

# DMR (Digital Mobile Radio)

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- Originally designed for the commercial market
- Has advantages and disadvantages for Amateur Radio use
- Open source system, anyone can design and build DMR radio equipment



# What is Digital Mobile Radio (DMR)?

- A European Telecommunications Standards Institute (ETSI) standard first ratified in 2005 and is the standard for “professional mobile radio” (PMR) users. Motorola designed their MotoTrbo line of radios based upon the DMR standards
- Meets 12.5kHz channel spacing and 6.25kHz regulatory equivalency standards
- Two slot Time Division Multiple Access (TDMA)
- 4 level FSK modulation
- Cutting edge Forward Error Correction (FEC)
- Commercial ETSI/TIA specs mean rugged performance and excellent service in RF congested urban environments
- Equipment interoperability is certified by the DMR Association

# DMR Tier 1

Tier 1 is a single channel specification originally for the European unlicensed dPMR 446 service. It is a single channel FDMA 6.25KHz bandwidth; the standard supports peer-to-peer (mode 1), repeater (mode 2) and linked repeater (mode 3) configurations. The use of Tier 1 standard has been expanded into radios for use in other than the unlicensed dPMR 446 service.

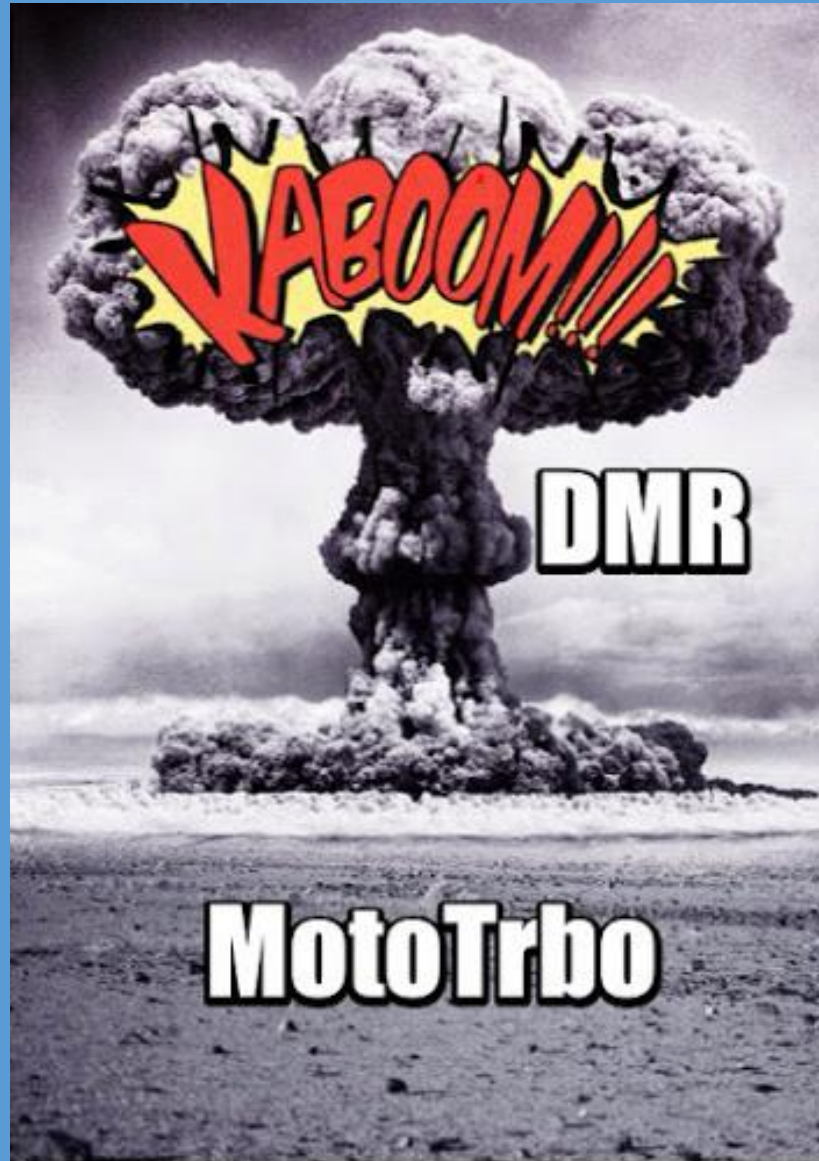
# DMR Tier 2

Tier 2 is 2-slot TDMA 12.5KHz peer-to-peer and repeater mode specification, resulting in a spectrum efficiency of 6.25KHz per time slot. Each time slot can carry voice and/or data, depending on system needs. Most amateur radio implementations of DMR are using voice on both time slots.

