



MOTOROLA SOLUTIONS

➤ DMR: THE FUTURE OF TWO-WAY DIGITAL RADIO

By Mike Swiatkowski, AA9VI (aa9vi@arrl.net)

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Digital Mobile Radio (DMR)

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2012

<http://dmrassociation.org>

<http://va3xpr.net>

Digital Mobile Radio

- An ESTI published worldwide standard
- Over a HALF DOZEN manufacturers of DMR radios
- Superior voice quality over older digital modes
- Longer battery life
- Supports multiple talk groups on one channel
- Supports data applications

EQUIPMENT

DMR equipment is available from a variety of manufacturers that can easily be used for ham radio purposes. The most commonly used and readily available units are from Motorola and Vertex Standard, as there are a large number of commercial users leveraging radios, especially in North America.



DMR radios are available in other HTs or mobile units, with the former being the most popular. Since these radios only operate on a single band, the majority of ham radio use of DMR is on the 70cm band and as such, anyone looking to get started in DMR should look for equipment that operates in the 403 – 470 MHz band split. For more information on recommend models, please refer to the [FAQ](#) page.

DMR (Digital Mobile Radio)

DMR is a [published international digital radio standard](#) that specifies the [2-slot \(channel\) TDMA communications](#).

DMR is amateur radio's newest digital protocol. DMR radios are produced by [several manufacturers](#) and they all work on our TRBO system. DMR is not compatible with Icom's D-Star technology. Competition between manufacturers is a big reason why DMR radio prices are fair. DMR is here to stay since it is not a single manufacturer technology.

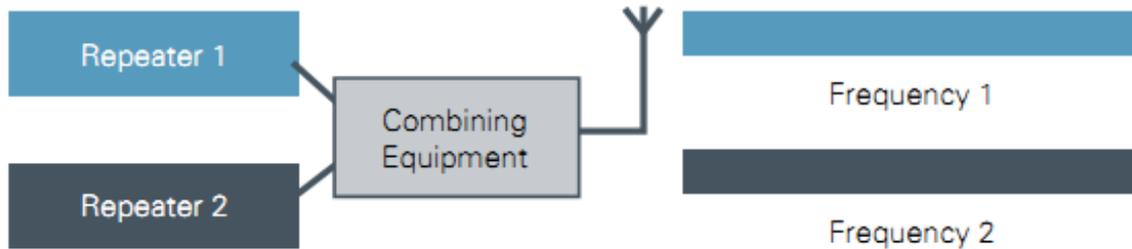


DMR also satisfies the FCC's narrowbanding mandate by being 6.25 kHz equivalent. It's actually more spectrum efficient than other 6.25 kHz modes since no guard band is needed for the two channels. Think of DMR as HALF the channel bandwidth of a 25 kHz analog signal with TWICE the number of voice channels. It's also features forward error correction, offers extended battery life, and did we mention it has superior voice quality over other digital voice modes?

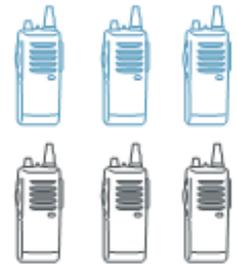
TWO Repeaters in One!

