



SLOVENSKI STANDARD
SIST EN 300 396-4 V1.2.1:2003

01-december-2003

Df]nYa b]gbc dc j b]fUX]c`fH9HF5ŁĚHY\ b] bY'nU\ H]j Y'nUbYdcgfYXb]`bU]b
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Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 4: Type 1 repeater air interface

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Ta slovenski standard je istoveten z: **EN 300 396-4 Version 1.2.1**

SIST EN 300 396-4 V1.2.1:2003
<https://standards.iteh.ai/catalog/standards/sist/547578d8-89a2-48ad-b83f-d0a5bbaf76be/sist-en-300-396-4-v1-2-1-2003>

ICS:

33.070.10	Prizemni snopovni radio (TETRA)	Terrestrial Trunked Radio (TETRA)
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SIST EN 300 396-4 V1.2.1:2003 **en**

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ETSI EN 300 396-4 V1.2.1 (2000-12)

European Standard (Telecommunications series)

Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 4: Type 1 repeater air interface

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Reference

DEN/TETRA-02007-4

Keywords

TETRA, radio, security

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Sous-Préfecture de Grasse (06) N° 7803/88

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Project Terrestrial Trunked Radio (TETRA).

The present document had been submitted to Public Enquiry as ETS 300 396-4. During the processing for Vote it was converted into an EN.

The present document is a multi-part deliverable 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: "Type 1 repeater air interface";

Part 5: "Gateway air interface";

Part 6: "Security";

Part 7: "Type 2 repeater air interface".

National transposition dates

Date of adoption of this EN:	8 December 2000
Date of latest announcement of this EN (doa):	31 March 2001
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	30 September 2001
Date of withdrawal of any conflicting National Standard (dow):	30 September 2001

1 Scope

The present document defines the Terrestrial Trunked Radio (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 Direct Mode Repeater (DM-REP) air interface and contains the specifications, where applicable, of the physical, data link and network layers according to the ISO model.

The specifications contained herein apply to a DM-REP as a stand-alone unit supporting a single call on the air interface (type 1 DM-REP). They also cover the operation of a Direct Mode Mobile Station (DM-MS) with a type 1 DM-REP.

NOTE 1: The specifications for a Direct Mode Repeater/Gateway (DM-REP/GATE) combined implementation are provided in ETS 300 396-5 [5], together with the specifications for a Direct Mode Gateway (DM-GATE).

NOTE 2: The specifications for a DM-REP as a stand-alone unit supporting two calls on the air interface (type 2 DM-REP) are provided in EN 300 396-7 [7].

The protocol for a DM-MS operating with a type 1 DM-REP is specified in clauses 5 through 8, 10 and 11. Much of this protocol is defined in the form of a "delta document" relative to the specifications provided in ETS 300 396-2 [2] and ETS 300 396-3 [3] for direct MS-MS operation. These clauses define where the protocol in parts 2 and 3 applies without change, or where it applies with the specified amendments, replacements or additions. Where no reference to parts 2 or 3 exists, the subclause should be regarded as independent.

The protocol for the DM-REP is specified in clauses 9 and 12.

The normative annex mainly specifies the parameter values used in the protocol.

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2 References

SIST EN 300 396-4 V1.2.1:2003

<https://standards.iteh.ai/catalog/standards/sist/547578d8-89a2-48ad-b83f-40a5bbaf76be/sist-en-300-396-4-v1-2-1-2003>

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

- [1] ETSI ETS 300 396-1: "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 1: General network design".
- [2] ETSI ETS 300 396-2: "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 2: Radio aspects".
- [3] ETSI ETS 300 396-3 (1998): "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] ETSI EN 300 392-2: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 2: Air Interface (AI)".
- [5] ETSI ETS 300 396-5: "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 5: Gateway air interface".
- [6] ETSI ETS 300 396-6: "Terrestrial Trunked Radio (TETRA); Direct Mode Operation (DMO); Part 6: Security".

- [7] ETSI EN 300 396-7: "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 7: Type 2 repeater air interface".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

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

call: there are two types of call, individual call or group call. An individual call is a complete sequence of related call transactions between two DM-MSs. There are always two participants in an individual call. A group call is a complete sequence of related call transactions involving two or more DM-MSs. The number of participants in a group call is not fixed, but is at least two. Participants may join (late entry) and leave an ongoing group call

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

called user application: user application which receives an incoming call

calling user application: user application which initiates an outgoing call

changeover: within a call, the 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 (DM): 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 V+D network. DM is performed without intervention of any base station

Direct Mode Call Control (DMCC): layer 3 entity responsible for setting up and maintaining a call in DMO

DM channel: specific grouping of timeslots in the DM multiplex structure related to a particular DM RF carrier i.e. DM frequency (or to a pair of duplex-spaced RF carriers for operation with a type 1B or type 2 DM-REP or a type 1B DM-REP/GATE). 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

Direct Mode Mobile Station (DM-MS): physical grouping that contains all of the mobile equipment that is used to obtain TETRA DM services. A DM-MS 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;
- **slave:** if the DM-MS is receiving traffic and/or signalling in a call; or
- **idle:** if the DM-MS is not in a call

DM-REP presence signal: message transmitted by a DM-REP in order to indicate its presence on an RF carrier