# DMR Tier 3

Tier 3 builds upon Tier 2, adding trunking operation involving multiple repeaters at a single site. Not all manufacturers' trunking implementation is Tier 3 compatible. Vendor specific protocols have expanded the trunking to multiple site operations.

# Growth of DMR



# How many users in Ohio?

There are approximately 1229 registered users in the database for Ohio.

There are currently just over 25,000 registered users in the US and over 53,000 worldwide.

This database is available from the DMR-MARC website:

<http://www.dmr-marc.net/>

Click on the button at the top of the page labeled “Database”

Click on the button labeled “User Database”



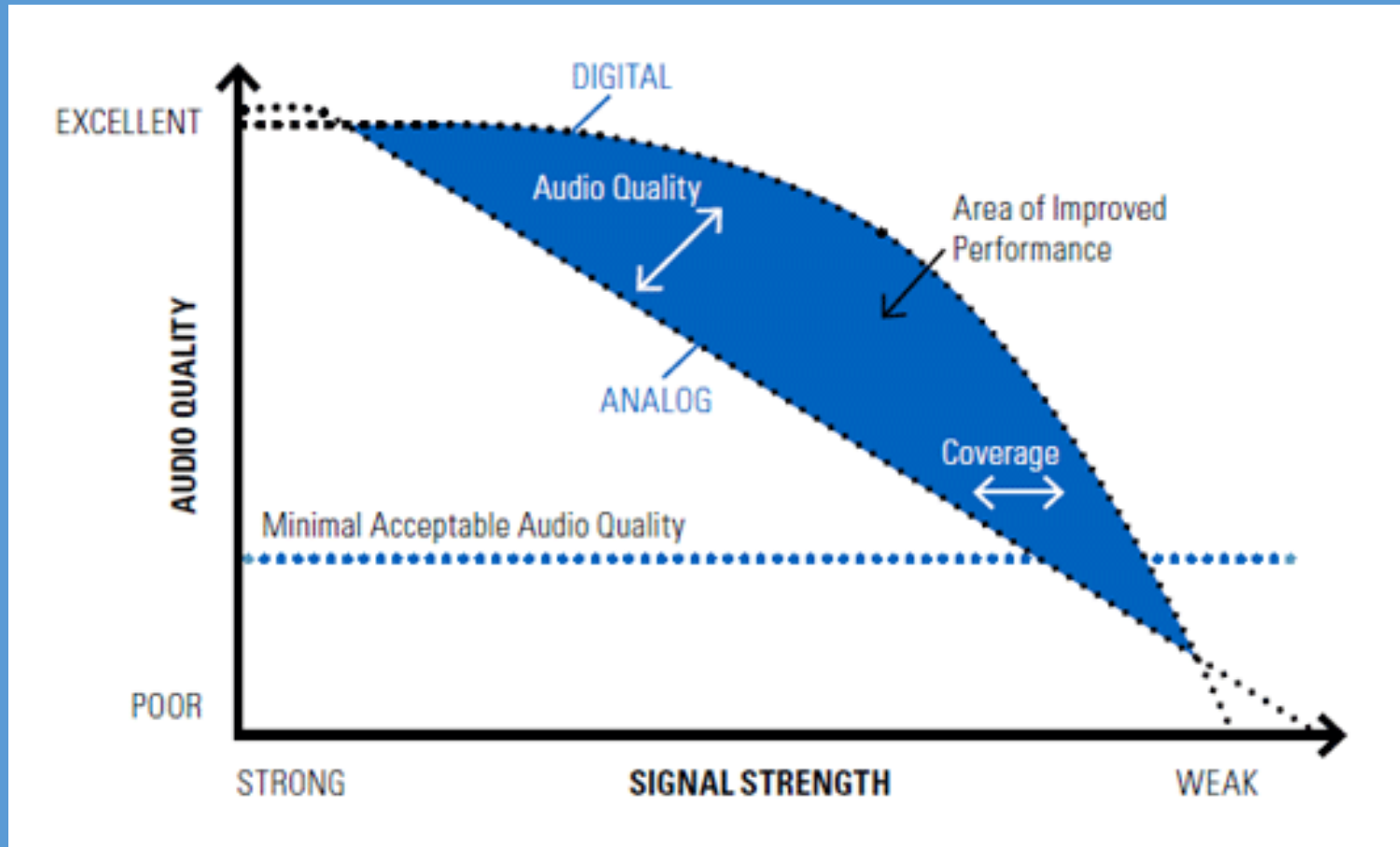
# Superior Audio Performance

DMR digital technology provides better noise rejection and preserves voice quality over a greater range than analog, especially at the farthest edges of the transmission range.

