

West Kootenay Amateur Radio Club

West Kootenay Amateur Radio Club Training

WKARC Training Reference Material

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WKARC Training

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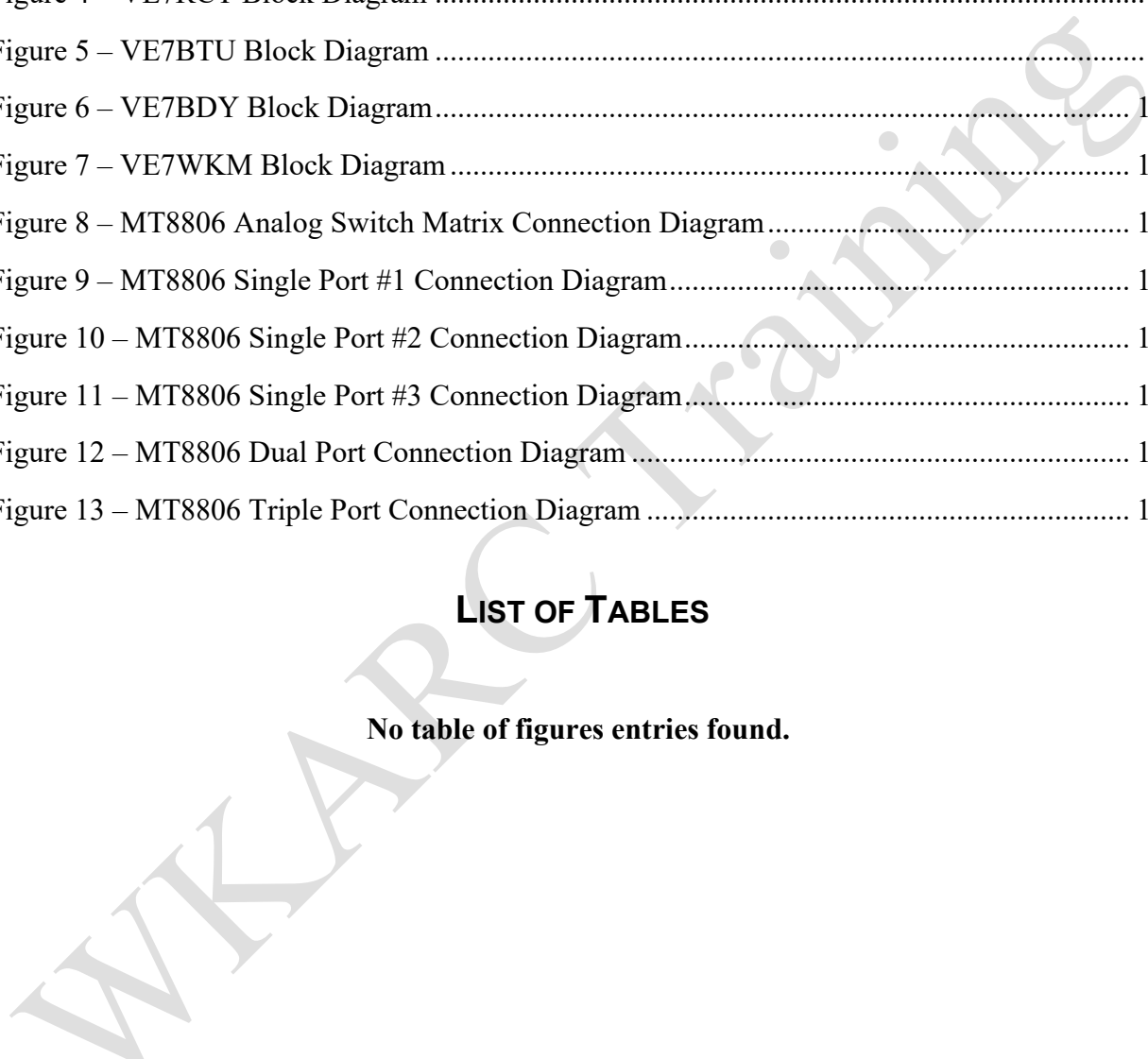
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1. INTRODUCTION

This document is used as reference material for the WKARC technical training sessions.

It explains what a radio repeater is, and its fundamental components. It will explain the WKARC's repeater systems, their components and how they are connected. There is a discussion regarding how the ARCOM RC210 repeater controller works, and how it controls a repeater.

