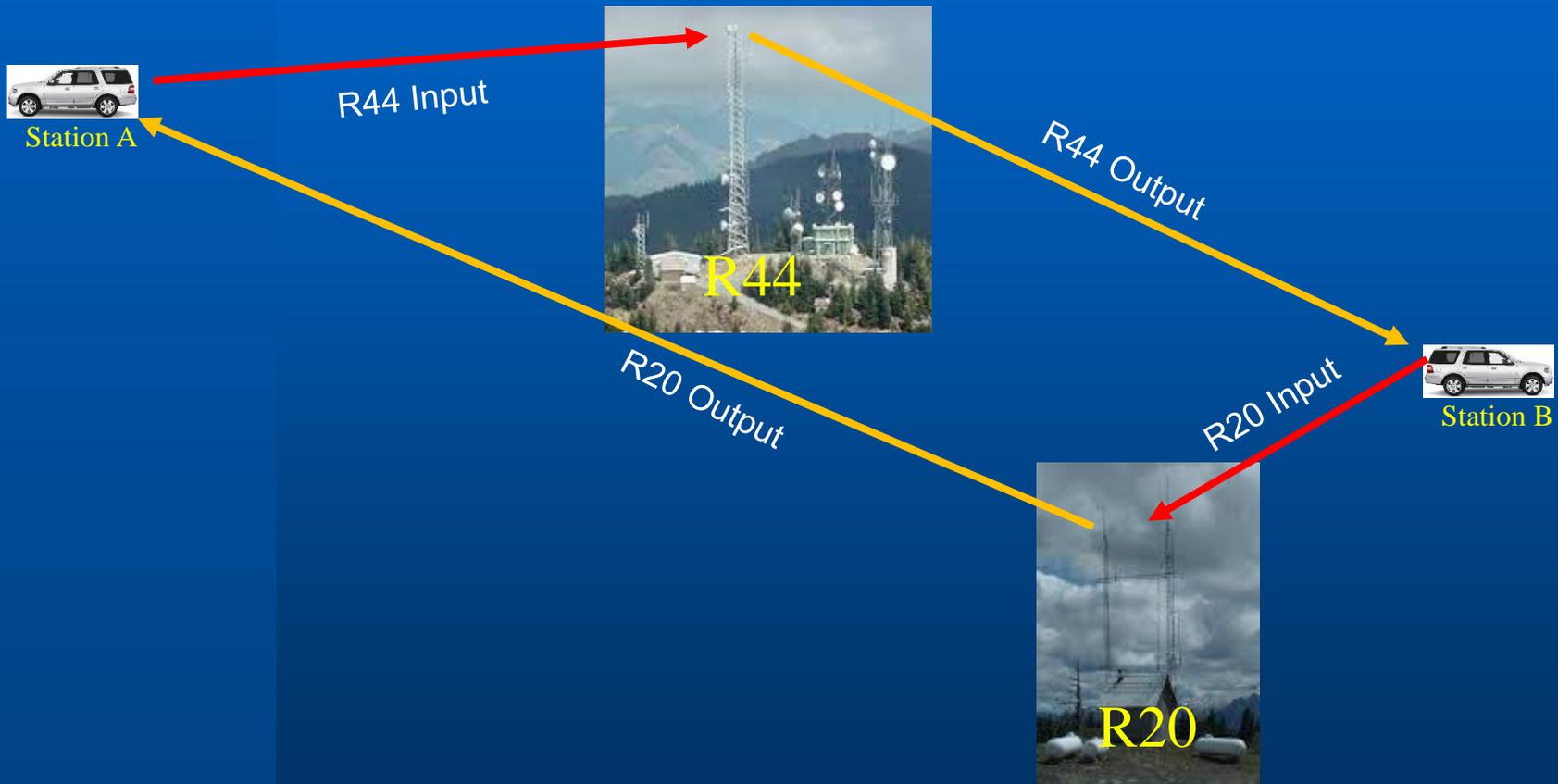
- Defined as when two (or more) stations, each using a different repeater, communicate with each other.
- All repeaters need to have the same output frequency (odd [3, 21, 31, or 37] or even [20, 24, 38, 44 & 48])
- All stations need to be on normal squelch (SELSQ “SQ NORMAL” on EFJs)

How/Why Does This Work?



- Repeaters are on mountain tops and can transmit much farther than a mobile/airborne/handheld radio
- So, the repeater can be heard farther away than the listening station can transmit
- This “problem” becomes an asset!

This is How It Works!



