



DIGITAL MOBILE RADIO (DMR)

LINKING, OPERATING PRACTICES AND PROGRAMMING
KØNGA MIKE, RMHAM

TOPICS

- Basics
- Operating Practices
 - Network Linking Setup
 - Best Practices
- Programming



The background is a dark blue gradient. In the center, there are three concentric circles of increasing size, each with a lighter blue tint. The corners of the image are decorated with white, stylized circuit board traces and circular nodes, resembling a network or data flow diagram.

DMR BASICS



MIKE'S DMR DOCTRINE

If something about using DMR for Amateur Radio doesn't make sense, remember that DMR was created for commercial use, and was never designed nor intended for Amateur Radio use.



WHAT IS DMR/TRBO?

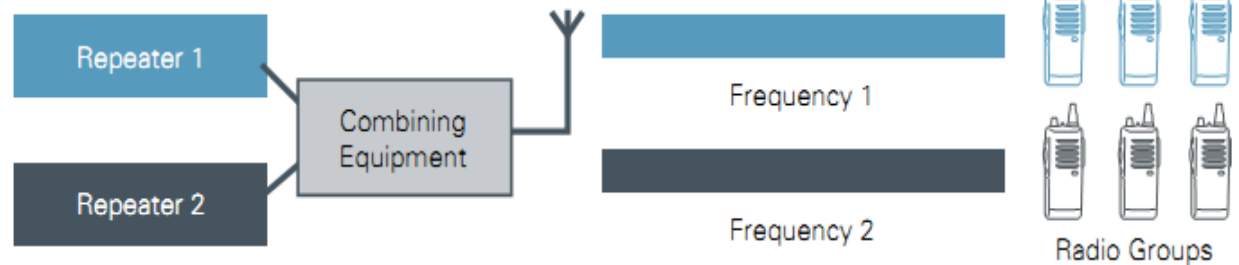
- DMR (Digital Mobile Radio) is an international commercial digital radio standard that originated in Europe*
- TRBO refers to MotoTRBO which is Motorola's implementation of the DMR standard
- Many Amateur Radio repeater networks use MotoTRBO equipment, which is why they are commonly referred to as "TRBO" networks
- You do not need to use a Motorola MotoTRBO radio to use these networks

* European Telecommunications Standards Institute (ETSI)

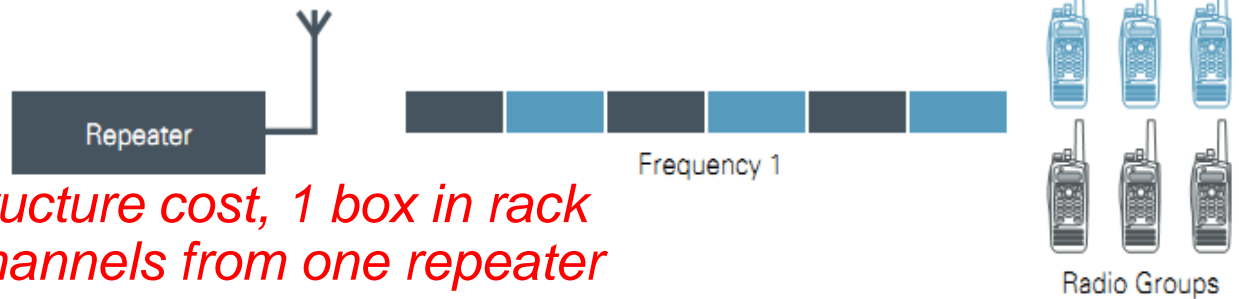
TWO REPEATERS IN ONE!

TDMA saves licensing and equipment costs by enabling the equivalent of two 6.25 kHz channels within a single licensed 12.5 kHz channel

