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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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## Foreword

This European Telecommunication Standard (ETS) has been produced by the Terrestrial Trunked Radio (TETRA) Project of the European Telecommunications Standards Institute (ETSI).

This ETS is a multi-Part standard and will consist of the following parts:

Part 1: "General network design";

**Part 2: "Radio Aspects";**

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

Part 4: "Repeaters ", (DE/RES-06007-4);

Part 5: "Gateways", (DE/RES-06007-5);

Part 6: "Security", (DE/RES-06007-6);

Part 7: "Repeater type 2", (DE/TETRA-02007-7);

Part 8: "PICS proforma", (DE/TETRA-02007-8);

Part 9: "SDL model", (DE/TETRA-02007-9).

Transposition dates	
Date of adoption of this ETS:	6 March 1998
Date of latest announcement of this ETS (doa):	30 June 1998
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	31 December 1998
Date of withdrawal of any conflicting National Standard (dow):	31 December 1998

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## 1 Scope

This European Telecommunication Standard (ETS) defines the TERrestrial Trunked RAdio system (TETRA) Direct Mode Operation (DMO). It specifies the basic air interface, the inter-working between Direct Mode (DM) groups via repeaters, and inter-working 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.

This part applies to the TETRA DMO Mobile Station - Mobile Station (MS - MS) 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.

## 2 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

- [1] <https://standards.iteh.ai/catalog/standards/sist/27de4a04-707b-4a4a-a764-6b924ef78b8/sist-ets-300-396-2-1999> ETS 300 113: "Radio Equipment and Systems (RES); Land mobile service; Technical characteristics and test conditions for radio equipment intended for the transmission of data (and speech) and having an antenna connector".
- [2] ETS 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".
- [3] ETS 300 395-2: "Radio Equipment and Systems (RES); Trans-European Trunked Radio (TETRA); Speech codec for full-rate traffic channel; Part 2: TETRA codec".

## 3 Definitions and abbreviations

### 3.1 Definitions

For the purposes of this ETS, the following definitions apply:

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

**broadcast:** A unidirectional point to multipoint mode of transmission.

**call transaction:** All of the functions associated with a complete unidirectional transmission of information during a call. A call can be made up of one or more call transactions. In a simplex call these call transactions are sequential.

**Direct Mode (DM):** A 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 Trunked network. DM is performed without intervention of any base station.

**Direct Mode Mobile Station (DM-MS):** A physical grouping that contains all of the mobile equipment that is used to obtain TETRA DM services. By definition, a Mobile Station contains at least one Mobile Radio Stack (MRS). For synchronization purposes, Direct Mode Mobile Stations can have one of two status levels:

- **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 and hence is **deriving** synchronization information from the channel.

**logical channel:** A generic term for any distinct data path. Logical channels are considered to operate between logical endpoints.

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

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

**quarter symbol number:** The timing of quarter symbol duration  $125/9 \mu\text{s}$  within a burst.

**simplex:** A mode of single or dual frequency working in which information can be transferred in both directions but not at the same time.

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

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

**useful part of a burst:** The 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.

### 3.2 Abbreviations

For the purposes of this ETS, the following abbreviations apply:

AI	Air Interface
BER	Bit Error Ratio
BN	Bit Number
DLB	Direct mode Linearization Burst
DLL	Data Link Layer
DM-MS	Direct Mode Mobile Station
DMO	Direct Mode Operation
DNB	Direct mode Normal Burst
DQPSK	Differential Quaternary Shift Keying
DSB	Direct mode Synchronization Burst
FN	Frame Number
LCH	Linearization CHannel
MER	Message Erasure Rate
MN	Multiframe Number
mod	modulo (base for counting)
MS	Mobile Station
PACQ	Probability of synchronization burst ACQuisition
PUEM	Probability of Undetected Erroneous Message
QN	Quarter symbol Number
SCH	Signalling CHannel
SN	Symbol Number
STCH	STealing CHannel
TCH	Traffic CHannel
TDMA	Time Division Multiple Access

TEI	TETRA Equipment Identity
TN	Timeslot Number
V+D	Voice plus Data

## 4 Radio aspects

### 4.1 Introduction

This clause 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 this ETS.

