



# SLOVENSKI STANDARD

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**Prizemni snopovni radio (TETRA) - Tehnične zahteve za neposredni način delovanja (DMO) - 2. del: Radijski vidiki**

Terrestrial Trunked Radio (TETRA) - Technical requirements for Direct Mode Operation (DMO) - Part 2: Radio aspects

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# ETSI EN 300 396-2 V1.4.1 (2011-12)



## Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 2: Radio aspects

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**Reference**

REN/TETRA-08192

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**Keywords**

TETRA, DMO, radio, repeater, gateway, air interface

**ETSI**

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## Foreword

This European Standard (EN) has been produced by ETSI Technical Committee Terrestrial Trunked Radio (TETRA).

The present document is part 2 of a multi-part deliverable covering the Technical requirements for Direct Mode Operation (DMO), as identified below:

Part 1: "General network design";

**Part 2: "Radio aspects";**

Part 3: "Mobile Station to Mobile Station (MS-MS) Air Interface (AI) protocol";

Part 4: "Type 1 repeater air interface";

Part 5: "Gateway air interface";

Part 6: "Security";

Part 7: "Type 2 repeater air interface"; (Historical)

Part 8: "Protocol Implementation Conformance Statement (PICS) proforma specification"; (Historical)

Part 10: "Managed Direct Mode Operation (M-DMO)". (Historical)

NOTE: Part 7, part 8 and part 10 of this multi-part deliverable are of status "historical" and will not be updated according to this version of the standard.

### National transposition dates

Date of adoption of this EN:	22 December 2011
Date of latest announcement of this EN (doa):	31 March 2012
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	30 September 2012
Date of withdrawal of any conflicting National Standard (dow):	30 September 2012

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# 1 Scope

This multi-part deliverable defines the Terrestrial Trunked Radio system (TETRA) Direct Mode Operation (DMO). It specifies the basic air interface, the interworking between Direct Mode (DM) groups via repeaters, and interworking with the TETRA Voice plus Data (V+D) system via gateways. It also specifies the security aspects in TETRA DMO, and the intrinsic services that are supported in addition to the basic bearer and teleservices.

The present document applies to the TETRA DMO Mobile Station to Mobile Station (MS-MS), DMO Type 1 repeater and DMO Gateway air interface and contains the specifications of the physical layer according to the OSI seven layer reference model.

It establishes the TETRA DM radio aspects (layer 1 and lower MAC):

- it defines and specifies the modulation;
- it defines and specifies the radio transmission and reception;
- it defines and specifies the synchronization;
- it defines and specifies the channel coding;
- it defines and specifies the channel multiplexing;
- it defines and specifies the control over the radio link.

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## 2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at <http://docbox.etsi.org/Reference>.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

### 2.1 Normative references

The following referenced documents are necessary for the application of the present document.

- [1] ETSI EN 300 113-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land mobile service; Radio equipment intended for the transmission of data (and/or speech) using constant or non-constant envelope modulation and having an antenna connector; Part 1: Technical characteristics and methods of measurement".
- [2] ETSI EN 300 392-2: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 2: Air Interface (AI)".
- [3] ETSI EN 300 396-3: "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 3: Mobile Station to Mobile Station (MS-MS) Air Interface (AI) protocol".
- [4] Void.
- [5] ETSI EN 300 396-5: "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 5: Gateway air interface".
- [6] ETSI EN 300 395-2: "Terrestrial Trunked Radio (TETRA); Speech codec for full-rate traffic channel; Part 2: TETRA codec".

- [7] ETSI TS 100 392-15: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 15: TETRA frequency bands, duplex spacings and channel numbering".

## 2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] ETSI Directives: "ETSI Statutes; ETSI Rules of Procedure; ETSI Board Working Procedures; Powers and Functions of the Board; Terms of Reference of the Operational Co-ordination Group (OCG); ETSI Technical Working Procedures; ETSI Drafting rules".
- [i.2] ETSI EN 300 392-1: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 1: General network design".
- [i.3] Void.
- [i.4] ETSI EN 300 396-7: "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 7: Type 2 repeater air interface". (Historical).

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## 3 Definitions, symbols and abbreviations

### 3.1 Definitions

For the purposes of the present document, the terms and definitions given in the ETSI Directives [i.1] and the following apply:

**Bit Error Ratio (BER):** ratio of the bits wrongly received to all bits received in a given logical channel

**call transaction:** all of the functions associated with a complete unidirectional transmission of information

NOTE: A call is made up of one or more call transactions.

