

dPMR: A low cost digital successor to PMR446 on the Horizon

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Introduction

PMR446 equipment has been a tremendous success with millions of units being sold and market penetration increasing as the unit cost has steadily fallen. Users range from large commercial organizations to families and children, as a result of which features vary to address each market segment. The biggest problem with this type of equipment, however, is the limited capacity; PMR446 has just 8 channels available so in urban areas channel sharing is inevitable. Access systems such as CTCSS can help prevent some of the annoying effects of this but not completely eliminate them. Today, dPMR technology offers the ability to replace PMR446 equipment with a modern digital radio with 16 new channels (additional to the existing 8 analogue channels), reliable digital speech, similar range and crucially, only a small cost premium for the benefits achieved with this new technology. CML Microcircuits facilitate this market with the highly optimised CMX7141 Digital PMR Processor and CMX618/CMX608 Vocoder solution.

dPMR Basics

The dPMR system is a FDMA digital voice system using 6.25kHz channels in the 446.1MHz to 446.2MHz band. The frequency allocation has been agreed by CEPT/ECC (see ECC/DEC/(05)12) and is in the process of being adopted throughout Europe for use with approved equipment on a license exempt basis. This is the same regulatory situation that PMR446 enjoys today, PMR446 occupying the 100kHz immediately below the dPMR allocation.

	PMR446	dPMR
ETSI Air-interface	EN 300 296	TS 102 490
Channel Spacing	12.5kHz (8 channels)	6.25kHz (16 channels)
Radio Performance Requirements	EN 300 296-2	EN 301 166-2
Tx Power	500mW EIRP	500mW EIRP
Voice	Analogue FM	Digital Voice at 3.6kbit/s and 4FSK modulation
Channel Access	PTT (CTCSS etc. available on some units)	PTT, talk-groups, one to one calls etc. LBT can be implemented
Data / Messaging	No	Yes
Packet Data	No	Yes
Range	Up to 2km	Up to 2km
Security	None	Scrambling may be applied by the manufacturer

Additional features of dPMR

As dPMR is digital, radio data communications can be simply accomplished. Thus status messaging, such as 'where are you?', 'return to base' etc. may be sent, as can text messages in a similar manner to SMS 'texting' on cellular terminals. Other data can be transmitted as well; for example it would be simple to offer an interface to allow GPS receiver position reporting to be transmitted.

At present, PMR446 conversations can be overheard by anyone with a suitable receiver - with the advent of dPMR with voice being digitally coded prior to transmission the prospect of adding additional data scrambling to the voice data becomes a real possibility.

Low Cost Digital?

Other digital systems targeted at License Exempt / PMR users have been proposed, but have not achieved mass-market success for one reason or another. At one time TETRA was seen as the sole future of digital PMR in Europe, but the complexity of the system, which makes it an excellent public safety solution, also means that it is inappropriate for volume commercial users. In the 1990s Europe started work on Digital Short Range Radio (DSRR) but this initiative was too early for the market. Today another technology DMR, which has much in common with the proposed APCO P25 Phase two, 2-slot TDMA, is competing for mid-tier PMR business, but, like TETRA, the complexity is such that low-cost solutions for the mass

market just aren't on the cards right now. This makes dPMR unique because the digital technology is simple but effective, re-using much of the well proven and low-cost PMR446 radio know-how as shown in [Figure 1](#).