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

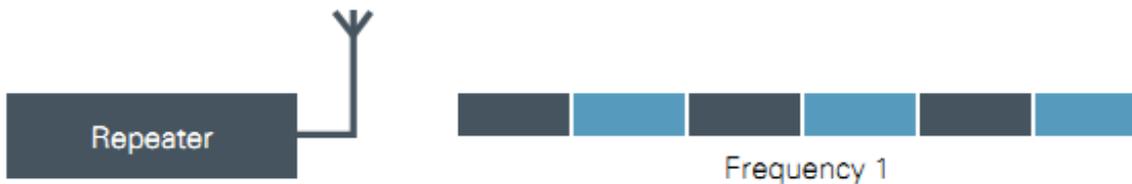


One call per repeater and channel



Radio Groups

Two-channel Digital TDMA System



Two calls per repeater and channel



Radio Groups

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

Half the Channel Bandwidth



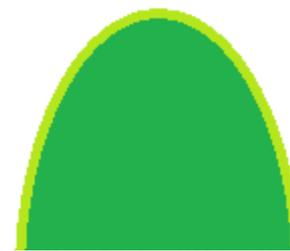
$f_c - 12.5$ f_c $f_c + 12.5$

Traditional Analog

25 kHz

Channel Bandwidth

1 Channel
1 Repeater



$f_c - 6.25$ f_c $f_c + 6.25$

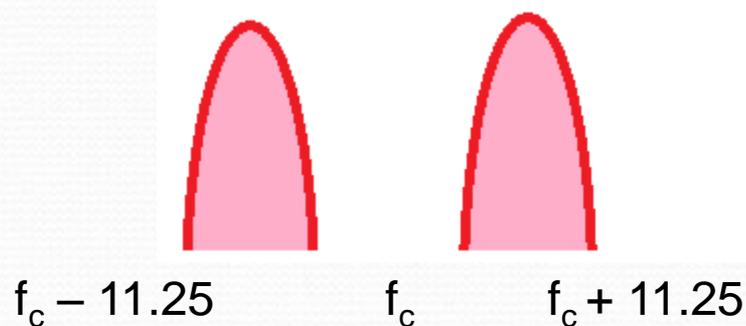
DMR

12.5 kHz

Channel Bandwidth

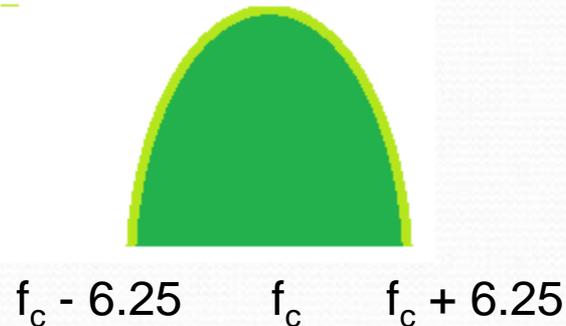
2 Channels
1 Repeater

More Spectrum Efficient than Older Digital Modes



Guard Band
as large as 10 kHz
between channels

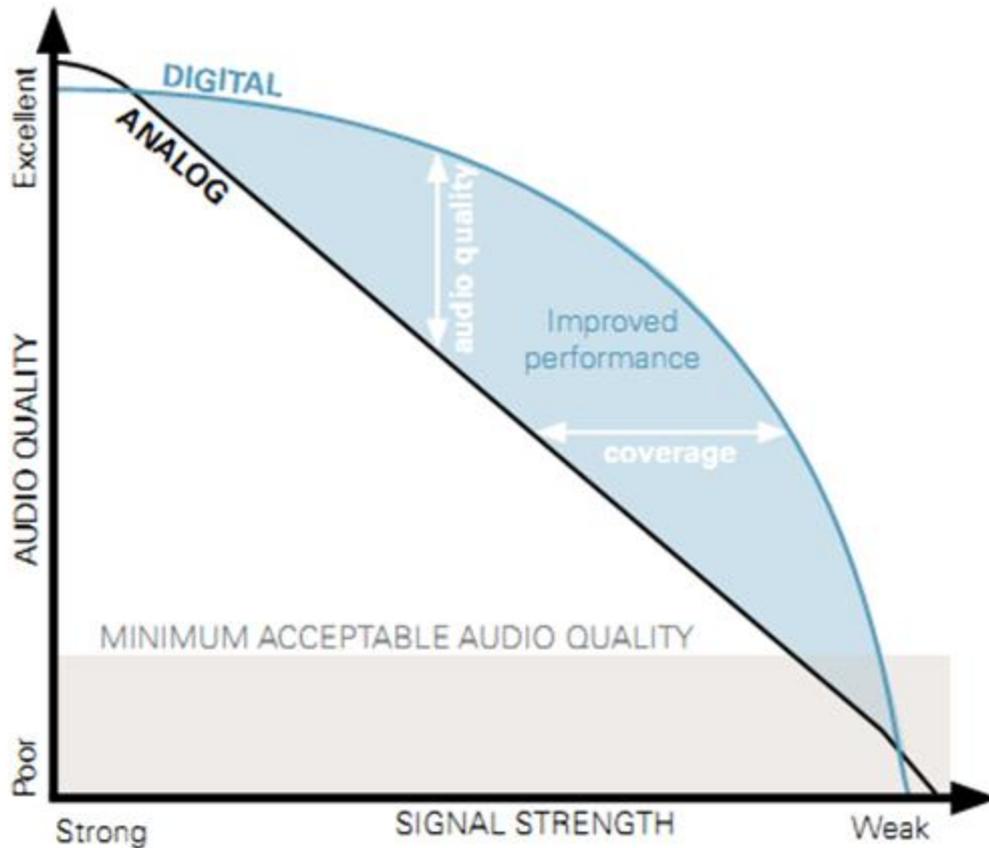
Total BW= 22.5 kHz



No Guard Band
between 2
channels

Total BW= 12.5 kHz

Better Signal Quality



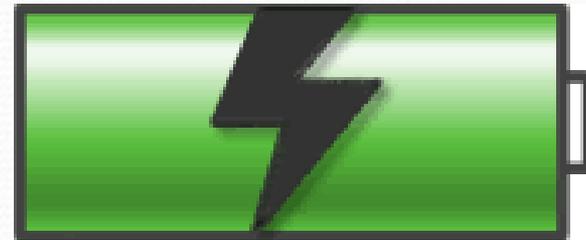
Digital voice retains better quality than analog as signal strength decreases.

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

Longer Battery Life



Older Digital Modes
(FDMA)



DMR
(TDMA)

“For each hour of usage the TDMA radios show between 19% and 34% less battery capacity is required than for the FDMA models.”

“40 percent improvement in talk time in comparison with analogue radios “

<http://dmrassociation.org>

Data and Voice at the Same Time



Slot 1 Voice



Slot 2 GPS Location

(or second channel voice when not sending GPS data)