**changeover:** within a call, process of effecting a transfer of the master role (and hence transmitting MS) at the end of one call transaction so that another can commence

**Direct Mode GATEway (DM-GATE):** device that provides gateway connectivity between DM-MS(s) and the TETRA TMO network

NOTE 1: The gateway provides the interface between TETRA DMO and TETRA TMO. A gateway may provide only the gateway function (DM-GATE) or may provide the functions of both a DM repeater and a DM gateway during a call (DM-REP/GATE).

NOTE 2: A gateway may have one of three roles on DMO side:

- **master:** if the gateway is either active in a call transaction transmitting traffic or control data, or is reserving the channel by means of channel reservation signalling or during the solicited registration procedure;
- **slave:** if the gateway is receiving traffic and signalling in a call from DM-MS;
- **idle:** if the gateway is not in a call.

**Direct Mode Mobile Station (DM-MS):** physical grouping that contains all of the mobile equipment that is used to obtain TETRA DM services

NOTE: For synchronization purposes, Direct Mode Mobile Stations may have one of three roles:

- **master:** if the DM-MS is either active in a call transaction transmitting traffic or control data, or is reserving the channel by means of channel reservation signalling and hence is **providing** synchronization information to the channel;

- **slave:** if the DM-MS is receiving traffic and/or signalling in a call transaction and hence is **deriving** synchronization information from the channel;
- **idle:** if the DM-MS is not in a call transaction but may be **deriving** synchronization information from the channel in order to follow the state of the DM channel.

**Direct Mode Operation (DMO):** mode of simplex operation where mobile subscriber radio units may communicate using radio frequencies which may be monitored by, but which are outside the control of, the TETRA TMO network

NOTE: Direct Mode Operation is performed without intervention of any base station.

**Direct Mode REpeater (DM-REP):** device that operates in TETRA DMO and provides a repeater function to enable two or more DM-MSs to extend their coverage range

NOTE 1: It may be either a type 1 DM-REP, capable of supporting only a single call on the air interface, or a type 2 DM-REP [i.4], capable of supporting two calls on the air interface. A type 1 DM-REP may operate on either a single RF carrier (type 1A DM-REP) or a pair of duplex-spaced RF carriers (type 1B DM-REP). A type 2 DM-REP operates on a pair of duplex-spaced RF carriers.

NOTE 2: A repeater may have one of two roles:

- **active:** if the repeater is active in a call transaction receiving and transmitting traffic and/or signalling messages;
- **idle:** if the repeater is not in a call.

**Direct Mode REpeater/GATEway (DM-REP/GATE):** device that combines the functions of a DM repeater and a DM gateway in a single implementation and is capable of providing both functions simultaneously

NOTE: The repeater part of the combined implementation may be either a type 1A repeater, operating on a single DM RF carrier, or a type 1B repeater, operating on a pair of duplex-spaced DM RF carriers.

**DM channel:** specific grouping of timeslots in the DM multiplex structure related to a particular DM RF carrier (i.e. DM frequency)

NOTE: The grouping may not always be fixed, but in DMO when operating in frequency efficient mode as an example, there are two DM channels, identified by the letters A and B.

**DM device:** DM-MS, DM-REP, DM-GATE or DM-REP/GATE

**Dual mode switchable Mobile Station (DU-MS):** MS that is capable to operate in TETRA DMO or in TETRA TMO one mode at a time

NOTE: Only one mode can be selected at any given time and the MS is not capable of monitoring a DM RF carrier while in TMO or a TMO channel while in DMO.

**Dual Watch Mobile Station (DW-MS):** MS that is either full dual watch MS (F-DW-MS) or idle dual watch MS (I-DW-MS)

NOTE: When idle, the MS periodically monitors both the DM RF carrier and the TMO control channel. If the MS is performing full dual watch, it is also capable of periodically monitoring the TMO control channel while in a DM call and a DM RF carrier while in a TMO call. Alternatively the MS may perform idle dual watch, in which case it need not be capable of monitoring the TMO control channel while involved in a DM activity (e.g. call) or a DM RF carrier while involved in a TMO activity (e.g. call).

**frequency efficient mode:** mode of operation where two independent DM communications are supported on a single RF carrier

NOTE: In frequency efficient mode the two DM channels are identified as channel A and channel B.

**logical channel:** any distinct data path

NOTE: Logical channels are considered to operate between logical endpoints.