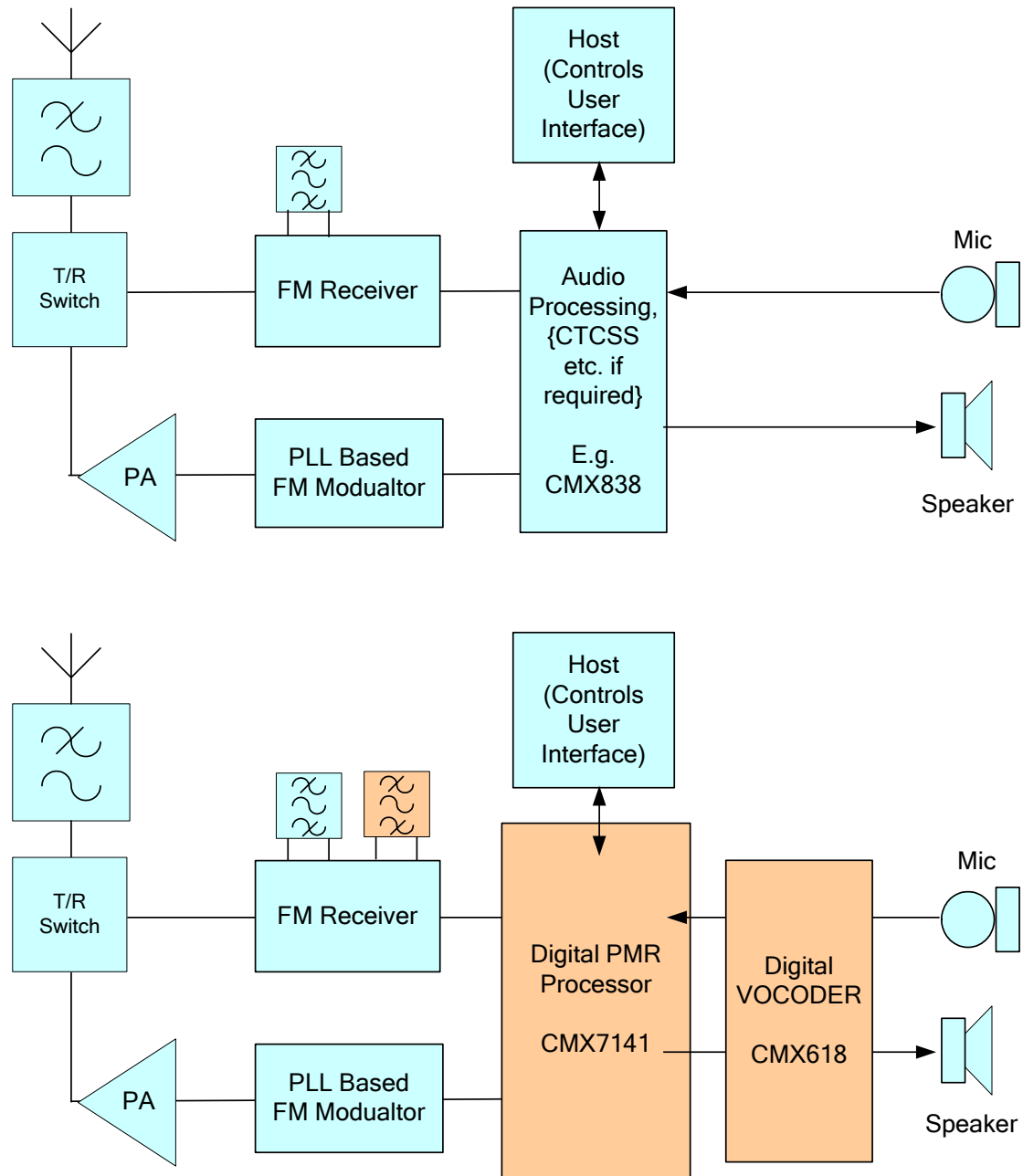


Figure 1 - Block diagram of PMR446 radio (top) and dPMR radio (bottom) showing common areas with a PMR446 radio (blue) and modified / additional areas for a dual mode analogue / dPMR design.

Design Challenges?

Many of the issues in developing dPMR terminals have been removed with the provision of integrated chipsets, the first to reach the market being the CMX7141 + CMX618 from CML Microcircuits. Uniquely, this interfaces to conventional FM transmitters and receivers making the design simple. The chipset seamlessly manages voice traffic with no intervention from the host microcontroller, which simply needs to control the user interface, monitor for PTT activity, control channel selection etc. then command the CMX7141 appropriately.