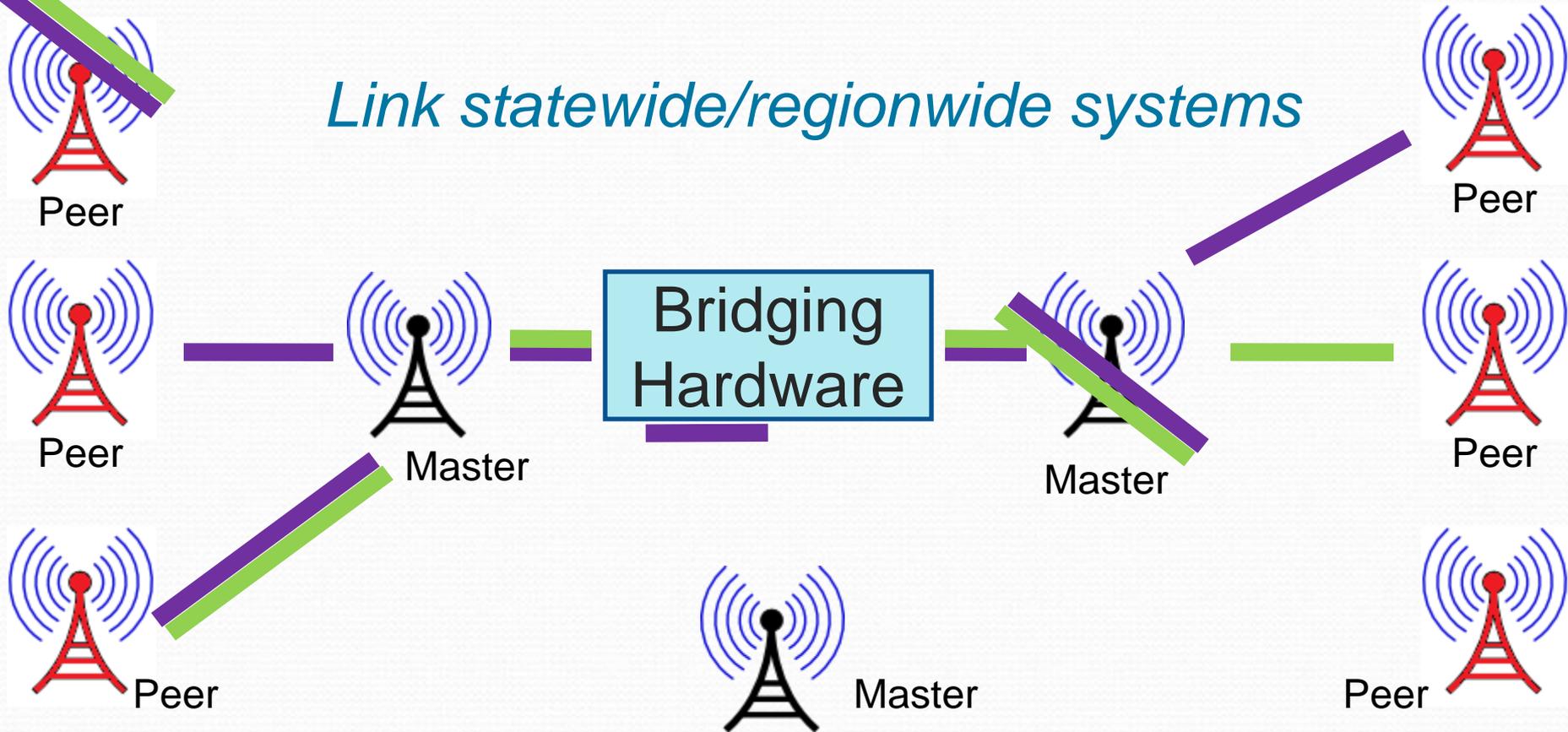


Give your location **WHILE** talking!

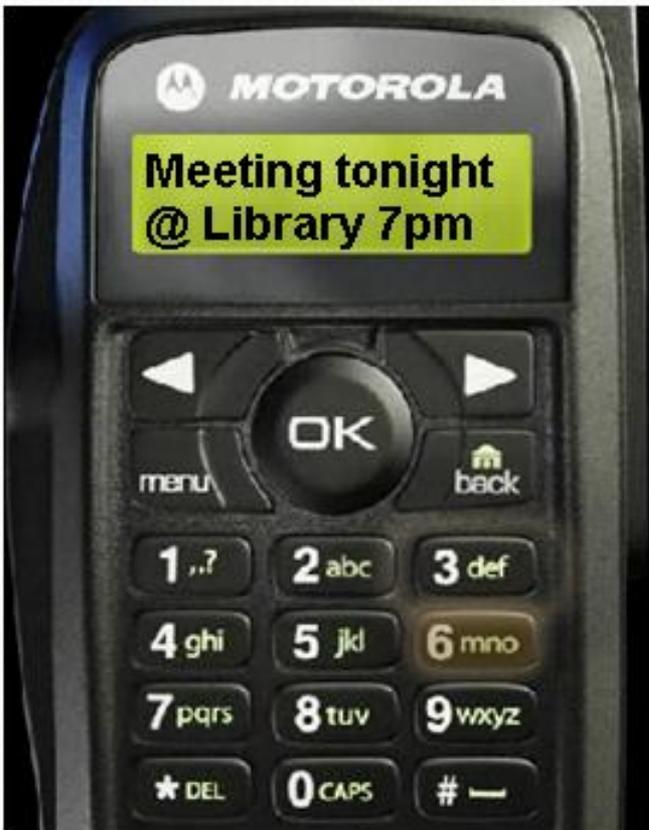
IP Site Connect

1 or 2 slots (channels)

Link statewide/regionwide systems



Free Text Messaging



Send to one person, or a group of people.

- Weather Alerts
- Club Meetings
- Announcements

Older Monochrome Radios

- XPR6550 Portable
- XPR4550 Mobile
- Make sure the radio is UHF1 (403-470 MHz) not 450-512 MHz (commercial band).



New Color Radios Now Available

- XPR7550 Portable
- XPR5550 Mobile
- SL7550 (slim line, looks like cell phone)



DMR-MARC

Motorola Amateur Radio Club Worldwide Network



- Motorola Amateur Radio Clubs and other private XPR8300/8400 and MTR3000 repeater owners
- 90+ site network in USA, Germany, Australia, South Africa, New Zealand, Spain, Switzerland, Austria, Canada, and Finland. (Nearly 4x growth in 1 year)
- 100% Pure Digital. Voice and text messaging supported.
- Weekly nets to discuss technical issues
- More than 1200 registered users
- To register or learn more <http://dmr-marc.net>
- There you will also find links to our bridge partners, our Yahoo group and other programming aids.