One of the reasons for this increase in performance is due to the effort put into the FEC and CRC coders when developing the standard. Receivers can detect and automatically correct transmission errors by analyzing the FEC bits inserted into the message packets enabling the radio to tell if there is an error. The DMR standard specifies more than 14 encoding and decoding techniques that are applied to the digital signal.

Using these, and other techniques, digital processing is able to screen out noise and re-construct signals from degraded transmissions, allowing users to hear everything much clearer.

# Range Improvement with Digital



# Timeslots (TS)

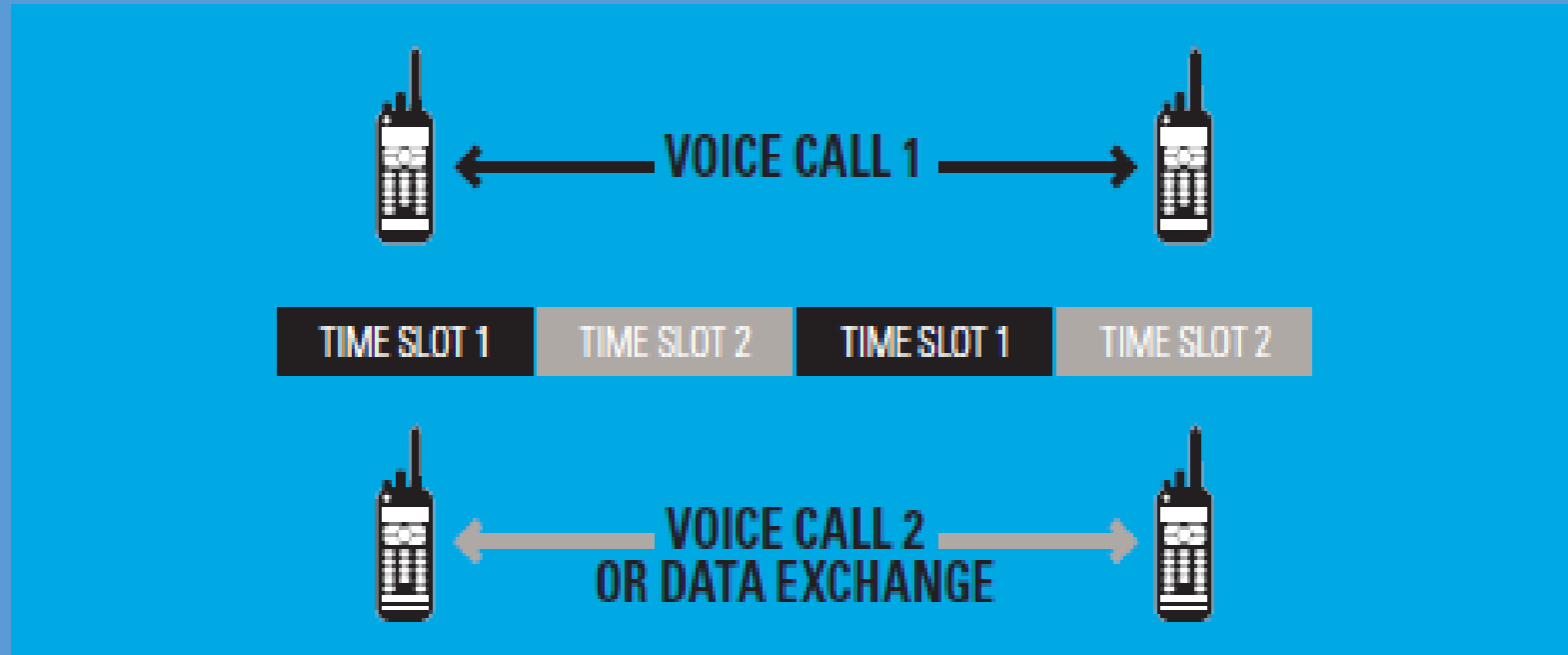
DMR utilizes 2 separate timeslots, called TS1 and TS2.