2. WHAT IS A RADIO REPEATER?



The above pictures show the BridgeCom BCR-50V stand-alone repeater which is used at the Crawford Bay Site. The BCR-50V repeater can be used by itself (stand-alone) or with an external controller. A Radio Repeater consists of the following components:

1. Receiver
2. Transmitter
3. Repeater Controller
4. Duplexer
5. Coax cables and Antenna

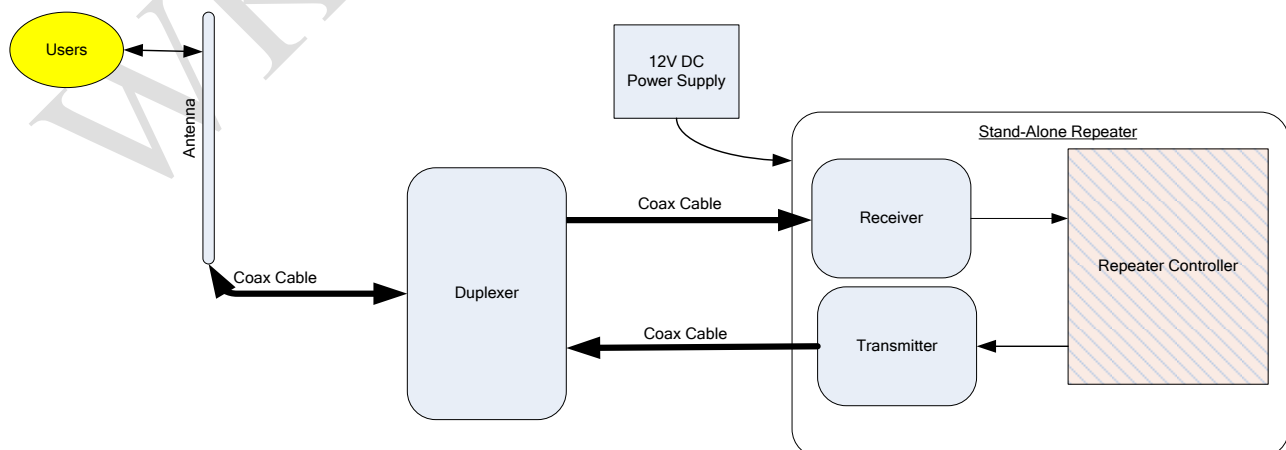


Figure 1 – Radio Repeater Block Diagram

2.1 Receiver

This component is the radio receiver which will receive the user's transmitted radio signal into the repeater. The receiving frequency **MUST** be different (referred to as the **OFFSET**) from the transmitter's frequency for the repeater to work in a full-duplex mode. Full-Duplex mode means that it will receive at the same time it is transmitting.

Typical Transmit/Receiver OFFSETs used:

2M Band: +/- **600 KHz**
70cm Band: +/- **5 MHz**

2.2 Transmitter

This component is the radio transmitter which is used to transmit the user's RF signal to the antenna. It will re-transmit the user's input RF signal, but at a different frequency from the RF signal that the user is transmitting on. The transmitting frequency **MUST** be different (referred to as an **OFFSET**) from the receiver's frequency for the repeater to work in a full-duplex mode. Full-Duplex mode means that it will receive at the same time it is transmitting.

2.3 Repeater Controller

This component is what connects the Receiver with the Transmitter. It can be built-in for some commercial repeaters, or it can be an external controller like the RC210. Without the controller, you would only have a receiver and a transmitter that would typically never go into transmit mode.

For WKARC usage, the internal repeater controller is disabled (if possible) and the external RC210 repeater controller is then used. An exception to this is the Mount Lavina site which uses the default built-in Daniels Electronics AC-3x controller. *(May change summer 2023)*



Figure 2 – ARCOM RC210 Repeater Controller

2.3.1 Audio Connection Paths

The radio repeater controller will internally connect the receiver's recovered audio and use it for the transmitter's modulation signal. This is the basic function of any radio repeater. See the diagram below:

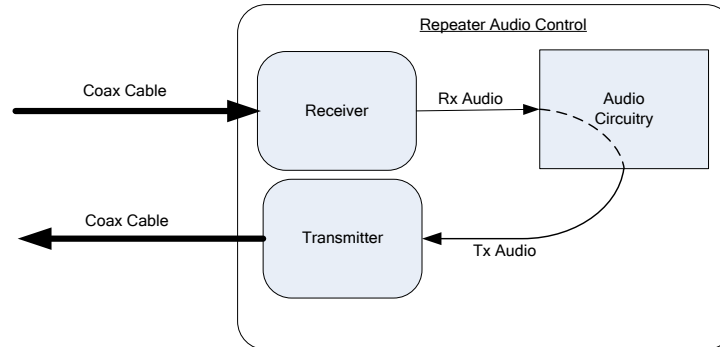


Figure 3 – Repeater Audio Path Block Diagram

2.4 Duplexer

The Duplexer is the device which combines the user's receive and transmit RF signals from/to the antenna and splits them for the repeater's separate receiver and transmitter module RF connections.

The Duplexer is a metal tuned RF cavity device. It is responsible for the following:

- Pass the repeater's transmit RF signal to the antenna, AND REJECT the user's receive RF signal from entering the repeater's transmitter path.
- Pass the user's transmitted (receive) RF signal from the antenna, AND REJECT the repeater's transmit RF signal from entering the repeater's receiver path.

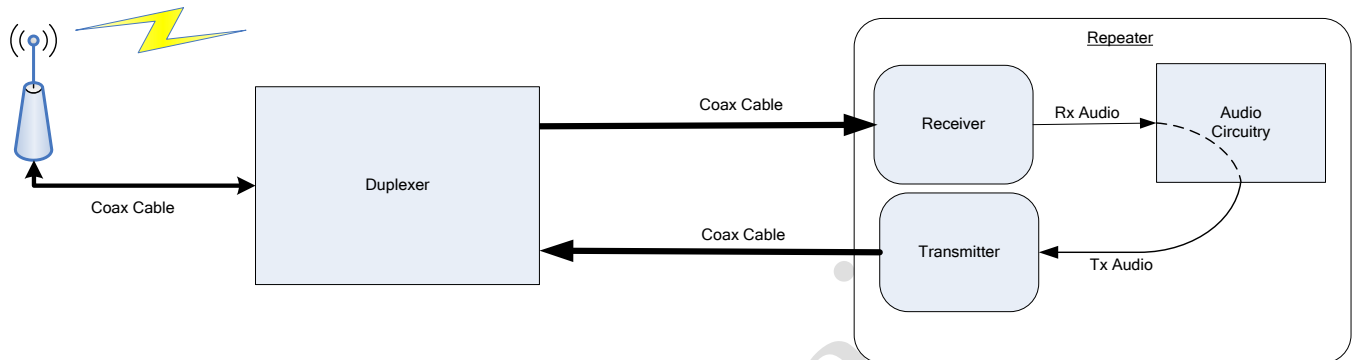
WKARC uses the Sinclair six cavity duplexers at the Slocan Ridge Site, and at the Crawford Bay site. These duplexers provide at least 90db of RF signal rejection to the opposite RF path side.



2.5 Coax Cables and Antenna

There are 3 coax cables that connect the radio repeater to the duplexer and the antenna.

- Duplexer LOW PASS side (uses lower frequency) to the Repeater (Rx or Tx)
- Duplexer HIGH PASS side (uses higher frequency) to the Repeater (Tx or Rx)
- Duplexer to the ANTENNA



3. WKARC REPEATER SITE CONFIGURATIONS

3.1 VE7RCT Slocan Ridge Configuration

The following diagram shows the VE7RCT repeater system. It consists of the RC210 repeater controller connected to 3 repeaters/radios; Port 1 and 2 radios are full-duplex repeaters, and Port 3 is a simplex mobile radio.

