What Is DMR (Digital Mobile Radio)

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Special Thanks to:

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Larry Shafron - N5LS
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
TDMA = Predictable doubling of capacity in existing 12.5 kHz channels.

12.5 kHz TDMA

- 1 analog voice path in 12.5 kHz channel profile
- 2 digital voice paths with TDMA in 12.5 kHz channel profile

6.25 kHz FDMA

- 12.5 kHz analog voice channels
- Only 1 new 6.25 kHz FDMA path achieved in existing 12.5 kHz license

Source: 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 channel. Each time slot can be either voice and/or data, depending on system needs. Most amateur radio implementations of DMR are using voice on both time slots.
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.
DMR VS OTHER DIGITAL MODES

- **DMR**: TDMA with 4 level FSK, C4FM (Continuous 4 Level FM) modulation with AMBE+2 codec (vocoder) 12.5kHz t/r 4.8 kbps x 2

- **Fusion**: FDMA with 4 level FSK. Uses AMBE+2 codec - Yaseu C4FM is a type of Differential Quadrature Phase Shift Keying (DQPSK) 12.5kHz t/r (transmission rate) 9.6 kbps

- **D-Star** uses an AMBE+ codec and GMSK modulation similar to GSM cell phones. (more artefacts because of AMBE+ codec) 6.25kHz t/r 4.8 kbps

- **P25 (APCO)** Phase 1: FDMA with 4 level FSK and IMBE codec

- **P25 Phase 2**: FDMA with new TDMA implementations, AMBE+2 codec and uses Continuous Quadrature Phase Shift Keying (CQPSK) modulation (very similar to C4FM)

- **Others included** are IDAS, dPMR, and NXDN (Kenwood Nexedge) which are all similar to D-STAR
Growth of DMR

Amateur DMR Growth by # Repeaters

Amateur DMR Growth by # Radio IDs

Courtesy KB0ZZT
How many users in Tennessee?

As of this writing, around February 2018, there are currently approximately 903 registered users in the database for Tennessee.

There are currently over 38,000 registered users in the US and over 86,000 worldwide.

If you go to the RADIO ID website:

http://www.radioid.net/

Click on the button at the top of the page labeled “Database”
Click on the button labeled “User Database”
Enter “Tennessee” in the State/Prov search box and then click on the “Search” button (This will only give you a max of 100)
<table>
<thead>
<tr>
<th>DMR ID</th>
<th>Callsign</th>
<th>Name</th>
<th>City</th>
<th>State/Prov</th>
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</table>
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 over 14 different coders to be used, each matched to different types of traffic being transmitted.

Through the use of coders 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.
Digital vs. Analog

The basic difference with digital repeaters is that the audio quality remains the same on the uplink and the downlink until the very end of the coverage range then the audio starts sounding broken on DMR systems (missing portions of the speech) caused by lost packets, some refer to this broken audio as sounding like R2D2. Data loss can also be incurred by the internet dropping the UDP packets used for moving traffic between repeaters and bridges.

DMR has advanced Forward Error Correction (FEC) which can correct small bit errors, slightly extending the usable range and improving communication quality.
Range Improvement with Digital

- Digital
- Analog
- Coverage
- Minimal Acceptable Audio Quality
- Excellent Audio Quality

Audio Quality vs. Signal Strength
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 Wide-Area, 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. 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 set to 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
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

- Repeater 1
- Combining Equipment
- Frequency 1
- Frequency 2

Two-channel Digital TDMA System

- Repeater
- Frequency 1

Radio Groups

One call per repeater and channel

Two calls per repeater and channel
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.

The only real purpose of using Color Codes is when multiple repeaters operating on the same frequency have overlapping coverage areas.
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 to many TG’s).

It should be noted that only one talk group can be using a time slot at a time.

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

Only 1 TG per TS can be used at a time. This means that you can have access to dozens (hundreds) of talkgroups per timeslot, but they will all be competing with each other for usage.
Talk Group Examples

Local (connects all repeaters in a local city / area) – Local2, Local9

Statewide (all repeaters in the State) – Tennessee Statewide TG 3147

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

North America TG 3100

Worldwide English

Worldwide

TAC310, TAC311,…TAC319 USA

Fusion Link

All-Star Link

Hytera Link

Parrot

Cactus (TX, AZ, CA)
Programming a DMR radio

Because the DMR standard was “born” out of the commercial world there is really no good way to program any DMR radio from the keypad. All DMR radios require some form of programming software and 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.
- Steps Involved -

• You MUST obtain a no-cost “User Id” from “www.radioid.net” to use DMR Amateur repeaters.

