

Introduction to Digital Mobile Radio (DMR)

Digital Mobile Radio, or “DMR” is one of several digital modes of communications over ham bands available to amateur radio operators. DMR has joined D-Star and Yaesu System Fusion (YSF) as popular alternatives to standard analog FM modulation among ham radio operators.

DMR has been in use in commercial two-way radio for many years. It was originally defined as an open standard by the European Telecommunications Standards Institute (ETSI) in 2005. Its use in the US was popularized by Motorola who began marketing DMR equipment under the trade name of MotoTRBO™ in 2006.

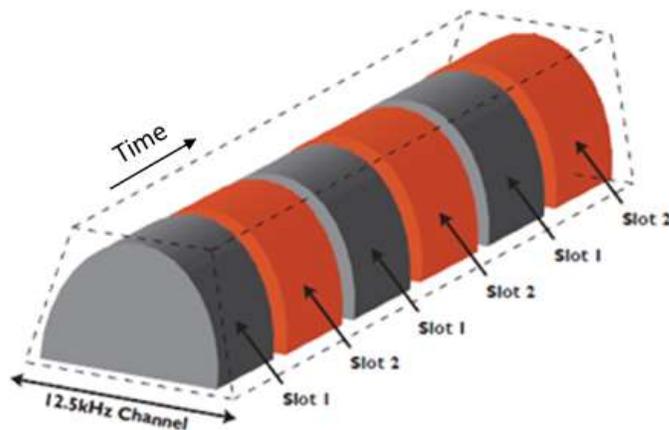
This article is intended to provide a basic understanding of DMR operation and terminology. It is not intended as a programming guide. See the links at the end of the article for programming information.

Theory of Operation

While a detailed explanation of technology is beyond the scope of this article, it is important for DMR users to understand some basic principles of DMR operation so that they understand the unique terminology used. It should be further noted that the explanation below is for the Tier II implementation of DMR, which is the portion of the ETSI standard used in amateur radio.

As with any digital mode, DMR converts an analog voice to a digital stream of information, transmitted over a standard FM radio channel, and reconverts

that digital information to analog voice at the other end using a compatible device. The primary differentiator of DMR compared to other modes is the use of a time division encoding scheme that allows 2 simultaneous conversations to coexist on a single frequency. Technically, this scheme is called Time Division Multiple Access (TDMA) and breaks the digital stream associated with each conversation into 30 ms alternative bursts of data. Each burst then occupies one of two defined “time slots” in the combined digital



stream. These time slots are defined as Time Slot 1 and Time Slot 2, or TS1 and TS2. Every transmission of a DMR radio uses one of these two time slots as defined in the programming of the radio for the particular channel being used.

One additional facet of the standard that is important to amateur radio is that, unlike some other modes, the encoded digital signals sent by DMR radios do not include a call sign or other text. DMR radios only transmit a unique digital ID number. In amateur radio, that number is unique to the user so as to provide consistent identification of the operator.

Getting Started in DMR

Much like any other amateur radio mode, the first step to getting on the air using DMR is to buy equipment. Luckily, there is a robust market of relatively inexpensive radios available to the ham radio market. A variety of handheld radios by Tytera (or TYT), Anytone, and Connect Systems (or CSI) can be purchased locally or on-line for around \$100-130 each for single-band units. Dual-band (2 meter and 440 MHz) handheld units are available in the \$175 range. Mobile units are also available and are about \$300 for dual-band units. Most DMR radios can also be used for conventional analog communications.

Links to DMR radio vendors are provided at the end of this article. Other sources may be available, but be cautious of DMR radios that are significantly lower in price than those discussed above. Regardless of your choice, be sure the radio is compliant with the **DMR Tier II** standard. Radios compliant only with Tier I will not work with DMR amateur radio repeaters.

The growth of DMR in the Kansas City area has been aided by the formation of a robust DMR repeater network that mostly uses 440 MHz frequencies, so most users find that a 440 MHz hand held is sufficient for DMR use.