Two-channel Analog or Digital FDMA System

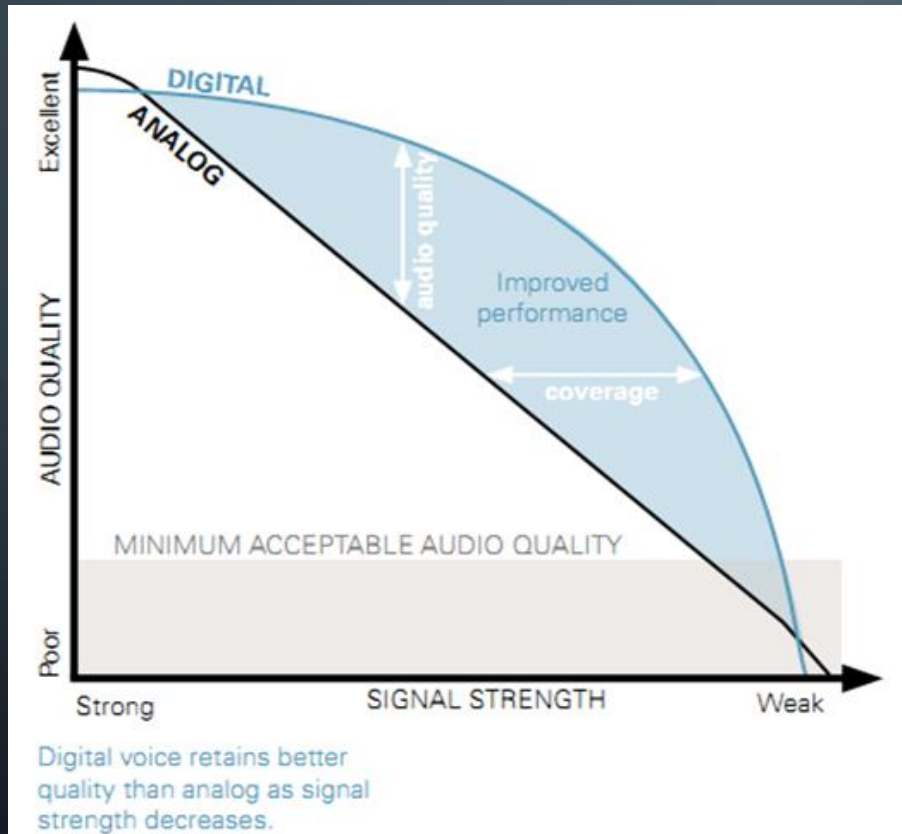


Two-channel Digital TDMA System



Lower infrastructure cost, 1 box in rack
TWO voice channels from one repeater

BETTER SIGNAL QUALITY



- No hiss, popping, or static
- Better RF range than older digital technologies
- Forward Error Correction and Cyclic Redundancy Check coders

The background is a dark blue gradient. In the center, there is a large, faint, light blue circle. The corners of the image are decorated with white line art resembling circuit boards or neural networks, with lines and small circles extending from the edges.

