

# D M R

DIGITAL MOBILE RADIO

101

WHAT YOU NEED TO KNOW

HOW TO GET STARTED



# ANALOG VOICE

MIC



Analog Modulator



# DIGITAL VOICE



1. Audio from the microphone is converted to digital PCM (Pulse Code Modulation) by an Analog-to-Digital (A/D) converter.
2. The vocoder compresses the digitized audio and adds forward error correction.
3. Finally, the compressed digital audio is modulated onto the carrier wave





# DIGITAL VOICE ADVANTAGES

- Less bandwidth than AM, FM, SSB
- Better signal quality at lower signal levels
  - Levels must be above a threshold where decode is possible
  - Multi-path impacts reception more than on analog FM
- Allows data to be piggybacked on voice signal
- Digital data is easy to route over the internet for repeater networking



# DIGITAL VOICE MODES

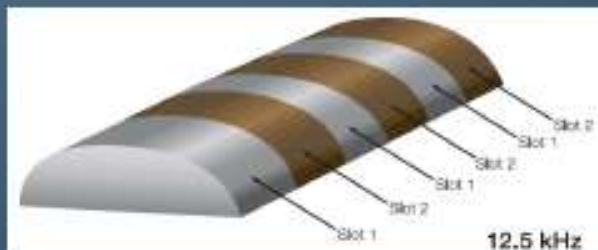
<b>Mode</b>	<b>Primary Users</b>	<b>Available in Radios from</b>	<b>AF9W Experience</b>
D-STAR - Digital Smart Technologies for Amateur Radio	Amateur	ICOM and Kenwood	High
DMR - Digital Mobile Radio	Commercial Land Mobile	Multiple commercial radio manufacturers including Motorola, Hytera, Vertex, and multiple Chinese manufacturers	High
System Fusion	Amateur	Yaesu	Low
P25	Government Land Mobile	Major commercial radio manufacturers including Motorola, Midland, ICOM, Vertex, etc	None



# BANDWIDTH COMPARISON



6.25 kHz



12.5 kHz



12.5 kHz







# DIGITAL VOICE NETWORKS





## WHAT IS A REPEATER NETWORK?

- A means of linking repeaters to expand range coverage of the system as a whole
- Linking can be accomplished using RF links or the internet
- Creates more traffic on a repeater



## WHY NETWORK?

- Brings more users to the repeater

Repeaters are very quiet without users

- Expands the geographic reach of a repeater
- Allows for easy cross connecting to other modes and services



# DMR LINKING





# POPULAR DMR NETWORKS

- MotoTrbo – Commercial DMR Network
  - Based on Motorola IPSC and cBridge
  - Central Server Architecture
  - Admin defined talkgroup structure
  - Original DMR-MARC amateur network
- Brandmeister – Amateur Radio DMR Network
  - Created in Europe by telecom experts
  - Distributed Server Architecture
  - User Defined talkgroup structure
  - Fastest Growing World-Wide Network



## OTHER DMR NETWORKS

- Hytera – Commercial DMR Network
  - Based on Hytera repeaters
  - Known as DMR+ in amateur circles
  - Similar structure as Mototrbo
  - Primarily in Europe and losing importance
- Homebrew – Amateur Radio DMR Network
  - More on this later