Talk Groups (new 2012)

- Time Slot 1, Talk Group 3 – North America, South Africa, South Pacific. NEW as of May 2012! **Reprogram radios if necessary!**
- Time Slot 1, Talk Group 1 – calls to Europe and the weekly DMR net only. Do not use for NAM- NAM QSOs.
- Time Slot 2, talk group 2 – Local Repeater QSOs.
- Time Slot 2, first 4 digits of state ID (KS = 3120) for statewide linked TS2 systems.
- Be courteous and use the local time slot for local repeater QSOs and don't monopolize the linked network time slot 1 if you don't have to.

Common Courtesy

- ALL RADIOS MUST HAVE A VALID 7-DIGIT DMR ID from our website <http://dmr-marc.net>, Under “Contact Us” Radios without an official ID should not be on the system. Period. Do not make up your own ID.
- Do not key up on TS1 and blow into mic to test your radio. You key up 90+ repeaters and that is annoying to all of us who listen.
- Do radio tests on TS2 with a voice ID.
- You must identify your callsign just like you did in the past on an analog repeater per FCC rules.

Status of C-bridge

- Links master repeaters (groups of 15-20), and bridges
- Mfr: Rayfield Communications Springfield, MO
- We have 5 masters (NYC, Schaumburg, Plantation, Montreal, and Germany), and 2 bridges connected to the DMR-MARC C-bridge and the DMR-MARC-IL C-bridges
- We have connections to multiple bridge partners including DCI, NC-PRN, NorCal, AZ TRBO, WØPM (MO), KØUSY (KS), Georgia DMR, SF TRBO

Ham Friendly Dealers

- Rayfield Communications, contact John Rayfield, Jr 800.743.9711. Mention you are part of MARC and inquire about ham pricing.
- Sandy's Communications in Mission Hills, CA
- E-Bay or Local Dealer
- TRBO DMR radios are DMR –and- Analog monoband
- Mobile: XPR4550 UHF band 1 (403-470 MHz) 25-45W, Portable: XPR6550 UHF band 1

Customer Programming SW

The screenshot displays the MOTOTRBO Customer Programming Software interface for a device named K9MOT S1. The software window has a menu bar (File, Edit, View, Device, Features, Remote, Window, Help) and a toolbar with icons for Open, Save, Delete, Cut, Copy, Paste, Search, Read, Write, Clone, Reports, and About. A tree view on the left shows the configuration structure for XPR 4650, including General Settings, Accessories, Buttons, Text Messages, Telemetry, Menu, Privacy, Network, Signaling Systems (MDC, FISHFAR, Quik-Call II, Sys1, Digital Emergency, Capacity Plus Eme), and Contacts (MDC, Call1, Quik-Call II, Digital, ALL CALL, PC CALL, and a list of individual contacts).

The main configuration area is titled "K9MOT S1" and includes tabs for "Top", "RX", and "TX". The "RX" tab is active, showing the following settings:

- Option Board Trunking:
- Lone Worker:
- Allow Talkaround:
- IP Site Connect:
- Messaging Delay (ms): 90
- Compressed UDP Data Header:
- RX Only:

Below these are two columns for RX and TX configuration:

RX Configuration:

- Frequency (MHz): 444.793750
- Ref Frequency (MHz): Default
- Group List: DMR-MARC1
- Emergency Alarm Indication:
- Emergency Alarm Ack:
- Emergency Call Indication:

TX Configuration:

- Frequency (MHz): 449.793750
- Ref Frequency (MHz): Default
- Contact Name: DMR-MARC1
- Emergency System: None
- VOX:
- Power Level: Low
- TOT (sec): 180
- TOT Rekey Delay (sec): 0
- Allow Interruption:
- TX Interruptible Frequencies:
- Admit Criteria: Color Code Free
- In Call Criteria: Follow Admit Criteria

At the bottom of the window, the status bar shows "Expert View", "19.96% Used", and "NUM".

GW3TRBO – Who's on Where?

Activity (Admin) Connected to Module: Ye

Filter Pause View Help

Packet Types

- [Call Activity] Channel Assignment: Group
- [Call Activity] Channel Assignment: Group Radio Data
- [Call Activity] Channel Assignment: Private
- [Call Activity] Channel Assignment: Private Radio Data
- [LE] Deregistration Request
- [LE] Deregistration Response
- [LE] Master Keep Alive Request