DMR END USER OPERATION

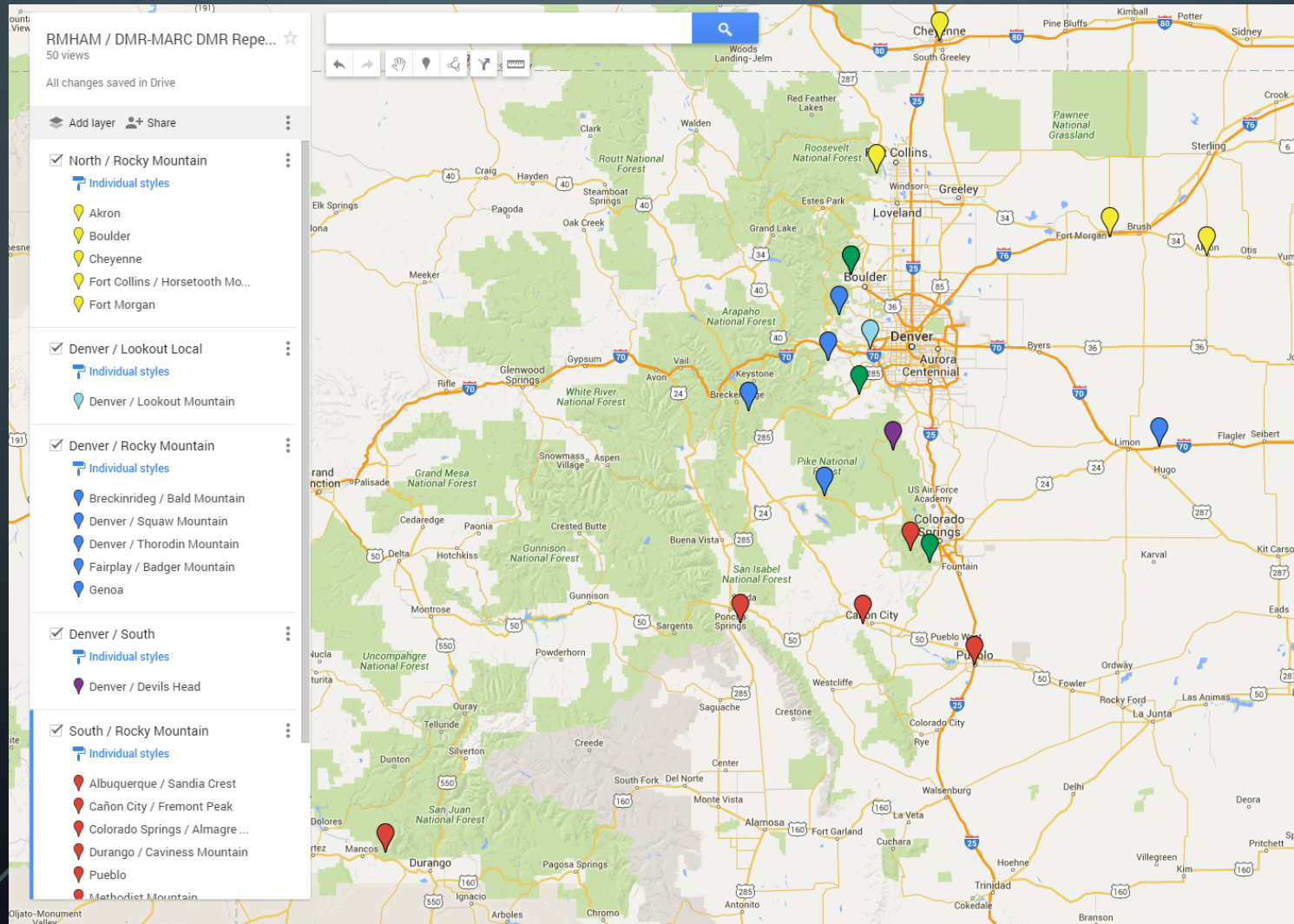
UNDERSTAND THE NETWORK

- Two major networks in Colorado
 - Rocky Mountain Ham Radio TRBO
 - DMR-MARC
- RMHAM TRBO is mostly Colorado, with some repeaters in New Mexico, Wyoming and Montana
- DMR-MARC is world-wide
- Each network will have their own Talk Groups, they own way of handling repeater slots, and sometimes operating/best practices.

RMHAM TRBO NETWORK

- Five Talk Groups: Rocky Mountain (wide), North, South, Denver, and Lookout Local
- When contacting another ham, use the smallest coverage talk group possible
- If necessary, use Rocky Mountain to make contact, then move to a smaller coverage talk group if possible
- Map: <http://bit.ly/rmham-trbo-map>