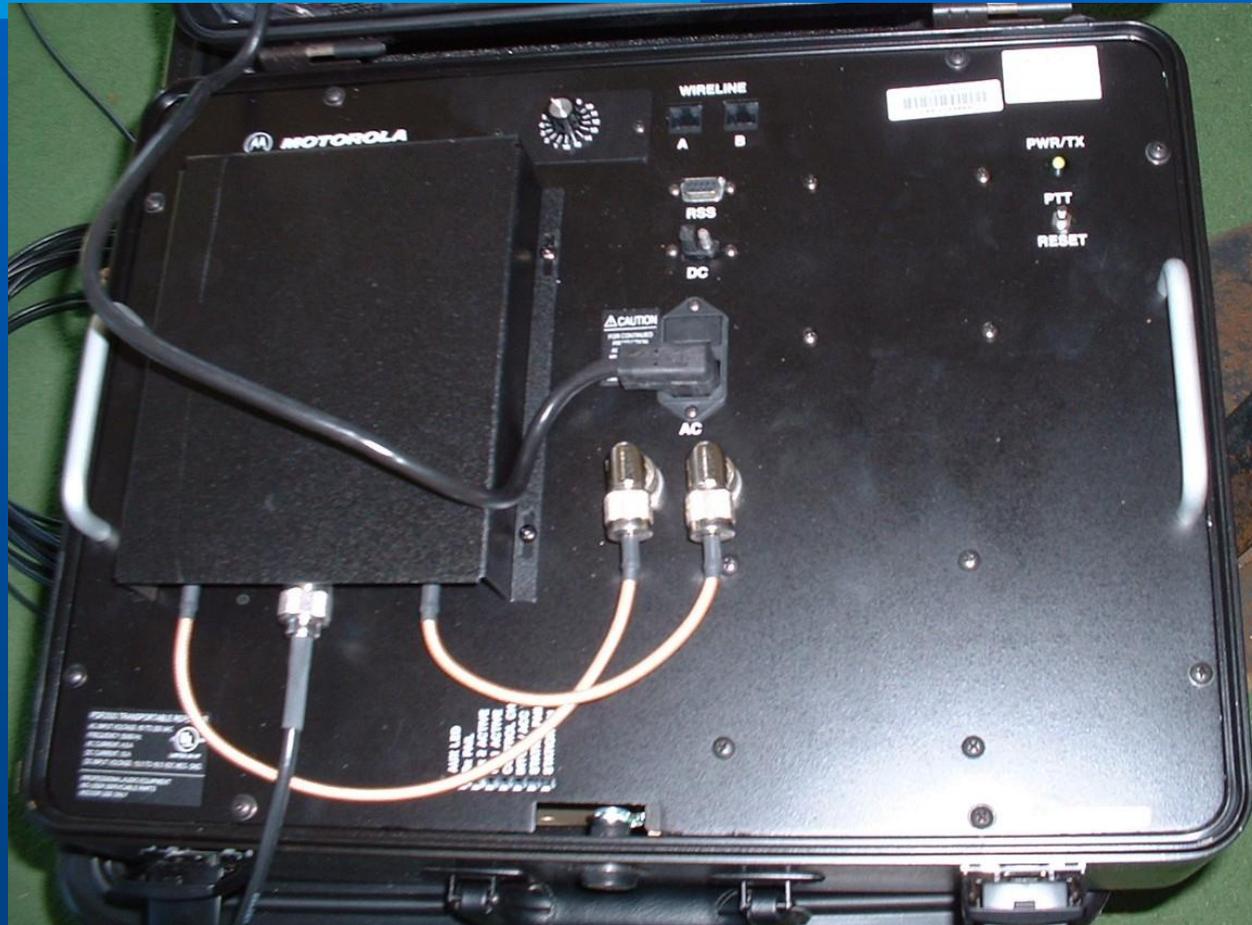


Procedures

- Always identify the repeater you are transmitting to
- Announce that you are using “Cross Repeater”
- Let the repeater “drop out” before transmitting

CAP Tactical/Airborne Repeaters

CAP Tactical Repeater



16"

20-1/2"



Features

- Can be used aboard aircraft
- Can be used at any ground location
- 12 VDC operation
- 110 VAC operation
- Plugs directly into aircraft system for airborne use
- Size: 16" x 20.5" x 8" once installed



Cover Removal

Cover can be removed by moving in direction of arrow



The hinges will unlatch



Included Items

- Antenna with magnetic mount
- Various AC / DC power cables
- Keys for locking the case when left in any insecure location.

Cover Inside



Antenna

Accessories

DC Power Cables

AC Power Cable

REPEATER CHANNELS			EF Johnson (Interim)	
Airborne (10W)	Land-base (25W)	Frequency Designator	Z1 (RXX)	(RXXP)
1	7	R63 or R63P	Ch 13	Ch 13
2	8	R64 or R64P	Ch 14	Ch 14
3	9	R67 or R67P	Ch 9	Ch 9
4	10	R68 or R68P	Ch 10	Ch 10
5	11	R69 or R69P	Ch 11	Ch 11
6	12	R70 or R70P	Ch 12	Ch 12

Cover Inside



Removable Plug
for Antenna & Power Cable
exit when cover is on.