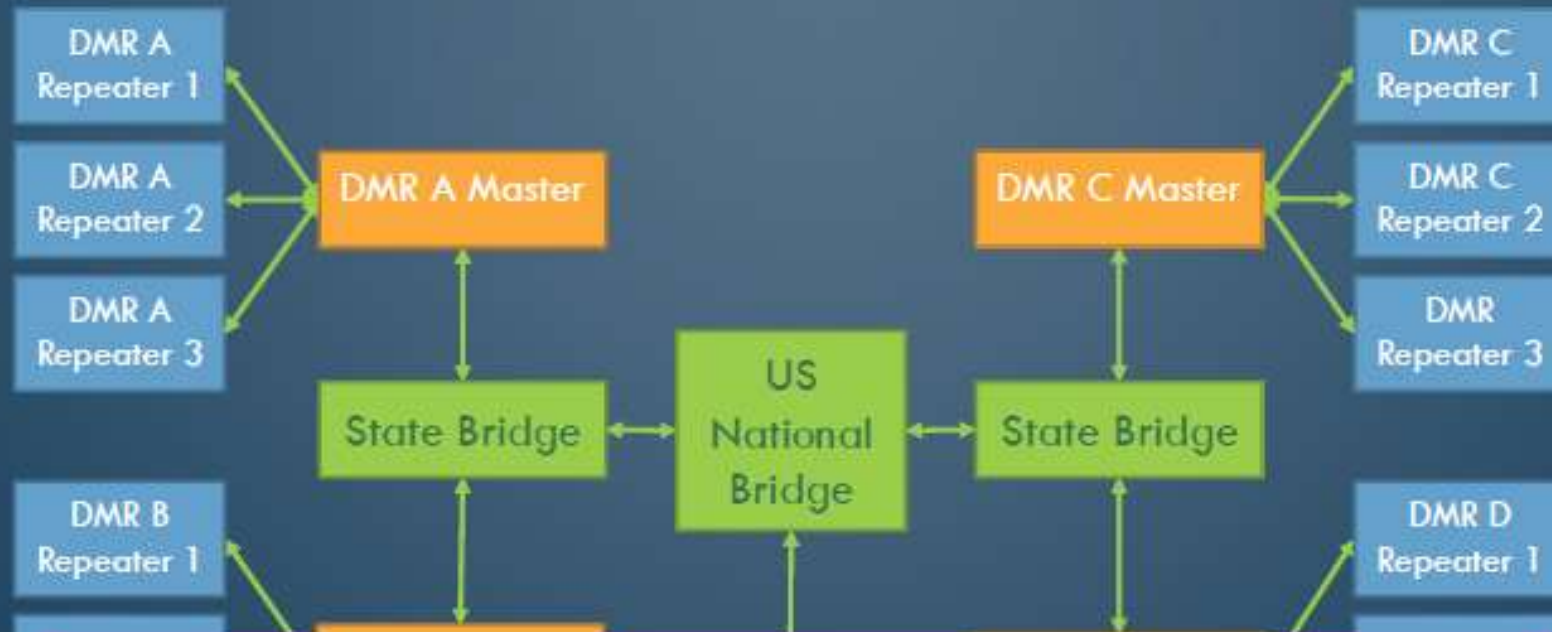
## DMR NETWORK HARDWARE SUPPORT

- Mototrbo supports Motorola IP Site Connect
- Hytera supports Hytera Multi-Site Connect
- Brandmeister supports the above plus Home Brew Repeater Protocol