After purchasing a compatible DMR radio, you will need to take one additional step before programming your radio. As noted above, each DMR user needs a unique ID number to identify their transmissions on the DMR network. That unique ID is assigned by a 3rd party organization called DMR-MARC. Users can request this ID from DMR-MARC by providing their call sign and E-mail address at the following link:

<https://www.radioid.net/register#!>

Your user ID will be returned to you by E-mail.

DMR Terminology

Programming of DMR radios presents a unique challenge to many hams for two reasons – 1) the programming is more complex than most other modes, and 2) the terminology used in DMR is unique to that mode as it has been carried over from its previous implementation in the commercial two-way radio world.

The following definitions are provided to aid in understanding DMR programming and terminology.

DMR Terminology	Definition
Channel	Somewhat corollary to a frequency in an analog radio, a Channel is the unique combination of frequency and contact (or talk group) in DMR. Multiple channels can be programmed for a given frequency or repeater, each with a different contact or talk group defined.
Code Plug	This refers to the programming installed in a DMR radio. As discussed below, this program consists of several parts that work together to form the “code plug” that defines the operation of the radio.
Color Code	Part of a repeater definition that is unique to DMR. The color code for a DMR repeater is similar in function to a PL tone for an analog repeater. The Color Code for a repeater can be a number from 0 to 15. The color code is set by the repeater operator/owner. The appropriate color code must be included in each channel definition to access the repeater.
Contact List	The part of the code plug that defines the relationship between the unique DMR ID number for individual users (see “private calls”) and groups (see “group calls”) and their name and/or call sign.
CPS	Customer Programming Software – the software created by each DMR radio manufacturer to allow user programming of their radios.
Group Call	A Group Call is a Contact List entry that is associated with a talk group. See “talk group” below.
Private Call	A Type of contact list entry associated with an individual. Private calls will always be a 7-digit number.
Talk Group	A pre-defined digital code for a dynamic group of users. Only users who have the talk group code programmed properly in their radio will hear traffic from others using the same talk group.

Talk Groups – Dynamic (or user-activated) and Static (or full-time).	Networked repeaters can be connected to any number of talk groups. Repeater operators can connect some common talk groups to the repeater on a full-time basis and allow others on a user-activated basis. Full-time talk groups will be heard by any user who has that talk group programmed in their radio whenever there is activity on that talk group. Dynamic talk groups must be activated by a user of the repeater by keying a DMR radio on that talk group. Dynamic talk groups will typically automatically be disconnected from the repeater after some period of inactivity. The repeater owner/operator defines the full time talk groups are configured on the repeater and what dynamic talk groups to allow and defines the time slot to be used in each case.
Time Slot	See discussion under “Theory of Operation”. Time slot becomes relevant when programming channels. Time slot information should match the repeater setup for talk groups that are defined as “full time” on the repeater.
Zone	A Zone is corollary to a bank of channels. Most DMR radios are limited to 16 channels that can be used at a time and they have a channel selector that only has 16 positions. Each group of 16 channels is called a Zone. DMR radios can support as many as 250 or so zones. Any channel can be assigned to any zone and a channel can be assigned to multiple zones.