Accessories



AC Power Cable



DC Power Cable for Battery Connection



Antenna



Aircraft DC Power Cable



Aircraft Antenna Cable



Repeater Case Keys



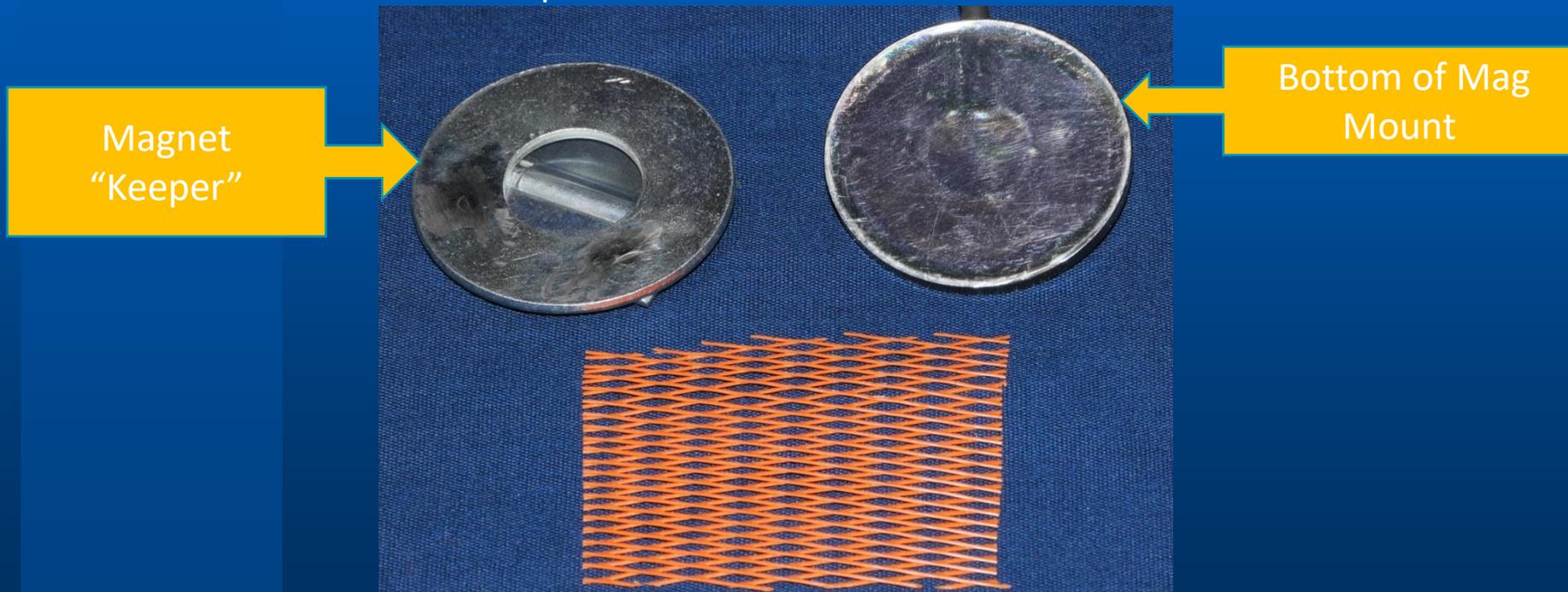
Antenna Magnetic Mount





Mag Mount

In order to reduce magnetic effects to aircraft compass and carry-on computers, a magnet "Keeper" should be placed on the mag mount base when carried in aircraft. A piece of plastic or other material should be placed between Keeper and Magnetic to facilitate release of Keeper.