Each timeslot is independent from the other meaning both can be used at the same time with no interference from each other.

TS1 is typically reserved for wide-area operation, while TS2 is typically more localized. But that is not always the case and is left up to the repeater owner to decide what time slots are to be used for a talk group. Because of this you will need to find out what TS is used for a specific talk group on any given repeater.

The radio transmits a very short burst on the time slot that it is using leaving “time” for the other slot to use. Since the transmitter is keyed for a very short duration as it sends the packet data an overall increase in battery life is also realized. In most cases up to 40% longer battery life than that of a traditional analog radio.

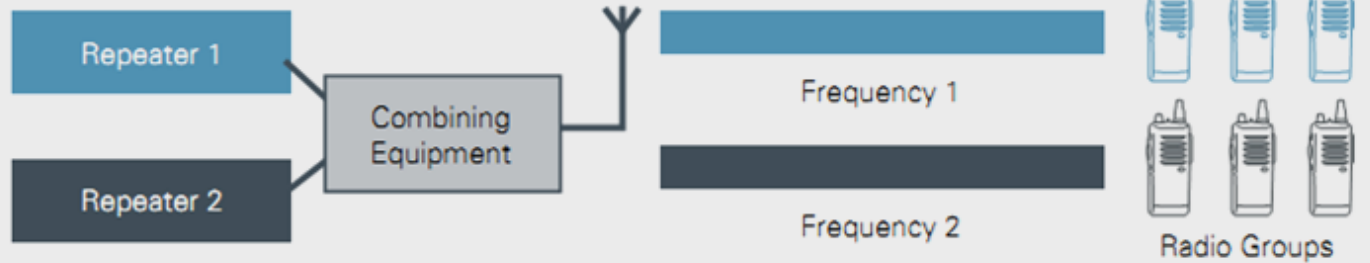
# 2-Slot TDMA



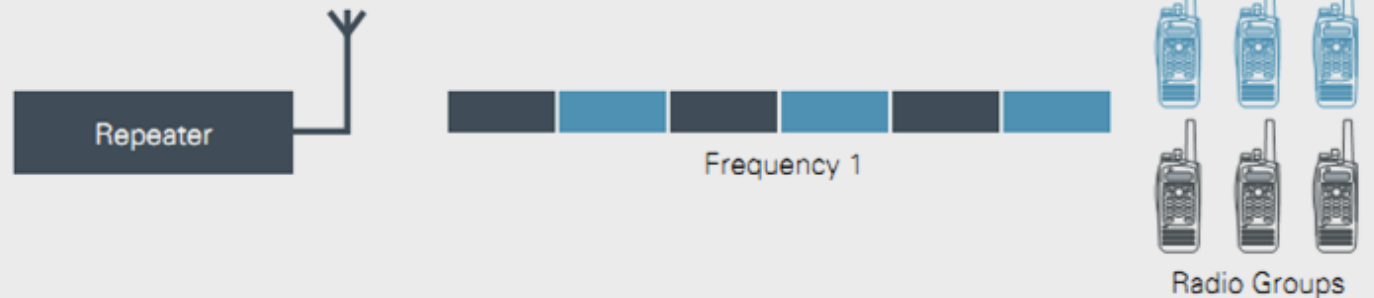
# 2-Slot TDMA vs Traditional System

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



# Color Codes (CC)

DMR repeaters use Color Codes much like analog repeaters use CTCSS or DCS, you can think of a Color Code as nothing more than a digital PL tone.