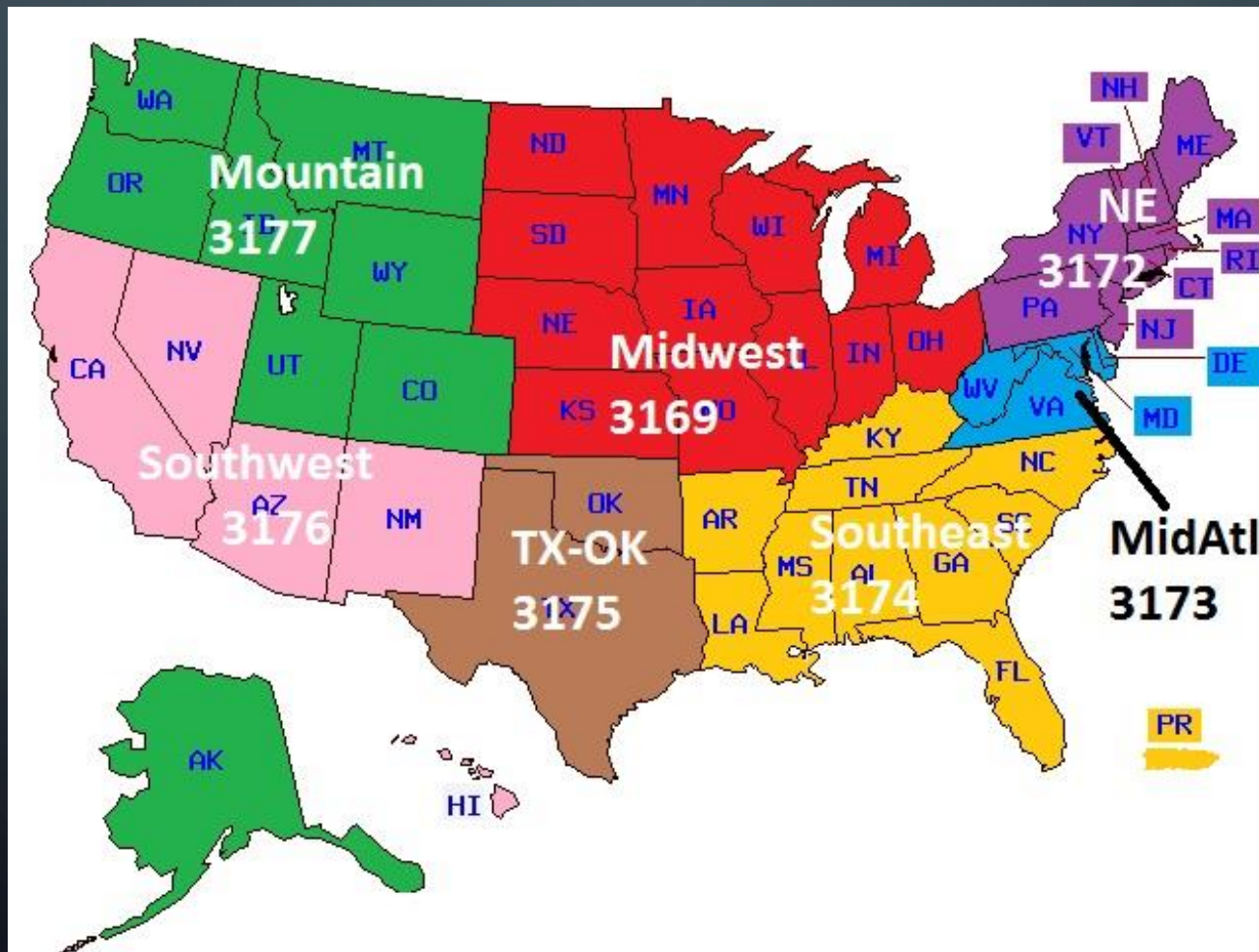
RMHAM TRBO COLORADO MAP



DMR-MARC

- World Wide, MANY talk groups
- World Wide, World Wide English, North America, Local, *US Regionals*
- Colorado is in the *Mountain* regional talk group
- Also has User Activated Talk Groups, sometimes called Tactical Talk Groups (e.g., TAC310), which are only active when you transmit on them.

DMR-MARC US REGIONAL TALK GROUPS



DMR NETS

- RMHAM TRBO Tech Net
 - First Saturday of the Month, 7:00 PM, Rocky Mountain talk group
- World Wide DMR-MARC Net
 - World Wide talk group, Saturdays, 16:00 UTC Summer, 17:00 UTC Winter
- DMR-MARC Tech Net
 - North America talk group, Thursdays, 01:00 UTC Summer, 02:00 UTC Winter (This translates to Wednesday Night in the States)

ID YOUR TALK GROUP

- When calling, identify which talk group you are transmitting on.
- “This is K-0-N-G-A on Rocky Mountain”
- Many Hams scan various channels and may want or need to turn scan off and tune to your channel to respond.
- If you don’t ID the talk group, the responding ham may not know which channel to tune to.
- BTW: Audio ID is required by FCC rule (see next slide)

GET A DMR-MARC RADIO ID

- dmr-marc.net -> Contact Us -> “I’d like a USER ID for my radio”
- Everything works best when each radio has a unique ID
- Put your Radio ID in the codeplug and upload to the radio
- Radio ID is **NOT** a replacement for ID’ing. You must still ID vocally every 10 minutes per FCC regulations.

LEVERAGE THE SAMPLE CODEPLUGS

- Available on the RMHAM Website
 - www.rmham.org
 - MotoTRBO/DMR -> Sample Codeplugs
- All RMHAM TRBO repeaters and many DMR-MARC repeaters already programmed in
- Quickest way to get on the air
- Use as a foundation for your own codeplug

AUDIO LEVELS

- Many radios allow you to increase the gain on the radio's microphone (internal and external)
- Some radios (early CS700s) needed the mic gain increased
- Don't overdo it; increase in small increments and test. Use your best judgement to increase further based on feedback from other Hams.