Mag Mount with Keeper



Connections

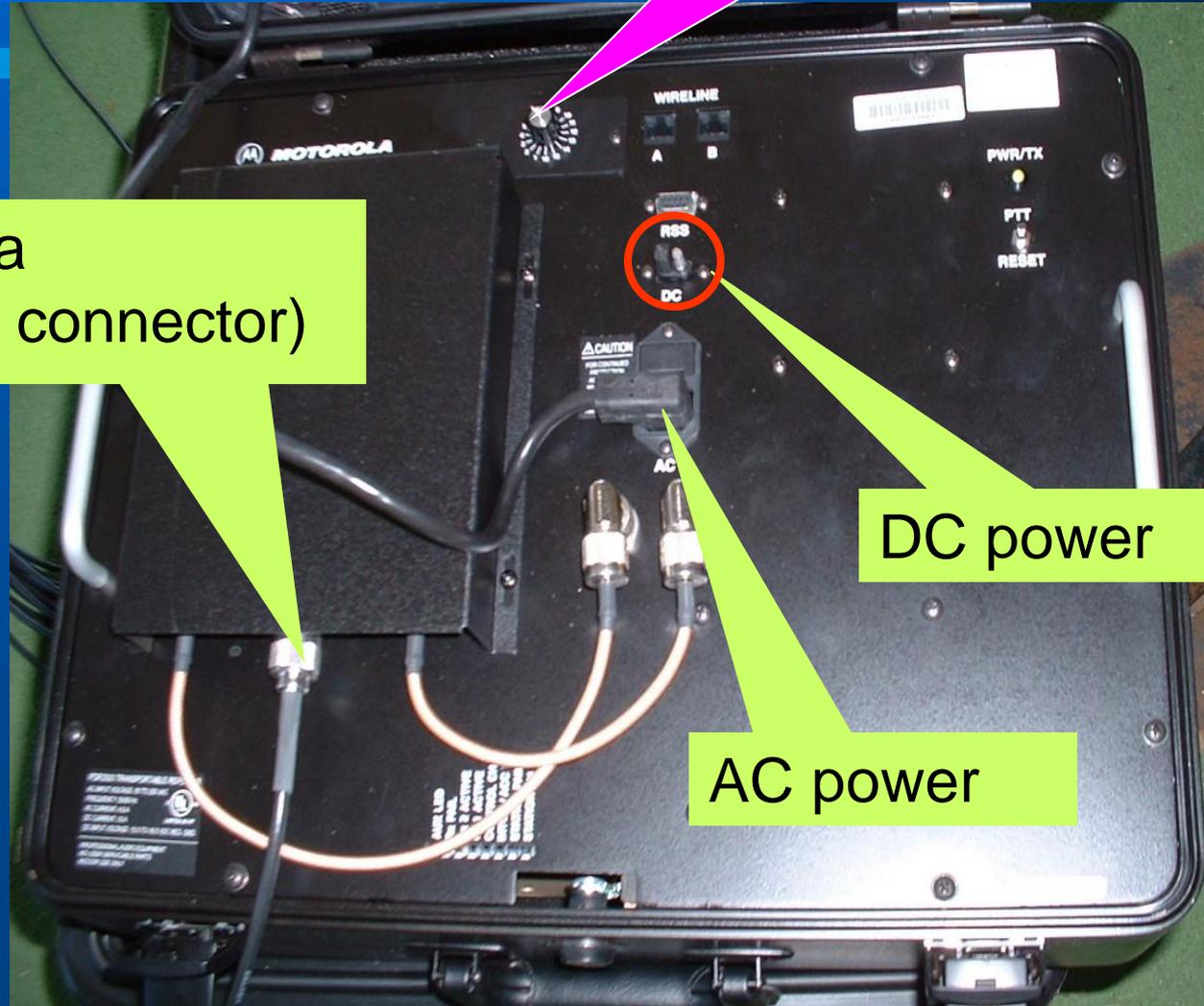


Channel selection

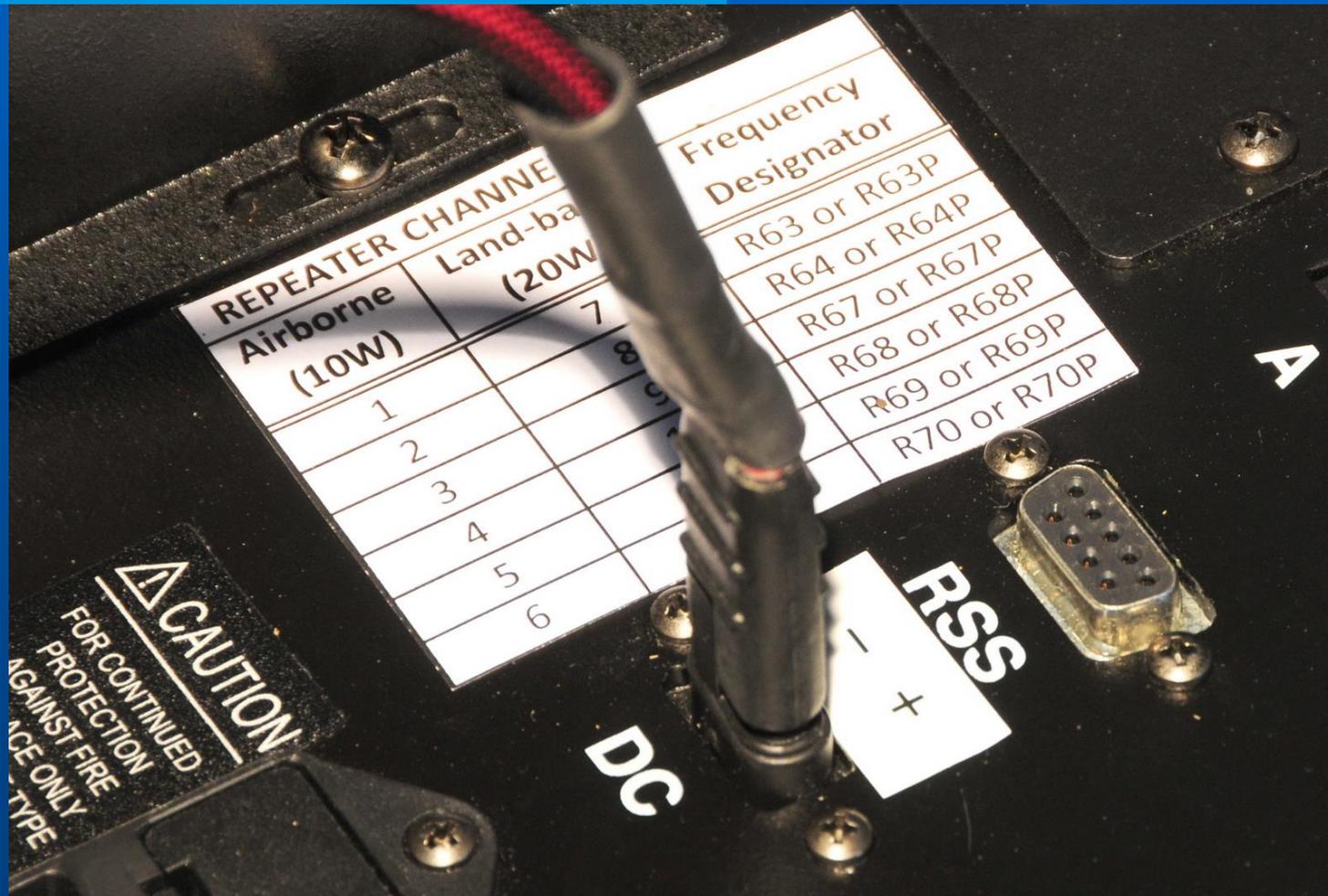
Antenna
(N-type connector)