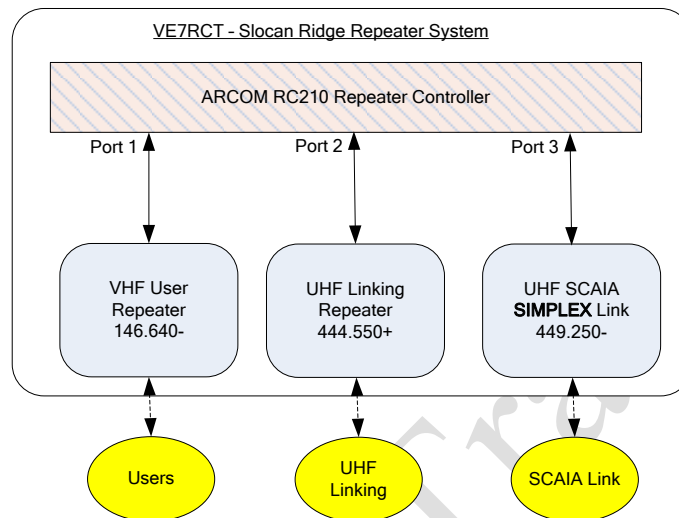


Figure 4 – VE7RCT Block Diagram

3.2 VE7BTU Crawford Bay Configuration

The following diagram shows the VE7BTU repeater system. It consists of the RC210 repeater controller connected to 2 repeaters/radios; Port 1 radio is a full-duplex repeater, and Port 2 is a simplex mobile radio.

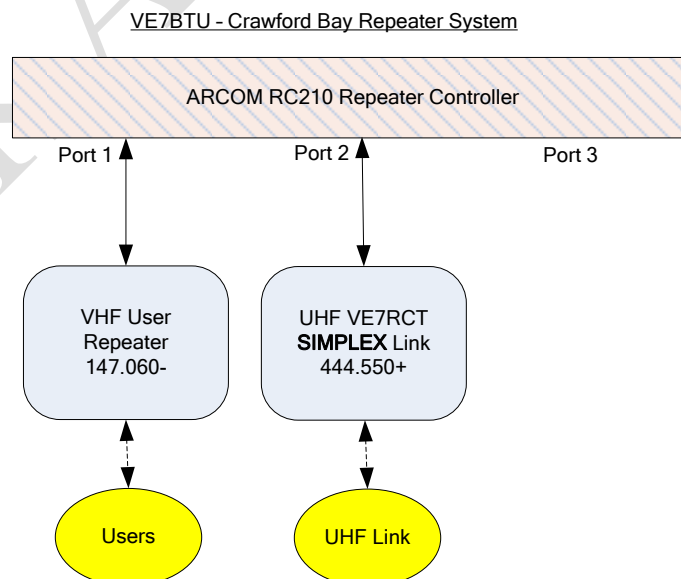


Figure 5 – VE7BTU Block Diagram

3.3 VE7BDY Taghum Configuration

The following diagram shows the VE7BDY repeater system. It consists of the RC210 repeater controller connected to 2 repeaters/radios; Port 1 radio is a full-duplex repeater, Port 2 is a simplex mobile radio, and Port 3 is connected to an RPi-Based AllStar Link.

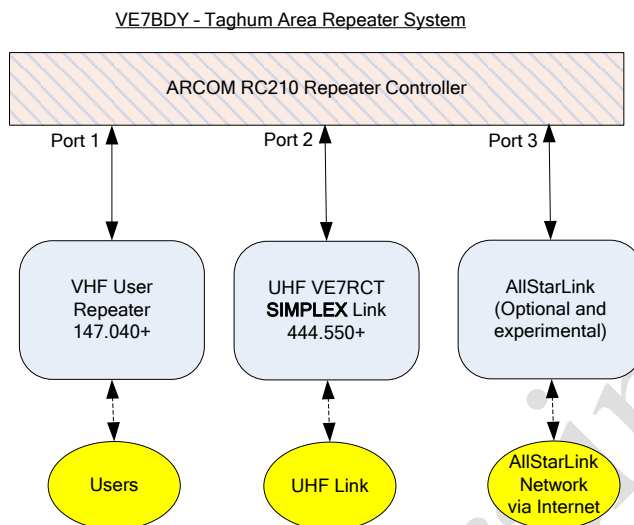


Figure 6 – VE7BDY Block Diagram

3.4 VE7WKM Mount Lavina Configuration

The following diagram shows the VE7WKM repeater system. It consists of the Daniels MT-3 Radio modules, contained in the Daniels sub-rack. It uses a fixed internal repeater controller connected to 2 internal Tx/Rx radio modules. First Tx/Rx radio module pair is a full-duplex VHF repeater, and the second Tx/Rx radio module is *acting as* a simplex UHF radio link.