• You must program a series of “Contacts” consisting of Talk Groups and Private Calls (other users) you want to connect to.

• You must create a series of “Digital Receive Groups” for now just create several empty groups we will be setting them up later.

• 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, Contact and Receive Group, you can use the same receive group for multiple channels up to 16 times.

• You must build a list of “Zones” or memory banks with sixteen (16) channels per Zone using the channels you just created.

• You must program the series of “Digital Receive Groups” you created in the earlier step with the channels you have for each Zone.
DMR IDs

• Every user has a unique 7-digit number that identifies them

• Amateur DMR: Linked to a name and a callsign

Regional Code  Sequential User Number

3 1 4 2 2 5 5

• Repeaters use a similar 6-digit convention with the same regional code

• Every transmission is tagged with a user ID

• List of IDs, callsigns, and locations is public
What you need to do first…

Before you can use the DMR network you MUST request a DMR ID through the DMR-MARC website:

http://dmr-marc.net/cgi-bin/trbo-database/register.cgi

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

**** ALL @YAHOO MAIL WILL NOT BE DELIVERED, BLAME YAHOO. ****
DMR USER / REPEATER Registration

Our goal is to have a master listing so you can take a DMR radio anywhere in the world and it will work without ID conflicts.

Now that we have started bridging networks it is important that no two users have the same ID.

If you are in EUROPE or AFRICA, go to: https://register.ham-digital.org/

NOTE: You only need a unique ID for every subscriber that is on the system at the SAME time, meaning during the same QSO on the same talkgroup.

You can reuse IDs for radios/subscribers that are not on the air at the same time. A mobile and base radio can have the same ID.

If you only use a mobile in the car and a portable at home you can use the same ID.

If you loan a radio to a friend, the radios are part of a club fleet, or the radio is used for linking/3rd party applications then multiple IDs are preferred and you should submit individual applications for each. **Most people will only need 1 or 2 IDs. We will require a pretty good reason to exceed this limit.**

Please only request IDs if you are going to use them NOW, don't reserve a block of IDs if you aren't using them in the immediate future.

PLEASE ALLOW 72 HOURS FOR ALL REQUESTS TO BE PROCESSED. If you do not receive a reply within 3 days, email us again. THANKS!

TERMS:

I will ensure that my radios [ARS] feature is turned off while operating on any of the radioid repeaters. (If equipped)

I will also disable AGC on my radio for best audio performance.

I further agree not to experiment with any new hardware or software (including 3rd party Motorola applications) that might overall effect the entire radioid network without having prior written permission from all repeater trustees whom my actions may affect.

Request New Repeater ID

Please complete the application below to have your repeater listed in the worldwide database. Our goal is to have a master listing so you can take a DMR radio anywhere in the world and it will work without ID conflicts. This form is for all worldwide DMR repeaters regardless of network affiliation.

REPEATER registration requires a valid frequency coordination from the recognized Spectrum Management or Repeater Council. Do not apply until you are ready to program and put the site On-the-Air and On-the-Network. This registration will trigger an automatic pin placement on the radioid map.

****DV4MINI, openSPOT, DVMEGA type devices do NOT require a separate ID, use an existing ID only, do NOT request an ID for them****

Requests for UPDATES to both Users and Repeaters
Request New Repeater ID

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Requests for UPDATES to both Users and Repeaters

Please contact the ID Team: idteam@radioid.net

**** DO NOT USE REGISTRATION FORMS BELOW TO MAKE CORRECTIONS, SEE THE LINE ABOVE ****

REPEATER registration requires a valid frequency coordination from the recognized Spectrum Management or Repeater Council.

By proceeding to the USER or REPEATER registration, you hereby agree to the above terms and conditions

Older versions of IE do not work well, please use a modern browser.

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

Donate

Please consider donating to help keep this service going. Donations are accepted but not required for service. Donations do not imply any special service or privilege.