DC power

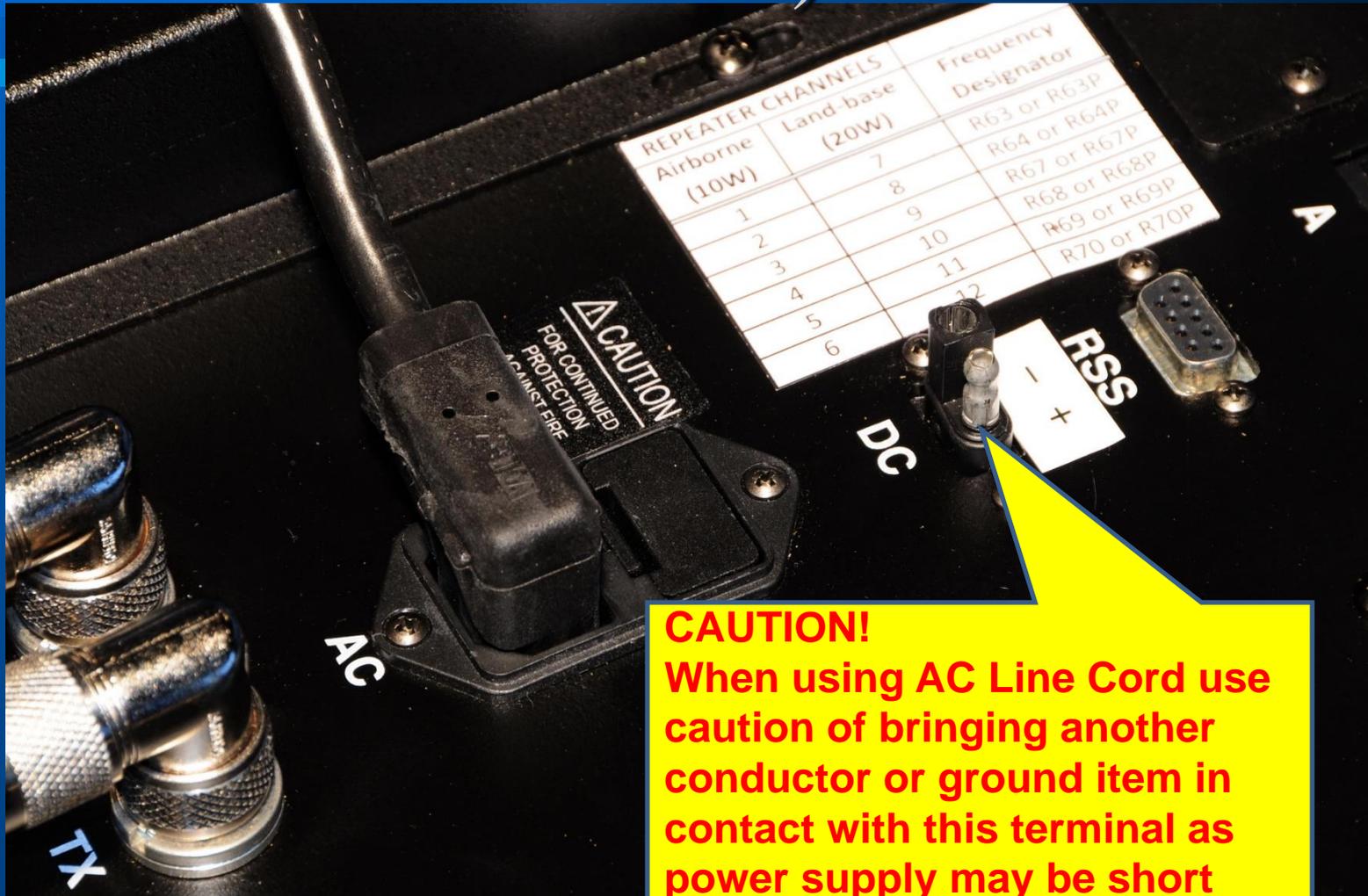
AC power



Power Connection – Aircraft cable



Power Connection – AC 120V Line Cord)

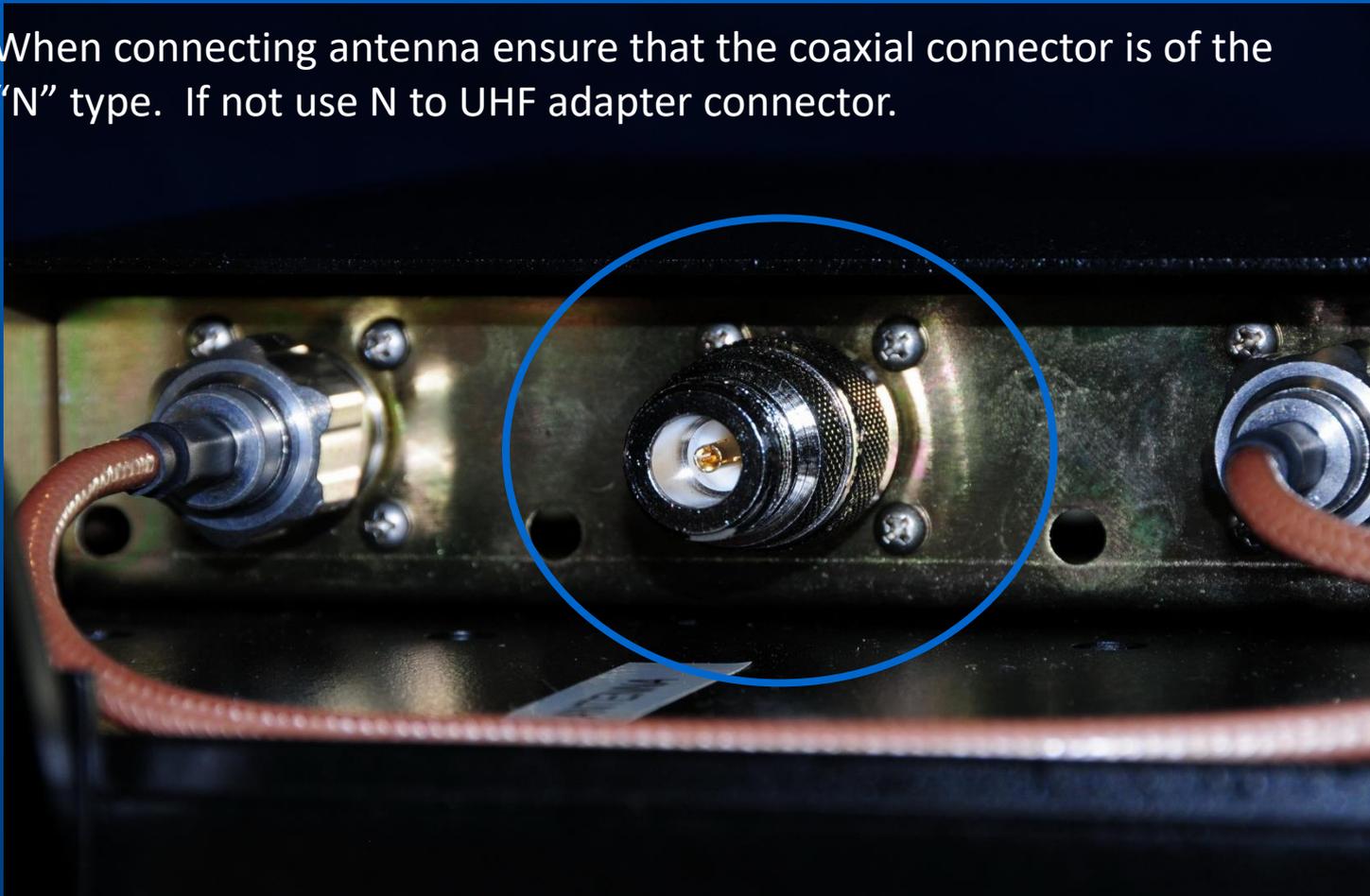


CAUTION!
When using AC Line Cord use caution of bringing another conductor or ground item in contact with this terminal as power supply may be short circuited

Antenna Connector – Type N



When connecting antenna ensure that the coaxial connector is of the “N” type. If not use N to UHF adapter connector.