Press **F1** for Help Select All
Unselect All

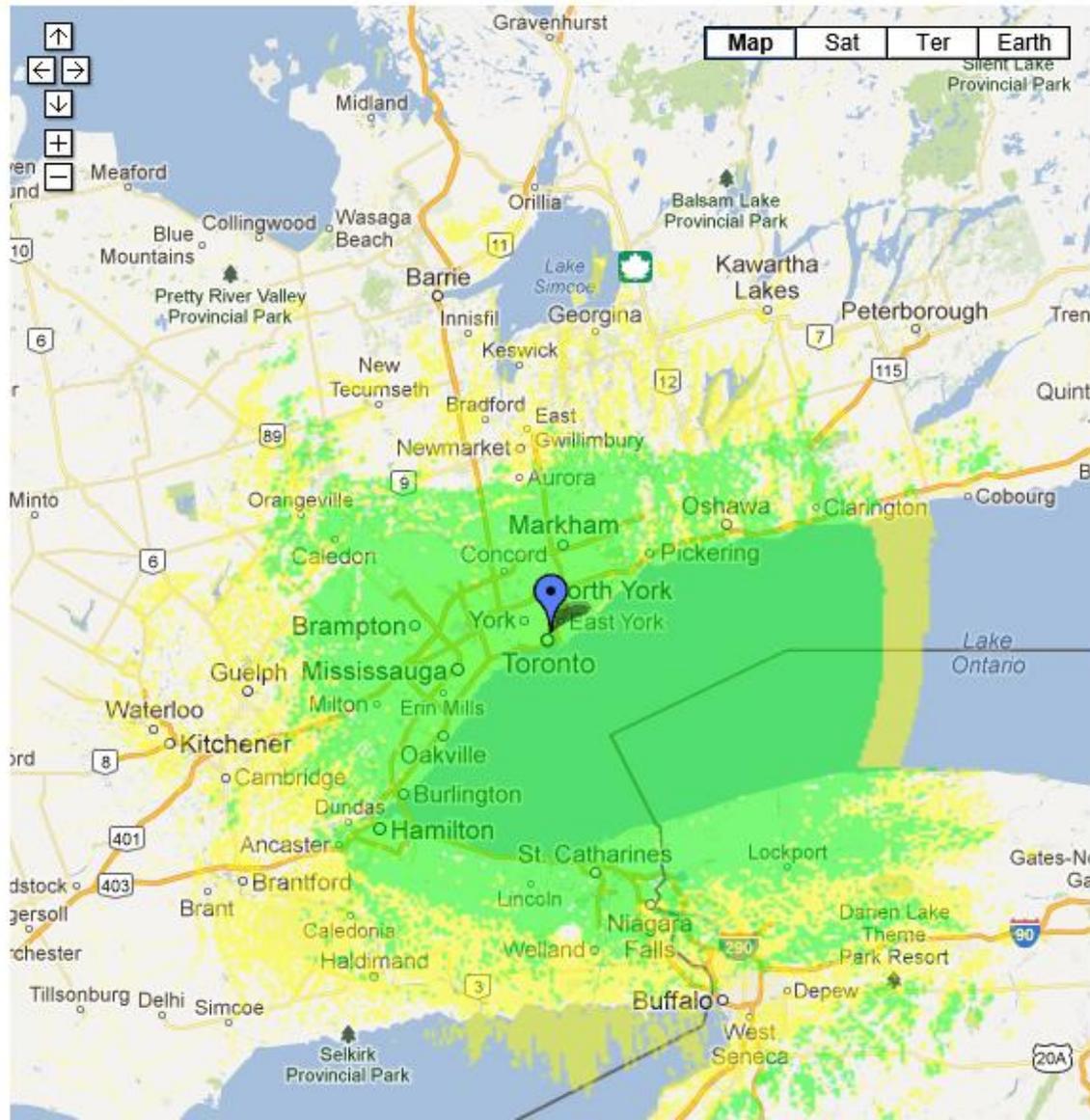
Site ID	Site ID Alias	Type	Group	ID Alias	ID	Target ID Ali	Timestamp	Elapsed T
310699	DMR-MARCC-BRIDGE	Group	1	K6EH - PAUL P1	3106001		7/14/2011 01:15:31.781	00:00:00.
2000				Peer 2000	2000	Peer 311210	7/14/2011 00:42:37.484	
262410	DFOMHR - Muelheim EU					Peer 262410	7/14/2011 00:30:16.671	
262410	DFOMHR - Muelheim EU					Peer 262410	7/14/2011 00:30:06.406	
2000				Peer 2000	2000	Peer 262410	7/14/2011 00:29:42.296	
7						Peer 7	7/14/2011 00:25:15.843	
7						Peer 7	7/14/2011 00:22:41.562	
310699	DMR-MARCC-BRIDGE	Group	1	K6EH - PAUL P1	3106001		7/13/2011 23:51:56.640	00:00:00.
311203	N4AMC - Lakeland FL	Group	1	W4RCC - Richard P	3112010		7/13/2011 23:51:20.343	00:00:00.
311702	K9MOT - Schaumburg IL	Group	1	AA9VI - MIKE M	3117121		7/13/2011 23:50:55.625	00:00:15.
2001						Peer 2001	7/13/2011 23:50:55.250	
311702	K9MOT - Schaumburg IL	Group	1	AA9VI - MIKE M	3117121		7/13/2011 23:50:40.500	00:00:00.
311203	N4AMC - Lakeland FL	Group	1	W4RCC - Richard P	3112010		7/13/2011 23:50:35.250	00:00:28.
2001						Peer 2001	7/13/2011 23:50:35.156	
311203	N4AMC - Lakeland FL	Group	1	W4RCC - Richard P	3112010		7/13/2011 23:50:07.515	00:00:00.
311702	K9MOT - Schaumburg IL	Group	1	AA9VI - MIKE M	3117121		7/13/2011 23:49:25.515	00:00:00.
311203	N4AMC - Lakeland FL	Group	1	W4RCC - Richard P	3112010		7/13/2011 23:49:00.937	00:00:00.
311702	K9MOT - Schaumburg IL	Group	1	AA9VI - MIKE M	3117121		7/13/2011 23:48:02.468	00:00:00.
311203	N4AMC - Lakeland FL	Group	1	W4RCC - Richard P	3112010		7/13/2011 23:47:58.203	00:00:00.
311702	K9MOT - Schaumburg IL	Group	1	AA9VI - MIKE M	3117121		7/13/2011 23:47:53.000	00:00:00.
311203	N4AMC - Lakeland FL	Group	1	W4RCC - Richard P	3112010		7/13/2011 23:47:24.953	00:00:00.
310699	DMR-MARCC-BRIDGE	Group	1	K6EH - PAUL P1	3106001		7/13/2011 23:47:09.453	00:00:00.
311203	N4AMC - Lakeland FL	Group	1	W4RCC - Richard P	3112010		7/13/2011 23:46:42.890	00:00:00.
310699	DMR-MARCC-BRIDGE	Group	1	K6EH - PAUL P1	3106001		7/13/2011 23:45:27.812	00:00:00.
311203	N4AMC - Lakeland FL	Group	1	W4RCC - Richard P	3112010		7/13/2011 23:45:06.359	00:00:00.
310699	DMR-MARCC-BRIDGE	Group	1	K6EH - PAUL P1	3106001		7/13/2011 23:44:27.390	00:00:00.
311203	N4AMC - Lakeland FL	Group	1	W4RCC - Richard P	3112010		7/13/2011 23:44:02.843	00:00:00.
310699	DMR-MARCC-BRIDGE	Group	1	K6EH - PAUL P1	3106001		7/13/2011 23:43:20.781	00:00:00.
311203	N4AMC - Lakeland FL	Group	1	W4RCC - Richard P	3112010		7/13/2011 23:43:01.937	00:00:00.
310699	DMR-MARCC-BRIDGE	Group	1	K6EH - PAUL P1	3106001		7/13/2011 23:42:44.546	00:00:00.
311203	N4AMC - Lakeland FL	Group	1	W4RCC - Richard P	3112010		7/13/2011 23:42:36.406	00:00:00.