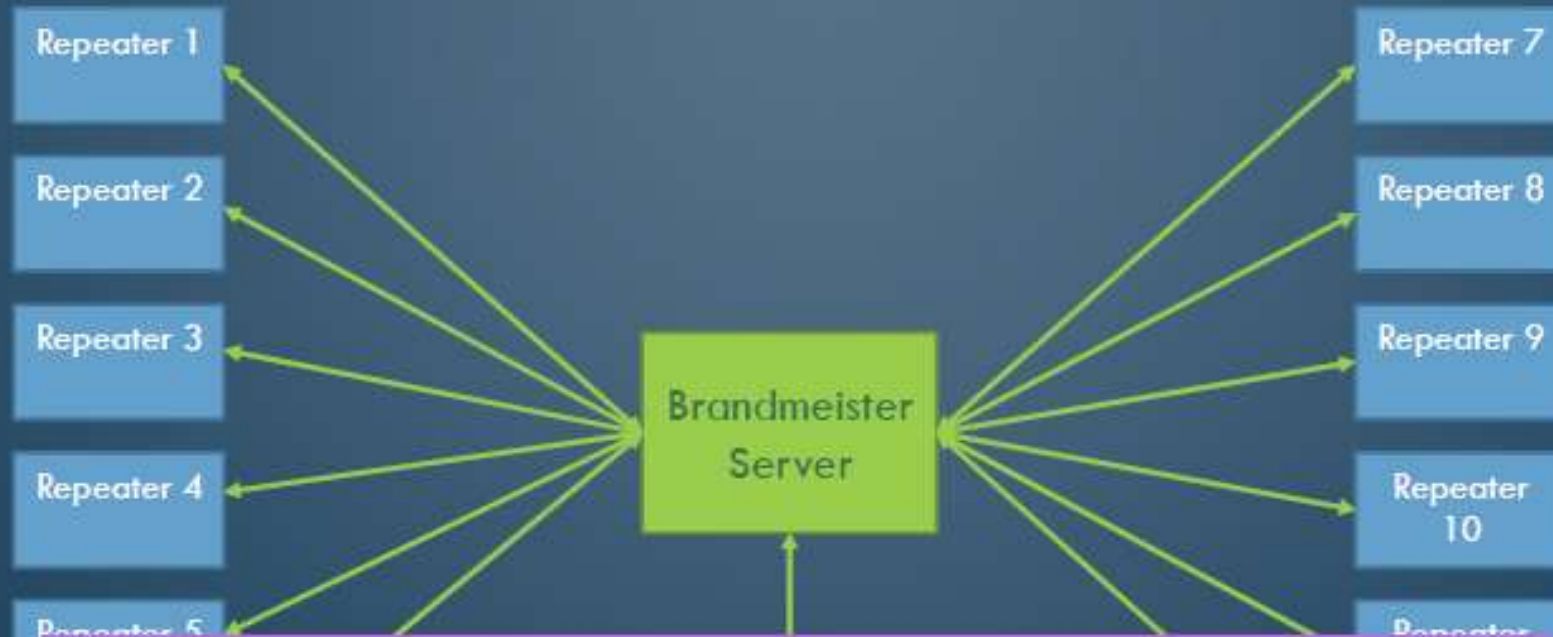
# MOTOTRBO/HYTERA LINKING



All Repeaters  
Connected to the Same Talkgroup  
Key Up Together



# BRANDMEISTER LINKING



All Repeaters  
Connected to the Same Talkgroup  
Key Up Together





## DMR NETWORK ADVANCEMENTS

- Original (still exist) DMR networks used Motorola IPSC protocol with Rayfield Electronics cBridge to interconnect master servers, e.g. DMR-MARC, PNW-DCI
  - Network topology controlled by IPSC Network owners
- Brandmeister protocol was invented in Germany to create an open network, i.e. topology managed by repeater owners





# WHAT THE HECK IS A TALKGROUP

- A Virtual Radio Channel normally defined by geographic region or language
- Think of talkgroups as a complicated tone squelch
- Each radio channel is programmed for
  - Repeater frequency and offset
  - Colorcode – sort of like DCS squelch – CC1 thru CC15
  - Timeslot – 1 or 2
  - Talkgroup



# TALKGROUPS AND REPEATERS

## TIMESLOT 1

Talkgroup Number	Pseudonym
1	World Wide
3	US / English

## TIMESLOT 2

Talkgroup Number	Pseudonym
2	Local Only
3100	DCI Bridge
3176	Southwest US Region
310	TAC 310



Repeater



Ch 1	TS1 TG 1
Ch 2	TS2 TG 2
Ch 3	TS2 TG 3176

Ch 1	TS1 TG 1
Ch 2	TS1 TG 3
Ch 3	TS2 TG 3176



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Ch 1	TS1 TG 1
Ch 2	TS2 TG 2
Ch 3	TS2 TG 3176

- Radio 1 Transmits on Ch 3
- Radio 2 hears voice on Ch 3

Ch 1	TS1 TG 1
Ch 2	TS1 TG 3
Ch 3	TS2 TG 3176





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Ch 1	TS1 TG 1
Ch 2	TS2 TG 2
Ch 3	TS2 TG 3176

