DMR — DIGITAL MOBILE RADIO

DIGIMES

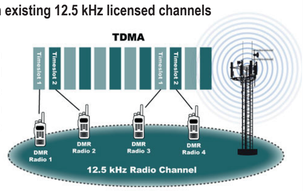
Advantages

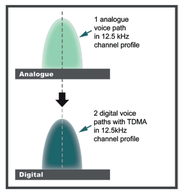
DMR products have many advantages over other digital public or land mobile radio technologies (PMR/LMR) targeted at the **business critical and commercial** sectors. As well as being able to match **or better** the existing features of analogue radios, the use of a two slot TDMA (Time Division Multiple Access) protocol results in **DMR** giving simple and effective scalability, energy efficiency, **cost efficiency** and a rich new set of features. **DMR** also brings the range and audio clarity benefits of digital radio communication. **DMR** is particularly well suited to the addition of new voice or data services because it **doubles capacity in existing** licensed channels. In particular, when new business-enhancing data applications are introduced, with **DMR** there is **no impact on existing** voice quality of service - a well-known issue due to the "chatty" spectrum hungry nature of many data applications. Moreover, **DMR** systems add this extra capacity **at no cost** to the user.

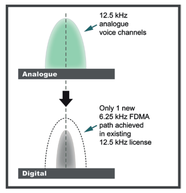
Benefits

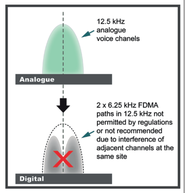
Predictable doubling of capacity in existing 12.5 kHz licensed channels

One of the principle benefits of DMR is that it enables a single 12.5 kHz channel to support two simultaneous and independent calls, achieved using TDMA. Under the DMR standard, TDMA retains the 12.5 kHz channel width and divides it into two alternating timeslots A and B where each timeslot acts as a separate communication path.



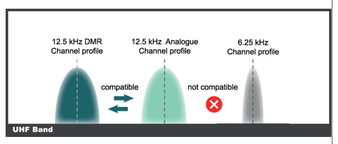






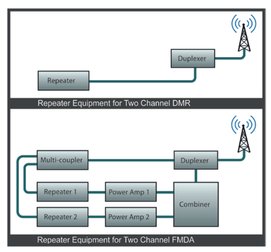
Delivers backwards spectrum compatibility with legacy analogue system

It may also be important for license holders to keep hold of existing licences to ensure backwards compatibility with their own legacy radios or with an external organisation's analogue system (for example an onsite contractor). As DMR uses 12.5 kHz channels the required spectrum compatibility is built in.



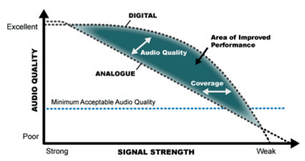
Efficient use of infrastructure equipment

Another advantage of the DMR TDMA approach is that you get two communications channels with one repeater, one antenna and a simple duplexer. Compared to FDMA solutions, two-slot TDMA allows you to achieve 6.25 kHz efficiency while minimising investments in repeaters and combining equipment.



Superior audio performance

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



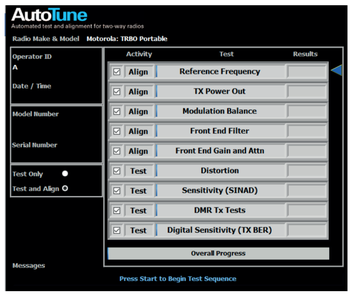
Instruments

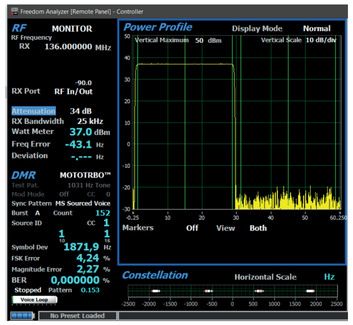
FREEDOM
Communication Technologies
R8100 Communication System Analyzer

FREEDOM
Communication Technologies
R8000C Communication System Analyzer

FREEDOM
Communication Technologies
R9000 Communication System Analyzer

DMR Test mode screens





Technical Parameters

TDMA

DMR employs a two-slot Time-Division Multiple Access (TDMA) system offering low cost and flexible digital voice and data solutions, and uses a well established 4FSK modulation scheme. The TDMA implementation in DMR uses a 12.5 kHz spaced radio carrier to send two simultaneous radio channels thus offering a spectrum-efficiency of 6.25 kHz per channel.