User Registration  Repeater Registration
DMR Advanced Database Search

User Search Criteria

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<th>Operator</th>
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<td>Equals</td>
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Search

Users Search: 1 Results

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<th>DMR ID</th>
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<th>Name</th>
<th>City</th>
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<td>DMR</td>
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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.

The code plug must contain a Contact List of Radio Id’s. The ID’s can either be group (Talk Groups) or private (Individual Users) and can include additional information such as call signs and names to be displayed. All DMR radios support a maximum number of entries in the contact list.

You can find copies of configured code plugs on the internet for different models of radios. Check out the different Yahoo DMR groups.
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.
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<thead>
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<th>Number</th>
<th>Name</th>
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<td>00000001</td>
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<td>Off</td>
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<tr>
<td>2</td>
<td>N America</td>
<td>00000003</td>
<td>Group Call</td>
<td>None</td>
<td>Off</td>
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<td>Group Call</td>
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<td>Off</td>
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<td>00000091</td>
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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
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).
- Channel Mode: Digital
- Channel Name: T-3100 USA
- Band Width: 12.5kHz
- RX Frequency (MHz): 432.55000
- TX Frequency (MHz): 432.55000
- Squelch: Normal
- Admit Criteria: Always
- RX Ref Frequency: Low
- TX Ref Frequency: Low
- TOT[s]: 180
- TOT Rekey Delay[s]: 0
- Power: Low
- Analog Data:
  - CTCSS/DCS Dec: None
  - CTCSS/DCS Enc: None
  - QT Reverse: 180
  - Rx Signaling System: Off
  - Tx Signaling System: Off
  - Reverse Burst/Turn-off Code: On
- Digital Data:
  - Private Call Confirmed: Off
  - Emergency Alarm Ack: Off
  - Data Call Confirmed: Off
  - Compressed UDP Data Header: Off
  - Emergency System: None
  - Group List: None
  - Color Code: 1
  - Repeater Slot: 2
  - Privacy: None
  - Privacy No.: 1
  - GPS System: 1
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.
### Zone Information

**Zone Name**: USA

**Available Channel**

- Simplex 1
- Simplex 2
- Simplex 3
- Simplex 4
- T-8951 TAC1
- T-8952 TAC2
- T-8953 TAC3
- T-8954 TAC4
- T-8955 TAC5
- T-8956 TAC6
- T-8957 TAC7
- T-8958 TAC8
- T-8959 TAC9
- T-3100 TAC10
- T-3101 TAC310
- T-3102 TAC311
- T-3103 TAC312
- P-4000 TAC1
- P-9990 TAC1
- T-3104 TAC1
- T-3105 TAC1
- T-3106 TAC1

**Channel Member**

- T-4000 All Disc
- T-9 REF Talk
- T-91 BM WW
- T-93 BM NA
- T-3100 USA
- T-31089 Hyt USA
- T-31090 US A0
- T-31091 US A1
- T-31092 US A2
- T-31093 US A3
- T-31094 US A4
- T-31095 US A5
- T-31096 US A6
- T-31097 US A7
- T-31098 US A8
- T-31099 US A9

**Add/Remove Buttons**: Add, Delete

**Pagination**: 1 of 28
Zone Information

Zone Name: USA

Available Channel

Simplex 1
Simplex 2
Simplex 3
Simplex 4
T-8951 TAC1
T-8952 TAC2
T-8953 TAC3
T-8954 TAC4
T-8955 TAC5
T-8956 TAC6
T-8957 TAC7
T-8958 TAC8
T-8959 TAC9
T-9019 TAC10
T-9021 TAC11
T-9022 TAC12
T-9030 TAC30
T-9031 TAC31
T-9032 TAC32
P-4000 Ref Disc
P-9990 Echo Test
T-3101 AL State
T-3102 AK State
T-3104 AZ State
T-3105 AR State
T-3106 CA State

Channel Member

T-4000 All Disc
T-9 REF Talk
T-91 BM WW
T-93 BM NA
T-3100 USA
T-31089 Hyt USA
T-31090 US A0
T-31091 US A1
T-31092 US A2
T-31093 US A3
T-31094 US A4
T-31095 US A5
T-31096 US A6
T-31097 US A7
T-31098 US A8
T-31099 US A9
Simplex