- Radio 1 Transmits on Ch 1
- Radio 2 hears nothing, only channel busy indicator

Ch 1	TS1 TG 3
Ch 2	TS2 TG 2
Ch 3	TS2 TG 3176



## TWO TYPES OF TALKGROUPS

### Always On

- All ways heard on repeaters with talkgroup as full time
- Mainly talkgroups of primary use by repeater users

### User Activated

- Only heard on repeater when activated by user
- Activated by pressing PTT on channel with TG





## UNIQUE BRANDMEISTER LINKING FEATURES

- D-STAR D-Extra or DCS to talkgroup gateway  
TG 31461 ↔ REF061B
- Yaesu WIRES-X to talkgroup gateway  
TG 31203 ↔ WiRES-X room 21696
- G4KLX YSF Reflector to talkgroup gateway  
TG 31203 ↔ YSFReflector US-KansasLink
- Echolink or Allstar hub to talkgroup gateway  
TG 31158 ↔ AllStar HUBS 42616, 28508





# GETTING ON THE NETWORK

RADIOS



# Commercial Radios

Motorola



Vertex



## DMR RADIO

Multiple Manufa

- Commercial
- Amateur Cent

Part 90 Certifie

BAOFENG®  
po fung

~~DMR~~  
DIGITAL MOBILE RAD

DM-5R Plus

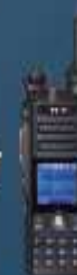
TIER I



Amateur Centric Radios



TYT



Radioddity



# DUAL BAND DIGITAL ANALOG

- MOST POPULAR
- COST EFFECTIVE
- EASY KEYBOARD PROGRAMMING

## ANYTONE - D868UV





# PROS

- Rugged and dependable
- Best RX & TX Specs
- Very few firmware changes

# CONS

- Highest Cost per unit
- Costly Accessories & CPS
- Limited number of zones, channels and Contact Lists
- Some with limited displays

## Commercial Radios



# PROS

- Low Cost Radio & Acc's
- Large Color Displays
- Available in Dual Band
- Free CPS and Cables
- Car Chargers / Batt EL's
- Hundreds of Zones/CH
- Thousands of Contacts

# CONS

- Reduced RX & TX Specs
- Some Not FCC Approved
- Some NO US Service
- Not all accessories are durable

## Popular Amateur Friendly Imports



Anytone D868UV



# GETTING ON THE NETWORK

## ACCESS POINTS





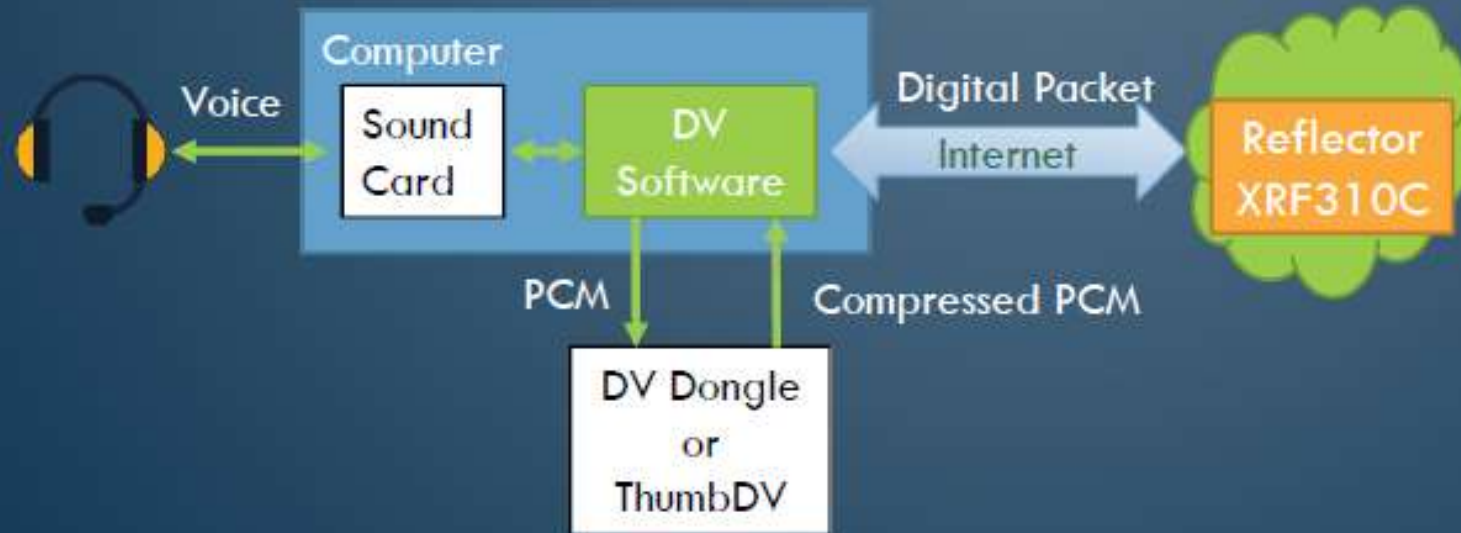
## WHAT IS AN ACCESS POINT AKA HOTSPOT?