**Message Erasure Rate (MER):** ratio of the messages detected as wrong by the receiver to all messages received in a given logical channel

**normal mode:** mode of operation where only one DM communication is supported on an RF carrier

**occupation:** time where a call transaction is in progress on a channel

**pre-emption:** transfer of the master role to the requested DM-MS

NOTE: This process may occur within a call during occupation or to set-up a new call during either occupation or reservation.

**Probability of Undetected Erroneous Message (PUEM):** limit ratio of the erroneous messages detected as right by the receiver to all messages received in a given logical channel

**quarter symbol number:** timing of quarter symbol duration 125/9  $\mu$ s within a burst

**radio frequency carrier (RF carrier):** radio frequency channel

NOTE: This is a specified portion of the RF spectrum. In DMO, the RF carrier separation is 25 kHz.

**reservation:** time where a "channel reservation" signal is present on the channel

**simplex:** mode of working in which information can be transferred in both directions but not at the same time

**timebase:** device which determines the timing state of signals transmitted by a Direct Mode Mobile Station

**timeslot number:** counter indicating the timing of timeslots within a DMO frame

**Trunked Mode Operation (TMO):** mode of operation where MSs communicate via the TETRA V+D air interface which is controlled by the TETRA Switching and Management Infrastructure (SwMI)

NOTE: This is also called V+D operation. The abbreviation "TMO" is used in the present document to pair with the abbreviation "DMO" instead of the abbreviation "V+D". "TMO" abbreviation is not used in EN 300 392-1 [i.2] and EN 300 392-2 [2].

**useful part of a burst:** part of the burst between and including the symbol time of SN0 and the symbol time of Snmax, with SN0 and Snmax as defined in clause 9 of the present document

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## 3.2 Symbols

For the purposes of the present document, the following symbols apply:

Ud	Direct Mode air interface
Um	Trunked Mode air interface

## 3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AI	Air Interface
BER	Bit Error Ratio
BN	Bit Number
DLB	Direct mode Linearization Burst
DLL	Data Link Layer
DM-GATE	Direct Mode GATEway
DM-MS	Direct Mode Mobile Station
DMO	Direct Mode Operation
DM-REP	Direct Mode-REPeater
DM-REP/GATE	Direct Mode-REPeater/GATEway
DNB	Direct mode Normal Burst
DQPSK	Differential Quaternary Phase Shift Keying
DR50	DM propagation model Rural area for 50 km/h
DSB	Direct mode Synchronization Burst
DU50	DM propagation model Urban area for 50 km/h
DU-MS	Dual mode (TMO - DMO) switchable Mobile Station

DW-MS	Dual Watch Mobile Station
FN	Frame Number
LCH	Linearization Channel
MAC	Medium Access Control
MER	Message Erasure Rate
mod	modulo (base for counting)
MS	Mobile Station
MS-MS	Mobile Station to Mobile Station
OSI	Open Systems Interconnection
PA	Power Amplifier
PACQ	Probability of synchronization burst ACquisition
PDF	Probability Density Function
PDS	Power Density Spectrum
PUEM	Probability of Undetected Erroneous Message
QN	Quarter symbol Number
RCPC	Rate-Compatible Punctured Convolutional
RF	Radio Frequency
RMS	Root Mean Square
SCH	Signalling Channel
SN	Symbol Number
SSVE	Sum Square Vector Error
STCH	Stealing Channel
SwMI	Switching and Management Infrastructure
TCH	Traffic Channel
TMO	Trunked Mode Operation
TN	Timeslot Number
V+D	Voice plus Data

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## 4 Radio aspects

[SIST EN 300 396-2 V1.4.1:2012](#)

### 4.1 Introduction <https://standards.itech.ai/catalog/standards/sist/90e8c2dc-7e94-414f-9422-e25b6313af43/sist-en-300-396-2-v1-4-1-2012>

Clause 4 is an introduction to the radio aspects of the TETRA DMO standard. It consists of a general description of the organization of the radio-related functions with reference to the clauses where each part is specified in detail. Furthermore, it introduces the reference configuration that will be used throughout the present document.

### 4.2 Set of logical channels

The radio subsystem provides a certain number of logical channels as defined in clause 9. The logical channels represent the interface between the protocol and the radio.

### 4.3 Reference configuration

For the purpose of elaborating the specification of the radio-related functions, a reference configuration of the transmission chain is used, as shown in figure 1. Only the transmission part is specified, the receiver being specified only via the overall performance requirements. With reference to this configuration, the clauses address the following functional units:

- clause 5: differential encoding and modulation;
- clause 6: characteristics of transmitter and receiver;
- clause 8: coding, reordering and interleaving, and scrambling;
- clause 9: burst building and logical channel multiplexing;
- clause 10: radio link measurements.