In 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
Entropia
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 Technology
Samhoo
Selex ES
Simoco
Tait
Tytera (TYT)
Vertex Standard
Wouxon
Yanton
Zastone
Zetron
ZTE
Hotspots

- Low-powered transceiver that connects to a DMR talk group via the Internet
- Many support DMR, DStar, C4FM
- No local repeater needed

SharkRF openSpot

Wireless Holdings dv4mini

PE1PLM DVMEGA w/RPi
DMR Hotspot - DVMega

The 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 Yaseu C4FM 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, DMR, Yaseu C4FM cross modem modes. Talk with your Yaseu C4FM radio on DMR or with your DMR radio on Yaseu C4FM.
Tytera (TYT) MD-380

- Single-band 5W HT
- Available from Amazon for less than $100
- Most common DMR radio in amateur use
- Modified firmware available (see md380tools)
- MD-390 also available (waterproofing, GPS)
- Rebranded by others (Retevis RT3)
Before running `flash` or `flashgps`, the radio must be in DFU mode. Power on holding PTT and top button.

Before running `flashdb` the radio should be in normal power ON mode. In the 'Devices\USB' menu, the radio will be called '@0000:ffff Patched MD380'.

`glv`  -- (Get Latest Version) Downloads and builds everything.
`glvusers`  -- Downloads and builds User DB only.

After `glv`, all commands below can be run without an Internet connection.

`flash`  -- (DFU) Write firmware to radios without GPS. (MD-380 / RT3)
`flashgps`  -- (DFU) Write firmware to radios with GPS. (MD-390 / RT8)
`flashdb`  -- (ON) Write User DB (Contacts) to radio

`lookup searchstring`  -- Search the User DB for given text
`menu`  -- Display this screen again (or Ctrl+D)
`help`  -- Display typical command recipes

`tyt@DmR:~$ _`
openSPOT User Manual

Note that this user manual is for the stable firmware version 0131. It’s updated with new information when a new stable firmware is released.

If you have questions, please ask them on our forum or in email. We only have these two official support platforms (we don’t have official support on Facebook or other platforms).

Components

Accessories

The openSPOT package comes with an AC/USB power supply, an antenna, a USB and an Ethernet cable. These are all you need to operate openSPOT, however, you will need a web browser on a computer, tablet or mobile phone for initializing openSPOT settings, but after that, openSPOT can work standalone.
Welcome to hose line

Hose line is an online streaming platform for the HAM radio Digital Mobile Radio (DMR) Brandmeister network. The project is still under heavy development, so if you encounter bugs, please try again at a later stage.

All Brandmeister Talk Groups are streamed on-demand and active participants will show up on the dashboard automatically. The Talk Groups are created on the fly, due to the decentralised nature of the Brandmeister network.
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In order to use Hoseline, you need at least:

- a **supported browser** (Chrome, Safari, Firefox)
- or, a **supported phone or tablet** (iPhone 5/6, iPad, Android 5)
- **fast internet connection** (at least 100 kbit/s)

This service is provided as-is, we do not provide any warranties. Information gathered by listening to the streams are to be treated as confidential. Do not use the information broadcasted here **without explicit consent** of the persons involved in a conversation!
Supporting the Amateur Spirit

Home of Tennessee's 1st DMR Net

Tg-3147 winter months 8pm
Summer months 9pm
UTC time - 01:00
Software / Hardware

For the Tytera (TYT) radio code plug software:
http://www.tyt888.com/?mod=download

Universal code plug editor:
http://n0gsg.no-ip.org/contact-manager/

For hardware:
http://www.grapevineamateurradio.com
http://www.gigaparts.com
http://www.mtcradio.com
DMR MARC Website:
http://www.dmr-marc.net

DMR MARC Talkgroups:
http://www.trbo.org/talkgroups

Brandmeister Network:
https://brandmeister.network

Brandmeister Talkgroups:
More Info

Amateur Radio Guide to Digital Mobile Radio:

Building a code plug how-to:

Brandmeister on-line monitor:
http://hose.brandmeister.network
References

https://www.motorolasolutions.com/content/dam/msi/docs/business/_documents/static_files/why_digital_white_paper_5_08.pdf


http://www.radioshop.com/upgrade-to-digital/