- Hardware and software that enables access to a digital radio network without the use of a classic repeater
- Converts voice to digital data and sends it to the network via the internet



# DIGITAL VOICE DONGLE

Provides AMBE chip to allow computer to act as access point



Internet Labs DV Dongle



Universal Digital Radio ThumbDV

## DV Software

- DVTool
- G4KLX Dummy Repeater and G4KLX ircDDBGateway





# DV ACCESS POINT

Low power simplex “repeater” for Radio over IP



Internet Labs DVAP



DVMega RPI Radio



SharkRF OpenSPOT

## DV Software

- WinDV
- G4KLX DStarRepeater and G4KLX ircDDBGateway
- G4KLX MMDVMHost and G4KLX ircDDBGateway
- OpenSPOT proprietary software





# DV HOMEBREW REPEATER

Hardware to homebrew DV repeater



ZUM MMDVM



STM32\_DVM\_USB

STM32\_DVM\_PiHat



## DV Software

- G4KLX DStarRepeater and G4KLX ircDDBGateway
- G4KLX MMDVMHost and G4KLX ircDDBGateway



# EXAMPLES OF CPS:

- Commercial radio CPS (Vertex)



List No.	Dig/ Ana	W/N	TAG	CH Info	Frequency		Color Code	Rpt Slot	RX Grp List	Priv Cfm	Contact No.
					RX	TX					
1	A	W5	OVARC-GR	█	440.40000	445.40000					
2	A	W5	OVARC-PD	█	444.10000	449.10000					
3	A	W5	KCOLL-LM	█	449.97500	444.97500					
4	A	W5	KCOLL-KP	█	444.87500	449.87500					
5	A	W5	KCOLL-MK	█	444.87500	449.87500					
6	A	W5	KCOLL-ML	█	444.87500	449.87500					
7	A	W5	448*7750	█	448.77500	443.77500					
8	A	W5	444*9250	█	444.92500	449.92500					
9	A	W5	VAIL 325	█	448.32500	446.32500					
10	A	W5	449*8000	█	449.80000	444.80000					
11	A	W5	BART 350	█	448.35000	443.35000					
12	A	W5	448*5500	█	448.55000	443.55000					
13	D	N	CH-013	█	433.50000	433.50000	1		1	-	1
14	D	N	CH-014	█	433.50000	433.50000	1		1	-	1
15	D	N	T-LM DCI	█	445.87500	440.87500	1	2	4	-	9
16	D	N	T-LMN-LC	█	445.87500	440.87500	1	2	2	-	3
17	D	N	T-LMN-NA	█	445.87500	440.87500	1	1	3	-	2
18	D	N	T-LMN-WW	█	445.87500	440.87500	1	1	1	-	1
19	D	N	T-LM3176	█	445.87500	440.87500	1	2	4	-	8
20	D	N	T-MTN LC	█	444.25000	449.25000	1	2	2	-	3
21	D	N	T-MTN NA	█	444.25000	449.25000	1	1	3	-	2
22	D	N	T-MTN WW	█	444.25000	449.25000	1	1	1	-	1
23	D	N	T-MT3176	█	444.25000	449.25000	1	2	4	-	8
24	D	N	T-MT DCI	█	444.25000	449.25000	1	2	4	-	9