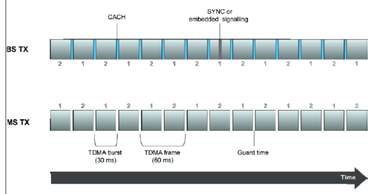
MODULATION

In the 4-level FSK modulation employed by DMR, each set of two bits (a dibit) is represented as a symbol with a fixed deviation from the transmit frequency. With a rate of 4,800 symbols/s a data rate of 9600 bit/s is achieved (utilising both TDMA slots).

Information bits		Symbol	4FSK deviation
Bit 1	Bit 2		
0	1	+3	+1,944 kHz
0	0	+1	+0,648 kHz
1	0	-1	-0,648 kHz
1	1	-3	-1,944 kHz

TDMA STRUCTURE

The DMR protocol is built around a 30 ms TDMA 2-slot structure. In the spaces between the transmitted blocks the protocol calls for the unit to be receiving. This therefore allows signalling and/or voice in the reverse direction, even during a conversation. The perception of the user will be that this unit is providing a full duplex conversation.



A generalised timing diagram of exchanges between the MS (mobile station) and the BS (base station) is shown in Diagram where the time slots for the two TDMA physical channels are labelled "1" and "2". The inbound transmission is labelled "MS TX" and the outbound transmission is labelled "BS TX".

•The inbound channel (MS TX) has an unused guard time between bursts to allow for Power Amplifier ramping and propagation delay.

•The outbound channel, which transmits continuously when the BS is activated, uses the equivalent of this guard time to insert a Common Announcement Channel (CACH) between bursts for traffic channel management (framing and access) and low speed signalling. If no information is available to transmit in channel 1 and/or channel 2, the BS transmits idle messages to fill out the bursts.

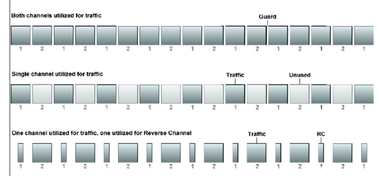
•All bursts have either a synchronization pattern or an embedded signalling field located in the centre of the burst.

BASIC CHANNEL TYPE

There are three main basic channel types used by DMR:

• Traffic channel with CACH - the same as the BS TX example in above. This channel type is used for outbound BS transmissions but is also used for the continuous transmission mode between MS units used for Tier 1 DMR.

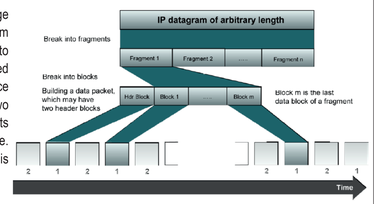
• Traffic channel with guard time - the same as the MS TX example in above. This channel type is used for inbound transmissions from an MS to a two-frequency BS.



Transmissions on the reverse channel can be used, for example, to support the operation of applications during speech sessions, for example to tell a transmitting radio to stop, because an emergency call is waiting, or to inform it of its signal strength, so that it can adjust it's transmit power.

PACKET DATA PROTOCOL (PDP)

If the PDP is required to transport a message whose length is bigger than a maximum length, the message is first split into fragments. Each fragment is then mapped into a single packet consisting of a sequence of data blocks 1 to m preceded by one or two header blocks. Each block is protected by its own Forward Error Correcting(FEC) code. The fragmentation and packetisation is illustrated in Diagram:



VOCODER

A vocoder (voice encoder) compresses the transmitted digital voice signal to enable it to fit into a smaller bandwidth channel and at the receiving end it uncompresses the signal. Different digital standards use different vocoder technologies. A full-rate vocoder compresses voice sufficiently for it to fit in a narrow-band (12.5 kHz) channel. A half-rate vocoder is necessary to compress it enough to fit into a 6.25 kHz channel or in one 12.5 kHz TDMA timeslot such as used by DMR.

Conclusion

DMR has been designed from the ground up **for users of professional** mobile radio. It efficiently **increases capacity**, gives **longer battery life** and **minimizes the use** of infrastructure. The standard also facilitates advanced functionality and control features and the use of business critical data applications. Finally **DMR** brings the range benefits and clarity of digital voice.

There are significant differences in the digital products that are currently being brought to market and users need to exercise care in choosing a solution. This is all the more the case because of the longevity of PMR products.

Buyers of PMR/LMR products need to consider a variety of higher order factors in their decision making: spectrum and licensing; system evolution potential, legacy compatibility, long term supply of compatible products and in these increasingly green times – energy use, as well as specific product features.

DMR stands up well when tested against all these criteria. **This is not surprising** – it is exactly what you would expect from a system designed from the outset **for the professional radio user**.