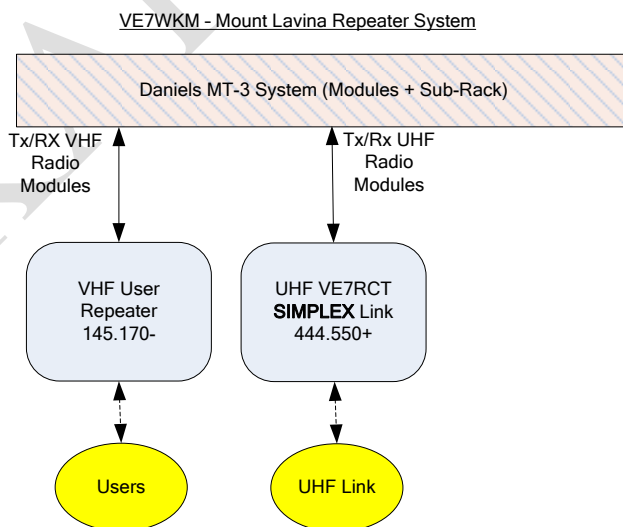


Figure 7 – VE7WKM Block Diagram

3.5 RC210 Linking Commands for WKARC Sites

The DTMF user codes listed below are current as of Nov 26, 2022. They are subject to change; possible changes may come in Summer 2023.

3.5.1 Slocan Ridge VE7RCT 146.640-

DTMF Code	Description
760#	Link VHF (Port 1) to SCAIA (Port 3) ON
761#	Link VHF (Port 1) to SCAIA (Port 3) OFF
762#	Link VHF (Port 1) to UHF Hub 440.550+ (Port 2) ON
763#	Link VHF (Port 1) to UHF Hub 440.550+ (Port 2) OFF
764#	Link UHF (Port 2) to SCAIA (Port 3) ON
765#	Link UHF (Port 2) to SCAIA (Port 3) OFF
766#	Link ALL Ports ON
767#	Link ALL Ports OFF

3.5.2 Crawford Bay VE7BTU 147.060+

DTMF Code	Description
662#	Link VHF (Port 1) to UHF Hub 444.550+ (Port 2) ON
663#	Link VHF (Port 1) to UHF Hub 444.550+ (Port 2) OFF

3.5.3 Taghum VE7BDY 147.040+

DTMF Code	Description
772#	Link VHF (Port 1) to UHF Hub 440.550+ (Port 2) ON
773#	Link VHF (Port 1) to UHF Hub 440.550+ (Port 2) OFF
774#	AllStar Link connection (ON) to VHF port
775#	AllStar Link disconnect (OFF) from VHF port
776#	AllStar Link connection (ON) to UHF port
777#	AllStar Link disconnect (OFF) from UHF port
798#	Connect all Ports
799#	Disconnect all Ports

3.6 RC210 Firmware

All the WKARC repeater sites that use the ARCOM RC210 repeater controller, use custom firmware developed by Lane, VE7IHL. It contains a subset of the functionality of the original ARCOM written RC210 firmware, intended for use with WKARC repeater systems. Functional enhancements have been made to the design of this firmware to increase its robustness to failures that may have previously occurred during power bumps and outages.

4. RC210 RADIO PORT LINKING

The RC210 repeater controller can control up to 3 radios; each radio can be full-duplex (repeater) or a simplex (link) radio. The following sections describe how the RC210 controller performs internal radio audio linking.

4.1 Internal Radio Audio Links

To perform radio port linking, the RC210 will connect the various internal audio paths as required to connect radio port(s) receiver audio to radio port(s) transmit audio. The RC210 also controls each radio ports PTT transmit start line.

Internally the RC210 controller has an analog switch array IC, the MT8806. The MT8806 under firmware control of the RC210's MCU, can connect any of its 8 analog inputs, to any of its 4 analog outputs. The MT8806 analog (*think audio signals*) connections are shown in the table below:

MT8806 Input Pin:	RC210 Internal Audio Connection:
Y0	Radio Port #1 Rx Audio
Y1	Radio Port #2 Rx Audio
Y2	Radio Port #3 Rx Audio
Y3	Speech IC Audio Output
Y4	CW/Tone Audio Output
Y5	Aux #1 input (not used)
Y6	Aux #2 input (not used)
Y7	Aux #3 input (not used)

MT8806 Output Pin:	RC210 Internal Audio Connection:
X0	Radio Port #1 Tx Audio
X1	Radio Port #2 Tx Audio
X2	Radio Port #3 Tx Audio
X3	Speech IC Audio Input

The MT8806 allows various analog (*think audio*) connections to this 8 x 4 analog switch array. This means that any **Y** input line can be connected to any **X** output line. This can be viewed as a *connection matrix*. See below:

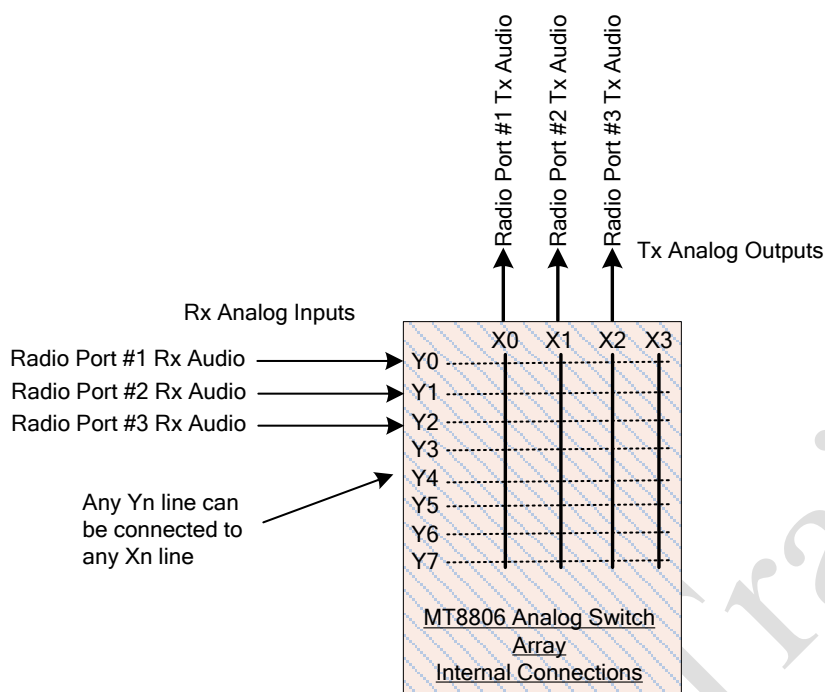


Figure 8 – MT8806 Analog Switch Matrix Connection Diagram

Normal repeater Port #1 linking will then link the Y0 input analog signal to the X0 analog output line. For normal repeater operation on any of the radio ports, it will link the repeater ports **Yn** analog input signal to the repeater ports analog **Xn** output line. See the table below:

Repeater Port:	MT8806 Input Pin:	MT8806 Output Pin:
1	Y0	X0
2	Y1	X1
3	Y2	X2

To link repeater ports together, the MT8806 audio switch array is setup to have each of the participating repeaters analog transmit inputs (*modulation*) connected to multiple radio ports receive analog input signals.

4.1.1 MT8806 Audio Linking a Single Repeater Port

Radio Port #1:

The diagram below shows connecting a repeater on Radio Port #1 only.

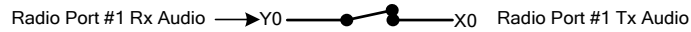


Figure 9 – MT8806 Single Port #1 Connection Diagram

Radio Port #2:

The diagram below shows connecting a repeater on Radio Port #2 only.

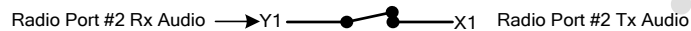


Figure 10 – MT8806 Single Port #2 Connection Diagram

Radio Port #3:

The diagram below shows connecting a repeater on Radio Port #3 only.

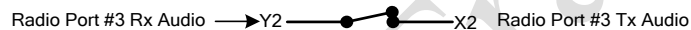


Figure 11 – MT8806 Single Port #3 Connection Diagram

4.1.2 MT8806 Audio Linking 2 Repeaters

The diagram below shows connecting a repeater on Radio Port #1 with another repeater on Radio Port #2. The analog audio switching depends on which repeater is currently receiving a signal.

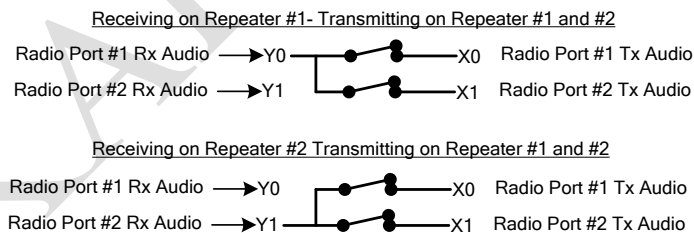


Figure 12 – MT8806 Dual Port Connection Diagram

4.1.3 MT8806 Audio Linking 3 Radio Ports

The diagram below shows connecting 2 repeaters on Radio Port #1 and Radio Port #2 with a simplex link radio on Radio Port #3. The analog audio switching depends on which repeater or simplex link is currently receiving a signal.