Sub Audio		ANI	Signaling		SQL	ARTS	SC Grp	Auto Scan	Save TX	TX PWR		TOT
Dec	Enc		Type	No.						1	2	
C-156.7	C-156.7	█	-	-	Nom	----	2	-	-	H	L3	█
C-156.7	C-156.7	█	-	-	Nom	----	2	-	-	H	L3	█
-----	C-100.0	█	-	-	Nom	----	2	-	-	H	L3	█
-----	C-100.0	█	-	-	Nom	----	2	-	-	H	L3	█
-----	C-110.9	█	-	-	Nom	----	2	-	-	H	L3	█
-----	C-107.2	█	-	-	Nom	----	2	-	-	H	L3	█
C-179.9	C-179.9	█	-	-	Nom	----	10	-	-	H	L3	█
C-156.7	C-156.7	█	-	-	Nom	----	10	-	-	H	L3	█
C-156.7	C-156.7	█	-	-	Nom	----	10	-	-	H	L3	█
-----	C-250.3	█	-	-	Nom	----	10	-	-	H	L3	█
-----	C-107.2	█	-	-	Nom	----	10	-	-	H	L2	█
C-110.9	C-110.9	█	-	-	Nom	----	10	-	-	H	L2	█
		█				----	CG	-	-	H	L2	█
		█				----	CG	-	-	H	L2	█
		█				----	1	-	-	H	L3	█
		█				----	1	-	-	H	L3	█
		█				----	1	-	-	H	L3	█
		█				----	1	-	-	H	L3	█
		█				----	1	-	-	H	L3	█
		█				----	1	-	-	H	L3	█
		█				----	1	-	-	H	L3	█
		█				----	1	-	-	H	L3	█
		█				----	1	-	-	H	L3	█
		█				----	1	-	-	H	L3	█
		█				----	1	-	-	H	L3	█
		█				----	6	-	-	H	L3	█
		█				----	6	-	-	H	L3	█



Group No.

01

Group TAG

TUCN DMR

Status

Conventional

Group Scan



CH Announce



CH	List	TAG	Info	SC	P2
1	20	T-MTN LC	<input type="checkbox"/>	✓	-
2	16	T-LMN-LC	<input type="checkbox"/>	✓	-
3	21	T-MTN NA	<input type="checkbox"/>	✓	-
4	17	T-LMN-NA	<input type="checkbox"/>	✓	-
5	22	T-MTN WW	<input type="checkbox"/>	✓	-
6	18	T-LMN-WW	<input type="checkbox"/>	✓	-
7	24	T-MT DCI	<input type="checkbox"/>	✓	-
8	15	T-LM DCI	<input type="checkbox"/>	✓	-
9	23	T-MT3176	<input type="checkbox"/>	✓	-
10	19	T-LM3176	<input type="checkbox"/>	✓	-
11	47	TM TC310	<input type="checkbox"/>	-	-
12	48	LM TC310	<input type="checkbox"/>	-	-
13	62	TUC LCL	<input type="checkbox"/>	✓	-
14			<input type="checkbox"/>		
15			<input type="checkbox"/>		



# EXAMPLES OF CPS:

- China DMR radio CPS (Anytone)