This reference configuration also defines a number of points of vocabulary in relation to the names of bits at different levels in the configuration.

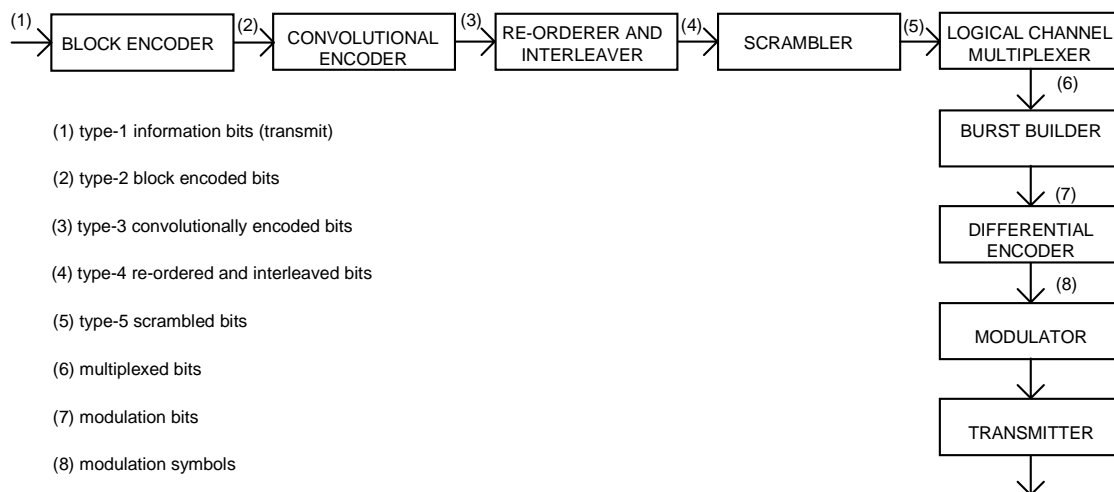


Figure 1: Reference configuration

## 4.4 Error control schemes

The different error control schemes are described in detail in clause 8.

## 4.5 Timeslot structure

The carrier separation is 25 kHz.

The basic radio resource is a timeslot lasting 14,167 ms (85/6 ms) and transmitting information at a modulation rate of 36 kbit/s. This means that the timeslot duration, including guard and ramping times, is 510 bit (255 symbol) durations.

The following clauses briefly introduce the structures of multiframes, frames, timeslots and bursts, as well as the mapping of the logical channels onto the physical channels. The appropriate specifications are found in clause 9.

### 4.5.1 Framing structure

A diagrammatic representation of the framing structure is shown in figure 2.

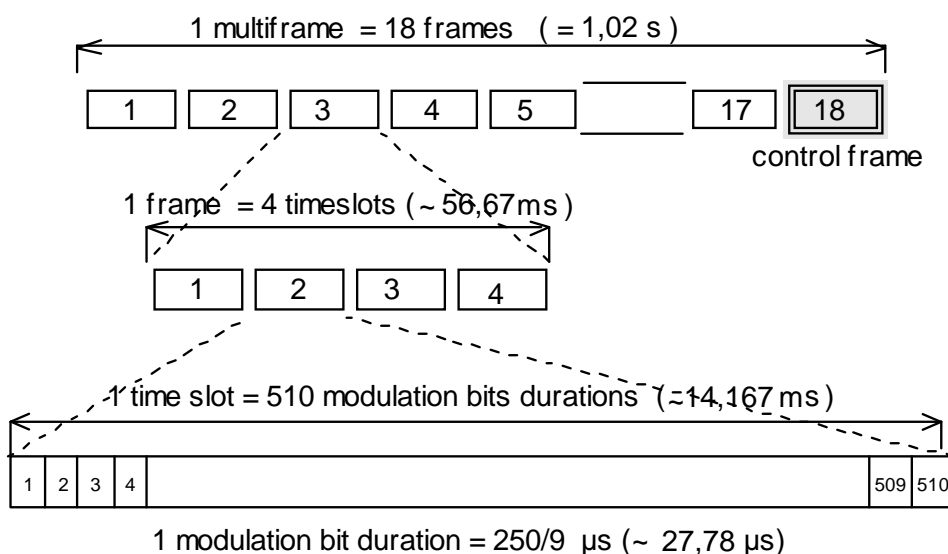


Figure 2: DM framing structure