Aircraft Interior



Antenna

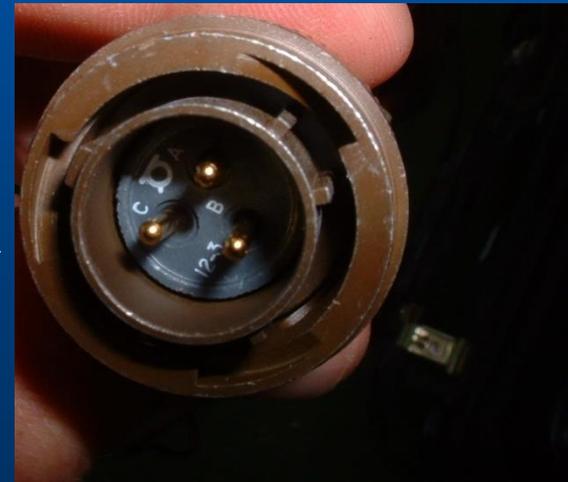
Power





Power Connection

- The unit comes with a cord for standard 110VAC outlets.
- The unit comes with a 12V cord that can be connected to an automotive battery
- The unit comes with a DC cord with this power plug that will interfacedirectly into the aircraft





This shows the “Aft Accessory Outlet” switch. This must be on for repeater to function.

Observer must remember to reactivate this after engine start

(This switch style circuit breaker and the circuit breaker panel is conveniently placed under the VHF-FM radio in this aircraft. Not all breakers are in the same location. Take time to become familiar with your particular aircraft.)



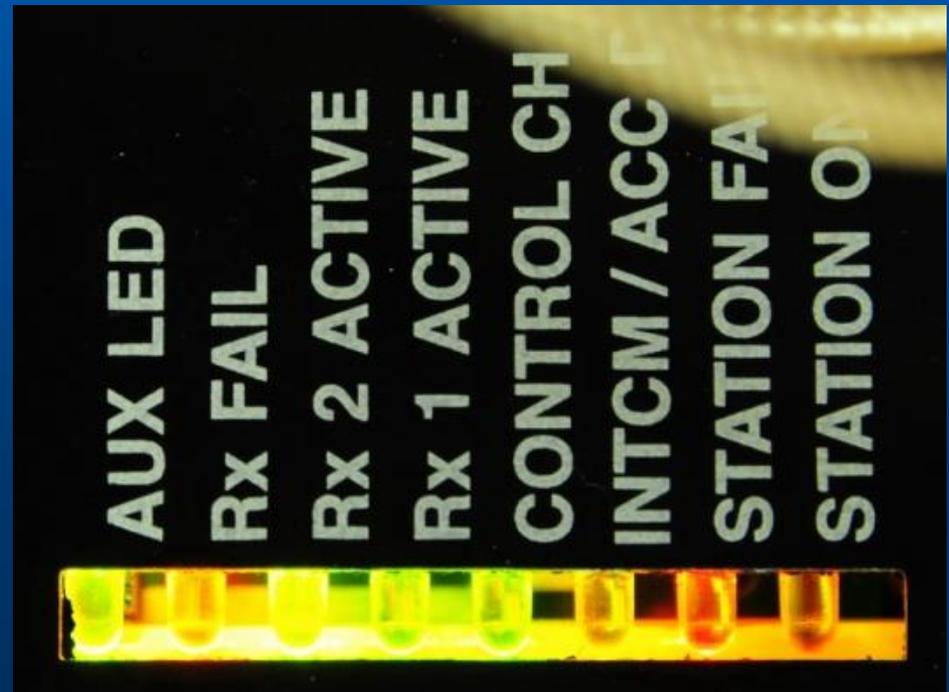
“Aft Accessory Outlet”
switch

Repeater Power Up



The Tactical Repeater has no ON/OFF switch. When power (either AC or DC) is applied to the repeater it will begin the power-up tests. Because of this, the **ANTENNA MUST BE CONNECTED BEFORE POWER IS APPLIED.**