TALK GROUPS AND REPEATER SLOTS

- Each repeater has 2 repeater slots (time slots)
- Each slot can handle 1 conversation at a time. Thus, each repeater can handle 2 simultaneous separate conversations
- Some networks allow multiple talk groups on the same repeater slot
- Only one talk group can be transmitting at a time on a single repeater slot
- It may be necessary to monitor the other talk groups on a repeater slot to determine if the slot is free to operate on*

*For more information, attend a programming forum.

The background is a dark blue gradient with faint, light blue circuit-like patterns. These patterns consist of thin lines and small circles, resembling a stylized electronic circuit or a network diagram. The patterns are located in the corners and along the edges of the frame.

PROGRAMMING

BASIC PROGRAMMING CONCEPTS

- In order to program a DMR radio for repeaters, you must know:
 - Repeater frequencies
 - Repeater Color Code
 - Desired Talk Group/Receive Group
 - The Repeater Slot that Talk Group is on

CHANNEL EXAMPLE

Customer Programming Software - HAM2000 [Untitled.rdb] - [DCH 1]

File Edit Program Option View Tools Window Help

ACH 1 DCH 1

CS750

- Radio Information
- General Settings
 - Conventional
 - Zone
 - Channel
 - Analog Channel
 - Digital Channel
 - DCH 1
 - Scan
 - DMR Services
 - Emergency
 - Personality
 - DTMF Services
 - MDC Services
 - 2Tone Services
 - 5Tone Services
 - Smart Call

ChannelAlias: DCH 1

Digital ID: 1

Color Code: 1

Repeater/Time Slot: Slot 1

Scan List: None

Auto Scan Start: ☐

Rx Only: ☐

Talk Around: ☐

Lone Worker: ☐

VOX: ☐

Receive

Frequency [MHz]: 400.000000

Offset [MHz]: 0.000000

Ref Frequency [MHz]: Middle

Rx Group List: None

Emergency Alarm Indication: ☐

Emergency Alarm Ack: ☐

Emergency Call Indication: ☐

Transmit

Frequency [MHz]: 400.000000

Ref Frequency [MHz]: Middle

Tx Contact: Contact1

Emergency System: None

Power Level: High

Close Print Help 1 of 1

Ready CS750 400-470 MHz USB 2016-04-04 09:41:07

COLOR CODE

- DMR repeaters use a Color Code as the first access point after the receive frequency
- Color Codes are designed to allow two repeaters with the same frequency to operate effectively if they are relatively close to each other
- You must know the Color Code of the repeater in order to successfully use the repeater

CONTACT LIST

- DMR radios use a Contact List for:
 - Private Call (used for Radio IDs)
 - Talk Groups (required for most repeaters)
 - All Call (often used for simplex)
- Radios with displays will show the Radio ID of person who is transmitting
- If you have the Radio ID in your radio's Contact List, the contact name or tag will display instead of the Radio ID
- Typical contact names include call sign and name

TALK GROUPS

- Access Control (analogous to tones on analog radios) is accomplished with Talk Groups
- If a repeater uses Talk Groups, you must know which Talk Groups the repeater uses in order to use the repeater with your radio
- Talk Groups are assigned to a Repeater Slot in a repeater
- More than one Talk Group can be assigned to a single Repeater Slot, but only one Talk Group can use the slot at any given time

CONTACT LIST EXAMPLE

Customer Programming Software - HAM2000 [C:\Users\michael\CloudStation\RMHAM\Connect Systems\RMHAM_CS750_SampleCodeplug_2016-03-31_Ne...]

File Edit Program Option View Tools Window Help

Contact

CS750

- Radio Information
- General Settings
- Conventional
 - Zone
 - Channel
 - Scan
- DMR Services
 - Text Message
 - Contact
 - Rx Group List
 - Encrypt
- Emergency
- Personality
- DTMF Services
- MDC Services
- 2Tone Services
- 5Tone Services
- Smart Call

No.	Contact Name	Call Type	Call Id	Receive Tone
1	DMR MARC WW	Group Call	1	No
2	DMR MARC LCL	Group Call	2	No
3	DMR MARC NA	Group Call	3	No
4	DMR MARC WW Eng	Group Call	13	No
5	DMR MARC Simplex	Group Call	99	No
6	Rocky Mountain	Group Call	700	No
7	Lookout Local	Group Call	710	No
8	South	Group Call	719	No
9	Denver	Group Call	720	No
10	North	Group Call	721	No
11	NoCo Net	Group Call	3171	No
12	DMR MARC MTN	Group Call	3177	No
13	NR2Y Marinus	Private Call	3108001	No
14	WA2YZT Paul	Private Call	3108002	No
15	K0JSC Jeff	Private Call	3108003	No
16	N2PDQ Dirk	Private Call	3108004	No
17	KF0KR Thomas	Private Call	3108005	No
18	N0GQX Gerald	Private Call	3108006	No
19	N0VBY Mike	Private Call	3108007	No