### 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.

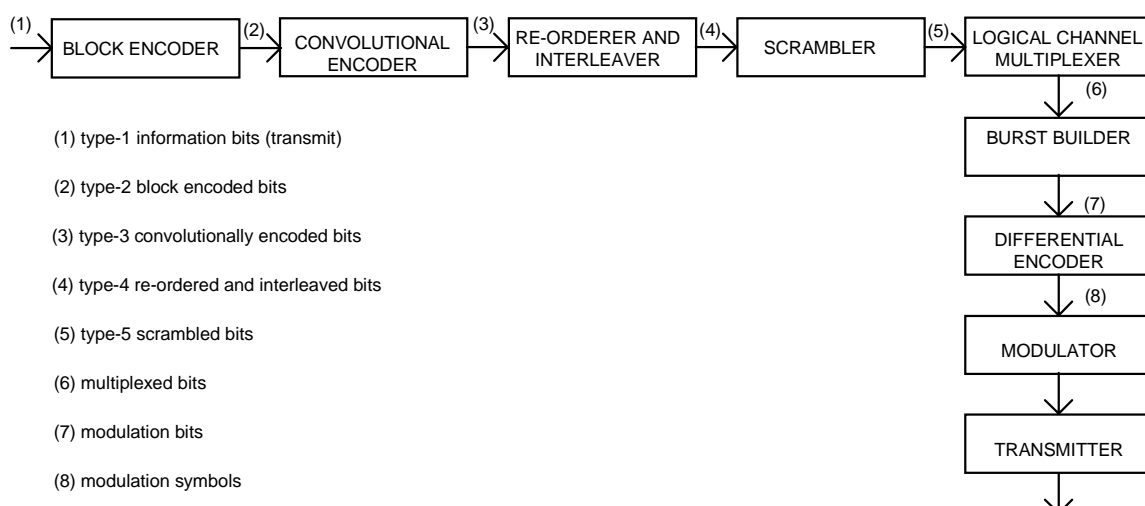


Figure 1: Reference configuration

### 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 subclauses briefly introduces 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.

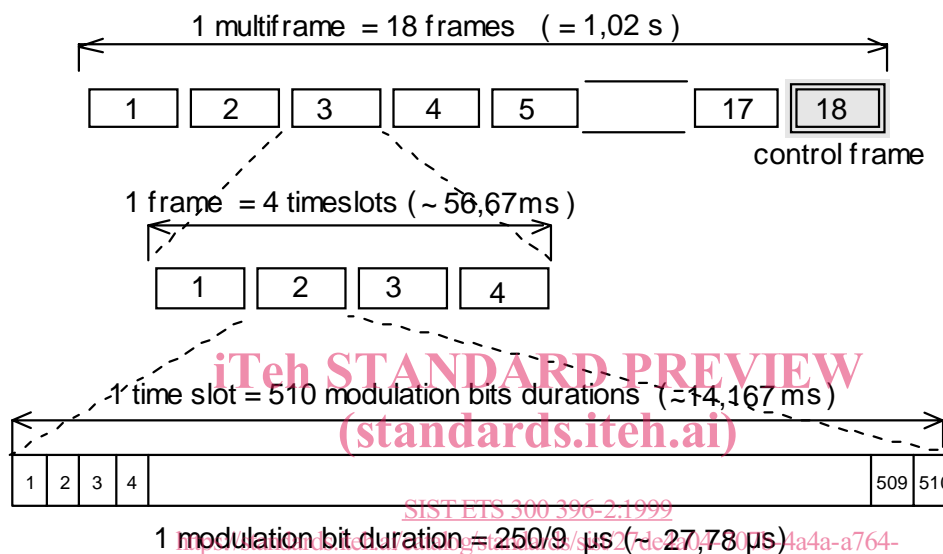


Figure 2: DM framing structure

One multiframe is subdivided into 18 frames, and has a duration of 1,02 s. The eighteenth frame in a multiframe is a control frame.

One frame is subdivided into 4 timeslots, and has a duration of  $170/3 \approx 56,67$  ms.

##### 4.5.2 Timeslots and bursts

The timeslot is a time interval of  $85/6 \approx 14,167$  ms, which corresponds to 255 symbol durations.

The physical contents of a timeslot is carried by a burst. There are three different types of bursts, as defined in clause 9.

##### 4.5.3 Mapping of logical channels onto physical channels

The mapping of the logical channels onto the physical channels, according to the mode of operation, is defined in clause 9.

#### 4.6 Coding, interleaving and scrambling

The coding, interleaving and scrambling schemes associated with each logical channel are specified in clause 8.

#### 4.7 Modulation

The modulation scheme is  $\pi/4$ -DQPSK (Differential Quaternary Phase-Shift Keying) with root-raised cosine modulation filter and a roll-off factor of 0,35. The modulation rate is 36 kbit/s. This scheme is specified in detail in clause 5.

#### 4.8 Transmission and reception

The modulated stream is transmitted on a radio frequency carrier.

The specific RF channels, together with the requirements on the transmitter and the receiver characteristics are specified in clause 6.

DM-MS power classes are defined in clause 6.

#### 4.9 Other radio-related functions

Transmission involves other functions. These functions, which may necessitate the handling of specific protocols, are the radio subsystem synchronization, and the radio subsystem link control.

The synchronization incorporates:

- frequency and time acquisition by the receiver;
- adjustment of the timebase in the DM-MS.

The requirements on synchronization are specified in clause 7.

#### 4.10 Performance

Under typical urban fading conditions the quality threshold for full-rate speech is reached at a  $C/I_c$  (co-channel interference) value of 19 dB, and the dynamic reference sensitivity level is -103 dBm for mobile equipment. Details of performance requirements in various channel conditions are given in clause 6.

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### 5 Modulation

#### 5.1 Introduction

The following specifications apply to the baseband part of the transmitter.

#### 5.2 Modulation type

The modulation used shall be  $\pi/4$ -shifted Differential Quaternary Phase Shift Keying ( $\pi/4$ -DQPSK).

#### 5.3 Modulation rate

The modulation rate shall be 36 kbit/s.

#### 5.4 Modulation symbol definition

$B(m)$  denotes the modulation bit of a sequence to be transmitted, where  $m$  is the bit number. The sequence of modulation bits shall be mapped onto a sequence of modulation symbols  $S(k)$ , where  $k$  is the corresponding symbol number.