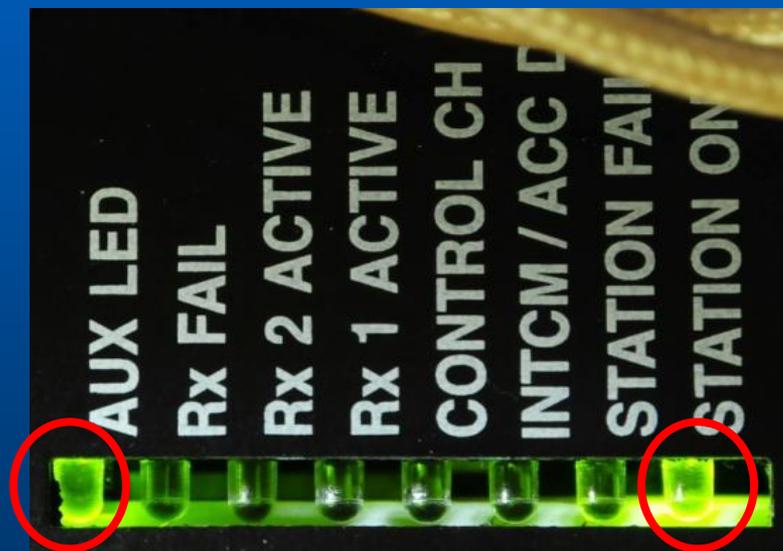
When power is initially applied the status LEDs will turn on as shown.





Repeater Power Up

After the power-up tests are complete (which takes approximately 41 seconds) the **AUX LED** indicator (far left) will be **flashing green** and the **STATION ON** LED (far right) will be a **steady green**.



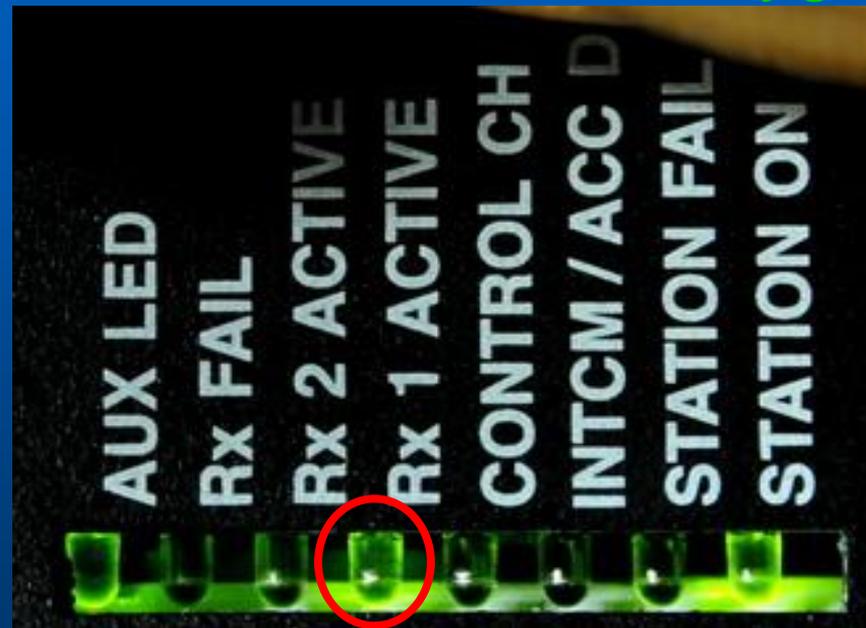
Flashing
Green

Steady
Green



Repeater Power Up

When the repeater is receiving an incoming signal, the Rx 1 ACTIVE LED will be **steady green**



**Steady
Green**



Repeater Power Up



When the repeater has power a **Green** LED below **PWR/TX** will be lit.

When the repeater is transmitting this **Green** LED will turn to **Red**.

Power (either AC or DC) is applied to the repeater

Red LED indicates repeater is transmitting. This is caused either by the repeater receiving a properly encoded signal or by a manual test of the repeater.



A manual test is accomplished by moving the Momentary **PTT/Reset** Switch to the “PTT” position. Releasing the **PTT/Reset** Switch returns the repeater to normal position.

Simple set-up, select channel



Airborne: Use ONLY channels 1 through 6

Ground: Use channels 7 through 12



Channels 13-16 are vacant

Channel selection may be either before or after power-up



Channels Explained

- The only difference between Airborne Channels 1 through 6 and Ground Channels 7 through 12 is the Transmit Power of the repeater.
- Regulations limit the transmit power aboard
- aircraft.
- The zone/channel used in the ground radio remains the same whether the repeater is on Channel 1 or on Channel 7.



Tactical Repeater Channels

- Airborne Use Channels @ 10 Watts
- CH 1 R-63
- **CH 2 R-64**
- CH 3 R-67
- CH 4 R-68
- CH 5 R-69
- CH 6 R-70
- Ground Use Channels @ 25 Watts
- CH 7 R-63
- **CH 8 R-64**
- CH 9 R-67
- CH 10 R-68
- CH 11 R-69
- CH 12 R-70



Ground-Based Use

- This can be placed atop (e.g.) tall buildings or other elevated structures with access to power to temporarily service an area. An external antenna/mount would be required.
- The unit is weather-resistant, having a protected entry point for the coax and power, hence could be left outdoors for limited periods of time.
- In this use, it must be protected against theft, et al

THE END



➤ Questions