No.	Receive Frequency	Transmit Frequency	Channel Type	Power	Band Width	TCSS/DC Decode	TCSS/DC Encode	Channel Name	Contact
1	441.00000	441.00000	D-Digital	High	12.5K	Off	Off	441.000 Simplex	Simplex
2	446.07500	446.07500	D-Digital	High	12.5K	Off	Off	446.075 Simplex	Simplex
3	446.50000	446.50000	D-Digital	High	12.5K	Off	Off	446.500 Simplex	Simplex
4	432.69000	432.69000	D-Digital	Low	12.5K	Off	Off	Spot Echo Test	Echo Test
5	432.69000	432.69000	D-Digital	Low	12.5K	Off	Off	Spot TSN 3104668	TSN 3104668
6	432.69000	432.69000	D-Digital	Low	12.5K	Off	Off	Spot TG9	Reflectors
7	432.69000	432.69000	D-Digital	Low	12.5K	Off	Off	Spot TG10	Local 10
8	432.69000	432.69000	D-Digital	Low	12.5K	Off	Off	Spot TAC 310	TAC310
9	432.69000	432.69000	D-Digital	Low	12.5K	Off	Off	Spot TAC 311	TAC311
10	432.69000	432.69000	D-Digital	Low	12.5K	Off	Off	Spot TAC 312	TAC312
11	432.69000	432.69000	D-Digital	Low	12.5K	Off	Off	Spot XLX Unlink	XLX Unlink
12	432.69000	432.69000	D-Digital	Low	12.5K	Off	Off	Spot XLX Link D	XLX Link Node D
13	432.69000	432.69000	D-Digital	Low	12.5K	Off	Off	Spot XLX Status	XLX Status



Channel Name

Receive Frequency

Transmit Frequency

Channel Type

Transmit Power

Band Width

TX Permit

Scan List

TX Prohibit

Work Alone

Talk Around

Digital

Contact

Radio ID

Color Code

Slot

Receive Group List

Digital Encryption

Encryption Type

Simplex TDMA

TDMA Adaptive

Call Confirmation

Analog

CTCSS/DCS Decode

CTCSS/DCS Encode

Squelch Mode

Optional Signal

DTMF ID

2Tone ID

5Tone ID

PIT ID

Reverse

2TONE Decode

Custom CTCSS

OK

Cancel

Previous

Next



Zone Name

Tucson MARC

A Channel

441.000 Simplex

B Channel

441.000 Simplex

Available Channel

2	446.075 Simplex
3	446.500 Simplex
4	Spot Echo Test
5	Spot TSN 3104668
6	Spot TG9
7	Spot TG10
8	Spot TAC 310
9	Spot TAC 311
10	Spot TAC 312
11	Spot XLX Unlink
12	Spot XLX Link D
13	Spot XLX Status
14	Spot XLX Talk
15	Spot BM Unlink
16	Spot USA 3100
17	Spot AZ 3104
18	Spot CA 3106
19	Spot CO 3108
20	Spot FL 3112
21	Spot ME 3123
22	Spot MA 3125
23	Spot NM 3135

&gt;&gt;

&lt;&lt;

Order By

ID

Name

Zone Channel Member

128	TUC MT 3100
129	TUC MT 3176
130	TUC MT Cactus
131	TUC MT LCL
132	TUC MT NA
133	TUC MT TAC 310
134	TUC MT WW
135	TUC MT WW Eng
56	MT LMN 3100
57	MT LMN 3176
58	MT LMN Cactus
59	MT LMN LCL
60	MT LMN NA
61	MT LMN TAC 310
62	MT LMN WW
63	MT LMN WW Eng
1	441.000 Simplex

Order By

ID

Name

Up

Down

OK

Cancel

Previous

Next





# WHAT DO YOU NEED TO GET STARTED IN DMR?

Get your Subscriber ID



www.dmr-marc.net

**DMR-MARC**

Motorola Amateur Radio Club Worldwide Network

<https://brandmeister.network/?page=register>

**DMR**  
**BrandMeister**



- Choose a radio that fits your needs and budget
- Decide how you will access the DMR network.  
Locate local repeaters, or buy/build Access Point
- Program your radio's Code Plug
- Get on the AIR and LISTEN
- When comfortable – PTT and Have FUN!