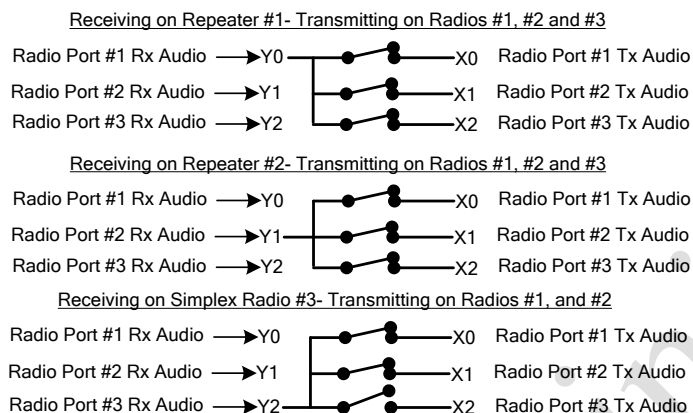


Figure 13 – MT8806 Triple Port Connection Diagram

For connecting the audio path to/from a simplex radio, the audio switching, and radio PTT (*places the radio into Transmit mode*) processing is handled by the RC210 firmware. As a simplex link radio can only receive or transmit at one time, extra processing is required.

5. USAGE OF SIMPLEX RADIOS FOR LINKING

A simplex radio is a mobile type of radio. It can only transmit or receive, but not at the same time. When a simplex radio is used for linking to another repeater system, while it is receiving and driving other RC210 radio ports, **it cannot go into transmit mode**. What this means is that if you hear audio coming from another linked repeater system via a simplex radio link, you will not be able to transmit back into the linked/remote repeater system **until the remote user unkeys**.

This is IMPORTANT to remember.

6. RC210 COURTESY TONES MEANINGS (BEEPS)

On each WKARC repeater system that uses the RC210 repeater controller, *Courtesy Tones* are configured to indicate to the local repeater user where the just heard audio is coming from. Courtesy Tones are generated when the user unkeys on an RC210 radio port. This allows for easy identification of which radio port the just heard user came from.

6.1 VE7RCT Slocan Ridge 146.640- Courtesy Tones

Courtesy Tone Heard	Courtesy Tone Description	Audio Comes from this radio port
(880Hz+680Hz) -100ms (450Hz) - 100msec	High Tone, then Low Tone	Radio Port #1 146.640- VHF User Repeater
(900Hz) – 75ms (900Hz) – 75ms	(2) 900Hz beeps	Radio Port #2 UHF 444.550+ Link
(1000Hz) – 75ms (1000Hz) – 75ms (1000Hz) – 75ms	(3) 1000Hz beeps	Radio Port #3 UHF 449.250+ SCAIA Link