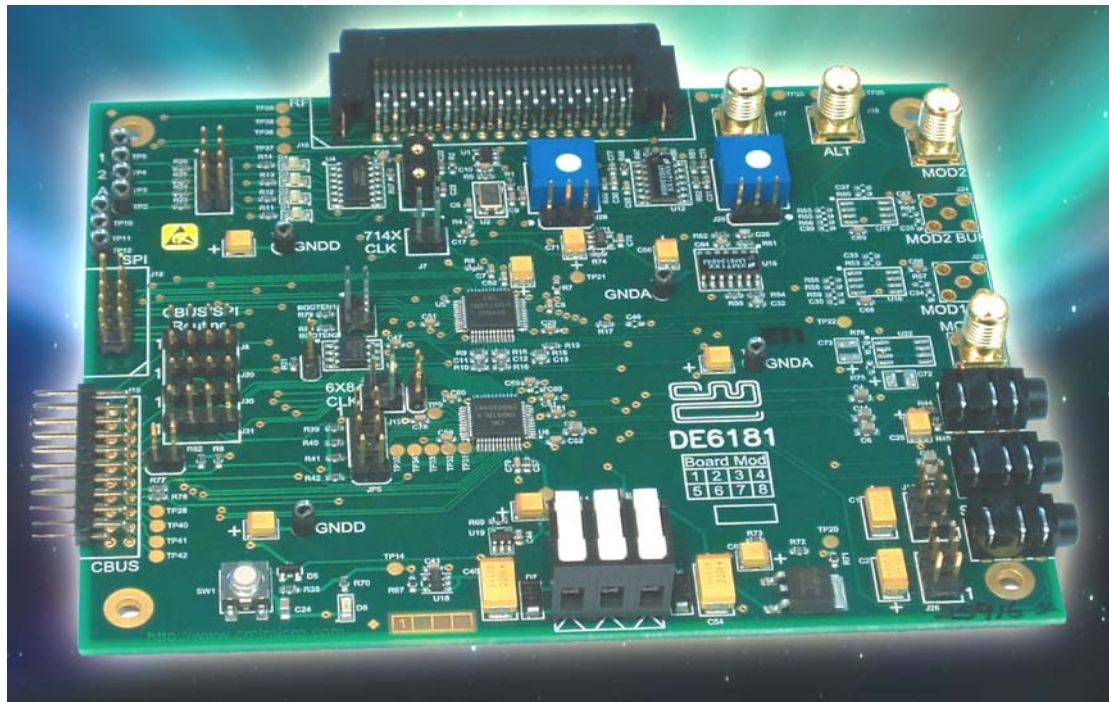


Figure 2 - Evaluation PCB for CMX7141 + CMX608 dPMR Chipset from CML

The radio performance limits are set by European Harmonised standard EN 301 166. The 6.25kHz channel spacing hasn't been widely used to date, but EN 301 166 has been around since 1997 and filter manufacturers already provide off-the-shelf components. Tests at Applied Technology Ltd (the RF, wireline telecoms and baseband processing specialist in Shepton Mallet) have shown good performance at both room temperature and at extremes. The main challenge is meeting phase noise requirements in the local oscillator, but that is nothing new for PMR radio designers. The transmitter design is 100% conventional using two-point modulation and is as simple as you can get; the CMX7141 supports adjustment of the levels on the two channels making alignment simple to automate.

Performance

Skeptics may point to performance compromises of using an essentially analogue radio with a digital modulation system, but advanced signal processing algorithms within the CMX7141 achieve excellent results. The bit error rate performance measured on test receivers is well in excess of EN 301 166 while comfortably meeting adjacent channel rejection and other radio performance requirements. The benefits of this approach are:

- Minimum cost radio
- Very low power consumption
- Proven Technology

Vocoder

The selection of a vocoder for a number of systems has been problematic for a number of years. dPMR has adopted a similar route to other standards in not defining a particular vocoder, but providing a voice channel with a 3.6kbit/s capacity. Within this capacity manufacturers can choose whichever vocoder they prefer. Two potential candidates have emerged: the 'IMBE+2' from DVSI Inc and 'RALCWI' technology promoted jointly by CML and SPIRIT Corp. Both solutions offer 2.4kbps vocoded data, which then has error correction added bringing the data rate to 3.6kbit/s. The performance of both is similar with similarly achieved PQMOS scores. Both vocoders are available for implementation in DSPs, but today only 'RALCWI' technology is available in chipset form that can drop straight into a low-cost product. A further advantage for manufacturers is that the chip comes without the need for any NRE payment or any royalties and a version, the CMX618, integrates the audio codec and interfaces reducing the size and number of components in the handset .

The dPMR MoU is considering whether to recommend one of the vocoders for dPMR however manufacturers are pressing ahead with designs. As many users buy a batch of terminals at the same time from the same manufacturer, inter-operability across different manufacturers products is not necessarily essential.