To access a repeater, you must use the same CC as the repeater.

There are 16 different CCs (CC0-CC15)

The use of Color Codes is not optional on DMR repeaters.

If the Color Code on your transceiver is not set correctly for the repeater you wish to use, you will not be able to access the repeater.

# Talk Groups (TG)

Talk Groups (TG) are a way for groups of users to share a time slot without distracting or disrupting other users of the time slot (one TS can have many TG's).

It should be noted that only one TG can be using a time slot at a time. This means that you can have access to dozens (hundreds) of TG's per timeslot, but they will all be competing with each other for usage.

If your radio is not programmed to listen to a TG, you will not hear that TG's traffic. (Group Lists allow you to hear all active TG's on the repeater timeslot)

# Talk Groups – the “network”

There are 2 major “networks” in the US that carry the TG’s across the internet. The DMR-MARC network (rigid) and the Brandmeister network (open).

Depending upon the network you are on the TG may have a different TG number.

There are two different ways that repeaters are linked to TG’s, Full Time (FT) or PTT. The repeater is always linked to the FT TG’s so anyone keying up on a FT group will “open” every repeater linked to that TG. In order to link a repeater to a PTT TG you must first key-up on that TG which then links the repeater to that TG. So “kerchunking” is allowed and expected on DMR. PTT TG’s are linked for up to 15 minutes of in-activity.



# TG Examples

Local2 (TG2) (connects all repeaters in a local city / area), always FT

Local9 (TG9) (local to the repeater) always FT

Statewide (usually FT on TS2, connects all repeaters in the State) – Ohio Statewide (TG3139)

Regional (US is divided into 7 multi-state groups) – (TG3169)

USA (TG1776)