Close Print Help

Add

Insert

Delete

Sort By Name

Sort By Id

Ready CS750 400-470 MHz USB 2016-04-04 09:49:01

RECEIVE GROUPS

- Receive Groups are how DMR radios use Talk Groups when receiving signals
- Talk Groups are assigned to Receive Groups. Receive Groups are assigned to the receive frequency on the channel in your radio.
- More than one Talk Group can be assigned to a Receive Group
 - Recommended config by DMR-MARC
 - Can cause confusion when scanning
- Remember Mike's DMR Doctrine

Customer Programming Software - HAM2000 [C:\Users\michael\CloudStation\RMHAM\Connect Systems\RMHAM_CS750_SampleCodeplug_2016-03-31_Ne...

File Edit Program Option View Tools Window Help

Contact DMR MARC WW

CS750

- Radio Information
- General Settings
- Conventional
 - Zone
 - Channel
 - Scan
- DMR Services
 - Text Message
 - Contact
 - Rx Group List
 - DMR MARC WW**
 - DMR MARC NA
 - DMR MARC WW Eng
 - DMR MARC LCL
 - DMR MARC MTN
 - DMR MARC Simplex
 - Rocky Mountain
 - North
 - South
 - Denver
 - Lookout Local
 - NoCo Net
 - Encrypt
- Emergency
- Personality
- DTMF Services
- MDC Services
- 2Tone Services
- 5Tone Services
- Smart Call

Contact List

Available

Alias
DMR MARC LCL
DMR MARC Simplex
Rocky Mountain
Lookout Local
South
Denver
North
NoCo Net
DMR MARC MTN

Add>>

<<Remove

Members

No.	Alias
1	DMR MARC WW
2	DMR MARC WW Eng
3	DMR MARC NA

Move Up

Move Dn

Rx Group List Alias: DMR MARC WW

Close Print Help 1 of 12

Ready CS750 400-470 MHz USB 2016-04-04 09:50:29

REPEATER SLOTS

- DMR repeaters have 2 “time slots” that share a frequency, allowing for two separate, simultaneous conversations
- This means one repeater can do the work of two while using less bandwidth than a single analog repeater
- You must know which Repeater Slot you wish to use in order to set up your radio (more on this later)

EXAMPLE CHANNELS

Channel	Color Code	Time Slot	Receive Frequency	Transmit Frequency	Talk Group
Squaw Colo	7	Slot 1	446.9375	441.9375	Colorado
Squaw Denver	7	Slot 2	446.9375	441.9375	Denver
Lee Hill WW	1	Slot 1	445.05	440.05	DMR MARC WW
Lee Hill WW Eng	1	Slot 1	445.05	440.05	DMR MARC WW Eng
Lee Hill NA	1	Slot 1	445.05	440.05	DMR MARC NA
Lee Hill LCL	1	Slot 2	445.05	440.05	DMR MARC LCL
Lee Hill MTN	1	Slot 2	445.05	440.05	DMR MARC MTN

EXAMPLE CHANNEL - RMHAM

Customer Programming Software - HAM2000 [C:\Users\michael\CloudStation\RMHAM\Connect Systems\RMHAM_CS750_SampleCodeplug_2016-03-31_Ne...]

File Edit Program Option View Tools Window Help

Contact DMR MARC WW Thorodin Rk Mtn

Canon South
Cheyenne Rk Mtn
Cheyenne North
Devils South
Devils Denver
Durango Rk Mtn
Durango South
Ft Morgan Rk Mtn
Ft Morgan North
Horsetooth Rk Mt
Horsetooth North
Lookout Local
Lookout Denver
Pueblo Rk Mtn
Pueblo South
Salida Rk Mtn
Salida South
Squaw Rk Mtn
Squaw Denver
Thorodin Rk Mtn
Thorodin Denver
Lee Hill WW
Lee Hill WW Eng
Lee Hill NA
Lee Hill LCL
Lee Hill MTN
Colorado Springs WW
Colorado Spgs WW E
Colorado Springs NA
Colorado Springs LCL
Colorado Springs MTN