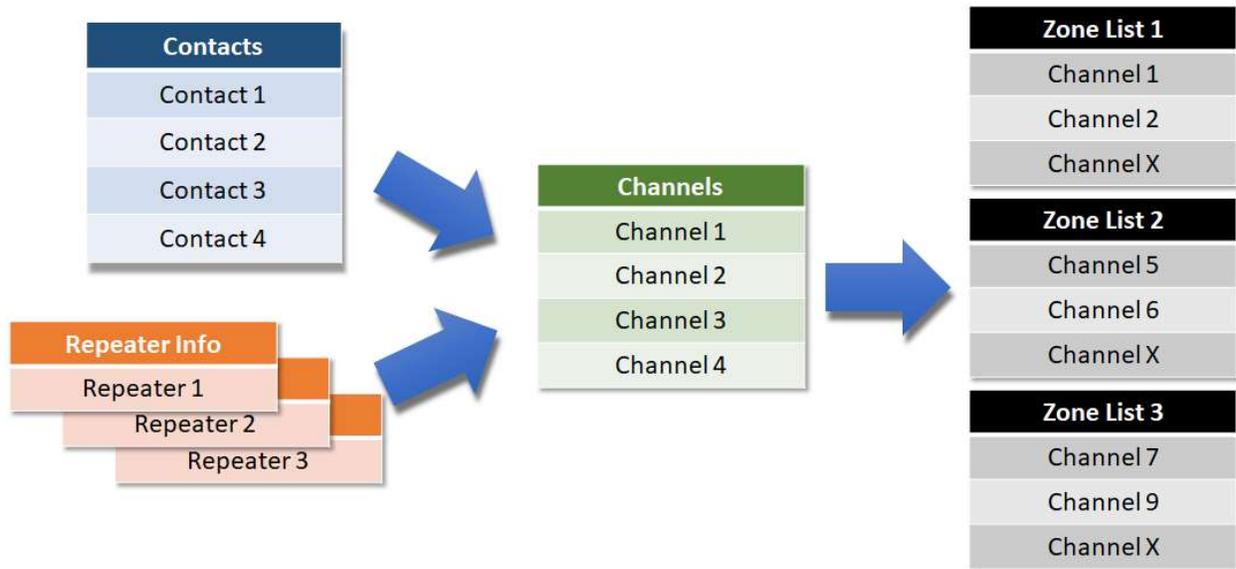
DMR Programming

In order to program any DMR radio, you will need to obtain the programming software (or CPS) specific to your radio and install that software on your computer. You should also have the cable that connects between the computer and the radio. The necessary software is available from the vendor of the radio.

Specific instructions on how to program a DMR radio is beyond the scope of this article, but tutorials are available on the internet for various models of radio. There is also a link to a tutorial created by the Back Yard Repeater Group (BYRG) at the end of this article.

Regardless of the model of your radio or the specifics of the programming software, the code plug will consist of the basic components illustrated in the figure below.

1. **A contact list.** This list should contain all the ID numbers for the talk groups (group calls) you intend to monitor or talk to. Note that it makes no difference if a talk group is defined as Static or Dynamic on any repeater – the contact list



entry is the same. Each entry may also include individual ID numbers (private calls) for specific operators that you know, or that may be active on the repeater(s) you choose. You will see name and call sign info displayed on your radio for any private call you include in your contact list. Transmissions from users not included in your contact list will only show their ID number.

2. **Channel information** – specific talk group (group call) information, and basic repeater info is combined to define “channels” in the code plug.
 - a. Basic **repeater information** includes the transmit and receive frequencies, color code, and time slot information. Note that the programming of the channel for any given repeater should follow any convention for time slots and talk groups established by the repeater owner/operator.
 - b. Multiple talk groups can, and commonly are, programmed for any given repeater. Also, the same talk groups can be programmed for multiple repeaters. Each channel, however, is a unique repeater/talk group combination.
3. **Zone information**. Each zone defines each channel associated with the 16 positions of the channel selection knob on the radio. Any channel can be assigned to any zone and the same channel can be assigned to multiple zones.

Networked Repeaters

In the DMR world it is common, but not required, to network repeaters together much like some analog repeaters are linked. In this way, talk groups can be used to transmit the same audio across multiple repeaters over a wide geography. Networked repeaters use

the internet to connect to a regional server called a “bridge”. There are two primary network systems in the US – DMR-MARC and Brandmeister. User IDs and most talk group definitions are used across both networks. However, a repeater networked through the Brandmeister network is not connected to a repeater networked through the DMR-MARC network.

You will need to consult information about your local repeater to determine which network, if any, is in use.

Links

[DMR Programming Tutorial](#)

Vendors for purchase of DMR radios:

[Associated Radio](#) (TYT)

[Connect Systems, Inc.](#)

[Bridgecom Systems, Inc.](#)

DMR User ID Request:

<https://www.radioid.net/register#!>