Coverage Area

Below is an interactive coverage map, which shows the approximate mobile coverage area for the VA3XPR repeaters, both analog FM and digital DMR:

GREEN = Good mobile coverage

YELLOW = Weak mobile coverage





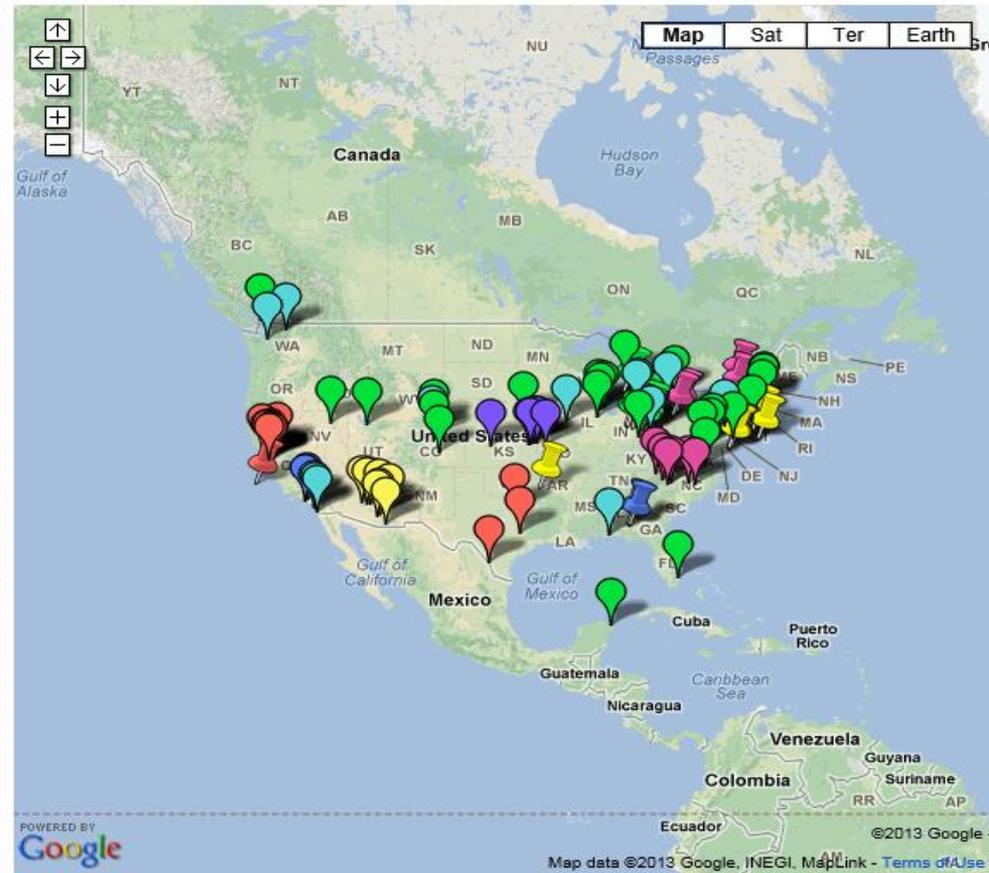
The VA3XPR digital DMR repeater, which consists of a Motorola MOTOTRBO XPR8400 UHF repeater and a Sinclair Res-Lok Q3220E duplexer, being staged prior to going live at the VA3XPR repeater site.



The VA3XPR repeater antennas, with the digital DMR repeater antenna on the left, facing NW and the newly installed analog FM repeater antenna on the right, facing SE.

Networked Repeaters

Below is an interactive map, which shows all of the DMR repeaters connected to the DMR-MARC network around the world. Zoom the map out to see DMR repeaters outside of North America.