# DMR Introduction (Digital Mobile Radio)

**Repeater** – Local operation and connected to the Internet for distant conversations.

**Hotspot** – A 10 to 20 milliwatt transceiver that must be connected to the Internet for any conversation. Use your personal DMR number as the number but add 01 to the first, 02 to the second ect.

**Talk Group** – The name given to a conference bridge to which any number of stations can be connected at once for conversations.

**Timeout** – a conversation on a repeater will stay connected for about 20 minutes after the last activity. A conversation on a hotspot will stay connected until a new talk group is selected or a disconnect command is issued.

**DMR-MARC** – The Motorola Amateur Radio Club network that allows interconnect of Motorola repeaters using a special router. No hotspots or home brew repeaters allowed on the network. Some talk groups in common with Brandmeister. A sysop determines routing.

**Brandmeister** – A network that allows home brew repeaters and hotspots. The user determines the routing for each talk group desired. An area grouping as well as an individual grouping is allowed rather than the point to point repeater grouping in MARC.



**Time Slot** – The DMR network allows two simultaneous conversations on the same frequency at the same time. Some radios can monitor both time slots at the same time and some cannot. A time division multiplex is utilized to allow the two time slots to coexist.

**Color Code** – Different packet headers are utilized to allow different users to access the same repeater without hearing each other. Think of it as a different CTCSS tone or DCS code in the analog world to prevent interference. This is used mostly in the commercial world rather than amateur repeaters. It could be used to avoid interference to users on the same frequency that would normally interfere with each other.

**Bandwidth** – DMR requires twice the bandwidth of the other digital modes and thus uses the same bandwidth as a normal FM voice transmission.

**Operating Procedure** – First key up with the Status talk group (5000 when it's working). Make sure on a repeater that you disconnect (4000) a previously active talk group (if it is still active) before keying up with the talk group you want to contact. A hotspot will automatically drop an existing talk group when a new one is keyed. Remember that when you key to a busy talk group you may be interrupting an ongoing conversation. After keying to a talk group, listen for a few minutes before giving your callsign. No CQ or QRZ is necessary, just give your callsign after being sure you are not interrupting an existing QSO.

**DMR Registration** – The current registration site for getting your DMR number is:



**DMR Registration** – The current registration site for getting your DMR number is:

<<https://register.ham-digital.org/>>

Be sure to register as an individual user and not a public unattended station (repeater).





# Adding a New Talkgroup to Your Codeplug

So let's say you found a talkgroup you want to add to your codeplug. There are 3 steps for making that addition. Use the Contact Manager program to load your code plug and add the new channel.

1. Add the Talkgroup to your Contacts list.
2. Add a Channel for the Talkgroup.
3. Add the Channel to a Zone

The details for doing this are outlined below. The concepts are the same for Motorola, Hytera and other DMR radios.

## Add the Talkgroup to Your Contact List

You have a couple of choices depending on your radio. For the CS700 and MD380, and MD-2017 the Digital Contacts list can be easily modified or contacts added using the EDIT function in the Contact Manager program. Enter your desired talkgroup number and the Contact Name as something you will recognize and this part is complete. Make sure the Call Type is a Group Call.



# Adding a New Talkgroup to Your Codeplug (cont)

## Add a Channel for the Talkgroup

Copy an existing channel for the frequency desired and paste it into the contact list. You will be allowed to change the channel name and save it. After it is added, edit the new channel and select the new Contact Name to your new channel and verify the timeslot is set to the same timeslot you have used for the rest of the channels for that frequency.

## Add the Channel to the Zone

Go to the Zone list and add the channel to the zone. The MD-380 will only allow 16 channels per zone, so you may have to remove one to be able to add a new channel.

Save the code plug and load it back into your radio programming software and upload it to your radio.

Note: Google [gDMR Contact Manager](#) to find the free N0GSG program that will allow a much simpler manipulation of a code plug than the manufacturers program. Transfer of one radio type code plug to another radio type is possible by executing two copies of Contact Manager side by side and copy/paste from one copy to the other.