Digital ID 12345
Color Code 7
Repeater/Time Slot Slot 1
Scan List TRBO Denver
Auto Scan Start ☐
Rx Only ☐
Talk Around ☒
Lone Worker ☐
VOX ☐

Receive
Frequency [MHz] 446.800000
Offset [MHz] 0.000000
Ref Frequency [MHz] Middle
Rx Group List Rocky Mountain
Emergency Alarm Indication ☐
Emergency Alarm Ack ☐
Emergency Call Indication ☐
Encrypt

Transmit
Frequency [MHz] 441.800000
Ref Frequency [MHz] Middle
Tx Contact Rocky Mountain
Emergency System None
Power Level High
Tx Admit Color Code Free
Tx Time-Out Time [s] Infinite

Apply

Close Print Help 29 of 69

Ready CS750 400-470 MHz USB 2016-04-04 09:53:56

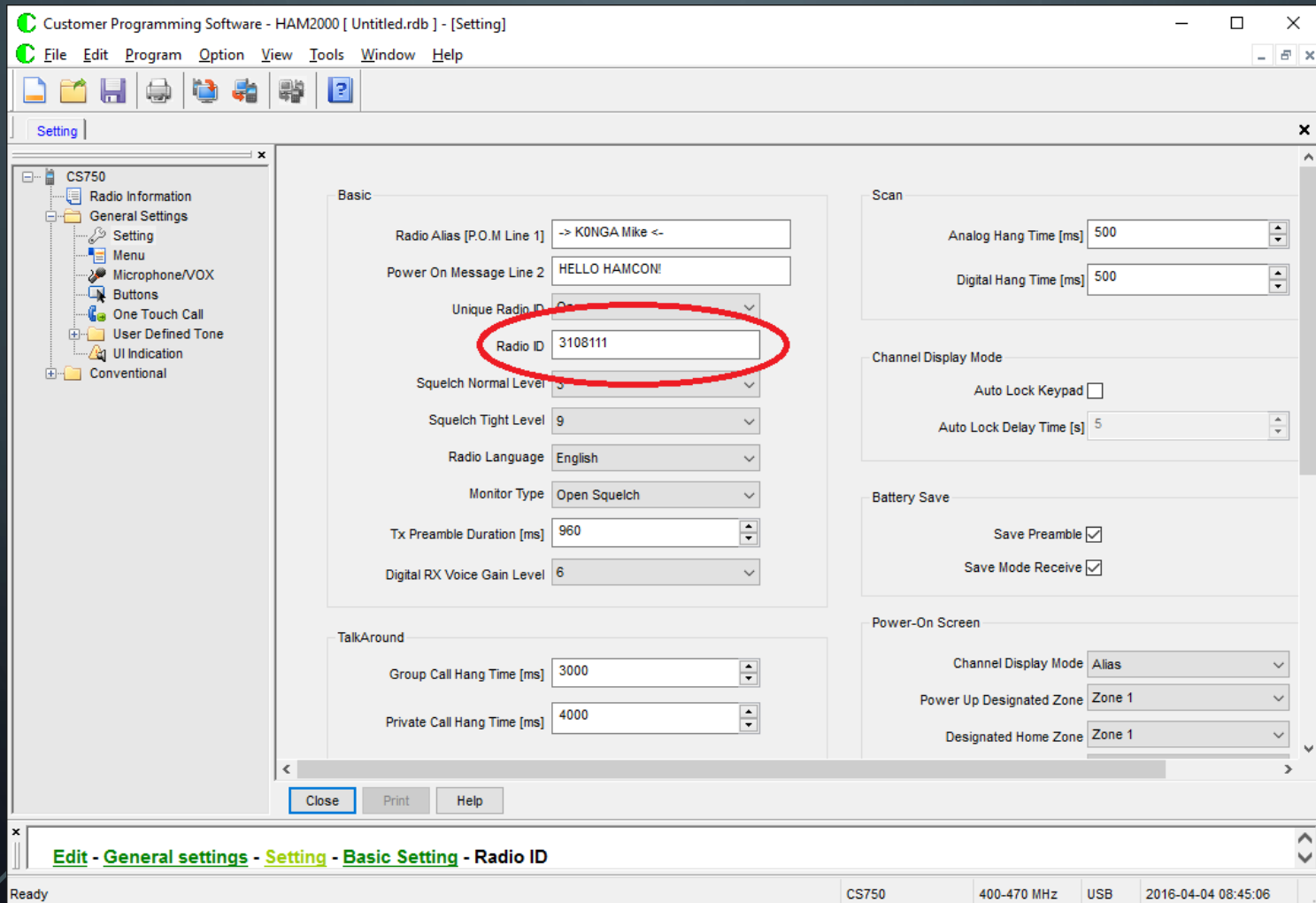
ADMIT CRITERIA

- Used to prevent transmit when a frequency is in use
- For Digital Channels, use “Color Code”
- For Analog Channels, do not use admit controls.
- Prevents “doubling” or transmitting at the same time without knowing
- Default settings in sample codeplugs

RADIO ID

- Identifies the radio to the DMR Repeater
- Each Radio's ID should be unique on the repeater/network
- Not a replacement for Call Sign
- Required for operation with the repeater

RADIO ID



ZONES

- Channels are assigned to Zones
- Only one (1) Zone can be in use (active) at a time
- On HTs, corresponds with channel selection dial
- Radios can have numerous zones
- Channels can be a member of more than one Zone

SCAN LIST

- Named list of channels grouped together
- List is assigned to a channel
- When that channel is activated, the list assigned to that channel will be scanned
- Lists can contain digital and analog channels
- Some radios have advanced scan list settings
- Scan Lists and Zones are completely separate entities (in most radios) and do NOT have to be identical

SCAN LIST EXAMPLE

Customer Programming Software - HAM2000 [C:\Users\michael\CloudStation\RMHAM\Connect Systems\RMHAM_CS750_SampleCodeplug_2016-03-31_Ne...

File Edit Program Option View Tools Window Help

Contact | DMR MARC WW | Thorodin Rk Mtn | **TRBO Denver**

CS750

- Radio Information