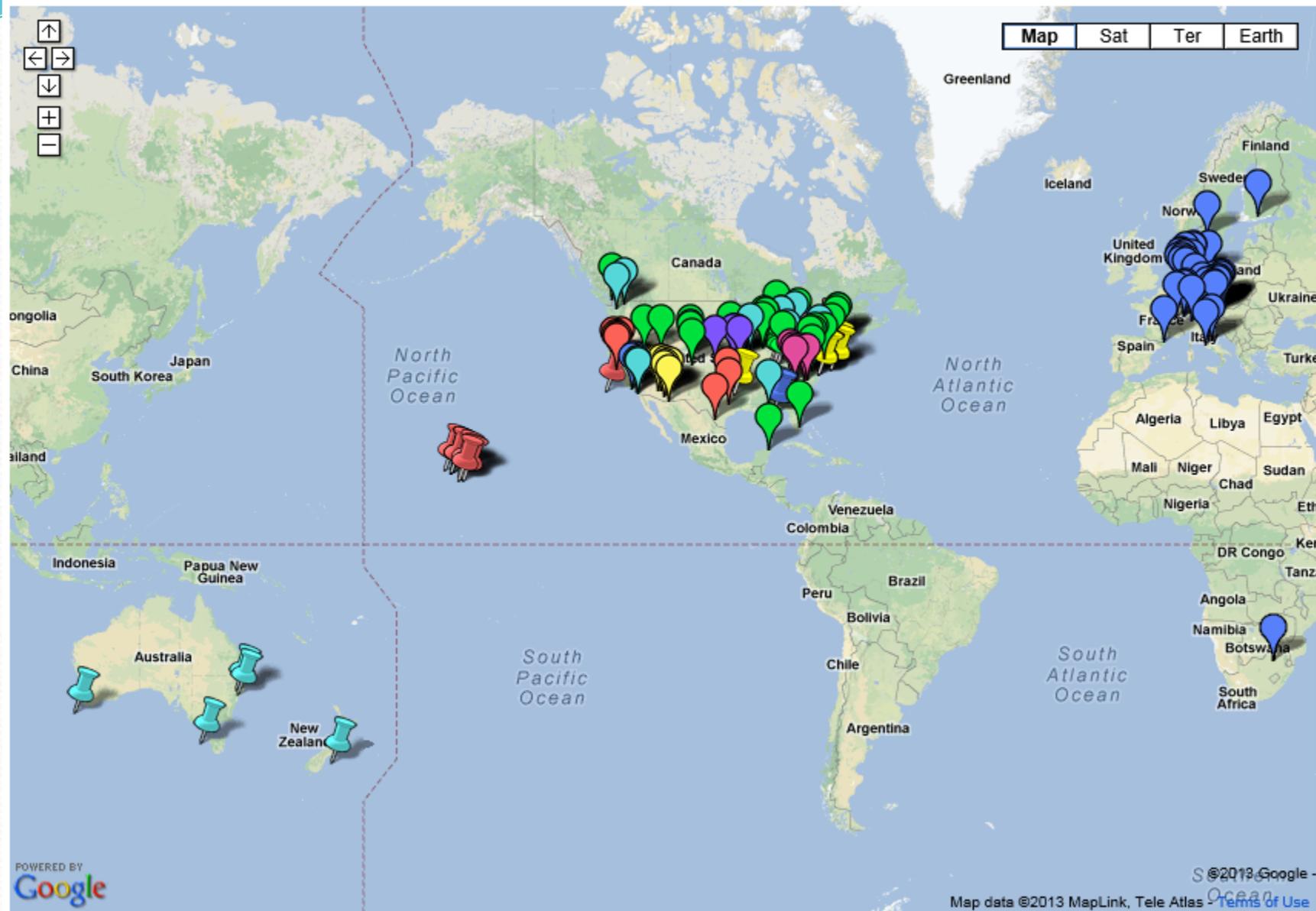


View [Amateur Radio DMR Networked Repeaters World Wide](#) in a larger map

LEGEND

GREEN = DMR-MARC Network – North America
BLUE = DMR-MARC Network – Europe
MAGENTA = North Carolina PRN Network
LIGHT BLUE = DCI Network
YELLOW = Arizona Network
RED = NorCal Network
PURPLE = KØUSY Kansas Network
RED TACK = SF-TRBO
BLUE TACK = Georgia DMR

DMR-MARC Networked Repeaters



View [Amateur Radio DMR Networked Repeaters World Wide](#) in a larger map

POWERED BY
Google

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Map data © 2013 MapLink, Tele Atlas - [Terms of Use](#)

Getting Started

Getting into the world of digital voice communications using DMR is easy! Just follow the below four steps and you'll be up and running in no time!

1. Check that you're within the coverage area of the VA3XPR digital DMR repeater

Verify that you are within the [coverage area](#) of the VA3XPR digital DMR repeater or another DMR repeater in your local area. A map of all repeaters connected to the DMR-MARC network can be found [here](#).

2. Request a DMR-MARC Subscriber ID for your DMR radio

All radios on the DMR-MARC network require a unique [Subscriber ID](#), so you will need to have one assigned before you can program your radio to operate on the VA3XPR digital DMR repeater. If you intend to have more than one DMR radio active at any given time, then you should request a unique Subscriber ID for each radio. **Please do not transmit with your DMR radio on the DMR-MARC network until you have received a Subscriber ID from DMR-MARC and have this programmed into your DMR radio. Using ad hoc Subscriber ID numbers will cause conflicts with other users on the network.**

3. Obtain a DMR radio and the required programming hardware & software

Obtain a DMR capable radio, the Customer Programming Software (CPS) and a programming cable from one of the sources listed on the [FAQ page](#). Alternatively, you can visit an authorized dealer to have your radio programmed for a fee.

4. Program your DMR radio

Program your DMR radio using the specifications found [here](#), plus the Subscriber ID you received from DMR-MARC. Refer to the following [programming tutorial](#) for step-by-step programming instructions.

Still need help?

Check out the [FAQ page](#) for more information or [contact us](#).

Specifications

SPECIFICATIONS

Below are the specifications for the VA3XPR digital DMR repeater.