Dual Watch Mobile Station (DW-MS): MS that is capable of both TETRA DMO and TETRA V+D operation. The MS is capable of periodically monitoring the V+D control channel while in a DM call, a DM RF carrier while in a V+D call and, when idle, it periodically monitors both the DM RF carrier and the V+D control channel

Direct Mode gateway: device that provides gateway connectivity between DM-MS(s) and the TETRA V+D network. The gateway provides the interface between TETRA DMO and TETRA V+D mode. 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)

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. 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, 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

frame number: counter indicating the timing of frames within a DMO multiframe

frequency efficient mode: mode of operation where two independent DM communications are supported on a single RF carrier (or pair of duplex-spaced RF carriers for operation with a type 2 DM-REP). In frequency efficient mode the two DM channels are identified as channel A and channel B

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

master link: communication link used for transmissions between master DM-MS and DM-REP

Medium Access Control (MAC) block: unit of information transferred between the upper MAC and lower MAC for a particular logical channel (e.g. SCH/F or STCH). The lower MAC performs channel coding for insertion into the appropriate physical slot or half slot

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 (or pair of duplex-spaced RF carriers for operation with a type 1B DM-REP or type 1B DM-REP/GATE)

presence signal: message transmitted by a DM-REP or a gateway in order to indicate its presence on an RF carrier

quarter symbol number: timing of quarter symbol duration 125/9 μ s within a burst

recent user: DM-MS that was master of the call transaction immediately prior to the current master's call transaction in a call

recent user priority: service which gives the recent user a preferred access to request transmission when the current master is ceasing its call transaction in a group call. This service is controlled by the current master

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

slave link: communication link used for transmissions between the DM-REP and slave or idle DM-MSs

surveillance: process of determining the current state of the DM RF carrier when in idle mode

timebase: device which determines the timing state of signals transmitted by a DM-MS

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

type 1 call: call using the protocol defined in the present document. There are two varieties of type 1 call:

- **type 1A call:** which is a call through a type 1A DM-REP;
- **type 1B call:** which is a call using the protocol for operation with a type 1B DM-REP.

A DM-MS may make a type 1B call through a type 1B DM-REP. It may also make a type 1B call through a type 2 DM-REP if permitted by the DM-REP.

type 1 DM-REP: DM repeater that supports a single call on the air interface. There are two varieties of type 1 DM-REP:

- **type 1A DM-REP:** which operates on a single RF carrier;
- **type 1B DM-REP:** which operates on a pair of duplex-spaced RF carriers, one used as the "uplink" from DM-MSs to the DM-REP and the other used as the "downlink" from the DM-REP to DM-MSs.

The protocol for operation with a type 1 DM-REP (either a type 1A or a type 1B DM-REP) is based on the protocol for normal mode in ETS 300 396-3 [3]

type 2 call: call using the protocol defined in EN 300 396-7 [7]. A DM-MS may make a type 2 call only through a type 2 DM-REP

type 2 DM-REP: DM repeater that is capable of supporting two simultaneous type 2 calls on the air interface. A type 2 DM-REP operates on a pair of duplex-spaced RF carriers, one used as the "uplink" from DM-MSs to the DM-REP and the other used as the "downlink" from the DM-REP to DM-MSs. The protocol for type 2 calls through a type 2 DM-REP is based on the protocol for frequency efficient mode in ETS 300 396-3 [3]. (A type 2 DM-REP may also optionally offer type 1B calls using the protocol defined in the present document)

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

3.2 Abbreviations

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

BER	Bit Error Ratio
BN	Bit Number
CRC	Cyclic Redundancy Check
DCC	Direct Mode Colour Code
DLB	Direct Mode Linearization Burst
DLL	Data Link Layer
DM	Direct Mode
DM-GATE	Direct Mode Gateway
DM-MS	Direct Mode Mobile Station
DM-REP	Direct Mode Repeater
DM-REP/GATE	Direct Mode Repeater/Gateway
DM-SDU	SDU from layer 3
DMCC	Direct Mode Call Control entity
DMO	Direct Mode Operation
DNB	Direct Mode Normal Burst
DO-MS	Direct Mode Only Mobile Station
DSB	Direct Mode Synchronization Burst
DU-MS	Dual Mode (V+D / Direct Mode) switchable Mobile Station
DW-MS	Dual Watch Mobile Station
FCS	Frame Check Sequence
FN	Frame Number
GSSI	Group Short Subscriber Identity
GTSI	Group TETRA Subscriber Identity
ISSI	Individual Short Subscriber Identity
ITSI	Individual TETRA Subscriber Identity
LCH	Linearization Channel
MAC	Medium Access Control
MCC	Mobile Country Code
MER	Message Erasure Rate
MNC	Mobile Network Code
MNI	Mobile Network Identity
mod	modulo (base for counting)
MS	Mobile Station
PACQ	Probability of synchronization burst acquisition
PDU	Protocol Data Unit
PL	Physical Layer
PUEM	Probability of Undetected Erroneous Message
QN	Quarter Symbol Number
RDC	Radio Downlink Counter
RF	Radio Frequency
RSSI	Radio Signal Strength Indication
SAP	Service Access Point
SCH	Signalling Channel
SCK	Static Cipher Key
SDS	Short Data Service