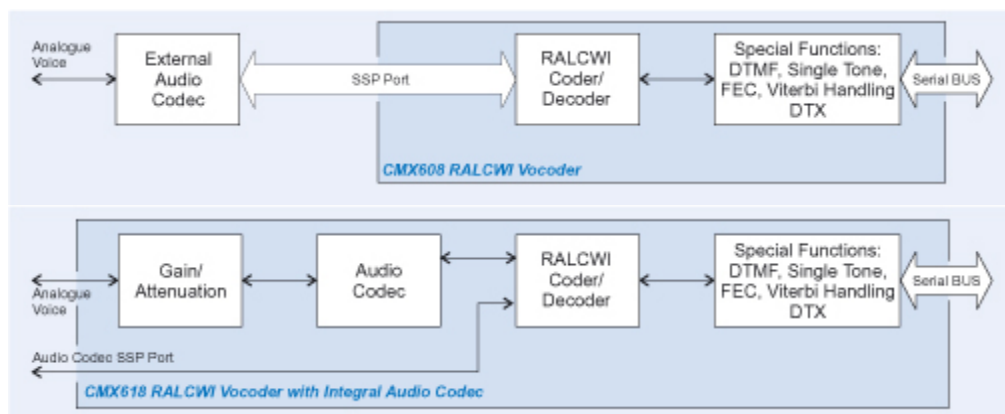


Figure 3 - CMX608 & CMX618 Vocoder IC Functionality

What can we expect for dPMR products?

The advent of chipset solutions means that huge savings in cost, size and power consumption are on the cards. Power consuming DSPs can be dispensed with, as can discrete ADCs & DACs. Digital Voice is always going to take a little more power than analogue due to the Vocoding process, but this power is only consumed during Tx and Rx (i.e. not standby). The CMX7141 manages this process effectively (under configuration from the host) to minimise power consumption whenever possible. Further, because dPMR transmissions are asynchronous, the digital part of the receiver can go to sleep until RSSI suggests the presence of a signal. All this means that dPMR terminals have the potential to reach similar performance standards to today's PMR446.

Done Deal?

Note quite, the dPMR air-interface standard is approved and published by ETSI but it is currently undergoing upgrades to add further features and facilities, however these are enhancements and don't really effect the low-tier PMR446 applications.

"We're convinced dPMR is going to be huge and we're talking to some very interesting potential players. That said, the traditional PMR manufacturers do appear to still be focusing on low / medium volume applications, classic 'mid tier' PMR. This leaves the door open for a company with a consumer electronics brand to come in and cream the top of the market next Christmas. It's a classic product, the sort of thing Amstrad or Binatone would have done a few years ago, high tech but low cost."

David Brooke - Head of Product Strategy, CML.

One area that does need further work is interoperability. Today no mechanism exists to test dPMR radio and test equipment manufacturers have been slow to incorporate the technology in their products. A dPMR MoU was established in 2007 (comprised of the Kenwood Corporation, Fylde Micro, CTE International, Icom Incorporated and CML Microcircuits). The key objective of this group is to ensure testing and interoperability issues are effectively addressed. ETSI is also working on test suites and drafts are already being discussed at Committee level.

The Future

As already noted, the air-interface standard is already being enhanced and the ECC is actively consulting on an allocation for dPMR/DMR in the VHF band (150-170MHz). Ofcom in the UK is already proposing an allocation in the former ERMES band at 169MHz. This would allow more channels to cope with growing demand and offer even better range than the already impressive performance achievable today.

Conclusion

The success of PMR446 has demonstrated a huge market for low cost 'walkie-talkie' equipment but the limited capacity and features of existing technology are a constraint. dPMR is now a proven technology offering a true low-cost digital successor to these applications. Could low cost dPMR be in the shops for next Christmas? The answer is: 'yes' if consumer electronics companies turn their attention to it.

Further Information

CML Microcircuits products cited throughout this article are:

CMX7141 Digital PMR Processor IC

CMX608 RALCWI VOCODER

CMX618 RALCWI VOCODER with integrated ADC and DAC.

Further information, datasheets and evaluation kits (DE6181) are available:

www.cmlmicro.com.

For details of dPMR: www.dpmr-mou.org (Site currently under development)

Details of CEPT/ECC Documents See www.ero.dk

All ETSI standards are available for free download at www.etsi.org