Frequency	442.3375 MHz (+5.0 MHz offset)
Colour Code	1
Time Slot #1	Group Call 1 (World Wide) Group Call 3 (North America)
Time Slot #2	Group Call 2 (Local)
TX Power Output	40 watts
Repeater Equipment	Motorola MOTOTRBO XPR8400 UHF (model # AAM27QPR9JA7BN)
Duplexer	Sinclair Res-Lok Q3220E
Antenna	JAG Electromagnetics JAG-450-4-1/2-SM
Antenna Gain	7 dBd omnidirectional
Elevation	625' ASL (250' above average terrain)

IMPORTANT

Please make note of the following items **BEFORE** attempting to use your DMR radio on the DMR-MARC network:

- 1. Subscriber ID:** Please do not transmit with your DMR radio on the DMR-MARC network until you have applied for and received a Subscriber ID from DMR-MARC. Using ad hoc ID numbers will cause conflicts with other users on the network, so unique ones are assigned to each user. To apply for a Subscriber ID, click [here](#).
- 2. Privacy Option:** By enabling the "Privacy" option in the programming software, you will be encrypting your signal. Since enabling this option is illegal both in Canada and the US, users are required to ensure that they do not enable the "Privacy" option.

FAQs

1. What is DMR?

DMR, which is short for Digital Mobile Radio, is a published standard for digital voice communications utilizing TDMA technology. There are several [manufactures](#) that build DMR radio equipment, including Motorola, Vertex Standard, Harris and Hytera, to name a few.

2. What is MOTOTRBO?

MOTOTRBO is the brand name for Motorola's DMR capable radios.

3. What are the benefits of using DMR?

The common benefits of using DMR include:

- Crystal-clear audio without background noise or static;
- Text messaging capability;
- Integrated voice and data applications on one device;
- Up to 40% longer battery life as compared to similar analog FM operation.

4. Who can I talk to using DMR?

Since the VA3XPR digital DMR repeater will be connected to the [DMR-MARC network](#), which includes hundreds of other DMR repeaters, users will be able to talk to other DMR users within Canada, plus other countries such as the United States, Germany, Australia, South Africa, New Zealand, Switzerland, Spain, Austria, Finland, and Sweden. Unlike using IRLP or EchoLink where other repeaters are dialed-on-demand using a node number, DMR users can communicate with one another simply by meeting one of the available channels. These channels include:

- Channel #1 = World wide & North American communications
- Channel #2 = Local VA3XPR communication

5. Does DMR provide better coverage than analog FM?

Not really. While DMR communication is completely noise free, once it reach the threshold of coverage, it will become unusable, whereas with analog FM, users may continue to be heard even when the signal is mostly noise. As such, usable coverage is very much subjective.

6. What Canadian license will I need to be able to use DMR?

Users will only need their Basic Qualification license to be able to use DMR.

7. Is DMR compatible with D-STAR?

No. These are separate digital technologies and are not compatible with one other.

8. How is the VA3XPR digital DMR repeater linked to the DMR-MARC network?

The VA3XPR digital DMR repeater will be linked to the [DMR-MARC network](#) using the Internet.

9. Can I connect to IRLP or EchoLink from the VA3XPR digital DMR repeater?

No. Access to IRLP and EchoLink is not available from the VA3XPR digital DMR repeater, however these services will still be available on the VA3XPR analog FM repeater.

10. Can I connect to the VA3XPR analog FM repeater from the VA3XPR digital DMR repeater, or vice versa?

No. These two VA3XPR repeaters will not be accessible from one another.

11. Can I use my DMR radio if I travel outside of the Toronto area?

Yes! Users with DMR radios can use any repeater on the [DMR-MARC network](#). You just simply need to add the frequency and channel information specific to other DMR-MARC networked repeaters into your DMR radio.

12. Will DMR radios work on analog FM also?

Yes. Most DMR radios will work on both DMR and analog FM.

13. What DMR radios can I use?

Since most DMR operation in the ham bands is on the 70cm UHF band, it is recommended that any radios for DMR use operate in the **403 – 470 MHz band split**. The recommended radios for use with DMR include the following:

Mobiles

- [Motorola XPR4550](#)
- [Motorola XPR5550](#)
- [Vertex Standard VXD-7200](#)

Portables

- [Motorola XPR6550](#)
- [Motorola XPR7550](#)
- [Motorola XPR3500](#)
- [Motorola SL7550](#)
- [Vertex Standard VXD-720](#)

14. Can I directly enter frequencies and other information into DMR radios?

Most DMR radios do not support the direct entry of frequencies and other channel related information, otherwise known as being Front Panel Programmable (FPP). There is, however, an option board that can be purchased from a 3rd party for some models of Motorola's MOTOTRBO DMR radios that will enable them to be FPP capable. Information on this option board can be found [here](#).

15. Where can I buy DMR radios?

DMR radios can be obtained from a number of sources, both new and used. Below are the common places

Used Equipment

- [eBay](#)
- [Kijiji](#)
- [Craigslist](#)
- [Batboard](#)

New Equipment

- [Motorola Authorized Dealers](#)
- [Vertex Standard Authorized Dealers](#)

Please note that many dealers are willing to provide "ham friendly" prices to hams for new equipment.

16. What is a Subscriber ID?

A Subscriber ID is a unique identification number that allows your DMR radio to operate on the DMR-MARC network. All DMR radios require a unique Subscriber ID and they can easily be obtained by completing a [request form](#). If you intend to have multiple DMR radios active at the same time, then you can request a Subscriber ID for each radio. **Please do not transmit with your DMR radio on the DMR MARC network until you have received a Subscriber ID from DMR MARC and have this programmed into your DMR radio. Using ad hoc Subscriber ID numbers will cause conflicts with other users on the network.**

17. What is the “Privacy” option found in the programming software?

The “Privacy” option found in the programming software is to enable encrypting your signal. Since enabling this option is illegal both in Canada and the US, users are required to ensure that they do not enable the “Privacy” option.

18. What if I decide to sell my DMR radio?

If you decide to sell your DMR radio, you should remove the Subscriber ID from the radio before it is sold. The person who purchases the DMR radio should request a new Subscriber ID of their own.