North America (D-MARC TG3) (BM TG 93) usually FT on TS1

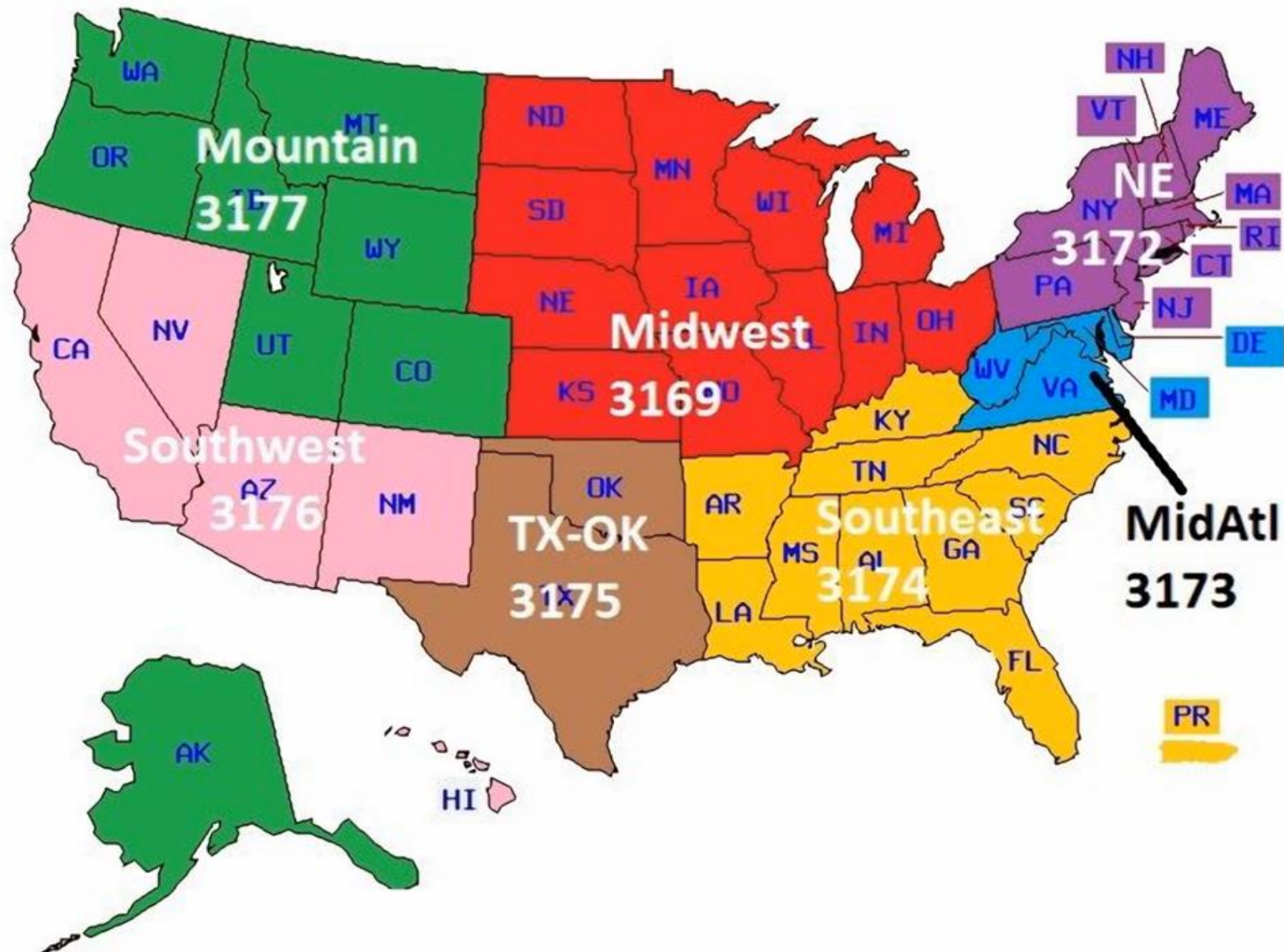
Worldwide English “WWE” (D-MARC TG13) (BM 913)

Worldwide (D-MARC TG1) (BM TG91)

TAC310 (TG310)...TAC319 (TG319) always PTT

Parrot (D-MARC TG9998, Brandmeister TG9990)

Cactus (TX, AZ, CA TG3185)



# Programming a DMR radio

Because the DMR standard was designed to be a commercial system there is really no good way to program any DMR radio from the keypad. All DMR radios require some form of programming software and programming cable in order to properly program the device.

Additionally a DMR ID is required and transmitted. However this ID is **NOT** adequate for use as your FCC ID (amateur call sign) meaning that you must ID with your amateur call sign when using DMR, unlike System Fusion or D-Star.

# What you need to do first...

Before you can use the DMR network you MUST request, at no cost, a DMR ID through the DMR-MARC website:

Go to:

<http://dmr-marc.net>

and at the top of the page click on “Register ID”

**\*\*\*\* Registration process takes AT LEAST 24 HOURS, re-applying will not speed up your request \*\*\*\***

**\*\*\*\* ALL @YAHOO MAIL WILL NOT BE DELIVERED, BLAME YAHOO. \*\*\*\***

[Donate](#)



[User Registration](#)

[Repeater Registration](#)

# Code Plugs

A code plug is simply a radio's configuration file.

Using your manufacturer's programming software, you configure the channels and operating parameters of a radio using a code plug file. This file is then uploaded to the radio.

Building a code plug can take many hours, especially if you want to program hundreds of channels.

You can find copies of configured code plugs on the internet for different models of radios. Search Facebook, Yahoo or Google Groups for various DMR groups. We have a Google Group called “Summit County Digital Mobile Radio Group”

# - Building a Codeplug, steps involved -

1. You must apply for a DMR ID. You will need to enter this ID into the “**General Settings**” section of your codeplug.
2. You must program a list of “**Contacts**” consisting of Talk Groups and Private Calls (other user ID’s) you want to connect to.
3. You must build a channel list of repeaters, or simplex frequencies you are going to use including its transmit and receive frequency, **Color Code**, **Time Slot**, and **Contact**.
4. You must build a list of “**Zones**” or memory banks with sixteen (16) channels per Zone using the channels you just created.
5. You should program a group of “**Digital Receive Groups**” with the channels you have added to each Zone.
6. You will need to update each channel in a Zone with the Digital Receive Group you created for that Zone.