6.2 VE7BTU Crawford bay 147.060+ Courtesy Tones

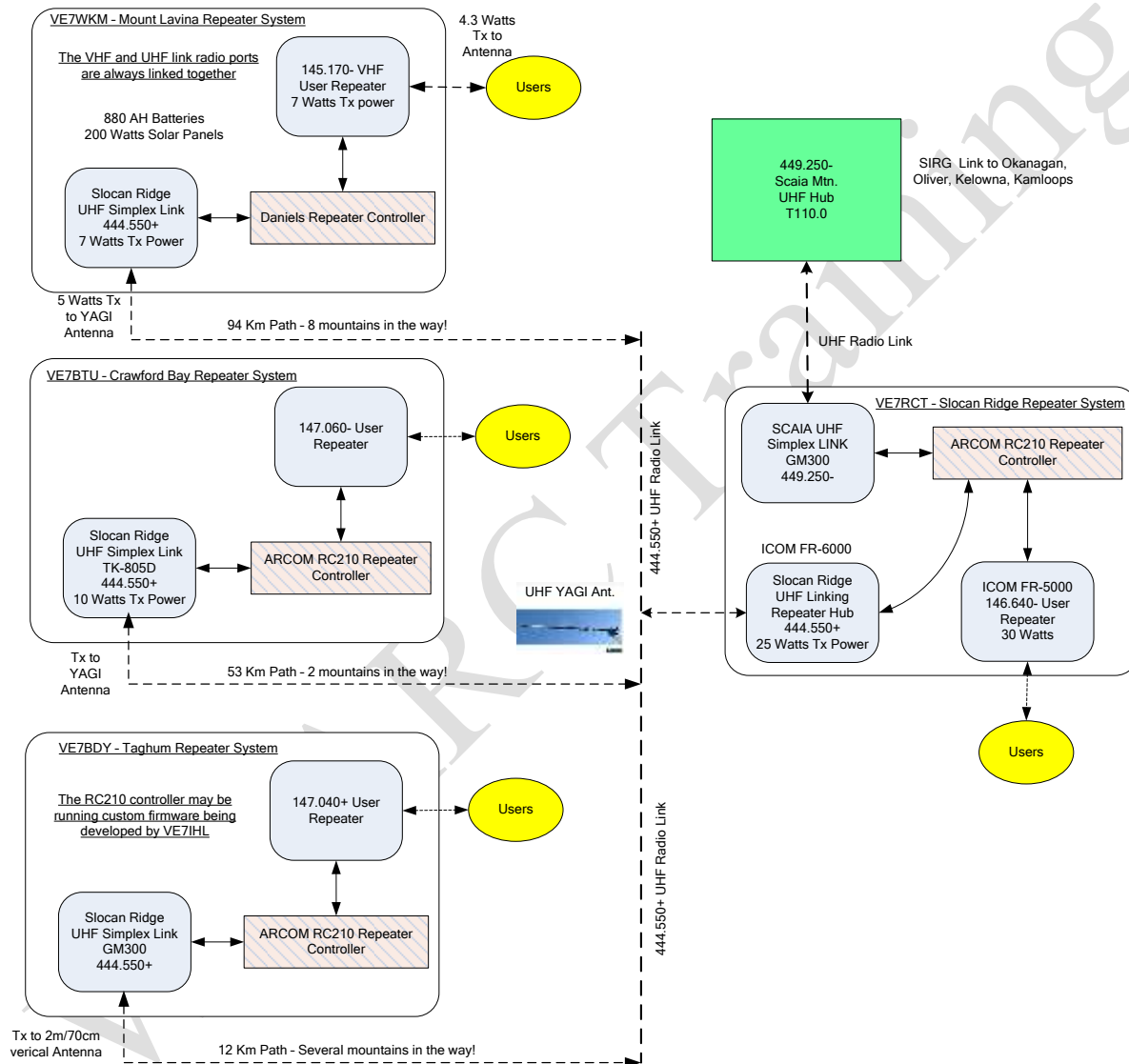
Courtesy Tone Heard	Courtesy Tone Description	Audio Comes from this radio port
(880Hz+680Hz) -100ms (450Hz) - 100msec	High Tone, then Low Tone	Radio Port #1 147.060+ VHF User Repeater
(1000Hz) – 75ms (1000Hz) – 75ms (1000Hz) – 75ms	(3) 1000Hz beeps	Radio Port #2 UHF 444.550+ VE7RCT Link

6.3 VE7BDY Taghum 147.040+ Courtesy Tones

Courtesy Tone Heard	Courtesy Tone Description	Audio Comes from this radio port
(880Hz+680Hz) -100ms (450Hz) - 100msec	High Tone, then Low Tone	Radio Port #1 147.040+ VHF User Repeater
(800Hz) – 100ms	(1) 800Hz beep	Radio Port #2 UHF 444.550+ VE7RCT Link
None	None	Radio Port #3 AllStar Link

7. WKARC MOUNTAINTOP RADIO REPEATERS LINKING

The following diagram shows WKARC's mountaintop repeaters and how they link over the UHF radio link. The Slovan Ridge VE7RCT repeater site is where the central linking occurs. The Slovan Ridge 444.550+ UHF linking repeater is used to link (connect) all the WKARC repeater sites together as desired. The 444.550+ UHF repeater can also be used as a user repeater, but it has no courtesy tones, no IDs, and no transmit hang time, so is not typically used as a user repeater.



The 444.550+ UHF radio links are implemented using commercial YAGI (log periodic) antennas, except for the VE7BDY repeater located in Taghum. It uses a 2m/70cm amateur radio vertical OMNI antenna.

8. SIRG MOUNTAINTOP REPEATER LINKING DIAGRAM

The following SIRG network diagram was prepared in OCT/2022. It is believed to be accurate.