- General Settings
- Conventional
 - Zone
 - Channel
 - Scan
 - TRBO Denver**
 - TRBO North
 - TRBO South
 - DMR MARC RMHAM
 - DMR MARC Other
 - RMHAM Analog
 - HAM 447
 - HAM 448
 - HAM 449
- DMR Services
- Emergency
- Personality
- DTMF Services
- MDC Services
- 2Tone Services
- 5Tone Services
- Smart Call

Alias
438.225 91.5
446.000 Simplex
446.000 Smplx PL
446.025 Simplex
446.025 Smplx PL
446.050 Simplex
446.050 Smplx PL
446.075 Simplex
446.075 Smplx PL
446.100 Simplex
446.100 Smplx PL
446.125 Simplex
446.125 Smplx PL
446.150 Simplex
446.150 Smplx PL

Add>>

<<Remove

No.	Alias
1	Selected
2	Badger Rk Mtn
3	Badger Denver
4	Boulder Rk Mtn
5	Breck Rk Mtn
6	Breck Denver
7	Devils Denver
8	Genoa Rk Mtn
9	Genoa Denver
10	Lookout Local
11	Lookout Denver
12	Squaw Rk Mtn
13	Squaw Denver
14	Thorodin Rk Mtn
15	Thorodin Denver

Move Up

Move Down

Scan List Alias: TRBO Denver

Priority Channel1: None

Priority Channel2: None

Tx Designated Channel: Last Active Channel

Signaling Hold Time [ms]: 50

Look Back Time A [s]: 2.0

Look Back Time B [s]: 2.0

Nuisance Delete: ☒

Nuisance Reset: ☒

TalkBack: ☒

Channel Marking: ☐

Close Print Help 1 of 9

Ready CS750 400-470 MHz USB 2016-04-04 09:56:37

ROAMING

- Automatic feature available on some radios
 - Motorola, Hytera, Vertex Standard
- Radio measure signal strength of channels in a list, determines the strongest signal, and tunes to that channel
- Best use case is for times when a single talk group needs to be used but the user will be moving through a large area.

BUTTONS

- Programmable!
- Every radio manufacturer is different
- Check the Sample Codeplug for what the buttons do
- Change to you heart's content, but remember what they do!

The background is a dark blue gradient. On the left side, there are white circuit-like lines and small circles. A large, faint, light blue circle is centered in the background.

QUESTIONS?

STUFF AND THINGS

- RMHAM Website – www.rmham.org
- DMR-MARC Website – www.dmr-marc.net
- Contact Me: K0NGA@arrl.net