# Contact List

A Contact List is a list of ID's assigned either to a Talk Group or to a single user. When entering a new contact you will need to define the "Type" of contact, either All Call, Group or Private, the contact's ID and how you wish the radio to react when that ID is heard.

# Channels

Channels are how you program the repeaters or simplex channels that you want to use. In analog this is similar to entering the repeater information or simplex information into your radio, RX Freq, TX Freq, PL tone etc...

For DMR the exact same holds true for TX and RX frequencies and PL tone (color code) except in addition you need you set which TS to use, scan list to use, group list to use, contact (talkgroup) to use and how you wish to access the repeater (admit criteria).



# Zones

DMR radios support Zones, a Zone is just a grouping of individual channels. Some radio models may limit the number of channels per Zone and the number of Zones allowed.

# RX Groups

All DMR radios allow you to configure RX Groups.

On the repeater you can use RX Groups to monitor all talkgroups on a single timeslot by adding each Group Contact or Group Call to an RX Group.

A typical RX Group may contain the following:

Local

Statewide

Regional

Simplex

# Scanning

All DMR radios support channel scanning. However you will ONLY hear traffic on the frequency, time slot, and talkgroup that you have programmed for that channel.

Scanning is S...L...O...W... and consumes a lot of battery power.

Scanning is good for analog or digital simplex, or to scan multiple repeaters but is really not necessary for talkgroup scanning, that is what Group Lists are for.

# Simplex

On the professional side of DMR, *talk-around* refers to operating simplex on a repeater output channel.

–This allows direct communication while still being able to hear the repeater.

–This allows users to directly contact other users listening on the repeater output frequency.

Amateurs typically use dedicated simplex channels so as not to interfere with repeaters.

# Simplex

The amateur DMR community has published a list of recommended simplex frequencies:

## UHF

1. 441.000
2. 446.500
3. 446.075
4. 433.450

## VHF

1. 145.790
2. 145.510

Use TG99 / CC1 / TS1 / Admit Criteria: Always / In Call Criteria: TX or Always

# DMR Radios

Alinco

Anytone

Aselsan

Avtec

BFDX

Celetra

CML Microcircuits

Connect Systems

DAMM

Eastcom

EMC Romulus

Entropy

Excera

Flyde Micro

Haige Communication

Harris

HQT

Hytera

JVC Kenwood

Kirisun

Kydera (KYD)

Lishing Fujian

Motorola

OMSK

Puxing

Quanzhou Keci

Radio Activity

Radiodata

RCA

Rexon Technonogy

Samhoo

Selex ES

Simoco

Tait

Tytera (TYT)

Vertex Standard

Wouxon

Yanton

Zastone

Zetron

ZTE

# DMR Hotspot - DVMega

The DVMega Raspberry Pi radio hotspot is a module that you can install on your RPi directly. The module has a modem and 10mW transceiver that will allow you to do D-Star, DMR and System Fusion directly from your home network.



# DMR Hotspot - openSpot

The openSpot by SharkRF (Tallin, Estonia) is a standalone radio IP gateway/hotspot that currently supports D-Star and DMR or Yaesu C4FM cross modem modes. Talk with your System Fusion radio on DMR or with your DMR radio on System Fusion.





# More Info

Amateur Radio Guide to Digital Mobile Radio:

[http://www.trbo.org/docs/Amateur\\_Radio\\_Guide\\_to\\_DMR.pdf](http://www.trbo.org/docs/Amateur_Radio_Guide_to_DMR.pdf)

Building a code plug how-to:

<http://ve3yyz.org/wp-content/uploads/2016/03/Draft-20160329-VA3WM-MD380-howto.pdf>

Brandmeister on-line monitor:

<http://hose.brandmeister.network>



# References

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